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Appendix D-1
Ecosystems and Vegetation Effects Assessment

Author: **Rescan Environmental Services Ltd.**
Date: **November 2007**

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Ecosystems and Vegetation Effects Assessment

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GLOSSARY, ACRONYMS AND ABBREVIATIONS

Glossary, Acronyms and Abbreviations

Glossary

ecosystem (terrestrial) As stated in RIC (1998): *A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred. For the purposes of Terrestrial Ecosystem Mapping (TEM), an ecosystem is characterized by a 'plant community' (a volume of relatively uniform vegetation) and the 'soil polypedon' (a volume of relatively uniform soil) upon which the plant community occurs (Pojar et al., 1987). Definition is taken directly from the TEM standards.* For the Bathurst Inlet Port and Road Project, the term "ecosystem" is sometimes used interchangeably with the terms "map unit", "plant community" or "plant association."

map unit A mapped ecosystem.

plant association Subgroups of plant communities, such as the "Non-tussock sedge association" as a subgroup of the "Sedge community", most of which are too small or indistinguishable to be mapped. This term is sometimes used interchangeably with the term "ecosystem."

plant community An assemblage of plants occurring in areas of equivalent environmental conditions. Plant communities are characterized by certain species which are inconspicuous or unrepresented in other communities (RIC, 1998). For the Project, most plant communities could be mapped. This term is sometimes used interchangeably with the term "ecosystem" and "map unit."

unsupervised classification Digital image classification technique that does not make use of training data, rather involves the use of algorithms that examine the unknown pixels in an image and aggregate them into a number of classes based on the natural groupings or clusters present in the image values; works on the premise that values within a given cover type should be close together in the measurement space, whereas data in different classes should be comparatively well separated (Lillesand *et al.*, 2004)

Acronyms and Abbreviations

BIPR Bathurst Inlet Port and Road

COSEWIC Committee on the Status of Endangered Wildlife in Canada

DEIS Draft Environmental Impact Statement

Geowest Geowest Environmental Consultants Ltd.

IPMP Invasive Plants Management Plan

KPI key performance indicators

LSA local study area

Glossary, Acronyms and Abbreviations

NRCan	Natural Resources Canada
the Project	the Bathurst Inlet Port and Road Project
the proponent	Bathurst Inlet Port and Road Project Joint Venture Ltd.
Rescan	Rescan Environmental Services Ltd.
RIC	Resources Inventory Committee
RSA	regional study area
SARA	*Species at Risk Act*
TEM	terrestrial ecosystem mapping
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
VEC	valued ecosystem component
VMP	Vegetation Management Plan
WKSS	West Kitikmeot/Slave Study

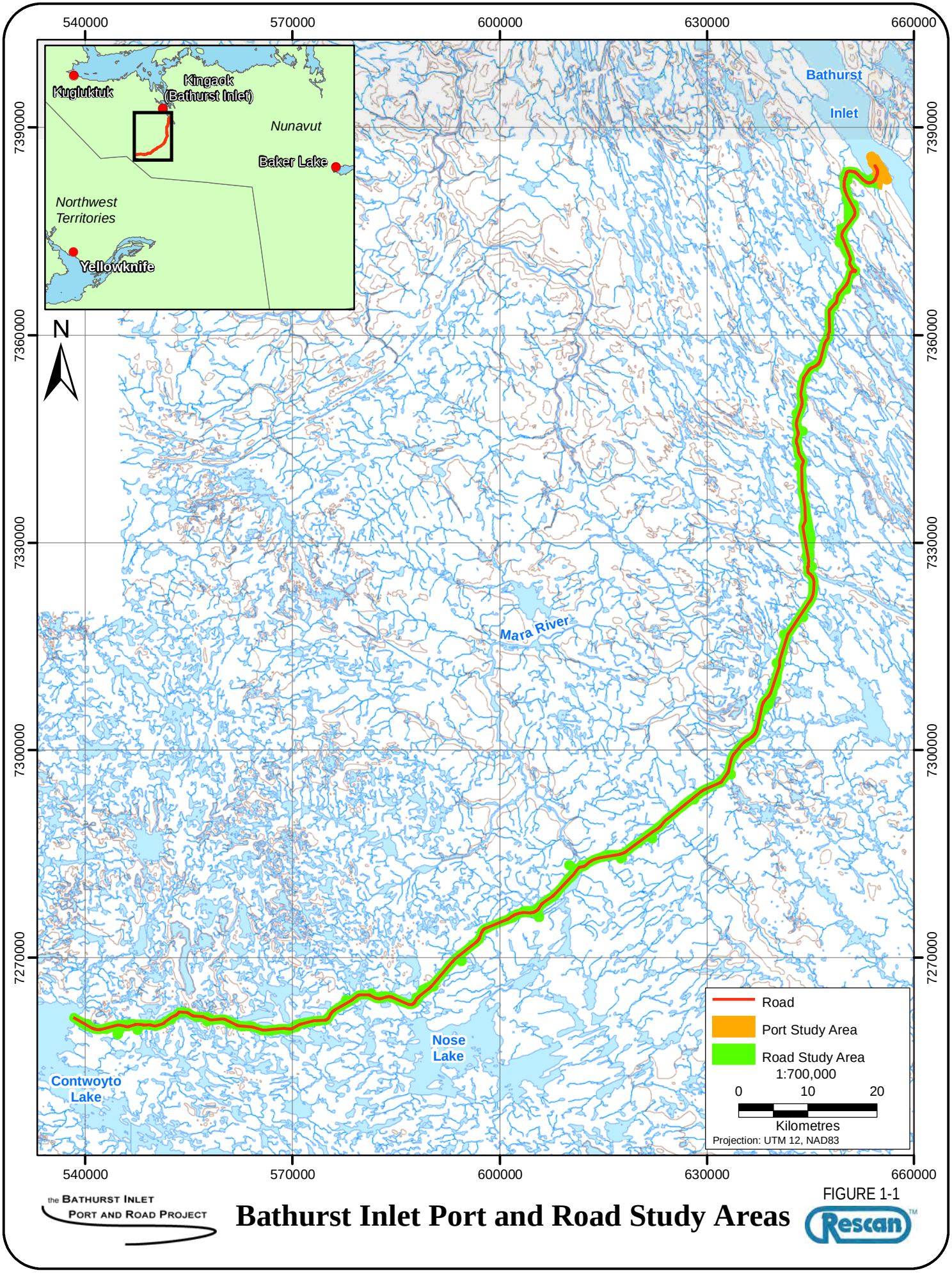
1. INTRODUCTION

1. Introduction

The Bathurst Inlet Port and Road (BIPR) Project (the Project) proposes the construction of a marine port on Bathurst Inlet in Nunavut, and a 211 km all-weather road between the port site and Contwoyto Lake (Figure 1-1). The Project is located south of Coronation Gulf in Nunavut and north of Lac de Gras in the Northwest Territories and is fully within the West Kitikmeot Planning Region.

Vegetation baseline studies were conducted by Geowest Environmental Consultants Ltd. (Geowest) in 2001 to characterize the plant communities and species (including common and rare plants) present in areas where new development is planned. Field surveys were completed and an ecosystem map was developed for the study area. The full baseline report is provided in Appendix D-4 of the Draft Environmental Impact Statement (DEIS).

This document outlines the baseline vegetation information collected to date and presents the potential effects of the Project on ecosystems and vegetation within the study area. The document also presents options for mitigation, management, and monitoring during construction, operations and maintenance, decommissioning, and closure.



the Bathurst Inlet Port and Road Project

FIGURE 1-1

Bathurst Inlet Port and Road Study Areas

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2. ENVIRONMENTAL SETTING

2. Environmental Setting

Information describing the terrestrial ecosystems and vegetation of the Project area was compiled from a combination of ecosystem mapping and field surveys. Descriptions of general landscape features, ecosystems, and plant species (including rare plants, plants of ecological significance, and invasive species) of the Project area are provided in this section.

2.1 Methodology Overview

2.1.1 Ecosystem Mapping

Ecosystem mapping is an effective way of stratifying the landscape into meaningful ecological units using a combination of attributes, such as climate, topography, soil, and vegetation (RIC, 1998). The result provides a landscape-level overview of the ecology of the area. For the Project, mapping served to identify trends in ecosystem distribution at both a regional and local level.

2.1.1.1 Regional Study Area

Ecosystem mapping using Landsat satellite imagery and digital image classification techniques was carried out in 2007 in an effort to characterize a larger regional study area (RSA) that would also contribute to the assessment of wildlife habitat. Mapping developed for the West Kitikmeot/Slave Study (WKSS) region (Matthews *et al.*, 2001) was available; however, a number of inconsistencies were identified in the area of interest that rendered the data suspect (*e.g.*, many larger waterbodies had been classified as wetlands and a large portion of information was missing at the port site).

Consequently, an area 60 km wide (30 km to either side of the road centreline) was mapped using Landsat 7 satellite imagery from August, 2000 that was obtained free of charge through GeoGratis (http://geogratis.cgdi.gc.ca/geogratis/en/index.html). The image selected was a 742 false colour composite with a pixel size of 14.25 m. This band combination is commonly used for geological applications and works well in arid areas (Quinn, 2001). It provides a clear land-water interface and allows for identification of different vegetation types. Vegetated areas appear as various shades of green while un-vegetated areas generally appear as shades of pink-magenta.

An unsupervised classification was run using the ISODATA algorithm and software from PCI Geomatics (Geomatica Focus). In an unsupervised classification, the computer examines the spectral value of each pixel and forms groups according to their similarity (Lillesand *et al.*, 2004). The resulting groups are statistically separate from one another and can be further refined by the analyst (either split into smaller or merged into larger groups). The resulting classes were grouped into map units to provide sufficient information regarding the distribution and extent of ecosystems present in the area. The RSA is shown in Figure 2.1-1.

2.1.1.2 Local Study Area

The local study area (LSA) was delineated within an area approximately 1 km wide surrounding the proposed road and associated facilities (roughly 500 m to either side of the road centreline).

Ecosystem mapping of this area generally followed the standards and guidelines established for Terrestrial Ecosystem Mapping (TEM) in British Columbia (RIC, 1998). Deviations from this approach were made in order to accommodate the treeless nature of the northern landscape and the differing climatic regime of the central Arctic. Polygons were identified on aerial photographs with a scale of 1:15,000. Full details of the mapping methodology are provided in Appendix D-4 of the DEIS. Changes to portions of the road centreline and facilities resulted in a few areas being unmapped within the LSA. Mapping developed for the RSA was used in these areas. The extent of the LSA is shown in Figure 2.1-1.

2.1.2 Rare Plants

Several older publications exist that identify rare vascular plants in the Canadian Arctic and Northwest Territories (McJannet *et al.*, 1993; McJannet *et al.*, 1995). Additionally, plants that are currently tracked federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) or the *Species at Risk Act* (SARA) were also considered. These sources were used to identify both candidate species that may occur in the study area, as well as the type of habitat that may support these species. During the conduct of the field surveys, crews were constantly watching for any plants that were potentially "rare" or "at risk."

2.1.3 Field Surveys

Field surveys provide a site-level evaluation of the ecosystems, plant species (including rare plants and invasive species), terrain, and soil characteristics present throughout the Project area. Surveys were carried out during the summer of 2001 (late July to early August) and involved the assessment of plots located at various intervals along the proposed road. Plot dimensions were generally 10 m by 10 m or as close to 100 m^2 as possible. Further details of the field survey methodology are presented in Appendix D-4 of the DEIS.

2.1.4 Integration of Landscape-level (Map) and Site-specific Information

Two levels of ecosystem classification were developed for the Project: mapped units and descriptive units. Mapped units are larger, landscape-level entities that are generally identifiable on aerial photographs and satellite images. They tend to correspond well with terrain features and are largely represented by plant communities.

Descriptive units usually result from field surveys, where the level of detail available to characterize ecosystems is substantially greater compared to that of air photo or satellite image interpretation. The spatial extent of descriptive units tends to be much more restricted, making them more difficult to map. Descriptive units often reflect plant associations. The entities (plant communities, plant associations, map units, and ecosystems) discussed throughout the report represent the integration of landscape-level (map) and site-specific (descriptive) information.

The linkage between plant communities, plant associations, and the map units that best describe them is presented in Table 2.1-1. Submergent communities, moss communities, and snowbank communities are the only entities not identified on either of the maps. These communities were only characterized in the field.

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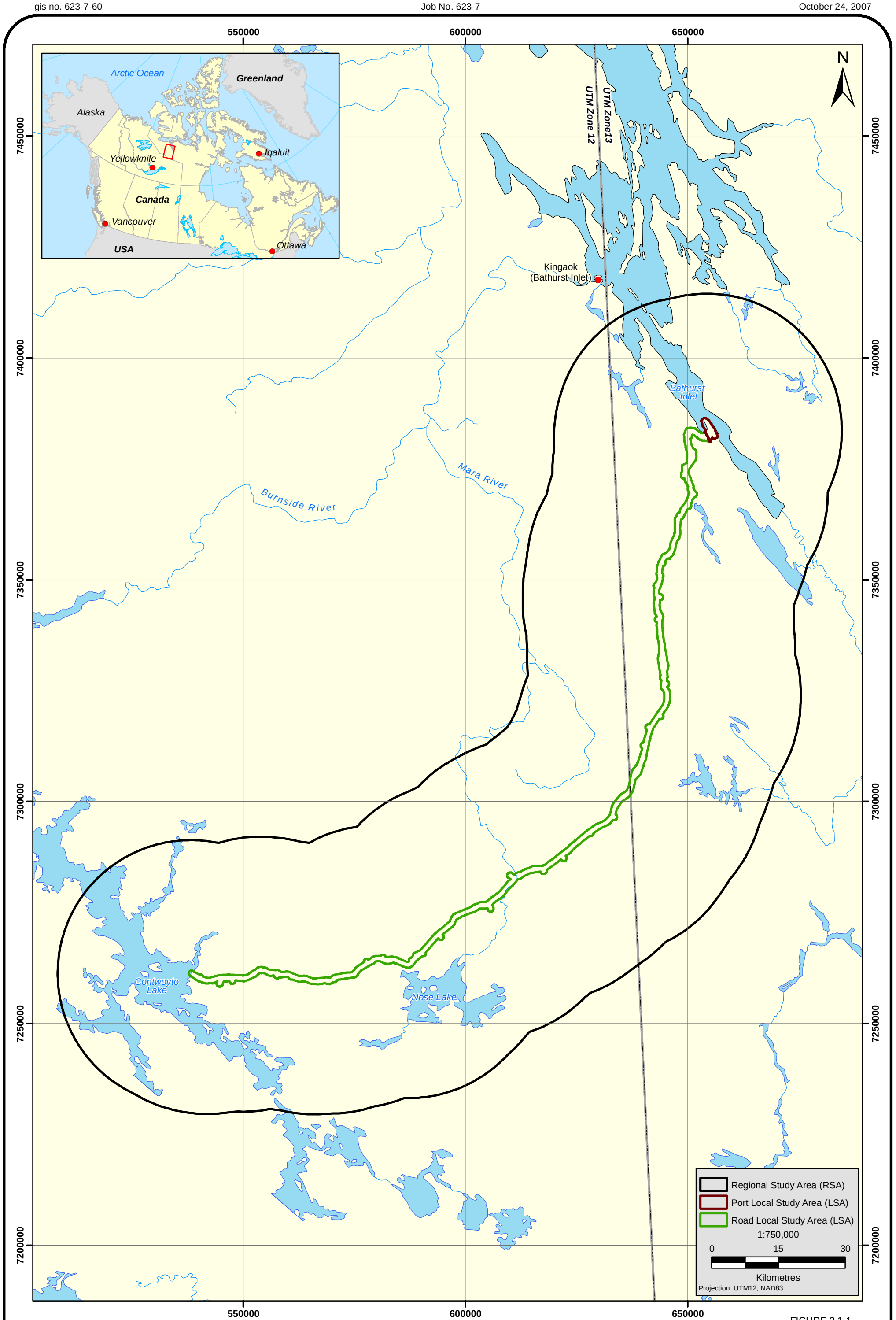

the Bathurst Inlet Port and Road Project

FIGURE 2.1-1

Ecosystem and Vegetation Study Area Boundaries

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Table 2.1-1
Plant Communities, Plant Associations, and Corresponding Map Units Identified in the Study Areas

Plant Community	Plant Association	Regional Study Area Map Unit (Satellite-based)	Local Study Area Map Unit (Polygon-based)
Submergent		-	-
Sedge		SE	SE
	Emergent sedge		
	Non-tussock sedge		
	Tussock sedge		
Moss		-	-
	Moss shore		
	Mossy cliff base		
Riparian Shrub		RS	RS
	Birch riparian		
	Willow riparian		
	Heath riparian		
	Alder/willow riparian		
Birch Shrub/"Seep"		BS	BS
Heath Tundra		HT	HT
	Upland heath tundra		
	Heath tundra on frost scars		
	Heath tundra on solifluction slopes		
	Heath tundra, hummocks/tussocks		
	Lichen-heath	LV	
	Lowland Arctic coast heath tundra		
Esker Complex		EC	EC
	Esker crest		
	Esker slopes		
	Pond margins in eskers		
Avens			AC
Saxifrage-Blueberry			SA
Snowbank		-	-
Lichen-Rock			LR
	Boulders in heath tundra		
	Boulder field/felsenmeer	BF	BF
	Bedrock	RO	RO
	Polished bedrock outcrops		
	Fractured bedrock ledges		
	Cliff faces		
Disturbed Sites		UN	DF, ES
	Animal dens		
	Nesting islands		
	Solifluction lobes		

(continued)

Table 2.1-1
Plant Communities, Plant Associations and Corresponding Map Units Identified in the Study Areas (completed)

Plant Community	Plant Association	Regional Study Area Map Unit (Satellite-based)	Local Study Area Map Unit (Polygon-based)
	Trails		
	Arctic roads		
	Camps		
Marine (Littoral)			
	Sandy beaches		BE
	Gravel beaches		GB
	Rocky points		
	Estuaries		
Water Features		WA	
	Lake		LA
	Ocean		OC
	Open water		OW
	Pond		PD
	Permanent snow		PS
	River		RI

2.1.5 Plant Tissue Chemistry

In July 2007, plant tissue samples of sedge (*Carex* sp.), cottongrass (*Eriophorum* sp.), and willow (*Salix* sp.) were collected from various locations along the road and at the port facility to establish baseline metals concentrations. Metal concentrations will be used for future monitoring during the operations and closure and reclamation phases. Future metal levels in plant tissue will be compared to baseline values in order to determine if changes in metal levels are occurring. Noticeable changes in metal levels over time could be further analyzed using a risk assessment approach to determine the potential exposure risks to wildlife that may be using the plants of the area as a food source.

The above-ground portion of herbaceous plants and newer/younger growth of woody species (shrubs) were collected. Approximately 250 g of material was collected and consisted of several individual herbs of the same species or the stems and leaves of shrubs of the same species.

While lichens are well known for their use as indicators of air pollution, they were not selected for chemical analysis. In order to be incorporated into a meaningful long-term monitoring program (for the Project, this would be a minimum of 50 years), the same lichen species would need to occur at fairly regular intervals within the study area footprint, and in sufficient quantities to withstand regular (*e.g.*, every three years) destructive sampling. Given the slow growth rates of Arctic lichen species and their rather limited distribution within the study area, the decision was made not to collect them until further determination could be made regarding their resilience to such a program.

Plant samples were collected by hand. Care was taken to ensure hands were clean during sampling and that any dirt and root material was removed prior to placement into labeled plastic bags. Samples were kept frozen prior to shipment to ALS Environmental in Vancouver, British Columbia, for analysis. The variables analyzed and their associated detection limits are included in Table 2.1-2. Results are presented as both wet and dry weight. Dry weight displays the metal levels present in plant tissue irrespective of moisture status, while wet weight better reflects *in situ* conditions and provides an approximation of the conditions under which consumers (*e.g.*, wildlife) may naturally encounter and ingest these plants. Further detail is provided in Appendix D-11 of the DEIS.

Table 2.1-2
Plant Tissue Chemistry Variables and Detection Limits

Metal	Wet Weight Detection Limit (mg/kg Wwt)	Dry Weight Detection Limit (mg/kg)
Percent Moisture	0.1	0.1
Aluminum (Al)	2	10
Antimony (Sb)	0.01	0.05
Arsenic (As)	0.01	0.05
Barium (Ba)	0.01	0.05
Beryllium (Be)	0.1	0.3
Bismuth (Bi)	0.03	0.3
Cadmium (Cd)	0.005	0.03
Calcium (Ca)	2	10
Chromium (Cr)	0.1	0.5
Cobalt (Co)	0.02	0.1
Copper (Cu)	0.01	0.05
Iron (Fe)	0.2	1
Lead (Pb)	0.02	0.1
Lithium (Li)	0.1	0.5
Magnesium (Mg)	1	3
Manganese (Mn)	0.01	0.05
Mercury (Hg)	0.001	0.005
Molybdenum (Mo)	0.01	0.05
Nickel (Ni)	0.1	0.5
Phosphorus (P)	5	20
Potassium (K)	20	100
Selenium (Se)	0.2	1
Sodium (Na)	20	100
Strontium (Sr)	0.01	0.05
Thallium (Tl)	0.01	0.03
Tin (Sn)	0.05	0.2
Titanium (Ti)	0.1	0.5
Uranium (U)	0.002	0.01
Vanadium (V)	0.1	0.5
Zinc (Zn)	0.1	0.5

2.2 Regional Overview

Efforts to place Canada's ecosystem diversity into a North American and global context have been made through the delineation of ecozones and ecoregions (NRCan, 2007). An ecozone represents an area containing a particular set of climatic features, landforms, plants, wildlife, and human activities. Ecozones can be subdivided into smaller units known as ecoregions, which are also characterized by distinctive landforms, macro- or mesoclimates, vegetation, soils, water, and human use.

The study area is located completely within the Southern Arctic Terrestrial Ecozone, one of three Arctic ecozones defined in Nunavut (Figure 2.2-1). This ecozone supports the highest diversity of species (both plant and wildlife) and has the most extensive vegetative cover. The climate is characterized as cold, dry Arctic. Summers tend to be short and cool while winters are long and very cold.

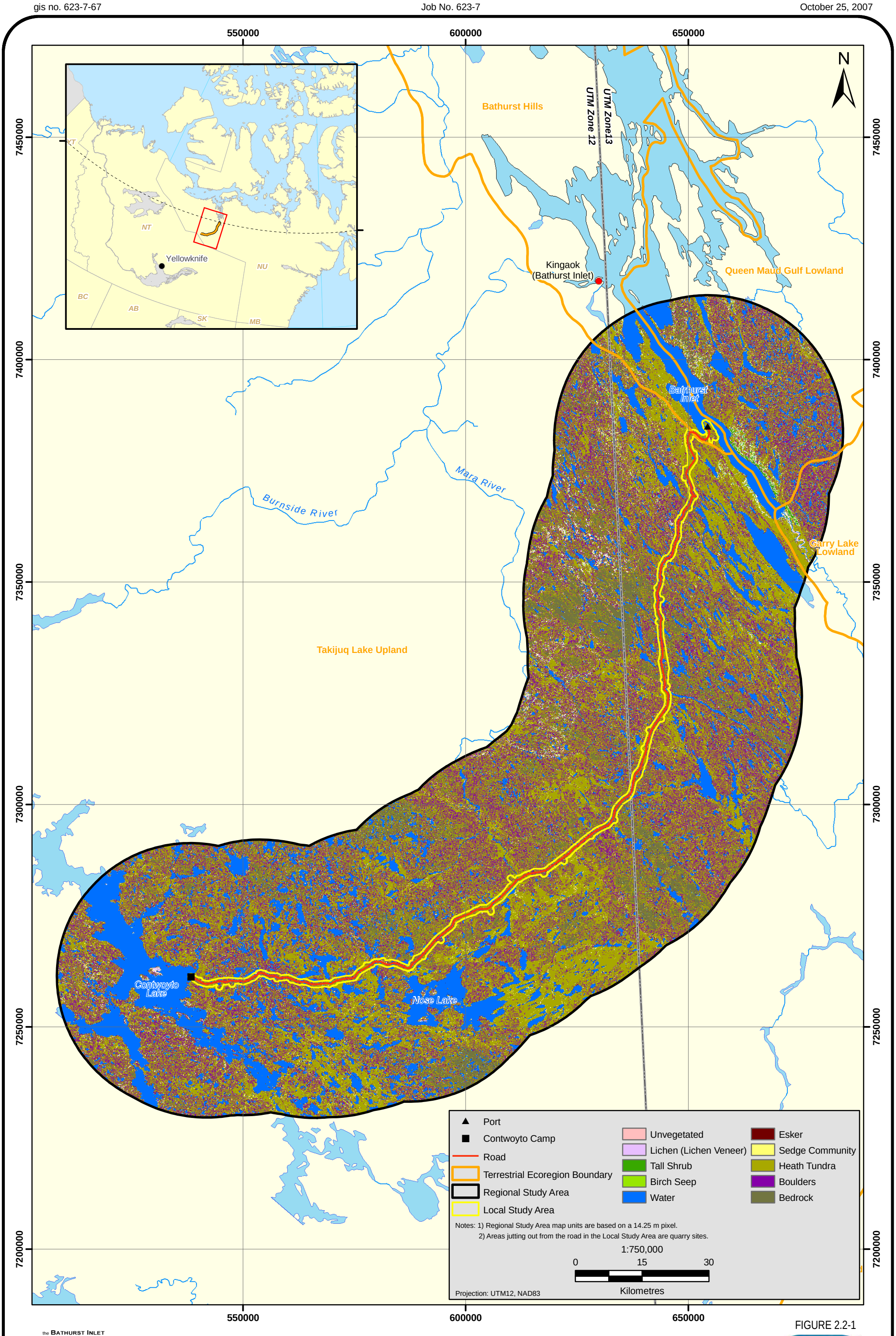
The physiography of the area is represented by flat plains and broadly rolling uplands. Bedrock outcrops are a common feature across the landscape. The area is known floristically as the "low Arctic." Vegetation is dominated by dwarf birch (*Betula nana*), willow (*Salix sp.*), heath species, and lichen, with sedge-moss wetlands occupying low-lying areas. Major river valleys can support scattered clumps of stunted spruce (*Picea sp.*) trees.

The Project RSA is situated within four terrestrial ecoregions: Bathurst Hills, Queen Maud Gulf Lowland, Garry Lake Lowland, and Takijuq Lake Upland. The majority of the RSA is within the Takijuq Lake Upland ecoregion. The remaining three cover only a small portion of the RSA at the northern-most end (Figure 2.2-1).

The Project LSA is situated within two terrestrial ecoregions. The Bathurst Hills ecoregion encompasses the Bathurst Inlet Port area and approximately the first 12 km of the road. The Takijuq Lake Upland ecoregion includes the remaining portions of the road south of Bathurst Inlet.

The RSA identified for the terrestrial ecosystems and vegetation portion of the Project is the same area used to assess wildlife habitat suitability. The area covers over 1.5 million hectares and is based on a 60 km wide corridor centred on the proposed road (Figure 2.2-1).

Ten map units were identified in the RSA and included both vegetated plant communities and un-vegetated features. The dominant plant community is heath tundra (Table 2.2-1, Plate 2.2-1). Other features commonly occurring across the landscape include water (predominantly as lakes), boulder fields, and bedrock outcroppings (Plate 2.2-2).



the Bathurst Inlet Port and Road Project

FIGURE 2.2-1

Ecology of the Regional Study Area

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Table 2.2-1
Distribution of Map Units within the Regional Study Area

Map Unit Name (Plant Community/Association)	Map Unit Code	Area (ha)	Proportion of Study Area (%)	Wetland
Heath tundra	HT	738,315	49	
Water	WA	332,442	22	
Boulder field	BF	191,720	13	
Bedrock	RO	173,779	12	
Sedge	SE	50,195	3	√
Lichen veneer*	LV	6,018	0.4	
Riparian tall shrub*	RS	5,982	0.4	
Esker	EC	2,328	0.2	
Birch seep*	BS	455	<0.1	
Un-vegetated	UN	450	<0.1	
Total		**1,501,684**	**100**	

***Data is from the WKSS region vegetation classification project (Matthews *et al*., 2001).**

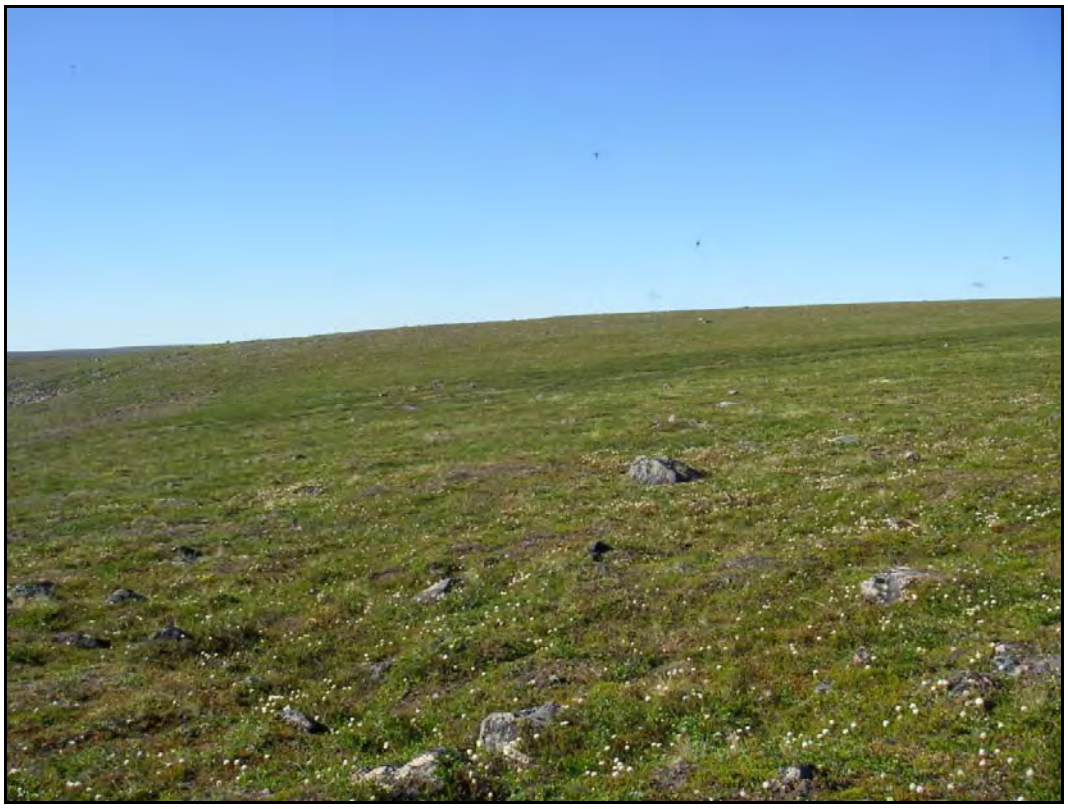

Plate 2.2-1. Heath tundra.

Plate 2.2-2. Boulder field (foreground) and bedrock outcroppings (background).

2.3 Local Overview

2.3.1 Port Site

The Project LSA covers approximately 972 ha (Table 2.3-1). A total of 31 field plots were surveyed at the port, largely in birch-dominated plant communities. The vegetation at the coast is rich and diverse compared to more inland areas. This is likely due to the low elevation, richer soils, and more protected local climate. Some halophytic (adapted to high salt conditions) plant species were documented in the area, along with marine communities, and a series of bird nesting islands that were not present inland (Appendix D-4 of the DEIS).

Twelve map units were identified within the LSA (Table 2.3-1). The dominant map unit is the heath tundra community (54%), followed by "ocean" (21%), and the birch seep community (8%). More detailed descriptions of these communities are provided in Appendix D-4 of the DEIS.

2.3.1.1 Rare and Sensitive Ecosystems

No rare or sensitive ecosystems were identified within the port study area; they are all commonly distributed throughout the Arctic coast wherever the terrain is suitable. In general, all tundra vegetation is sensitive to disturbance, and it can take years, and sometimes decades, to recover.

Table 2.3-1
Distribution of Map Units within the Port Study Area

Map Unit Name (Plant Community/Association)	Map Unit Code	Area (ha)	Proportion of Study Area (%)	Wetland
Heath tundra	HT	525	54	
Ocean	OC	206	21	
Birch seep	BS	75	8	
Sedge	SE	41	4	√
Avens	AC	36	4	
Bedrock	RO	34	3	
Lake	LA	17	2	
Exposed soil	ES	14	1	
Lichen-rock	LR	10	1	
Open water	OW	5	1	√
Beach materials	BE	4	0.4	
Boulder field	BF	4	0.4	
Total		**972**	**100**	

Wetlands are unique ecosystems that offer many important ecological functions. Wetlands often provide critical habitat for aquatic and terrestrial wildlife, provide habitat for rare or uncommon plants, absorb pollutants, and assist with the regulation of water quality and hydrologic cycles. Wetlands were not formally mapped within the study area, but two map units (sedge communities and open water) identified within the port study area have features commonly associated with wetlands and have therefore been considered as such for the purposes of this report. Sedge communities cover 41 ha (4% of the study area) while open water covers 5 ha (1% of the study area) (Table 2.3-1).

Some plant communities and associations are also important to wildlife. Communities valuable to wildlife identified within the port site include:

- **birch seep:** shrubs are an important food source for ungulates and provide habitat for various wildlife species (*e.g.*, nesting birds);
- **littoral communities in Bathurst Inlet (includes the beach materials map unit):** sensitive to marine pollution; in the case of bird nesting islands, any damage to the nesting environment could affect a population of birds over a large area; and
- **sedge communities:** important for grizzly bears and caribou in the spring; although their extent is not limited and they are not perceived as requiring special status.

2.3.1.2 Rare and Significant Plant Species

No rare plant species were identified within the port study area during field surveys, however, some locally uncommon species such as orchids, louseworts, and legumes, were identified, the details of which are provided in Appendix D-4 of the DEIS.

Eight plants identified within the port study area are culturally significant to Inuit, six of which can be linked to species in the area (Table 2.3-2, Appendix F-5 of the DEIS). Common uses of these plants include food and kindling for starting fires.

Table 2.3-2
Culturally Significant Plants Identified within the Port Study Area

Inuit Name	Description	Likely Species	No. of Locations
aaukpik	Cloudberry	*Rubus chamaemorus*	3
avalakiak	Willow-like plant	*Betula glandulosa*	30
eehoktin / igaagnik	Small low-lying plant	-	-
kangoyat / kanooyak	Narrow-leaved cotton-grass	*Eriophorum angustifolium*	5
kigotaginak	Blueberries	*Vaccinium spp.*	26
kublakot	Used instead of tea	-	-
mahok	Licorice root	*Hedysarum alpinum*	10
okpigak	Willow	*Salix spp.*	9

Dashes indicate no information available.

Also considered as part of this report are plant species of ecological significance. Rather than listing individual species, plant groups have been identified. Lichens collectively have been identified as being ecologically significant. Lichens are well known for being good indicators of air quality due to their sensitivity to may airborne pollutants (Tyler, 1989; Markert, 1993; Blett *et al.*, 2003). They are primary colonizers of barren Arctic habitat and can be used as indicators of ecosystem health. They are also an important food source of caribou in the harsh Arctic environment.

Of the 31 plots surveyed within (or near) the port site area, 13 species of lichen were identified. The most common species were *Flavocetraria nivalis* (formerly *Cetraria nivalis*) (12 plots) and *Lepraria neglecta* (12 plots). At least one species of lichen was identified in 68% of the plots.

Other plant species/groups of particular importance to wildlife are discussed in Appendix D-3 of the DEIS.

2.3.2 Road

The road study area covers approximately 29,914 ha (Table 2.3-3). A total of 300 field plots were assessed near the road and covered a wide range of plant communities. The road quickly gains elevation near the coast and then gradually levels off inland, reaching an interior elevation of approximately 630 m. Inland areas have harsh Arctic weather, little snow insulation, and thin soils. The resulting vegetation is less diverse compared to coastal areas.

Twenty map units were mapped within the road study area (Table 2.3-3), the descriptions of which are provided in the baseline report by Geowest (Appendix D-4 of the DEIS). The dominant map unit is heath tundra (63%), followed by birch seep (8%), and sedge (8%). Of the 20 plant communities identified during map development, 12 cover only 1% or less of the total road study area.

Table 2.3-3
Distribution of Map Units within the Road Study Area

Map Unit Name (Plant Community/Association)	Map Unit Code	Area (ha)	Proportion of Study Area (%)	Wetland
Heath tundra	HT	18,939	63	
Birch seep	BS	2,436	8	
Sedge	SE	2,322	8	√
Pond	PD	1,376	5	
Bedrock	RO	1,194	4	
Lake	LA	1,069	4	
Boulder field	BF	778	3	
Lichen-rock	LR	472	2	
Riparian shrub	RS	421	1	√
Esker complex	EC	347	1	
Avens	AC	254	1	
Saxifrage-blueberry	SA	119	0.4	
River	RI	69	0.2	
Open water	OW	47	0.2	√
Gravel bar	GB	24	0.1	
Exposed soil	ES	23	0.1	
Beach materials	BE	18	0.1	
Lichen veneer*	LV	3	<0.1	
Disturbance features	DF	1	<0.1	
Permanent snow	PS	1	<0.1	
Total		**29,914**	**100**	

***Data is from the WKSS region vegetation classification project (Matthews *et al.*, 2001).**

2.3.2.1 Rare and Sensitive Ecosystems

No rare or sensitive ecosystems were identified; they are all commonly distributed throughout the central barrenlands wherever the terrain is suitable. In general, all tundra vegetation is sensitive to disturbance, and it can take years, and sometimes decades, to recover.

Three map units identified within the road study area have been associated with wetlands for the purposes of this report. Sedge communities cover approximately 8%, riparian shrub communities cover 1%, and open water covers <1% of the study area (Table 2.3-3).

As previously mentioned, there are some plant communities or associations that are more important to wildlife than others. Those identified within the road study area include:

- **birch seep and riparian shrub:** shrubs are an important food source for ungulates and provide habitat for various wildlife species (*e.g.*, nesting birds);
- **esker complexes:** important for denning for mammals such as foxes, wolves, wolverine, and ground squirrels, and travel corridors for wildlife;

- **lichen veneer:** dry, windswept areas supporting a continuous mat of lichen which is an important food source for ungulates; and
- **sedge communities:** important to wildlife, especially grizzly bears and caribou in the spring; although their extent is not limited and they are not perceived as requiring special status.

2.3.2.2 Rare and Significant Plants

No rare plant species were identified within the road study area during field surveys. However, some locally uncommon species such as ferns, louseworts, and legumes were identified (Appendix D-4 of the DEIS).

Eight plants identified within the road study area are culturally significant to Inuit, six of which can be linked to species in the area (Table 2.3-4, Appendix F-5 of the DEIS). Common uses of these plants include food and kindling for starting fires.

Table 2.3-4
Culturally Significant Plants Identified within the Road Study Area

Inuit Name	Description	Likely Species	No. of Locations
aaukpik	Cloudberry	*Rubus chamaemorus*	8
avalakiak	Willow-like plant	*Betula glandulosa*	262
eehoktin / igaagnik	Small low-lying plant	-	-
kangoyat / kanooyak	Narrow-leaved cotton-grass	*Eriophorum angustifolium*	76
kigotaginak	Blueberries	*Vaccinium spp.*	276
kublakot	Used instead of tea	-	-
mahok	Licorice root	*Hedysarum alpinum*	4
okpigak	Willow	*Salix spp.*	60

Dashes indicate no correlation to species available.

Lichens are considered ecologically significant (see Section 2.3.1.2), and 22 different species were identified within the road study area. Of the 300 plots surveyed within (or in the vicinity of) the study area, the most common lichen species were *Flavocetraria nivalis* (183 plots), *Flavocetraria cucullata* (formerly named *Cetraria cucullata*) (89 plots), and *Thamnolia vermicularis* (81 plots). At least one species of lichen was present in 81% of the plots.

Plant species and groups of particular importance to wildlife are discussed in Appendix D-3 of the DEIS.

2.3.3 Plant Tissue Chemistry

Results of the lab analyses are presented in Appendix D-11 of the DEIS as both dry and wet weight. Dry weight displays the metal levels present in plant tissues irrespective of moisture status, while wet weight better reflects *in situ* conditions and provides an approximation of the conditions under which consumers (*e.g.*, wildlife) may naturally encounter and ingest these plants.

A total of 27 samples were analyzed: 15 willow (including two replicate samples), ten sedge, and two cottongrass. Metal concentrations in many of the samples were below analytical detection limits. In these cases, half of the detection limit value was used for data summaries.

Plant tissue metal concentrations will be used for future monitoring during the operations and closure and reclamation phases. Future metal levels in plant tissue will be compared to baseline values in order to determine if changes in metal levels are occurring. Results associated with the cottongrass samples should be viewed as anecdotal due to the small sample size (N=2). The identification of possible trends in metals concentrations in plant tissues will focus on those associated with willows and sedges, due to their larger sample sizes. Noticeable changes in metal levels over time could be further analyzed using a risk assessment approach to determine the potential exposure risks to wildlife that may be using the plants of the area as a food source.

3. METHODOLOGY

3. Methodology

3.1 Valued Ecosystem Component Selection

Valued ecosystem components (VECs) associated with ecosystems and vegetation were identified based on a review of baseline study results, plant status (particularly as it relates to conservation, cultural importance, and use by wildlife species), and comments received by regulatory agencies and the public. The VECs include:

- Plant communities and associations (with emphasis on those that are sensitive or serve particular ecological functions, listed below);
  - Sedge communities (wetlands);
  - Beach materials (littoral communities);
  - Riparian areas (tall riparian shrub, birch seep);
  - Esker complexes;
  - Lichen veneer;
- Rare or significant plant species or species groups; and
- Species of ecological importance to Inuit and wildlife.

In general, all plant communities and associations (map units, ecosystems) were included as a VEC due to the inherent sensitivity of the Arctic environment to disturbance. The effects of the Project on ecosystems with particular ecological functions such as wetlands, riparian areas, and those identified as important wildlife habitat are emphasized.

Plant species or species groups considered as rare or significant (*e.g.*, from a regulatory, cultural, or wildlife perspective) were also included as VECs. Rare plant species include those tracked federally by COSEWIC and SARA, those of interest to the government of Nunavut, and species identified in McJannet, *et al.*, (1993 and 1995). Species of ecological importance include those that are of cultural value to Inuit and those that are of importance to wildlife. No rare plant species were identified in the study areas during baseline studies, and as such they will not be assessed further.

3.2 Boundaries

The spatial and temporal boundaries used in the assessment of effects of the Project on ecosystems and vegetation are discussed in detail below.

3.2.1 Spatial Boundaries

Effects of the Project on ecosystems and vegetation are addressed spatially within the LSA (Figure 3.2-1). The Project footprint was developed from information associated with the port, road, and Contwoyto Camp facilities.

Areas that will be affected by the Project have been identified in terms of the amount of disturbance anticipated. Roads, quarries, and general infrastructure have been assigned a designation of "lost" to indicate that the current vegetation and plant communities will be completely removed and essentially replaced by infrastructure, at least for the duration of the Project. Lost areas reflect the most severe form of ground disturbance.

Areas that will also be affected by Project activities, but to a lesser extent, have been identified as "degraded." These areas are generally located adjacent to infrastructure and may become degraded due to activities associated with construction and operations (*e.g.*, road maintenance including the deposition of graded material (snow, dirt) on road edges, the potential introduction of invasive plants, and an increase in dust deposition).

Degraded areas have been subdivided into two levels of intensity: "heavily degraded" and "lightly degraded." Heavily degraded areas are located immediately adjacent to infrastructure (*e.g.*, facility edges) and are anticipated to be affected most by construction and operations activities. Lightly degraded areas extend well beyond facility edges and may be subject to effects associated with dust deposition or invasive plant establishment.

The footprint used in the effects assessment is shown in Figure 3.2-1. The following features are included in the footprint, along with their approximate dimensions and associated disturbance level:

Port Site

- port facilities (lost);
- facility edge: 5 m from "lost" edge (heavily degraded); and
- dust buffer: 95 m from "heavily degraded" edge (lightly degraded).

Road

- road bed and surface: 13.2 m wide (lost);
- road pull-outs at every kilometre and at bridge crossings: 4 m width by 50 m length (lost);
- rock quarries: 39 sites that vary from 0.6 ha to 3.4 ha in size (lost);
- road edge effects: 5 m from "lost" edge (heavily degraded); and
- dust buffer: 95 m from the "heavily degraded" edge (lightly degraded).

Contwoyto Camp

- camp infrastructure (lost);
- camp edge effect: 5 m from "lost" edge (heavily degraded); and
- dust buffer: 45 m from "heavily degraded" edge (lightly degraded).

Ecosystem and Vegetation Effects Assessment Boundaries

FIGURE 3.2-1

the Bathurst Inlet Port and Road Project

Rescan™

Areas designated as "degraded" will be subject to more indirect effects due to their proximity to infrastructure. The width of the buffer zone around Project facilities was either 100 m or 50 m and was based upon the amount of activity anticipated within each area (*i.e.*, less industrial activity is anticipated to occur at the Contwoyto Camp compared to the road or port site). Buffer zone sizes were also based on the deposition properties of suspended particulate matter. Larger dust particles (*e.g.*, with an aerodynamic diameter >100 μm) generally settle out near the source (*e.g.*, within 10 m), while particles with aerodynamic diameters between 30 and 100 μm are more susceptible to impeded or gravitational settling and tend to be deposited within 100 m of the source (US EPA, 1995). Particles with aerodynamic diameters smaller than 10 μm are dispersed over much larger distances and were not assessed for their potential effects on ecosystems and vegetation.

3.2.2 Temporal Boundaries

The temporal boundaries used for the ecosystems and vegetation section of the Project effects assessment follow those outlined for the Project as a whole (Appendix A-5 of the DEIS). The effects assessment was divided into four temporal stages, defined by Project phase:

1. construction (30 months);
2. operation and maintenance (estimated 20 years);
3. decommissioning and closure (approximately 2 years); and
4. post-closure (>50 years).

The time period considered for the post-closure phase was established using an estimate of the time it could take ecosystems and vegetation to recover from disturbance. The possibility remains that Arctic ecosystems may never recover to pre-disturbance/baseline conditions, however given enough time, they will be able to recover sufficiently to support stable and sustainable communities composed of native plant species.

3.3 Approach and Methods

The EA approach taken to assess the effects of the Project on ecosystems and vegetation have been described in Section 3.2 (Boundaries) above, and are similar to the methods outlined for the Project as a whole (Appendix A-5 of the DEIS).

4. EFFECTS ASSESSMENT

4. Effects Assessment

The primary effect of the Project on ecosystems and vegetation of the area will be the removal of these elements by infrastructure development. Other effects include increased dust deposition on vegetation located adjacent to dust sources (*e.g.*, roads and construction areas), the potential introduction of invasive plant species to previously unaffected areas, and changes to local hydrology, all of which can lead to ecosystem degradation.

4.1 Port Site

The port site footprint developed for the ecosystems and vegetation assessment covers 216 ha, which is 22% of the 972 ha LSA (Table 4.1-1). The majority of the footprint area (78%) is associated with the dust buffer.

Table 4.1-1
Disturbance Associated with the Port Site Footprint

Feature	Lost (ha)	Heavily Degraded (ha)	Lightly Degraded (ha)	Total Disturbance Area (ha)
Facilities	32			32
Facility Edges		4		4
Road	6			6
Road Edges		6		6
Dust Buffer			168	168
Total	**38**	**10**	**168**	**216**

Heath tundra is the most common ecosystem within the port footprint area and will be subject to the most disturbance (Table 4.1-2). Heath tundra supports plant species of cultural importance to Inuit (*e.g.*, dwarf birch and willow) and development at the port will likely result in restricted access to these plants at this location. However, as heath tundra is the most abundant plant community in both the LSA and RSA, the opportunity remains to make use of these species at other locations.

A high proportion of ecosystems of ecological importance, such as birch seeps and sedge communities, will also be disturbed, (29% and 21% of the amount identified in the LSA, respectively). The largest areas of disturbance, irrespective of ecosystem, are associated with the dust buffer, where light degradation is anticipated. The effects of dust on plant communities with a higher lichen component may be more pronounced due to their sensitivity to environmental pollutants.

Largely non-vegetated features such as exposed soil and bedrock outcrops will be subject to the most severe form of ground disturbance (*i.e.*, lost) and will lose the highest proportion of area overall (7% and 6%, respectively). Heath tundra ecosystems will also lose approximately 6% of

their available area in the LSA to development. These features have been identified within the larger RSA and cover fairly extensive areas.

Table 4.1-2
Ecosystem Disturbance within the Port Site Footprint

Map Unit Name (Plant Community/ Association)	Map Unit Code	Lost (ha)	Heavily Degraded (ha)	Lightly Degraded (ha)	Total Disturbance Area (ha)	Available In LSA (ha)	Proportion Disturbed (%)
Heath Tundra	HT	30	8	129	166	525	32
Birch Seep	BS	3	1	18	22	75	29
Sedge	SE	1	0.5	7	9	41	21
Bedrock	RO	2	0.3	6	9	34	25
Avens	AC	1	0.2	3	5	36	14
Exposed Soil	ES	1	0.1	1	3	14	17
Lichen-Rock	LR	0.2	0.1	2	2	10	19
Lake	LA	<0.1	<0.1	1	1	17	3
Boulder Field	BF	0.1	<0.1	0.3	0.5	4	14
Open Water	OW	0	0	0.1	0.1	5	2
Ocean	OC	0	0	0	0	206	0
Beach Materials	BE	0	0	0	0	4	0
Total		**38**	**10**	**168**	**216**	**972**	**22**

4.2 Road

The road footprint covers just over 5,000 ha, which is 17% of the 29,914 ha LSA (Table 4.2-1). The majority of the footprint area (88%) is associated with the dust buffer.

Table 4.2-1
Disturbance Associated with the Road Footprint

Feature	Lost (ha)	Heavily Degraded (ha)	Lightly Degraded (ha)	Total Disturbance Area (ha)
Facility	79			79
Facility Edge		0.3		0.3
Road	300			300
Road Edge		235		235
Dust Buffer			4,408	4,408
Total	**379**	**235**	**4,408**	**5,022**

The most common ecosystem within the road footprint is heath tundra (Table 4.2-2). Heath tundra supports plant species of cultural importance to Inuit (*e.g.*, dwarf birch and willow). Loss of access to these plant species as a result of Project development is likely to be small owing to the extensive distribution of this plant community in both the LSA and RSA.

Table 4.2-2
Ecosystem Disturbance within the Road Footprint

Map Unit Name (Plant Community/ Association)	Map Unit Code	Lost (ha)	Heavily Degraded (ha)	Lightly Degraded (ha)	Total Disturbance Area (ha)	Available In LSA (ha)	Proportion Disturbed (%)
Heath Tundra	HT	258	165	3,056	3,479	18,939	18
Birch Seep	BS	33	23	431	487	2,436	20
Sedge	SE	26	19	374	419	2,322	18
Bedrock	RO	18	6	120	144	1,194	12
Lichen-Rock	LR	9	5	87	101	472	21
Esker Complex	EC	14	5	72	91	347	26
Riparian Shrub	RS	5	4	68	77	421	18
Boulder Field	BF	7	3	63	73	778	9
Avens	AC	4	2	42	48	254	19
Pond	PD	0.3	0.2	40	40	1,376	3
Saxifrage-Blueberry	SA	2	1	22	25	119	21
Lake	LA	1	0.4	12	13	1,069	1
Open Water	OW	0.4	0.3	6	7	47	14
River	RI	0.1	<0.1	5	5	69	8
Exposed Soil	ES	1	0.3	4	5	23	23
Gravel Bar	GB	0.3	0.2	4	4	24	18
Beach Materials	BE	0	0	1	1	18	4
Permanent Snow	PS	<0.1	<0.1	0.4	0.4	1	52
Lichen Veneer	LV	0	0	0	0	3	0
Disturbance Features	DF	0	0	0	0	1	0
Total		**379**	**235**	**4,408**	**5,022**	**29,914**	**17**

Communities of ecological importance such as esker complexes, birch seeps, riparian shrub, and sedge communities, will also be disturbed, however, much of the disturbance will be within lightly degraded areas. The effects of dust on plant communities with a higher lichen component may be more pronounced due to their sensitivity to environmental pollutants.

The largest proportion of area to be lost is 4% and will be from esker complexes (14 of 347 ha lost) and areas with permanent snow (0.03 of 1 ha lost). Eskers have been identified in the larger RSA (2,328 ha); the amount of esker area to be lost represents approximately 0.6% of the eskers identified in the RSA.

4.3 Effects of Dust Deposition

The effects of dust on vegetation vary with the deposition load, duration, and frequency, as well as the chemical properties of the dust, and the plant species involved. The more common effects of dust include:

- physical smothering of leaf surfaces;
- blocking of stomata;

- alteration of leaf physiology; and
- microclimatic and/or microsite changes.

The deposition of dust onto vegetation reduces the amount of light reaching leaf surfaces, thereby affecting photosynthetic processes (Thompson *et al.*, 1984; Pyatt and Haywood, 1989; Farmer, 1993). Similarly, smaller particle sizes can obstruct stomata, which will also negatively affect photosynthesis (Environment Australia, 1998). Dust has been shown to increase leaf surface temperature, which can positively affect respiration but negatively affect photosynthesis and productivity (Eller, 1977).

Depending on its chemical composition, dust can alter the microclimatic and microsite conditions of areas adjacent to dust sources. In Arctic climates, dust-related effects have manifested as changes to soil pH, soil nutrient regime, the depth of permafrost thaw, plant species composition, and earlier snowmelt due to changes to the surface albedo of snow (Walker and Everett, 1991; Auerbach *et al.*, 1997; Gunn, 1998).

Chronic effects of dust on vegetation may be greater in evergreen plant species compared to deciduous species. This is due in part to the latter dropping their leaves during the winter months, thus avoiding the effects of cumulative dust build-up on leaf surfaces (Auerbach *et al.*, 1997). The effects of chronic dust build-up could lead to a shift in species composition, and possibly plant community composition, away from typical tundra assemblages that support evergreen plants.

The effects of dust may also be more pronounced in sensitive plant groups such as lichens. Lichens are well-known for being good indicators of air quality due to their sensitivity to environmental pollutants (Tyler, 1989; Markert, 1993). Lichens can concentrate a variety of pollutants in their tissues and often accumulate sulphur, nitrogen, and metals from atmospheric sources better than vascular plants (Blett *et al.*, 2003). Regular dust deposition could result in changes to, or a decline in, local lichen populations.

Ambient total suspended particulate (TSP) concentrations were evaluated as being of moderate magnitude and moderate significance in the air quality effects assessment (Appendix B-2 of DEIS). The restricted use of the road during the year and the time of year for operations (predominantly winter) will help limit dust production and will reduce the overall effect of dust deposition on vegetation.

4.4 Introduction of Invasive Plant Species

Invasive plants generally refer to species whose establishment and (often rapid) spread can adversely affect ecosystems, habitats, and/or other species (Haber, 1997). Invasive species are most often non-native, non-indigenous, foreign, or exotic, however, native species, if introduced into new, suitable environments, can act as invasives as well. Invasive plants, as discussed here, refer to those that are not native.

The successful establishment of invasive plants into an area depends on several factors, including:

- the availability of suitable habitat;
- a means of access; and
- a dispersal mechanism.

The ground disturbance associated with construction activities inadvertently creates the type of habitat favoured by invasive plant species. Transportation corridors to and from construction areas provide a means of access, as well as additional habitat in the form of disturbed road verges. Vehicles and machinery can serve as dispersal mechanisms for plant propagules (seeds and/or vegetative parts) that get lodged in tires, the undercarriage, or mud on the surface of the vehicle. Propagules can also be transported via ships, either in ballast water or cargo.

The low incidence of invasive plants occurring in the Arctic has long been attributed to factors such as harsh climatic conditions, the presence of permafrost, and limited land development (Schrader and Hennon, 2005; Carlson and Shephard, 2007). Recent studies of the changes in Alaskan flora over time have revealed that invasions may just be delayed and that the level of development and invasive plant propagules present have reached a point that they may now become more noticeable (Carlson and Shephard, 2007).

Effective management strategies are required early in Project planning to address the introduction, spread, and effects of invasive species on the environment (Haber, 1997). Preventing invasive plant species from entering an area is often more efficient and cost effective than dealing with their removal once established (Clark, 2003; Polster, 2005; USDA, 2006; Carlson and Shephard, 2007). Arctic areas are still at a considerable advantage in this respect, as much of the land is not yet affected by human development and non-native plants are largely restricted to populated and high-use areas (Carlson and Shephard, 2007). Specific measures can be integrated into development projects that limit the introduction of non-native species into developed areas and control their potential spread into natural areas.

Similar to the effects of dust on vegetation, the restricted use of the road during the year and the time of year for operations (predominantly winter) will help limit the potential introduction and establishment of invasive species in the area, which will reduce the overall effect of invasive species on native vegetation.

4.5 Changes to Local Hydrology

Linear developments such as roads have been shown to, among other things, disrupt surface water drainage and sedimentation patterns across the landscape, which can result in the alteration of both upstream and downstream plant communities (Pomeroy, 1985; Spellerberg and Morrison, 1998; Trombulak and Frissell, 2000). Roads intercept surface and shallow subsurface flows which can increase upstream ponding and can lead to the development of wetter ecosystems (Pomeroy, 1985; Trombulak and Frissell, 2000). Upstream ponding may also lead to permafrost degradation and the development of thermokarst, which can lead to further alterations in vegetative cover (Pomeroy, 1985). Additionally, the reduced transmission of water flows through the roadbed to downstream communities could result in their drying out, leading to changes in species composition away from wetter assemblages.

Plant communities in the Project area that are likely to be most affected by altered hydrological regimes include sedge communities, tall riparian shrub, and birch seeps, all of which have been considered communities of ecological importance.

4.6 Summary of Effects

The loss of plant communities (ecosystems) and plant species/groups of ecological concern will occur at construction and the effects will be carried through to decommissioning and post-closure (Table 4.5-1). The effect has a **high magnitude** and **local extent**. The **duration** of the effect will extend into the **far future** as Arctic ecosystems are slow to respond to disturbance. The effect will occur **once** and will be **reversible** in the **long-term**, however plant community structure and composition may be different than what was originally present. The slow recovery time of Arctic ecosystems to disturbance also results in them having a **low ecological resilience**. Development of the Project will have a **low** influence on resource capacity, as all of the plant communities that will be lost have been identified elsewhere in the area. The **probability of occurrence** for this effect is **high** and the significance has been rated as **moderate**.

The degradation of plant communities (ecosystems) and plant species/groups of ecological interest due to dust deposition, the potential introduction of invasive plant species, and alteration of local hydrology will start at construction and will continue through to decommissioning and post-closure. The effect is of **low magnitude** and will occur within a **local extent**. The **duration** of the effect will extend into the **long-term** as Arctic ecosystems are slow to respond to disturbance. The effect will occur on a **regular** basis and will be **reversible** in the **long-term**, however alterations to the original plant community in terms of structure and species composition may occur. The slow recovery time of Arctic plant communities and species/groups to disturbance also results in them having a **low ecological resilience**. Development of the Project will have a **low** influence on resource capacity, as all of the plant species/groups of ecological significance that will be affected have been identified elsewhere in the area. The **probability of occurrence** for this effect is **moderate** and the **significance** has been rated as **low**.

Table 4.5-1
Summary of Effects Assessment for Ecosystems and Vegetation

Description of Potential Effect					Mitigation and Enhancement	Evaluation of Residual Effect										
Description	**Project Phase (Timing)**	**Project Component**	**Direction**	**Nature**	**(Design Changes, Management, Monitoring, Compensation, Enhancement)**	**Description of Residual Effect (after mitigation)**	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological Context (Resilience)**	**Influence on Resource Capacity**	**Probability of Occurrence**	**Significance**	**Confidence Limit**
Loss of Plant Communities (including those of ecological interest)	Construction through to Decommissioning	Port Site and Road	Adverse	Direct	Optimized footprint size and placement	Unavoidable loss of plant communities	High	Local	Far Future	One Time	Long-term	Low	Low	High	**Moderate**	High
Degradation of Plant Communities (including those of ecological interest)	Construction through to Decommissioning	Port Site and Road	Adverse	Indirect	Lower speed limits (dust reduction), invasive plants management plan, drainage structures	Unavoidable degradation of plant communities	Low	Local	Long-term	Regular	Long-term	Low	Low	Moderate	**Low**	Intermediate
Loss of Plant Species/Groups of Ecological Interest	Construction through to Decommissioning	Port Site and Road	Adverse	Direct	Optimized footprint size and placement	Unavoidable loss of plant species/groups	High	Local	Far Future	One Time	Long-term	Low	Low	High	**Moderate**	High
Degradation of Plant Species/Groups of Ecological Interest	Construction through to Decommissioning	Port Site and Road	Adverse	Indirect	Lower speed limits (dust reduction), invasive plants management plan, drainage structures	Unavoidable degradation of plant/species groups	Low	Local	Long-term	Regular	Long-term	Low	Low	Moderate	**Low**	Intermediate

5. MITIGATION AND MANAGEMENT PLANS

5. Mitigation and Management Plans

A Vegetation Management Plan (VMP) and Invasive Plants Management Plan (IPMP) will help identify areas where vegetation management is required and where invasive plants may become problematic. Both plans are offered as recommendations and will be refined during the environmental assessment process leading to the Final Environmental Impact Statement (FEIS) and Project Certificate. The plans each include a monitoring component which is discussed in Section 6 below.

5.1 Vegetation Management Plan (VMP)

5.1.1 Objectives

The objectives of the VMP are to maintain a healthy vegetative cover and to re-vegetate (either naturally or assisted) disturbed areas to lower the overall effects of Project development on ecosystems and vegetation. Maintaining and re-establishing healthy vegetation is not only beneficial to the plant species involved, but it also benefits wildlife through the maintenance and restoration of habitat, and minimizes soils-related effects (such as erosion) that result from vegetation disturbance and removal.

Re-vegetation will likely be a combination of natural colonization and the application of suitable seed and fertilizer (Appendix G-6 of the DEIS). Reclaimed surfaces will be prepared to encourage re-vegetation through colonization by native species wherever possible.

5.1.2 General Practices to Minimize Disturbance to Ecosystems and Vegetation

The most effective strategies to reduce the effects of development on ecosystems and vegetation include minimizing the footprint area (thus limiting the extent of disturbance) and optimizing facility placement (*e.g.*, avoiding sensitive ecosystems and plants). Restricting Project operations to developed areas will also limit encroachment into adjacent areas.

The placement and size of infrastructure has been taken into account during the initial design stages of the Project, and will continue to be a consideration as plans are further refined. The activities to be undertaken during Project construction, operations, and closure are described below.

- **Identification of areas where healthy vegetation is maintained.** A general site survey will be carried out to identify areas where healthy vegetation is maintained and where vegetation is showing signs of degradation. Estimates will be made of the extent of intact (undisturbed) and degraded vegetation.
- **Identification of areas where re-vegetation is required.** This is included in the general site survey described above and will also be part of the soils-related monitoring records that require a description of vegetation characteristics. The total extent of disturbance

will be approximated and will include an estimate of the amount of new disturbance incurred.

- **Implementation of re-vegetation efforts.** This will involve seeding disturbed areas (identified from the general site surveys) with appropriate vegetative material. Material (seed or otherwise) will be composed of non-invasive species. The long-term re-vegetation goal is to encourage the re-establishment of native vegetation. Treatments will be timed such that they optimize success (*e.g.*, in association with favourable weather events).

5.2 Invasive Plants Management Plan (IPMP)

Effective strategies are required in the early stages of Project planning that address the introduction, spread, and control of invasive plant species (Haber, 1997). The objectives identified below have been incorporated into the IPMP. The plan is designed to work within the framework of the VMP.

5.2.1 Objectives

The objectives of the IPMP are to prevent the establishment of invasive plant species and to maintain a healthy vegetative cover in and around development areas.

5.2.2 General Practices to Minimize the Effects of Invasive Plants

Preventing the establishment of invasive plants in an area is the most effective management strategy. A general awareness of activities that facilitate invasive plant establishment and growth is also beneficial. These include:

- **Identification of potential methods and vectors of introduction.** Understanding how invasive plants can be introduced into an area is key to identifying preventative measures that reduce the likelihood of this from happening. Invasive plants can be introduced at any time during the development and continued use of an area.

  Construction activities generate the largest initial disturbances and create suitable conditions for both the introduction and persistence of invasive plants. Vehicles and machinery are common transport and dispersal mechanisms for invasive plant propagules, and existing roadways provide easy access to invasive plant sources.

  Project staff will be informed of their role in preventing or assisting invasive plant establishment. Measures include ensuring that work vehicles travelling to/from site are clean, learning to identify common invasive plant species, and reporting invasive plant locations to an identified point of contact.

- **Prevention of invasive plant establishment.** Preventing the introduction of invasive plant species is oftentimes more efficient and cost effective than dealing with their removal once they have become established (Clark, 2003; Polster, 2005). Restricting the movement of propagules into unaffected areas and creating or maintaining environments

that do not favour the establishment of invasive plants are basic, effective approaches. Specific preventative measures can include:

- ensuring vehicles are clean prior to their entry on site;
- minimizing ground disturbance, where possible; and
- maintaining a healthy vegetation cover or capping exposed soil to prevent the establishment of unwanted vegetation in disturbed/high traffic areas.

For the BIPR Project, contractors will be required to thoroughly clean their equipment with high pressure washers before dispatching them to the tundra.

The treatment of invasive plants will be tailored for affected areas. For example, less aggressive invasives found in more sensitive areas (*e.g.*, in wetlands, riparian areas), may be prioritized for treatment over more aggressive invasives that are restricted to disturbed areas, such as roadsides.

5.3 Other Management Plans

Management plans associated with other disciplines will also be implemented and will assist with minimizing the effects of the Project on ecosystems and vegetation. These plans include:

- Fugitive Dust Management Plan (Appendix B-2 of the DEIS) will implement measures directed at minimizing fugitive dust emissions during construction and operations;
- Dustfall Monitoring Plan (Appendix B-2 of the DEIS) will monitor dust levels in the snowpack and serves to identify when critical dust levels have been exceeded;
- Soil Management Plan (Appendix D-2 of the DEIS);
- Hazardous Materials Handling Plan (Appendix G-4 of the DEIS);
- Spill Management Plan (Appendix G-4 of the DEIS); and
- Closure and Reclamation Plan (Appendix G-6 of the DEIS).

6. MONITORING AND EVALUATION

6. Monitoring and Evaluation

A vegetation specialist contracted by the proponent will conduct all vegetation monitoring and will ensure the management plans are being implemented.

6.1 Vegetation Management Plan

The monitoring and reporting requirements associated with the VMP are outlined below.

6.1.1 Monitoring

The assessment of re-vegetated areas will be carried out in conjunction with surveys identified in the soil management plans and the closure and reclamation plan. The timing of the surveys will be dependent upon when areas were re-vegetated and what the soil erosion potential is (*e.g.*, areas with high soil erosion potential will likely be surveyed more frequently following treatment). Test plots will be established at longer-term monitoring stations.

6.1.2 Reporting

Desired outcomes and Key Performance Indicators (KPIs) will be summarized into an annual report. A photographic record of surveyed locations will also be included to monitor and document rehabilitation progress. Records of re-vegetation and rehabilitation activities will be kept at the BIPR office or another designated site.

6.1.3 Responsibilities

The proponent will be responsible for implementing the VMP and associated activities. The proponent will appoint an appropriate individual or group to undertake and oversee the monitoring programs and report results, who will also serve as a point of contact for information dissemination. The proponent will ensure that all employees and contractors involved in VMP activities have appropriate awareness and training.

6.1.4 Key Performance Indicators

The desired outcomes are to maintain a healthy vegetative cover and to re-vegetate disturbed areas to reduce the overall effects of Project development. KPIs include:

- the number of times monitoring is carried out each year (minimum two);
- the number of internal reports produced each year (minimum one);
- estimate of extent of total disturbance (yearly approximation in hectares, with new disturbance areas identified, if possible);
- estimate of extent of re-vegetation carried out (yearly approximation in hectares); and
- estimate of re-vegetation success (yearly calculation based on estimate of area re-colonized).

6.2 Invasive Plants Management Plan

The monitoring and reporting requirements associated with the IPMP are outlined below.

6.2.1 Monitoring

Early detection of invasive plant establishment relies, in part, on the identification of disturbed areas, which is an activity associated with the VMP. Once identified, these areas can then be surveyed for the extent of invasive plant colonization. Surveys would include an assessment of the species and number of individuals present or, if establishment has been rapid, an estimate of percent cover.

Early detection also includes routine monitoring of vehicles entering an unaffected area. If the vehicle is dirty and could therefore contain invasive plant propagules, it may be turned away to be washed. Contractors will be required to thoroughly clean their equipment with high pressure washers prior to their use on the BIPR Project.

6.2.2 Treatment

Treating invasive plants requires knowledge of their biology and ecology, as the treatments may be as variable as the plants themselves (Polster, 2005). Persistence is often required when treating invasive plants, and often a single treatment is insufficient to ensure success. Treatment methodologies will focus on the long-term health of the area. The long-term re-vegetation goal is to encourage the re-establishment of native vegetation.

Following treatment, areas will be re-evaluated to determine if the treatment was effective. Surveys for treatment effectiveness will be carried out three months after the treatment has been applied; the need for further treatment will also be evaluated during this time. Treated areas will be re-vegetated with a suitable cover that prevents the re-establishment of invasive species. Re-vegetation success will be monitored according to the methods established in the VMP.

6.2.3 Desired Outcomes and Key Performance Indicators

The desired outcomes of the IPMP are to prevent the establishment of invasive plant species and to maintain a healthy cover of native ecosystems and vegetation. KPIs include:

- the number of times monitoring for invasive plants is carried out each year (minimum two);
- the number of reports produced each year (minimum one);
- estimate of extent of areas with invasives (yearly approximation in hectares, with newly invaded areas identified, if possible);
- estimate of extent of treatment carried out (yearly approximation in hectares); and
- estimate of treatment success (yearly calculation based on total amount of area treated versus amount of area successfully treated, in hectares).

6.2.4 Reporting

Desired outcomes and KPIs for the IPMP will be summarized into an annual report. A photographic record of surveyed locations will also be included to document rehabilitation progress. Records of control and rehabilitation activities will be kept at the requisite BIPR office or another designated site.

6.2.5 Responsibilities

The proponent will be responsible for implementing the IPMP and associated activities. The proponent will appoint an appropriate individual or group to undertake and oversee the monitoring programs and report results, who will also serve as a point of contact for information dissemination. The proponent will ensure that all employees and contractors involved in the program have appropriate awareness and training.

6.3 Plant Tissue Chemistry

Plant samples will be collected for metals analysis throughout the construction, operations, and closure and decommissioning phases of the Project (*e.g.*, during the summer following the fifth winter season of operations and again after the tenth winter season). The methodology will be the same as that identified in Appendix D-11 of the DEIS. Sampling locations will be similar to those visited in 2007. Additional samples will likely be collected near the snow core sampling locations that will be identified as part of the dustfall monitoring program (Appendix B-2 of the DEIS).

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An explanation of the acronyms used throughout this reference list can be found in the *Glossary, Acronyms and Abbreviations* section.

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Appendix D-2

Bedrock Geology, Surficial Material, and Soils Effects Assessment

Author: **Rescan Environmental Services Ltd.**
Date: **November 2007**

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Bathurst Inlet Port and Road Project Bedrock Geology, Surficial Material, and Soils Effects Assessment

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

ARD	acid rock drainage
BIPR	Bathurst Inlet Port and Road
CO_2	carbon dioxide
DEIS	Draft Environmental Impact Statement
Geowest	Geowest Environmental Consultants Ltd.
KPI	key performance indicator
ML	metal leaching
Rescan	Rescan Environmental Services Ltd.
Sobek ABA	600-compliant Acid-Base Accounting
the Project	the Bathurst Inlet Port and Road Project
the proponent	Bathurst Inlet Port and Road Joint Venture Ltd.
US EPA	United States Environmental Protection Agency
VEC	valued ecosystem component

1. INTRODUCTION

1. Introduction

The Bathurst Inlet Port and Road (BIPR) Project (the Project) requires 680 ha for construction of a port site on Bathurst Inlet and an all-weather road between the port and Contwoyto Camp (Figure 1-1). The port study area is approximately 159 ha and will include a wharf, a dock, a 200-person camp and services, a 220 million litre diesel fuel tank farm, a maintenance shop, and an airstrip. The road route is 211 km long and will have related quarry sites along the route. The southern end of the road will terminate at Contwoyto Camp. This camp area is 1.45 ha and includes a 20-person camp, a truck-parking area, and services at Contwoyto Lake.

This report first presents the environmental setting and baseline conditions for the bedrock geology, surficial materials, and soils within the Project area. Following the environmental setting, an assessment of the potential effects of the Project is discussed.

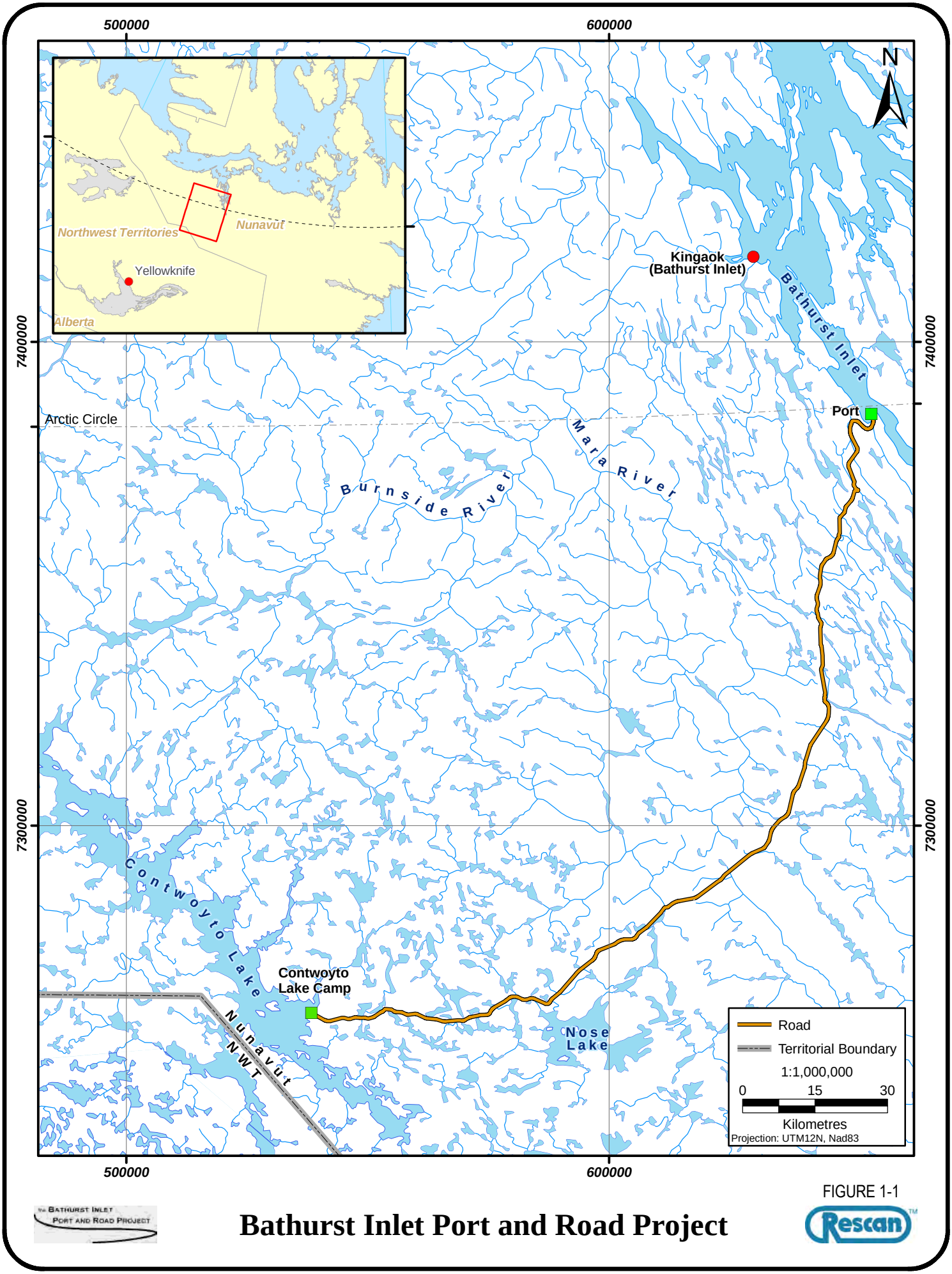


FIGURE 1-1

Bathurst Inlet Port and Road Project

2. ENVIRONMENTAL SETTING

2. Environmental Setting

Development associated with the Project will directly and indirectly affect soils. Direct impacts may include the loss of soils during construction, maintenance and operations, and closure phases. Indirect impacts may include a temporary change from baseline conditions through the disturbance of soils during construction, maintenance and operations, and closure phases.

Geological mapping and sampling were carried out at a reconnaissance level along the road route by Rescan Environmental Services Ltd. (Rescan) in the summer of 2001 (Appendix D-5 of the Draft Environmental Impact Statement (DEIS)). The bedrock was sampled where mineralization occurred and a general effort was made to check representative lithologies. Potential rock quarries were identified based on the findings of the reconnaissance survey. Maps (scale 1:60,000) were created to identify various lithologies, structural measurements, sample locations, proposed quarry sites, and the all-weather road route. The detailed report is included in Appendix D-5 of the DEIS.

Field investigations and subsequent mapping of the surficial geology and soils were completed at the port and along the road route by Geowest Environmental Consultants Ltd. (Geowest, 2003; Appendix D-4 of the DEIS). Fieldwork was carried out by surficial geologists and Inuit assistants. One-hundred and nineteen plots were established between Bathurst Inlet and Contwoyto Lake. Soils were excavated to bedrock or to 75 cm depth. Roughly 4,500 terrain units (or polygons), averaging 6.6 ha, were delineated and twenty-nine soil map units were created. The detailed report is included in Appendix D-4 of the DEIS.

2.1 Bedrock Geology

The Bathurst Inlet to Contwoyto Lake area occurs within the Slave Province of the Canadian Shield. The Slave Province is characterized as having underlying rock from the Archean Age (2,500 to 3,800 million years ago) and the Yellowknife Supergroup. These are overlain by sediments of the Epworth and Goulburn groups. About two-thirds of the Slave Province is underlain by granitic rocks of which possibly half are high-grade migmatites and mixed banded granitic gneisses. The remainder consists of batholiths of massive or slightly gneissic granitic rocks of various compositions.

The Slave Province has been affected by numerous periods of deposition, intrusion, folding, faulting, regional metamorphism, and erosional events. This geologic activity has created regions of complex geology and abundant mineralization. Bedrock identified during the fieldwork consisted of granites, gneisses, mafic volcanics and intrusives, schists, carbonaceous sediments, argillite, and diabase dikes.

Two shear zones were mapped along the road. These are comprised of highly fractured rock with a strong fabric that displays calc-silicate alteration, visible sulphides, and strong rusty oxidation staining. The first shear zone is at km 102 and is 30 m wide. It is highly friable and weathered. The second shear zone is at km 104 and is 15 m wide.

An environmental and geochemical concern along the proposed road corridor, around the port area, and at the nearby rock-quarry and granular sand-gravel sites has the potential for acidic rock drainage (ARD) and accelerated metal leaching (ML). This ML-ARD carries the potential for creating deleterious drainage that would enter, and could degrade, the surrounding environment (Morin and Hutt, 2007; Appendix D-6 of the DEIS) and contamination of the soils in the vicinity. This could result in an inhospitable environment for plant establishment and survival.

ARD testwork showed that up to 50% of the surficial samples collected for this study might generate ARD someday (Morin and Hutt, 2007; Appendix D-6 of the DEIS). However, the uncertainties in laboratory analyses, including measurements near inaccurate detection limits, and with other technical issues meant the percentage was not highly reliable. Nevertheless, a large geochemical zone around the southwestern end of the proposed road, from proposed Quarry Q23 to Quarry Q39, showed the greatest ARD potential. Also, a geochemical zone with high neutralizing capacity, around Gravel-Site G5 to Quarry Q7, could be used to offset the ARD potential in other zones if needed.

Exploration for carving stone materials along the proposed road route was conducted in conjunction with the bedrock geology mapping. No occurrences of soapstone or other materials suitable as carving stone were identified.

2.2 Surficial Materials

Various surficial materials and geomorphic processes (*i.e.*, isostatic rebound, permafrost processes, and slumping) have resulted in the present day landscape and soil types of the study area. Surficial materials vary across the Project area and include marine (52 ha), lacustrine (30 ha), fluvial (14 ha), glaciofluvial (54 ha), morainal (399 ha), residual bedrock (1 ha), bedrock (37 ha), and organic accumulations (40 ha). Each type of surficial material is discussed in detail below.

2.2.1 Morainal Deposits

Moderately coarse textured morainal deposits are the most extensive surficial materials west of Amagok Creek. They occur as veneers and blankets over bedrock and, in some areas, as drumlins. This material, also referred to as glacial till, has variable textures that range from silty clay to gravelly sand. Thicknesses vary from lithic veneers (<10 cm) and blankets (>100 cm), to thick (>20 m) deposits. Coarse fragment content ranges from 5%, with subrounded and subangular gravels and cobbles, to greater than 75%, with subrounded boulders and stones. Drainage is well to poor. Soil colour of morainal deposits varies such that the soils in well drained sites are grayish to pale brown and those in poorly drained sites are dark brown to dark grayish brown. The pH is generally slightly acidic to neutral (pH 6.5 to 7.0), but tills with a pH of 5.3 are also found.

2.2.2 Glaciofluvial Outwash

Glaciofluvial outwash occurs on a variety of landforms, but generally it is found on level to near level topography where slopes are less than 2%. Drainage is rapid and well for most sites but poor in areas that have groundwater seepage. Textures range from silt loam with up to 25% rounded and subrounded gravels and cobbles, to sandy gravel with up to 85% rounded and

subrounded gravels. If present, coarse fragments increase with depth. The pH ranges from extremely acidic (pH 4.3) to alkaline (pH 8.0). Soil colour varies from greyish brown to pale brown to dark brown.

Several esker complexes occur within the study areas (Plate 2.2-1). Eskers located on the uplands, west of Bathurst Inlet, are part of an extensive esker group that has its greatest development around Contwoyto Lake. These eskers are continuous (>10 km) and up to 30 m in thickness, reaching 20 m in height and over 30 km in length. Generally, the esker side slopes are 30% to 50% but eskers within the Amagok Creek valley are as steep as 70%. These eskers are particularly high in gravels, cobbles, stones, and boulders such that coarse fragment content on the surface varies, in most instances, from 35% to 85%. Drainage is generally rapid and pH values range from slightly acidic (pH 6.0 to 6.5) to alkaline (pH 8.0). Soil colour varies from dark greyish brown to light brownish grey to yellowish brown.

Plate 2.2-1. Esker complex (Geowest, 2003).

2.2.3 Marine Sediments

East of Amagok Creek, coarse to moderately coarse textured stone free marine sediments occur as blankets and veneers overlying bedrock or as thick sediments within the valley bottoms. Marine sediment thicknesses varies from less than 50 cm (overlying bedrock) to greater than 10 m and are composed of loamy sand to coarse sand. Silt loam and loam are the most common textures at higher elevations. Overall, coarse fragment content is low (0% to 10%).

Permeability is high in the marine materials but drainage is highly variable and reflects the topographic position of the deposits. Moderately well to well drained sediments are found on

2% to 15% slopes and imperfect to poorly drained sediments occur on slopes less than 2% or where groundwater seepage is prevalent. Soil colour varies from greyish brown to dark yellowish brown and the pH ranges from acidic (pH 5.5) to neutral (pH 7.0).

2.2.4 Lacustrine Sediments

Lacustrine sediments of variable texture are typically found adjacent to most waterbodies and are prevalent in the study areas (Plate 2.2-2). Deglaciated lake basins and localized ponding of ice-dammed waters have generated thin, local, lacustrine deposits throughout the study region. Lacustrine sediments are generally found in low-lying areas or where the topography is depressed such that slopes are less than 5%. Textures range from varved clays to fine sand.

Overall, lacustrine sediments are generally free of coarse fragments. Drainage varies from moderately well to poor but is predominantly imperfect to poor. Soil colour varies from grey to yellowish and olive brown, depending on drainage. The pH ranges from slightly acidic (pH 6.0) to alkaline (pH 8.0).

Plate 2.2-2. Lacustrine Sediments (Geowest, 2003).

2.2.5 Fluvial Sediments

Fluvial sediments occur in a variety of areas including adjacent to active stream channels, in low-lying topography between shallow lakes, an area with springs. Fluvial sediments vary from well to poorly sorted sands and gravels. Coarse fragment content ranges from less than 10% rounded gravels and cobbles, to 75% rounded gravels in a sand matrix.

Drainage is rapid to poor and soil colour is generally brownish grey to brown. The pH is medium acidic (pH 5.5 to 6.5) with occasional alkaline (pH 8.0) deposits.

2.2.6 Residual Bedrock

Residual bedrock is common within the study area. This is unconsolidated or partly weathered material developed *in situ* by weathering of unconsolidated bedrock. The most important bedrock weathering process is frost wedging and shattering. Features attributed to these processes include extensive areas of angular bedrock fragments, scree and talus deposits, and irregular bedrock outcrops. Porous and well-bedded sedimentary rock, such as shales, sandstones, and limestone are especially susceptible to frost wedging and shattering.

In the study area, residual bedrock consists of up to 90% platy cobble-sized fragments within a sandy matrix and is covered by a thin layer of litter. Bedrock is generally found within 100 cm of the mineral surface.

2.2.7 Organic Accumulations

Organic accumulations have developed on bedrock, morainal, and lacustrine materials in depressional terrain where the groundwater flow is at or near the surface for much of the year, or where seepage is pronounced (Plate 2.2-3). The organic deposits are poorly drained and highly saturated, resulting in the accumulation of sedges and sphagnum peats. Most of the peats are fibric (poorly decomposed) or mesic (moderately well decomposed). Accumulations are generally less than 50 cm in thickness but some exceed 100 cm. Ice and clay lenses are common and frost heaving frequently brings boulders and stones to the surface.

Plate 2.2-3. Organic accumulation ((Geowest, 2003).

2.3 Soils

The following is a description of the soils and common permafrost features that occur in the Project area.

2.3.1 Soil Classification

Soils of the Cryosolic Order are widespread within the study areas. These soils form on either mineral or organic materials with permafrost within 1 m or 2 m of the surface. They have a mean annual soil temperature below 0^{o} C. Three Great Groups have been identified within the Cryosolic Order: Turbic, Static, and Organic Cryosols. Turbic Cryosols, unlike Static Cryosols, have marked evidence of cryoturbation (frost mixing).

An analysis of the 119 detailed sites suggests that Turbic Cryosols are more common on upland sites than Static Cryosols. In the Project area, Turbic Cryosols develop on a variety of materials, including moraine and lacustrine. Static Cryosols are common on coarser-textured materials including marine, glaciofluvial (outwash and eskers), and fluvial sediments. These soils are well to rapidly drained and sandy textured. They tend to be transitional to the Brunisolic Soil Order especially where they occur on coarse textured esker, outwash, and marine landforms.

Organic soils occur in lower slope and valley bottom positions. They are classified as a Terric subgroup since these soils are shallow (<1 m) and tend to grade in composition between fibric and mesic materials.

2.3.2 Permafrost Features

Permafrost of frozen ground describes soil that is at or below freezing (0^{o} C) for two or more years. Common permafrost-related features in the study area include patterned ground, mudboils, and skin flows. Mass wasting processes that operate in the active layer include frost creep, solifluction, and cryoturbation.

Although the Bathurst Inlet to Contwoyto Lake area is found within a zone of continuous permafrost, permafrost was not found in all surficial materials (Table 2.3-1).

Table 2.3-1
Surficial Materials Associated with Permafrost Processes

Surficial Material	Permafrost Process
Moraine	Patterned ground, frost-heaving, solifluction, cryoturbation
Glaciofluvial	Cryoturbation, frost-heaving
Marine	None
Lacustrine	Cryoturbation, solifluction
Fluvial	None
Residual bedrock	Frost wedging
Organic	Frost-heaving, ice and clay lenses

2.3.2.1 Patterned Ground

Most patterned ground phenomena occurs in the active layer of soil which is a zone that thaws each summer and refreezes each autumn as it fluctuates above and below 0^{o} C. Patterned ground may include stone circles, raised turf mounds, and boulder fields and belts (Plate 2.3-1). Stone circles occur when vertical and lateral frost heaving forces rocks to the surface and into circles.

Other permafrost features that occur on morainal landforms in the Project area include boulder belts and fields. In the study area, boulder belts are generally found on upland topography and take the form of nonsorted stripes. Highly eroded boulder fields are common on lower slope positions adjacent to lakes or in depressional topography.

Plate 2.3-1. Boulder field (Geowest, 2003).

2.3.2.2 Frost Creep and Solifluction

Frost creep and solifluction describe the movement of soil particles downslope. Frost creep is the ratchet-like downslope movement of particles as the result of frost heaving of the soil and its subsequent settlement upon thawing. Movement associated with frost creep decreases from the surface downwards. Solifluction is a general term for mass wasting and it describes the slow downward flow of saturated, unfrozen soil material.

2.3.2.3 Mudboils

Mudboils develop on poorly sorted sediments (mud) with a significant silt or clay content (Plate 2-3.2). They consist of rounded to elongated patches of bare soil one to three metres in

diameter. Natural moisture contents are near the liquid limit so muds liquefy and flow readily in response to slight changes in moisture content or slight internal or external stresses. When downslope movement cannot relieve the stresses, mud may burst through a semi-rigid surface layer to create a mudboil.

Plate 2-3.2. Mudboil (Geowest, 2003).

The occurrence of these "jelly-like" conditions in soils was found in lacustrine, glaciolfluvial, and morainal materials. These sites were characterized by having well to poorly drained silty and sandy textures, a low (<25%) coarse fragment content, groundwater seepage, and active permafrost processes (*i.e.*, cryoturbation and solifluction). Jelly-like soils are super-saturated and tend to flow when disturbed.

2.3.2.4 Skin Flows

Skin flows or detachment failures are attributed to saturated soil conditions and high porewater pressure. They are the result of thaw consolidation. These can occur as mudflows or direct slumps. This rapid mass movement may also occur in the active layer with the permafrost table acting as a lubricated slip plane. The permafrost table, therefore, controls the depth of the failure. Skin flows occur particularly during summer or following a disturbance to the soils or vegetation.

2.4 Contaminated Sites in the Project Area

Development and non-traditional land use increased in the northern region of Canada after World War II. In particular, military facilities, exploration camps, mines and industrialized

communities were developed in the West Kitikmeot region. These developments led to issues related to contamination of sites with garbage, construction debris, un-used fuels, and anthropogenic chemicals.

The BIPR road passes through areas that have been impacted by human development. This section provides an overview of the contaminated sites identified within 20 km of the proposed road route and port location. Contaminated sites in the region have been identified and characterized by the Contaminated Sites Directorate (CSD) under Indian and Northern Affairs Canada (INAC).

The CSD manages contaminated sites located on Crown Land in Nunavut that fall under INAC control (http://www.ainc-inac.gc.ca/nu/nuv/cts_e.html). The Directorate is responsible for assessing these sites and managing their clean-up and maintenance on a priority basis.

2.4.1 Sources of Information on Nunavut Contaminated Sites

A contaminated sites database was developed for the Canadian North by INAC in 2002. This database contains over 2,000 waste sites. Some of these sites are contaminated with refuse and debris, but are not necessarily chemically contaminated; and others are sites that are contaminated with PCBs, mercury, heavy metals, *etc*.

The database of contaminated sites for Nunavut contains historical information collected from various sources (public, private, government, *etc*.). Much of the historical data available for the West Kitikmeot was collected during the West Kitikmeot community mapping project (undertaken by the Nunavut Planning Commission Transition Team in the 1990s). The CSD is currently in the process of verifying these historical records and conducting assessments of the contaminated sites. This process is scheduled to be completed in 2012 (*pers comm*. Natalie Plato, P.Eng., Director, Contaminated Sites Program, INAC).

The procedure used by the CSD to identify and assess the environmental impact of these sites is described in the Federal Approach to Contaminated Sites (CSMWG, 1999). Site assessments are conducted in accordance with CAN/CSA Z768 Phase I Environmental Site Assessment (CSA) 1994 and CAN/CSA Z769 Phase II Environmental Site Assessment (CSA) 1998.

2.4.2 Identified Contaminated Sites

This enumeration of contaminated sites in the Project Area is provided at NIRBs request in the Guidelines for this Project. The contaminated sites identified by INAC near the road and port are illustrated in Figure 2.4-1 and listed in Table 2.4-1. Only those contaminated sites within 20 km of the proposed development are considered relevant to the environmental setting, the other sites are listed for completeness. Table 2.4-1 also lists the year of scheduled assessment. This gives an indication of the timing and degree of certainty for the identification of potential contaminants of concern.

Six sites identified by INAC as contaminated are located within 20 km of the road and port. These sites varied in land use from fuel caches, to airports, to camps.

Table 2.4-1
Characteristics of Contaminated Sites Near the Proposed Development

Site	Year Assessed or of Planned Assessment	Site Description	Land Tenure	Latitude (°)	Longitude (°)	Distance from Development (km)
WK118	**2010**	**FUEL CACHE**	**Inuit Owned Land**	**65.4833**	**-110.167**	**1.3**
WK116	**2010**	**CAMP, FUEL CACHE**	**Inuit Owned Land**	**65.4736**	**-110.352**	**8.2**
WK117	**2010**	**AIRPORT**	**Inuit Owned Land**	**65.4744**	**-110.375**	**9.3**
WK121	**2010**	**UNKNOWN**	**Inuit Owned Land**	**65.5944**	**-110.347**	**15.8**
WK072	**2010**	**CAMP, FUEL CACHE**	**Inuit Owned Land**	**65.6277**	**-110.225**	**17.5**
WK155	**2010**	**UNKNOWN**	**Inuit Owned Land**	**66.2411**	**-107.365**	**17.6**
WK023	2004	CAMP, FUEL CACHE	Crown	65.2680	-109.382	21.2
WK119	2010	UNKNOWN	Inuit Owned Land	65.5792	-110.564	21.6
WK120	2010	CAMP	Inuit Owned Land	65.5778	-110.619	23.7
WK024	2004	UNKNOWN	Crown	65.2388	-109.378	24.4
WK060		FUEL CACHE	Crown	66.8167	-107.567	30.8
WK026	2010	CAMP	Crown	66.5333	-108.633	44.7

Note: Sites indicated in bold are located within 20 km of the BIPR road and port development.

Fuel caches and airports represent sources of possible petroleum-based hydrocarbon contamination including jet fuel, diesel, gasoline, *etc*. Camp locations are also possible sources of petroleum-based hydrocarbons including heating oil tanks, generators, and the fuel caches used as supply depots. Camp locations have the potential to have other waste streams associated with biological waste, construction debris, and domestic garbage. The sites that are identified as unknown (WK121 and WK155) presents an even larger degree of uncertainty as no information is available as to the nature of land use and potential contaminants.

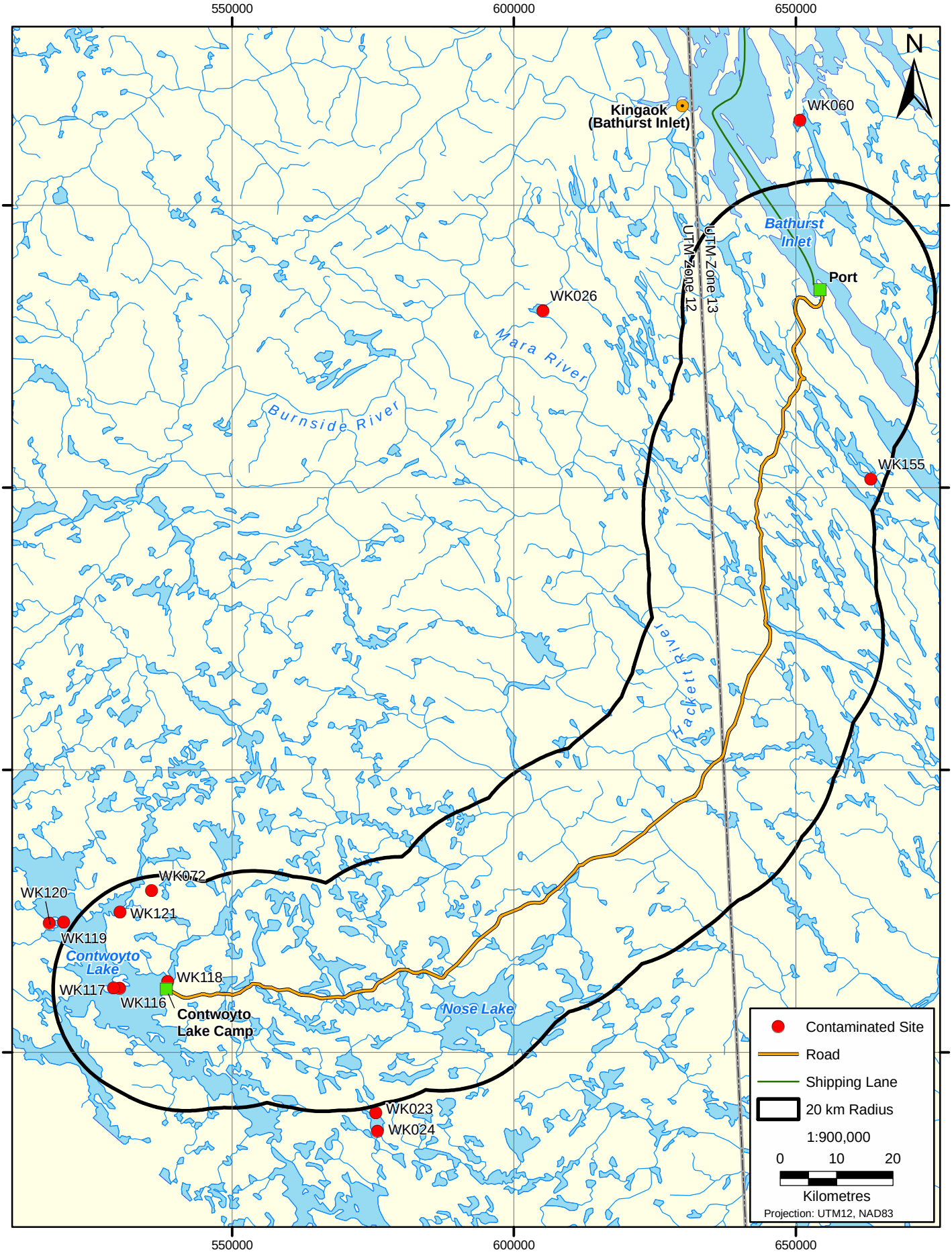


FIGURE 2.4-1

Locations of Contaminated Sites near the BIPR Project

3. EFFECTS ASSESSMENT METHODOLOGY

3. Effects Assessment Methodology

This effects assessment follows a detailed methodology, which includes information on all Project activities and definitions to table headers, that is outlined in Appendix A-5 of the DEIS. Information used to evaluate the Project effects on bedrock, surficial materials, and soils was gathered from two baseline reports (Geowest, 2003; Appendix D-5 of the DEIS). These reports characterize bedrock geology, surficial geology, soils, ecosystem mapping, and permafrost features within the study area.

The effects assessment requires the identification of valued ecosystem components (VECs), the establishment of spatial and temporal boundaries, and the assessment of the Project on these. The following is a description of the VECs, boundaries, and approaches and methods used to carry out the effects assessment.

3.1 Valued Ecosystem Component Selection

The selection of VECs associated with bedrock, surficial materials, and soils was based on the review of baseline study results and the Project description. Two VECs have been identified:

- soil quality; and
- permafrost.

Soil quality is recognized as a VEC since soils support ecosystems, vegetation, and wildlife VECs. The potential of soils to support these VECs is dependent on the preservation of their physical, chemical, and biological properties through good management practices. Some soils are also particularly sensitive to disturbance and their identification is necessary in order to develop appropriate handling methods.

Permafrost is also recognized as a VEC. Disturbance to permafrost has implications in terms of foundation stability and climate change, as melting can result in the release of carbon dioxide (CO_2).

3.2 Boundaries

Boundaries were derived from reviewing the proposed development plans, taking into account the different degrees of terrain alteration (disturbance levels) that are anticipated to occur, and the expected duration of the Project.

3.2.1 Spatial Boundaries

Spatial boundaries were created based on anticipated alteration related to Project development activities. The level of soil disturbance will vary according to the activity associated with each infrastructure type. However, the disturbance will occur only at the local level and not at the regional level. Thus, the effects assessment for soil quality and permafrost is only conducted at the local level.

3.2.1.1 Port Site

The port site will occupy approximately 48 ha (Figure 3.2-1). Infrastructure will include: a wharf, a 200-person camp with services, a 220 million litre fuel tank farm, a diesel power plant, ammonium nitrate storage, sedimentation ponds, a truck and trailer maintenance shop, a sewage treatment plant, a fuel dispensing area, a heliport, and an airstrip. The airstrip will be approximately 1,200 m in length and 70 m wide (60 m airstrip bed and 5 m of edge on either side).

Also included within the port site study area is a <1 ha area that will be used as a landfill/soil stockpile area and a small section (~ 2 km) of the road down to No Name Creek. The road width will total 23 m. This will include 13 m of road bed and 5 m of road edge on either side. Road edges are included within the assessment since soils adjacent to the road bed will be disturbed with the construction and operation of the road bed. Pullouts will be located along the road every 1 km and will alternate sides. Pullouts will be 4 m wide and 50 m long. Three quarry sites or borrow pits (herein termed 'a quarry') are also located within the Port Site.

3.2.1.2 Road

The Project area includes the road and Contwoyto Camp (Figure 3.2-2). The road between No Name Creek and Contwoyto Camp will be approximately 211 km long. The footprint of the road, pullouts, and quarry access roads are the same across the Project as discussed in Section 3.2.1.1. Thirty-nine quarry sites are located along the road.

Contwoyto Camp will occupy approximately 1.45 ha. This will be a 20-person camp and include services and a truck-parking area.

3.2.2 Temporal Boundaries

The Project has an approximate planned life of 24 years. This includes a two-and-a-half year construction period and a 20-year operation and maintenance period. Decommissioning and closure are expected to take an additional two years. Some potential effects (*e.g.*, ARD) could extend into post-closure and may need to be continuously monitored far into the future.

3.3 Approach and Methods

The nature and extent of the potential effects are described in order to identify the need for suitable mitigation, management, and monitoring programs. Quantitative data were used wherever possible but when not available effects were described based on professional expertise and best professional judgement. There are soils within the Project area that have been classified as Undefined because they were outside of the mapping boundary. They have been included in the effects assessment since these soils may also be affected.

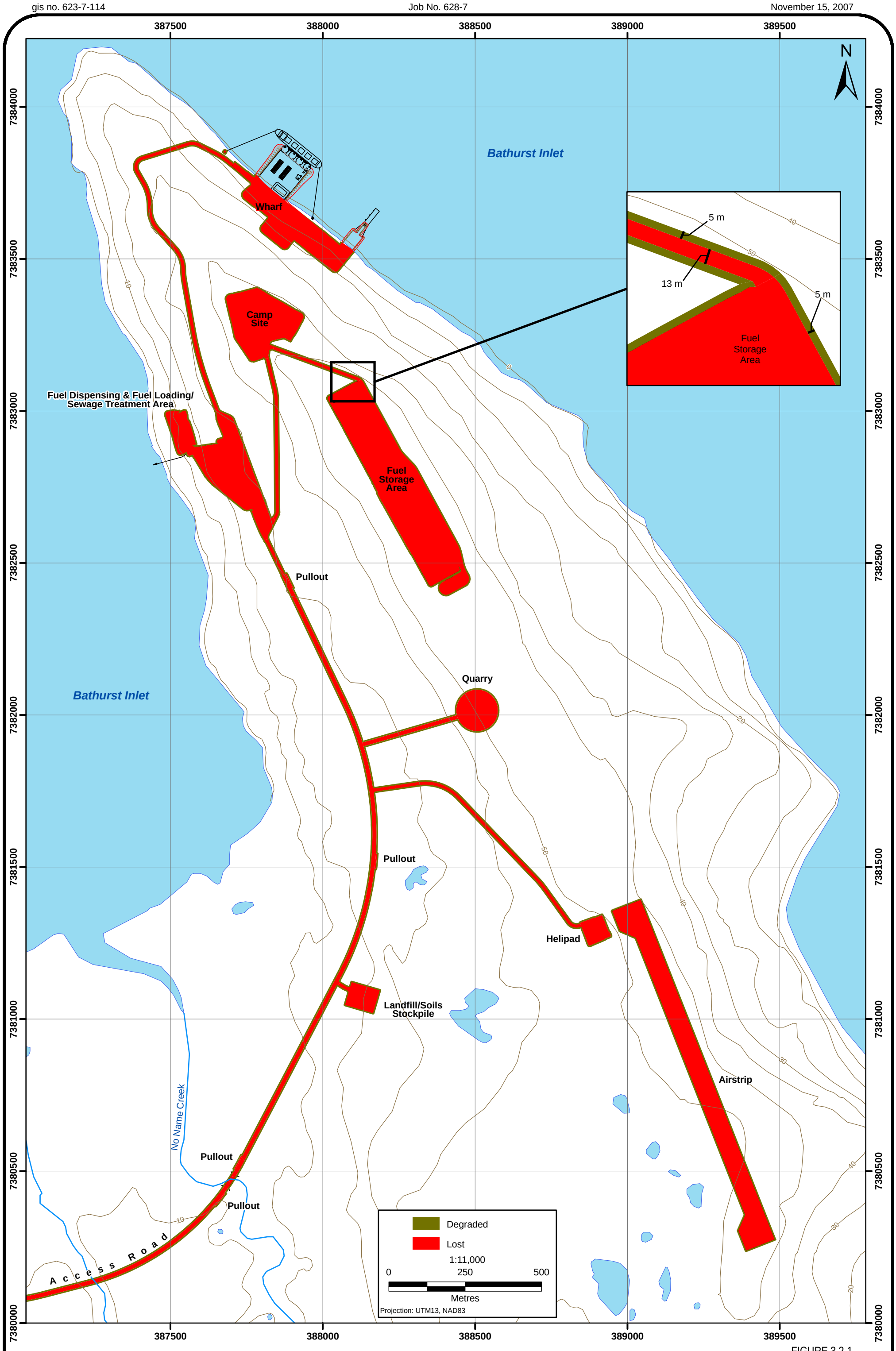
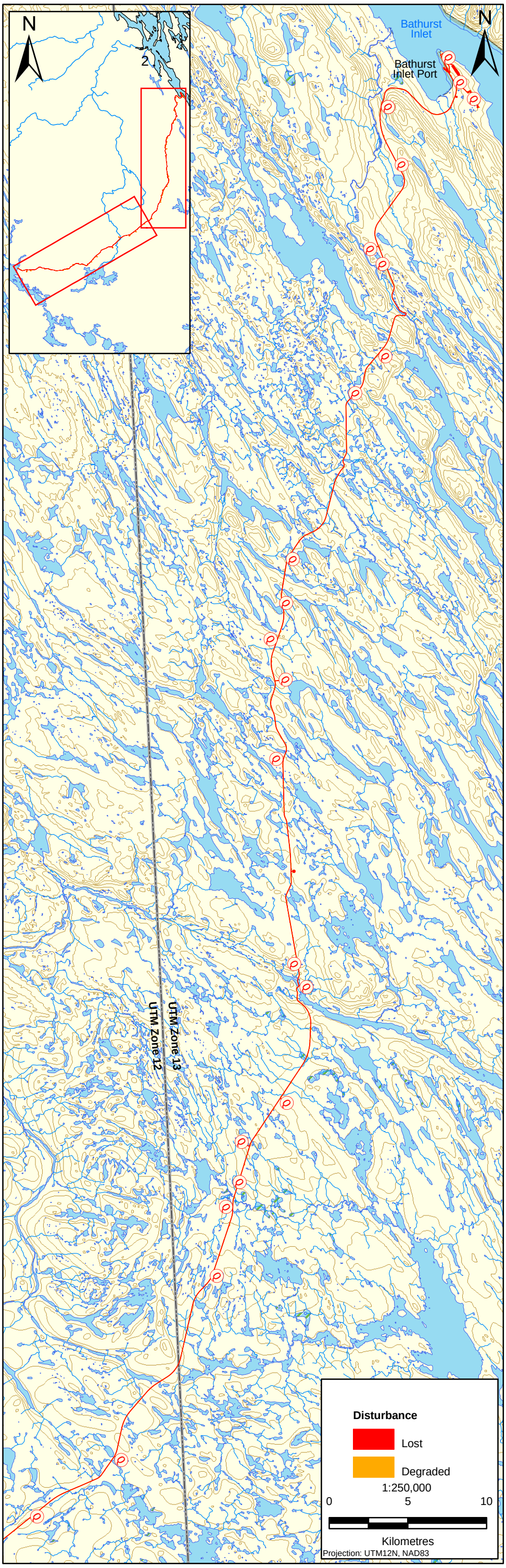


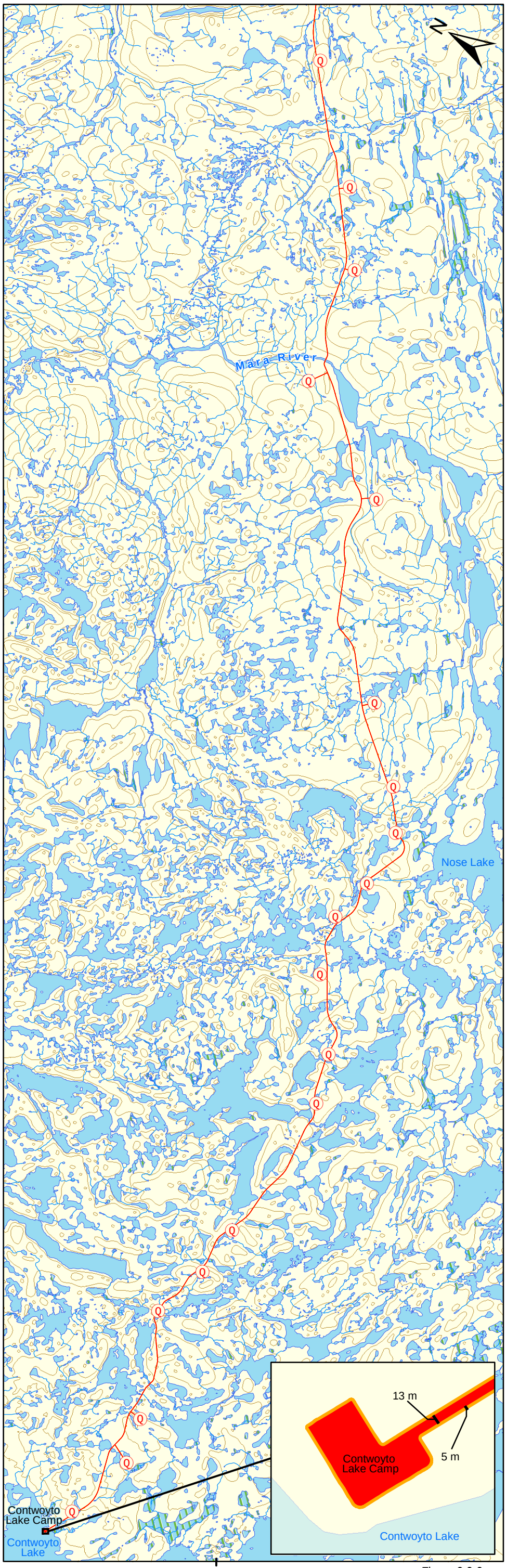
FIGURE 3.2-1

Footprint of Port Study Area

the Bathurst Inlet Port and Road Project

Rescan™





the Bathurst Inlet Port and Road Project

Footprint of Road Study Area

Figure 3.2-2

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4. EFFECTS ASSESSMENT

4. Effects Assessment

4.1 Identification and Description of Potential Project Effects

The potential effects related to bedrock, soil quality, and permafrost for each Project component and phase are discussed in the following section.

4.1.1 Bedrock

Sulphides were noted in the bedrock along the road at kms 102 and 104 (Appendices D-4 and D-5 of the DEIS). If the surfaces of these areas are exposed during construction, they could potentially result in acid generation. Acid generation can adversely affect soils and consequentially vegetation and any waterbodies that could receive acidified water. The area around the south western end of the proposed road, between Quarry 23 and 39, also indicated ARD and ML potential (Morin and Hutt, 2007).

4.1.2 Soils

Activities associated with each temporal stage of the Project have the potential to create adverse effects on soil by altering baseline conditions. Within the study area, two levels of soil disturbance (lost and degraded) have been used to indicate the Project's potential effects on soil quality.

4.1.2.1 Soil Loss

The most severe effect on soils has been termed "lost." This term describes the covering or removal of soils with permanent infrastructure such as the road surface, quarries, and structures such as the fuel tank farm.

4.1.2.2 Soil Degraded

Areas where the degree and extent of soil disturbance is expected to be lower have been termed "degraded." Soil degradation describes soils that are disturbed for the Project. These include the road edges and soils affected during the construction of the facilities. These effects on soils include: soil compaction, erosion (wind and water), decreased soil fertility, and contamination.

Soil Compaction

Soil compaction is the reduction of pore space between soil particles. Smaller pores in the soil limit the amount of water and nutrients available to the plant roots. Compaction also interferes with root penetration and limits living spaces for invertebrates. These effects may lead to reduction in plant establishment and growth. Compaction may also reduce surface water infiltration, increasing the amount of runoff.

Soil Erosion

Soils may be susceptible to wind erosion when vegetation is removed and soils are dry. If this occurs, the fertile surface soils may be lost, exposing less fertile materials. Exposed loose, coarse textured materials may result in severe damage to adjacent vegetation through sandblasting and may result in an excessive amount of sediment entering waterways. This may affect fish populations and water quality.

Soils which have had vegetation removed are also particularly sensitive to water erosion. They may be susceptible to splash erosion which can result in a loss of soil structure with the effect of sealing off the surface, thereby, preventing root penetration and seedling development. A large amount of soil can be lost and slope failure can occur during high rainfall events on steeply sloping, bare slopes. With failures, fertile surface soils and the landform may be lost.

Soil Fertility

The fertility of a soil is measured by the quantity of nutrients for plant growth. If fertility is altered, a dramatic change may occur to vegetation and microbial populations that are important in nutrient cycling.

Soil Contamination

Contaminated soils are those that contain metals or hydrocarbons in amounts that have negative effects on the environment. Common sources of contaminants are lubricants, oil, fuel from vehicles, metals in road dust, and road runoff. Depending on the nature of the contamination, the soils may/may not be reclaimed.

4.1.3 Permafrost

Disturbance of the surface soils may result in permafrost melting. This can have a direct impact on the physical stability of structures located on them as soils melt, they may flow or lose their structural integrity. As well, melting of the permafrost can expose organically enriched soils to increased decomposition which can result in the release of CO_2.

4.2 Effects Assessment

The Project will directly affect approximately 415 ha of land, potentially resulting in the loss of 363 ha of soils (not including boulder fields, residual bedrock, rock, and undefined material). It will indirectly affect a further 245 ha potentially degrading roughly 225 ha of soils (not including boulder fields, residual bedrock, rock, and undefined material) (Table 4.2-1). Approximately 60% of land that will be directly disturbed are of morainal origin and 65% of the degraded area will also be morainal material. The morainal materials in the Project area vary in depth from thin veneers (2 to 20 cm thick) over bedrock to blanket deposits (>1 m thick). Morainal veneers can be found in small pockets in between bedrock outcropping.

4.2.1 Port Site

The port site includes the airstrip, three quarries, a road, camp, landfill/soil stockpile, fuel storage and sewage facilities, helipad, wharf, and pullouts.

4.2.1.1 Construction Phase

During the construction phase, the main activities that will affect soils include: clearing and levelling the site for on-land facilities; constructing the camp, service and maintenance shop; and constructing the gravel airstrip. As a result, the total area expected to be affected from construction is approximately 48 ha; 38 ha may be lost and the remaining 10 ha may be degraded (Table 4.2-2).

Table 4.2-1
Surficial Material and Bedrock Disturbance Associated with the Project Footprint

Material	Lost		Degraded	
	Area (ha)	Area (%)	Area (ha)	Area (%)
Boulder field	3.2	1	2.3	1
Colluvium	1.1	<1	0.8	<1
Fluvial	7.7	2	5.9	2
Glaciofluvial	34.2	8	19.4	8
Lacustrine	17.5	4	12.4	5
Marine	39.2	9	12.5	5
Morainal	241.1	58	157.5	64
Organic	23.1	6	17.0	7
Residual	0.7	<1	0.5	<1
Rock	26.1	6	11.2	5
Undefined	21.6	5	5.1	2
Total	**415.3**	**100**	**244.5**	**100**

Table 4.2-2
Surficial Material and Bedrock Disturbance Associated with Port Site Construction

Infrastructure	Material	Area (ha)	Area (%)
Lost			
Airstrip (including a quarry)	Marine	5.74	12
	Undefined	2.18	5
Bathurst Inlet Camp	Marine	3.75	8
Landfill/Soil Stockpile	Marine	0.78	2
Facility	Marine	<0.01	<1
Fuel Storage	Marine	9.87	20
	Organic	0.45	1
Fuel Storage/Sewage	Marine	4.58	9
	Undefined	0.48	1
Helipad	Marine	0.62	1
Port (including a quarry)	Marine	2.00	4
Pullout	Marine	0.03	<1
	Morainal	<0.01	<1
	Organic	0.01	<1
Quarry	Marine	1.47	3
Quarry Access	Marine	0.42	1
	Organic	0.01	<1
Road	Marine	5.17	11
	Morainal	<0.01	<1
	Organic	0.41	1
	Undefined	0.25	1
Subtotal		**38.22**	**79**
Degraded			
Airstrip Edge	Marine	0.96	2
	Undefined	0.37	1

(continued)

Table 4.2-2
Surficial Material and Bedrock Disturbance Associated with Port Site Construction (completed)

Infrastructure	Material	Area (ha)	Area (%)
Facility Edge	Marine	2.85	6
	Open Water	0.03	<1
	Organic	0.03	<1
	Undefined	0.11	<1
Quarry Road Edge	Marine	0.53	1
	Organic	<0.01	<1
Road Edge	Marine	4.58	9
	Morainal	<0.01	<1
	Organic	0.31	1
	Undefined	0.25	1
Subtotal		**10.01**	**21**
Total		**48.23**	**100**

Soils located within the port site study area are predominantly marine (>90%), followed by organic and morainal materials. The most susceptible marine soils to degradation are located at higher elevations. These soils are silty-loam and loam in texture and have a low coarse fragment content. They are subject to compaction, particularly when wet, to wind erosion when dry and water erosion, when denuded of vegetation. The potential effects may be reversible and short-term if mitigation strategies are implemented directly after the construction stage. Mitigation techniques for erosion will require revegetating the area affected and using erosion cloth for short-term requirements (techniques such as the use of straw bails and silt fences may be required to prevent eroded sediments from entering the ocean). Mitigation for compacted, bare soils includes ripping and revegetation. With mitigation, the effects will likely be **Low** and will likely extend for the length of the project as the climate is harsh and vegetation is slow growing.

The overall adverse effect of soil loss in the construction phase for the port site will require mitigation and enhancement techniques at closure. These techniques will involve ripping, applying salvaged material, and revegetating the area. Even if applied properly and within a suitable timeframe, the residual effect may result in degradation of soil quality. Degradation of soil quality has a high probability of occurrence at a local extent. The frequency will be once but the duration will be far into the future. This is reversible in the long term but it will be at a low ecological context until the quality improves. The effect is **Moderate** in significance (Table 4.2-3).

4.2.1.2 Operation and Maintenance Phase

The majority of soil disturbance associated with the development of the port site occurs one-time in the construction stage. However, there are activities at this phase (*i.e.*, fuel storage and dispensing fuel to haulage vehicles) that may affect soils such that they become contaminated with fuel. All soil types are susceptible to soil contamination if a fuel spill occurs. Mitigation

Table 4.2-3
Summary of Effects Assessment for Soils

Description of Potential Effect					Mitigation and Enhancement	Evaluation of Residual Effect										
Description	**Project Phase (Timing)**	**Project Component**	**Direction**	**Nature**	**(Design Changes, Management, Monitoring, Compensation, Enhancement)**	**Description of Residual Effect (after mitigation)**	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological Context (Resilience)**	**Influence on Resource Capacity**	**Probability of Occurrence**	**Significance**	**Confidence Limit**
Soil Loss	Construction	Port and Road	Adverse	Direct	Reclamation at closure (ripping, applying salvaged material, revegetation), clean up spills immediately, maintain equipment and vehicles.	Degradation of soil quality, some soil may be lost	High	Local	Far future	One Time	Long-term	Low	Low	High	**Moderate**	Intermediate
Soil Loss	Operations to Decommissioning	Port and Road	Adverse	Direct	Clean up spills immediately, maintain equipment and vehicles.	Degradation of soil quality, some soil may be lost	High	Local	Far future	One Time	Long-term	Low	Low	High	**Moderate**	Intermediate
Soil Degradation	Construction to Decommissioning	Port and Road	Adverse	Direct	Install liners under stationary equipment and storage areas used for heavy equipment, clean up spills immediately.	Degradation of soil quality	Moderate	Local	Long-term	Sporadic	Short-term	Low	Low	High	**Low**	Intermediate
Permafrost Melting	Construction to Decommissioning	Port and Road	Adverse	Direct	Backfilling exposed permafrost with material similar to that which have been extracted and placed at a similar bulk density, minimize the spreading of side cast soil on the snow, and insulate the bottom of all structures.	Melting permafrost	Low	Local	Far-future	One Time	Long-term	Low	Low	Moderate	**Low**	Intermediate

techniques for vehicle contamination will require the placement of liners under stationary equipment and storage areas that will be used for heavy equipment. Also, cleaning up spills immediately after they occur and maintaining equipment and vehicles reduce the potential effects of contamination. Degradation of soil quality due to fuel contamination will likely be a residual effect after mitigation. This has a high probability of occurrence, and a low magnitude at a local extent. The frequency will be sporadic with a short duration and the effects are reversible in the short term. The significance level is rated as **Low**.

4.2.2 Road

The road will be approximately 211 km long, extending from the port site to Contwoyto Camp.

The road, pullouts, and quarries will be the same dimensions as in the port site. Thirty-nine quarry sites are located along the road between the port site and Contwoyto Camp. Access to the quarries will be on roads of various lengths, dependent on the quarry distance from the road, but will be 23 m wide; 13 m road bed and 5 m of road edge on either side.

The road terminates at Contwoyto Camp. Contwoyto Camp occupies approximately 1.45 ha. It will include a 20-person camp plus services and a truck-parking area.

4.2.2.1 Construction Phase

Activities that will affect the soils during construction of the road include: extracting and crushing road construction material from quarries, construction of the road and pullout bases, and levelling the site for camp and associated facilities. The total area expected to be affected from construction is approximately 612 ha. Of this, 377 ha may be directly affected and 235 ha may be indirectly affected along the road, and at the quarries (Table 4-2.4). At Contwoyto Camp, 1.45 ha may be lost and 0.27 ha may be degraded.

As a result of these activities, soils along the road beds (including the main road and quarry access roads), pullouts, quarries, and areas within the boundary of the camp facilities have a potential to be lost.

A total (lost plus degraded soils) of 398 ha of morainal materials and 35 ha of glaciofluvial soils will be affected within the road study boundary. The predominantly coarse texture of these materials makes them somewhat more resilient to soil compaction from heavy machinery than the finer textured lacustrine material that covers approximately 18 ha within the road study boundary. However, morainal deposits that are silty clay in texture and have low coarse fragments will also be susceptible to soil compaction.

The soils disturbed during construction activities can be mitigated immediately. The intensity of mitigation will depend on the level of disturbance and may range from benching quarry slopes, to applying salvaged topsoil, to ripping such as in compacted areas and quarry bottoms, and revegetation with native seed. If carried out properly, the effects may be **Low** and will likely extend for the length of the project as recovery as plant establishment and growth is generally slow in this climate.

Table 4.2-4
Surficial Material and Bedrock Disturbance Associated with Road Construction

Infrastructure	Material	Area (ha)	Area (%)
Lost			
Contwoyto Camp facility	Morainal	1.45	<1
Pullout	Boulder field	0.05	<1
	Colluvium	0.02	<1
	Fluvial	0.29	<1
	Glaciofluvial	0.46	<1
	Lacustrine	0.27	<1
	Marine	0.09	<1
	Morainal	3.12	1
	Organic	0.34	<1
	Rock	0.16	<1
	Residual	0.01	<1
Quarry	Fluvial	<0.01	<1
	Glaciofluvial	10.14	3
	Lacustrine	1.17	<1
	Morainal	36.12	10
	Organic	0.32	<1
	Rock	12.78	3
	Undefined	15.76	4
Quarry road	Boulder field	0.02	<1
	Colluvium	0.22	<1
	Fluvial	0.06	<1
	Glaciofluvial	1.28	<1
	Lacustrine	0.92	<1
	Morainal	9.17	2
	Organic	1.14	<1
	Rock	0.85	<1
	Undefined	2.81	1
Road	Boulder field	3.11	1
	Colluvium	0.85	<1
	Fluvial	7.34	2
	Glaciofluvial	22.32	6
	Lacustrine	15.10	4
	Marine	4.71	1
	Morainal	191.19	51
	Organic	20.37	5
	Rock	12.28	3
	Undefined	0.10	<1
	Residual	0.64	<1
Subtotal		**377.34**	**62**

(continued)

Table 4.2-4
Surficial Material and Bedrock Disturbance Associated with Road Construction (completed)

Infrastructure	Material	Area (ha)	Area (%)
Degraded			
Contwoyto camp facility edge	Morainal	0.27	<1
Quarry road edge	Boulder field	0.04	<1
	Colluvium	0.16	<1
	Fluvial	0.06	<1
	Glaciofluvial	2.10	1
	Lacustrine	0.90	<1
	Morainal	12.49	5
	Organic	1.00	<1
	Rock	1.82	1
	Undefined	3.33	1
Road edge	Boulder field	2.26	1
	Colluvium	0.63	<1
	Fluvial	5.86	2
	Glaciofluvial	17.34	7
	Lacustrine	11.45	5
	Marine	3.58	2
	Morainal	144.70	62
	Organic	15.67	7
	Rock	9.37	4
	Undefined	1.06	<1
	Residual	0.47	<1
Subtotal		**234.56**	**38**
Total		**611.90**	**100**

The overall adverse effect of soil loss in the construction phase will require more intensive mitigation and enhancement techniques at closure. These techniques will involve ripping, applying salvaged material, and revegetating the area. Even if applied properly and within a suitable timeframe, the residual effect may result in degradation of soil quality. Degradation of soil quality has a high probability of occurrence and a moderate significance at a local extent. The frequency will be once but the duration will be far into the future. This effect is reversible in the long term but it will be at a low ecological context until the quality improves. The resulting residual effect will be **Moderate** (Table 4.2-3).

Rock is located on approximately 26 ha of the road study boundary. Although rock is very resilient to construction disturbance, weathering processes such as frost wedging and shattering may result overtime in areas that will be blasted. This may increase the potential of ARD along the road and will need to be monitored and mitigation techniques may be needed. Mitigation for ARD contamination may include such techniques as liming and covering the bedrock.

4.2.2.2 Operation and Maintenance Phase

Similar to the port site, the majority of activities that will adversely affect soils will occur within the construction phase of the Project. However, the continuous use of the road may result in contamination of the road bed and edges with lubricants, oils, grease, and metals from the trucks deposited as dust or from road runoff. This may result in a gradual contamination of the soils along the road bed edges and little mitigation can be carried out for this contamination. Good management practices such as ensuring regular maintenance of vehicles should reduce this soil contamination. The effects will be irreversible and the probability of occurrence is high. However, the magnitude and significance will likely be **Low** and will affect the local area only. The duration of contamination will likely extend for the life of the Project and will occur continuously with road use (Table 4.2-3).

Potential contamination of soils with lubricants, grease, *etc.*, in areas of equipment and vehicle storage including parking areas can be minimized by the use of liners under these stationary equipment and storage areas. Also, cleaning up spills immediately after they occur and maintaining equipment and vehicles are management techniques that will reduce the potential for contamination. With these mitigation measures, the residual effect should be **Low** and reversible (Table 4.2-3).

4.2.3 Permafrost

Permafrost occurs throughout the Project area. Melting of permafrost can result in the loss of the soils structural integrity, potentially affecting road and building foundations. It can also result in the formation of sinkholes and surface collapse. Therefore the minimization of disturbance to permafrost is very important.

4.2.3.1 Construction

As permafrost is continuous throughout the Project area, any activities that require excavation of the active layer over the permafrost (the layer that thaws during the summer months) or the permanently frozen soils, can expose the underlying frozen soils to unusually warm conditions. Most of the buildings that will be located in the Project area do not have excavated foundations. The major opportunity for disturbance to the permafrost will be in the construction of parts of the Port Site, Contwoyto Camp, and possibly other areas where the soils will be salvaged for reclamation purposes. Mitigation, such as backfilling exposed permafrost with material similar to that which have been extracted and placed at a similar bulk density, should reduce the potential of exposing the permafrost to warming and limit the amount of degradation. As well, during road excavation in the winter months, deposition of side cast soil onto the snow can result in melting the snow as it may absorb heat. This may have a detrimental affect on the permafrost. Therefore, minimizing spreading of side cast on the snow will reduce the potential to affect the permafrost.

The melting of permafrost is predicted to have a high magnitude and will likely extend for the medium term. This effect is predicted to have a moderate probability of occurrence. The significance level is predicted to be **Low** (Table 4.2-3).

4.2.3.2 Operation and Maintenance

Permafrost may be subject to degradation during the operation and maintenance stage. To minimize the potential of degradation, all structures should be well insulated at the bottom to minimize heat loss from below the structures where it can migrate downward and heat the soils. As well, minimizing the amount of soil side cast onto the snow will reduce the potential to affect permafrost.

Similar to the construction phase, the melting of permafrost at the operation and maintenance phase has a high magnitude that will likely be medium term in duration *i.e*. extend for the duration of the Project.. This has a moderate probability of occurrence. The significance level is predicted to be **Low** (Table 4.2-3).

4.2.4 ARD/ML

The potential effects of ARD/ML on watercourses is discussed within the Water Quality Section (Appendix C-2, Section 6, of the DEIS).

5. MITIGATION AND MANAGEMENT PLANS

5. Mitigation and Management Plans

The construction and operation of the Project may result in the loss and degradation of soils, in the exposure of acid generating bedrock which could potentially affect soil (and water) quality, and in permafrost melting. Management practices during the construction phase will be different from those in the operations phase. Careful management in the construction phase will reduce the level of management and mitigation required (and associated costs) in the operations phase.

The following is a description of the main areas of concern related to the Project:

- loss of soils where covered with roads, buildings, facilities associated with the camps and port, and other infrastructure including the fuel storage, parking areas, and quarry sites;
- edge effects on soils;
- water and wind erosion of soils;
- soil compaction;
- loss of soil fertility;
- soil contamination related to construction and maintenance equipment as well as to vehicle use;
- soil (and water) contamination from ARD and ML; and
- degradation of permafrost

This section provides an overview of the management plans related to these concerns. They include soil management plans, a permafrost management plan, and an ARD/ML plan. These plans focus on reducing the effects of the eight main areas of concern listed above. They describe measures to reduce the likelihood of adverse effects and, where a disturbance is unavoidable, to minimize the magnitude of any effects over the short and long term.

5.1 Soil Management Plans

Soils will be disturbed by all components of the Project during the construction and operations phases. The soils may be buried, mixed, or salvaged for later rehabilitation. Mixing of the soils can result in a dilution or loss of the surface organically and nutrient rich surface materials. The reduction in fertility and productivity due to erosion occurs when the organically enriched surface materials are lost exposing the underlying infertile subsurface soils (Lal, 2001). Eroded materials can be deposited into/onto adjacent resources (*e.g.*, waterways), thereby degrading them.

The following soil management plans have been developed to reduce the opportunity for a negative impact to occur on the soils and to minimize short- and long-term impacts where disturbance will occur: They are offered as recommendations to serve as mitigation measures.

- Soil Erosion Management Plan;
- Soil Contamination Management Plan;

- Soil Handling Management Plan; and
- Permafrost Management Plan.

The proposed plans address concerns identified in the Environmental Effects Assessment (Section 4).

5.1.1 Soil Erosion Management Plan

5.1.1.1 Objectives

Roughly 80% of the road traverses topography that is level to very gently sloping (0% to 5%) with the remainder occurring on slopes ranging from 6% to 26% with less than 0.2% occurring on slopes greater than 26%. The Contwoyto Camp area is level. There are more slopes in the port area with approximately 50% occurring on slopes between 0% and 5% and the remainder on slopes between 6% and 26%. The fuel storage/sewage and wharf/port area at Bathurst port (Figure 3.2-1) will be located on sloping topography. Steep areas such as along river banks and long, steep cut slopes of quarry facilities are particularly susceptible to water erosion. Erosion of quarry and river banks can result in bank failure.

The objectives of the Soil Erosion Management Plan are to reduce the potential for surface erosion and provide mitigation measures where it may occur.

5.1.1.2 Design Considerations

Where possible the road and other facilities have been designed to minimize vegetation and soil disturbance. The most successful means of reducing erosion is minimizing the loss of vegetation.

5.1.1.3 Management Activities

Erosion may occur during construction and following construction if erosion control practices are not implemented. At quarry sites, water and wind erosion may occur during the excavation of the quarry material. Sediment barriers can be used to reduce the potential of particles, generated because of water erosion, from entering waterways. Reducing the amount of exposed soils following completion of quarrying will minimize on-going erosion. To reduce this, most quarries will be developed in bedrock outcrops. Soils suitable for rehabilitation will be salvaged from quarry sites as required prior to quarrying and stockpiled in areas where they will not be disturbed until quarrying is completed. Once the soils become exposed and are subject to erosion, erosion cloth can be used to stabilize the slopes for the short term. Geotextiles, made from natural or synthetic fibres installed directly onto bare slopes have been found to reduce soil erosion (Rickson, 2006). Once the material is taken out of the quarries, the excavated steep slopes of the quarries, and any other cut slopes that expose erodible material, will be resloped and benched to reduce the effective slope length. At closure, the stockpiled soil will be spread on the benches and planted with native seed (see Closure Plan, Appendix G-6 of the DEIS). In quarries, where slopes are very steep, a berm at the top of the quarry edge will be constructed to inhibit wildlife from going over the edge. Quarries will be sited in bedrock. Disturbance of permafrost soils will be avoided to the greatest extent possible.

The slopes adjacent to waterways are of particular concern. During construction, best management practices will be put place to minimize erosion on slopes to ensure generated sediment will not reach waterways. Following completion of bridge construction, the riverbanks will be armoured.

Soils subject to wind erosion will be revegetated as soon as possible to minimize erosion, where possible. As a vegetative cover is critical in preventing wind erosion, every effort will be made to minimize its removal or disturbance. It will be difficult to reduce wind erosion during the construction of the various facilities. Water trucks will be used to wet particularly dusty areas during the summer months.

The following general practices will be included in the plan:

- Specific sites highly susceptible to soil erosion will be identified on the road plans and at Contwoyto Camp and the port site.
- All creeks downstream of construction sites will be noted.
- Vegetation loss and disturbance will be minimized to reduce the amount of exposed soil.
- Soils slated for excavation suitable for reclamation will be delineated on a map.
- Instructions will be given on the appropriate use and handling of sediment barriers and erosion cloth.
- Employees will be informed of the risks associated with soil erosion when working in erosion-prone areas.
- Culverts will be used to reduce road failure through erosion.

No additional soil erosion will likely occur during operation of the road and facilities. However, dust will be generated from vehicle use on the road during operations. Watering high dust areas or further application of coarse gravels may be required to reduce this.

5.1.2 Soil Contamination Management Plan

5.1.2.1 Objectives

Large vehicles and heavy equipment will be used in the construction of the various facilities. Fuel spills may occur in areas where fuel is stored and dispensed. Contamination from lubricants, such as oil and grease, may occur in parking areas, high traffic zones, and along road edges from runoff. This will have a negative impact on the soils (and potentially waterways) and prevent or hinder rehabilitation. Good clean-up practices and preparation for such events is mandatory. The objective of this plan is to provide a set of protocols in the event of a spill to reduce the negative impact of such an event on the soils and adjacent areas.

5.1.2.2 Design Considerations

The proponent has developed a spill response plan.

5.1.2.3 Management

Soil contamination may occur during the construction and operations phases. Soil contamination will be minimized by:

- using well-maintained equipment to avoid oil, grease, and other lubricant leaks;
- establishing lined equipment storage areas (away from sensitive vegetation types) complete with shovels, spill blankets, and bins for contaminated soils;
- ensuring a well secured and designed area for disposal of contaminated material;
- ensuring spill response and disposal of contaminated soils is carried out properly and promptly; and
- ensuring contractors and personnel are trained and aware of the plan.

5.1.3 Soil Handling Management Plan

5.1.3.1 Objectives

It is expected that the Project will be in use for many generations into the future. Nevertheless, the Project proponent acknowledges that non-renewable resources are finite and that some day the road and associated facilities may no longer be required. Therefore, planning for final closure and abandonment activities of all components is required. The objective of the Soil Handling Plan is to develop a protocol to minimize the loss of fertility and soil structure where soil is to be salvaged and stockpiled. Organic soils require very specific handling procedures due to their poor structural integrity.

5.1.3.2 Design Considerations

Where possible, the proponent will ensure that the soils are handled according to the plan where required. In locations where there is little or no topsoil or where the soils are not supporting vegetation, separation of topsoil and subsoil will not be required.

5.1.3.3 Management

Soils will be handled in the salvage and reclamation stages. Soils will be salvaged as the facilities are constructed, where possible. Reclamation will occur progressively at the Port, Contwoyto Camp, and quarry sites where soils can be salvaged. This will minimize the amount of on-going disturbance and the potential for degradation due to unnecessary exposure of the soils to climatic effects prior to reclamation.

In areas to be excavated where topsoil is 15 cm or thicker, it will be carefully removed and placed in a separate stockpile. Stockpiles will be broadcast fertilized and planted with native seed (Closure Plan, Appendix G-6 of the DEIS).

For reclamation, soils will only be applied to surfaces where sufficient base material occurs and warrants reclamation. Soils will not be spread when they are excessively wet. Compaction of the base material will be assessed and where compacted, will be lightly ripped and planted with native seed.

5.2 Permafrost Management Plan

5.2.1 Objectives

The objective of this management plan is to minimize melting of the permafrost.

5.2.2 Design Considerations

Where possible, the proponent has undertaken to design the road and other facilities to minimize disturbance to the permafrost by avoiding disturbance of the active layer.

5.2.3 Management

Effects on permafrost may occur in the construction phase. They can be minimized by following several practices:

- identification of specific sites with high potential of permafrost (wet and fine textured soils) on the construction plans;
- minimization of disturbance to permafrost;
- informing employees of the importance of avoiding disturbance of permafrost when working in permafrost areas;
- backfilling of excavated areas of exposed permafrost;
- minimizing side-casting of soils materials onto snow during winter construction and road maintenance; and
- use of construction practices that avoid excavation of permafrost soils by utilizing an insulating layer of overfill material except in instances where excavation to bedrock is necessary or cuts to grade are unavoidable. These situations will be uncommon in this project.

5.3 Environmental Geochemistry, ARD/ML, and Drainage Chemistry

This portion of the environmental management plan addresses dissolved inorganic chemical aspects of waters and soil in and below the construction areas. The inorganic chemistry or water and soil quality can be affected by construction activity, so due care is required before, during, and after construction in an area. This includes due care for ARD and ML.

Recent precedents for roads established in Canada include the following:

- successful prosecution under the *Fisheries Act* for ARD/ML relating to a road cut a few metres high and a few hundred metres long;
- visual examination of every horizontal metre of rock cut along dozens of kilometres of road alignment, with sampling and analysis as appropriate;
- major realignment of a highway to avoid disturbance of potentially acid-generating rock;

- special environmental controls and remediation for reactive rock removed from rock cuts and quarries and for broken rock used in the road bed; and
- failure of geologic maps, preconstruction environmental and geologic surveys, and surficial sampling of exposures to reliably identify all geochemically reactive rock.

For this Project, initial pre-construction studies have indicated some potential for ML/ARD, from surficial samples of both rock and unconsolidated materials. Also, any blasting may add species to drainage waters, like nitrate, nitrite, and ammonia to drainage waters.

5.3.1.1 Management

All prospective quarries will be tested for ML/ARD and sources of ML/ARD will be avoided.

Table 5.3-1
Recommended Solid-Phase Analyses for Estimating Effects on Drainage Chemistry

Analytical Package	Included Measurements
US EPA 600-compliant Acid-base Accounting ("Sobek ABA")[a]	Paste pH
	Total sulphur
	Sulphide
	Leachable sulphate
	Sobek neutralization potential
	Inorganic carbonate
	Total carbon
ICP-based Total Elements	Several dozens of metals and other elements
Whole-rock Total Elements	Approximately a dozen elements often representing most of the sample's mass

[a]**ABA includes many additional, calculated parameters based on the results of all analytical packages.**

Before construction, local waters should be analyzed for baseline water quality. In this way, any pre-existing water quality problems would not be attributed later to road construction, and any later construction impacts would be reliably defined. Parameters in the water quality and soil analyses included:

- immediate field measurements of pH and electrical conductivity, plus immediate in-field filtering and/or preservation of laboratory samples;
- general parameters, including laboratory pH, electrical conductivity, alkalinity, acidity, suspended solids, and dissolved solids;
- anions, including sulphate, chloride, and fluoride;
- nutrients, including nitrate, nitrite, ammonia, and phosphorus; and
- cations, total metals, and dissolved metals, including but not limited to calcium, magnesium, sodium, potassium, aluminum, arsenic, antimony, manganese, molybdenum, selenium, zinc.

Detection limits should be at or below applicable water quality and soil objectives and guidelines.

As any substantial amounts of rock or unconsolidated material is disturbed, a geologist or engineer experienced in environmental drainage chemistry and ML/ARD should visually examine the disturbed material and the remaining walls. This visual examination (which requires solid-phase analyses of Table 5.1-1, as well as experience and knowledge, for confirmation) should look for evidence of reactive material, such as:

- sulphide minerals like pyrite that might react quickly when exposed to air and moisture;
- rusty secondary iron staining that might signify already reactive rock;
- other secondary mineral staining that might represent already active ML, such as green staining, often reflecting copper leaching; and
- carbonate minerals like calcite that can dissolve quickly in rainwater and thus release any impurities such heavy metals and other elements into drainage waters.

Any rock showing significant evidence of past, current, or future geochemical reactivity should be collected and submitted for analyses of the parameters listed in Table 5.1-1. Any analytical results indicating a potential problem with future drainage chemistry requires immediate design of remediation procedures such as long-term water treatment. These procedures should be implemented immediately, unless a delay is justified by the analyses.

Before disturbance, local waters should be analyzed for baseline water quality. Then, during construction, local water should be periodically analyzed for the following reasons:

- changes from baseline conditions might indicate some reactive material had not been detected; and
- the success of any implemented remediation efforts would be characterized.

Frequent, inexpensive field measurements of pH and electrical conductivity in local waters, like puddles and seeps, would provide advance warning of any major changes in baseline water chemistry.

6. MONITORING AND EVALUATION

6. Monitoring and Evaluation

The following is a discussion of the recommended monitoring programs that should be carried out to assess the progress of the mitigation plans designed to reduce the effects of the Project. Management plans also require a protocol on reporting, identification of responsible agencies, and a means of gauging the implementation of the plans.

6.1 Soil Erosion

6.1.1 Monitoring

The objective is to monitor the areas exhibiting erosion in order to reduce or halt this phenomenon. Areas recognized as having a potential for erosion will be monitored at the beginning and end of the snow free season to detect signs of erosion. As the success of the erosion control management plan will vary over short distances, sites which are showing signs of erosion will be marked on a map for on-going monitoring. Where erosion is noted, sites will be monitored at the beginning and end of the warm season. Personnel will be instructed on the recognition of the indicators and signs of potential erosion. Monitoring will be carried out every year following snowmelt until sites are stabilized. If erosion is increasing, the site will be treated as it will accelerate if not checked.

Air quality (using snow cores is recommended) and vegetation will be monitored for dust as described in Appendices B-2 and D-1. Based on the findings of the snow core and vegetation dust monitoring program, testing of soil chemistry (pH and metals), may be required (*e.g.*, every five years or as deemed necessary). Changes in soils chemistry will provide an indicator that existing practices may require revision to reduce this effect.

6.1.2 Reporting

Mitigation activities will be recorded in a record book, which will be kept at the office of BIPR Joint Venture Ltd. or other designated site. The size of the area affected by erosion, the length, depth, and number of rills and gullies will be recorded.

Any changes to the monitored sites will be brought to the attention of the Environmental Monitor or other designated person.

6.1.3 Responsibilities

The proponent will ensure that personnel involved in construction and carrying out the mitigation measures are trained. As well, the proponent will ensure that personnel are aware of the plan and that water trucks are available when required for dust suppression in the summer.

6.1.4 Desired Outcomes and Key Performance Indicators

The desired outcome of the soil erosion management plan is that little or no sediment enters waterways, that landforms are stable, vegetation and surface soils remain in place, and dust does not negatively affect soil chemistry. In addition, visual signs of disturbances will be reduced.

An ongoing photographic and written record at strategic locations will be produced annually as a means of measuring changes over time. In summary, the key performance indicators (KPIs) are:

- percent of bare surface;
- area of sheet erosion;
- depth, width, length of rills;
- depth, width, length of gullies;
- area occupied by gullies and rills;
- quantity of sediment in waterways;
- maintenance of soil chemical characteristics; and
- slope/bank stability.

The key indicator of reduced dust generation will be records indicating the maintenance or improvement of air quality. The key indicator of dust generated by vehicles using the road may be an increase in metals and soil acidity. The change would occur gradually over time. In summary, the KPIs for dust control are:

- air quality records;
- condition of vegetative surfaces; and
- soil chemical properties near the road.

The deposition of non-contaminated dust on the soils will not be detrimental.

6.2 Soil Contamination

6.2.1 Monitoring

Fuel and vehicle storage areas will be monitored weekly during construction and operations by designated personnel under the direction of the proponent. The Environmental Monitor or designated person (s) will ensure that contractors and any other personnel are familiar with the plan.

6.2.2 Reporting

The Environmental Monitor or other designated person will keep a record of spills and events. They will keep training current to ensure the equipment operators and other employees are trained in the event of staff turnover. The record will be turned over to regulatory agencies as required.

6.2.3 Responsibilities

The proponent will ensure that the personnel involved in construction are aware of the plan and know the protocol for spill clean up and spill prevention. .

6.2.4 Desired Outcomes and Key Performance Indicators

The desired outcome is little or no soil contamination will occur and the impact of spills will be minimal due to rapid response and effective treatment. The KPIs will be records indicating a low incidence of spills. In summary, the KPIs are:

- number of spills reported;
- area contaminated;
- equipment maintenance records; and
- personnel training records.

6.3 Soil Handling

6.3.1 Monitoring

The stockpiled soils and reclaimed areas will be monitored at mid point of the growing season annually until vegetation has been well established. Areas exhibiting low or no plant establishment will be treated immediately.

6.3.2 Reporting

Personnel designated by the proponent will keep a record of the surface condition of the stockpiled soils and reclaimed area.

6.3.3 Responsibilities

The proponent will ensure that personnel involved in construction are aware of the plan and know the protocol.

6.3.4 Desired Outcomes and Key Indicators

The desired outcome is that erosion is not occurring on stockpiles and a vegetative cover will be achieved such that the soils will be stabilized. With time, native plants should encroach onto the reclaimed sites. The KPIs are increased plant cover and plant species composition consistent with adjacent non-disturbed areas. In summary, the KPIs are:

- percent of bare surface; and
- encroachment and establishment of native vegetation with time.

6.4 Permafrost Management Plan

6.4.1 Monitoring

Sites where the permafrost has been disturbed will be monitored annually in the summer for a minimum of five years and longer if sinkholes, *etc*., occur. Areas where there is evidence of permafrost melting will be ameliorated immediately to halt the acceleration of melting.

6.4.2 Reporting

Inspection reports will be recorded in a record book, which will be kept at the proponent's office or other designated site. A description of findings will be recorded and sinkholes or other signs of permafrost melting will be delineated on a map. All mitigation steps will be recorded in detail. A photo record will assist in the long-term evaluation of the amelioration. Any changes or indications of increased melting, structural instability, or other signs of regression will be closely documented. The proponent will provide guidelines to the Environmental Monitor or designated personnel on reporting requirements.

6.4.3 Responsibilities

The proponent will ensure that the personnel involved in construction and site and road maintenance are made aware of the management plan. The proponent will designate the appropriate personnel to ensure that the contractors and appropriate construction personnel are informed.

6.4.4 Desired Outcomes and Key Performance Indicators

The desired outcome of the permafrost management plan is to reduce permafrost disturbance and to stabilize it if it has been disturbed. The KPIs are:

- stabilization of surface; and
- absence of sinkholes and other indicators of melting.

6.5 Environmental Geochemistry, ARD/ML, and Drainage Chemistry

Management plans have been developed for monitoring the potential effects of ARD/ML on watercourses within the Water Quality Section (Appendix C-2, Section 6, of the DEIS).

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An explanation of the acronyms used throughout this reference list can be found in the *Acronyms and Abbreviations* section.

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Appendix D-3
Wildlife and Wildlife Habitat Effects Assessment

Author: **Rescan Environmental Services Ltd.**
Date: **November 2007**

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Bathurst Inlet Port and Road Project Wildlife and Wildlife Habitat Effects Assessment

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

AAD	Astronomical Applications Department
AVCD	adverse conditioning
ATV	all-terrain vehicle
BBS	Breeding Bird Survey
BC MPC	Bathurst Caribou Management Planning Committee
BIPR	Bathurst Inlet Port and Road
CBC	Christmas Bird Count
CESCC	Canadian Endangered Species Conservation Council
CITES	Convention on the International Trade of Endangered Species
CMS	Convention on Migratory Species
COSEWIC	Committee on the Status of Endangered Species in Canada
CPUE	catch per unit effort
CWS	Canadian Wildlife Service
DDT	dichloro-diphenyl-trichloroethane
DEIS	Draft Environmental Impact Statement
EA	environmental assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
GN DOE	Government of Nunavut Department of Environment
GNWT ENR	Government of the Northwest Territories Department of Environment and Natural Resources
LSA	local study area
NIRB	Nunavut Impact Review Board
NPC	Nunavut Planning Commission
NRCan	Natural Resources Canada
NTKP	Naonaiyaotit Traditional Knowledge Project
NWT	Northwest Territories
PCBs	polychlorinated biphenyls
the Project	the Bathurst Inlet Port and Road Project

Acronyms and Abbreviations

the proponent	Bathurst Inlet Port and Road Project Joint Venture Ltd.
Rescan	Rescan Environmental Services Ltd.
RIC	Resources Inventory Committee
ROW	right-of-way
RSA	regional study area
SARA	*Species at Risk Act* (Canada)
SGPP	short-grass prairie population
TAH	total annual harvest
UNEP	United Nations Environment Programme
USF WS	United States Fish and Wildlife Service
VEC	valued ecosystem component
VRPC	variable range point count survey
WKRLUP	West Kitikmeot Regional Land Use Plan
WKSS	West Kitikmeot/Slave Study
WMMP	Wildlife Mitigation and Management Plan

1. INTRODUCTION

1. Introduction

This wildlife and wildlife habitat effect assessment is divided into the following sections:

- **Chapter 2 (Environmental Setting):** a description and contextualization of the wildlife community in the areas associated with the proposed Bathurst Inlet Port and Road (Figure 4.1-12; BIPR Joint Venture Ltd., Appendix F-5 of the Draft Environmental Impact Statement (DEIS)) Project (the Project);
- **Chapter 3 (Methodology):** a description of the environmental assessment process and the methodology used to assess the potential effects of the Project on wildlife and wildlife habitat;
- **Chapter 4 (Effects Assessment):** an assessment of potential effects of Project phases and components on wildlife and wildlife habitat;
- **Chapter 5 (Mitigation and Management Plans):** a mitigation and management strategy to minimize potential negative impacts of the proposed Project on wildlife and wildlife habitat; and
- **Chapter 6 (Monitoring and Evaluation):** a monitoring program to evaluate, and adaptively adjust suggested mitigation and management programs, based on measures of program success.

Wildlife considered in the environmental setting are species known or suspected to occur within the Project footprint and surrounding areas. Unique or rare species, habitats and ecological functions that the area provides for wildlife are highlighted to illustrate priorities for conservation. Data sources for the environmental setting are from Inuit Traditional Knowledge, the government, literature reviews, neighbouring mine developments, baseline research, habitat suitability modelling and expert opinion. When knowledge gaps were identified, they were highlighted.

Second, an effects assessment was conducted for wildlife species that were determined to be valuable ecosystem components (VECs). Wildlife VECs include species that have a designated conservation status, are of particular importance to the Inuit or local economy, are umbrella or keystone species, are indicators of healthy ecosystem function, or serve an important ecological function. Potential effects were evaluated for their impacts on relevant VECs at a meaningful geographical scale. Effects were evaluated in terms of their direction, nature, magnitude, spatial extent, duration, frequency, reversibility, resilience, influence on resource capacity and probability of occurrence. From the assessment, the level of significance (adverse or beneficial) and confidence of the assessment were determined.

Third, a series of mitigation and management strategies were developed in order to minimize the negative effects of the Project on VECs, as determined from the effects assessment. The mitigation and management strategies developed include Environmental Management Plans (EMPs) with strategies to meet objectives. The plans also identify company personnel, including contractor staff responsible for EMP work and reporting, and identify conditions that might hinder the effectiveness of the plans.

Finally, a monitoring plan was developed in order to assess the success of the management and mitigation plans at achieving their objectives. The monitoring plan outlines the objectives, a schedule for collecting monitoring data and all details required to collect, evaluate and report data. Information from the monitoring program will be integrated back into the Project design such that management and mitigation strategies can be adaptively managed to maintain the integrity of the wildlife interacting with the Project.

2. ENVIRONMENTAL SETTING

2. Environmental Setting

2.1 Objectives

This environmental setting describes the wildlife community and wildlife habitat in the areas associated with the proposed Project.

The primary goals of this environmental setting are to:

- describe baseline conditions of the Project area that can be used to direct the environmental assessment (EA), and develop management plans and future monitoring and mitigation efforts;
- identify and provide relevant baseline information on rare or endangered species that may be present or have the potential to occur in the Project area;
- identify and provide relevant baseline information on wildlife and wildlife habitat that may be sensitive to the development or limiting for certain species or groups;
- identify any data limitations to existing regional or local knowledge; and
- provide the baseline information required to identify VECs that will be used in the EA and for which mitigation and monitoring plans will be developed.

2.2 Spatial Boundaries

Wildlife baseline studies, literature reviews and Inuit Traditional Knowledge within the Project area were considered at two scales: broad (regional study area (RSA)) and fine (local study area (LSA)) (Figure 2.2-1). When determining the spatial boundaries of baseline study efforts, many factors were considered including the movement and home range sizes of wildlife species, as well as the distances that construction and operation impacts could extend.

2.2.1 Regional Study Area

The RSA covers approximately 1.5 million hectares and encompasses the road, the port, Contwoyto Camp and a 30 km buffer on either side of the proposed right-of-way (ROW) (Figure 2.2-1). A 30 km buffer distance was used to delineate the RSA to provide a study area boundary that encompassed regional wildlife population effects, and also provided a regional sample of habitat (a representation of habitat available for use by wildlife relative to the habitat being lost or functionally altered by the Project). The 30 km buffer was developed by using literature reviews of effects of developments on the spatial movements of larger Arctic wildlife, primarily caribou (Nellemann and Cameron, 1996a; Nellemann and Cameron, 1998a; Johnson *et al.*, 2005).

2.2.2 Local Study Area

The LSA includes the proposed ROW and a 500 m buffer (either side of the centreline) surrounding the road alignment, Contwoyto Camp and the port site (Figure 2.2-1). The LSA covers 26,438 ha (2% of the RSA area), of which 25,756 ha is associated with the road and 681 ha is associated with the port.

2.2.3 Project Footprint

The Project's terrestrial footprint is the total area subject to vegetation and/or soil disturbance, which may have direct and indirect effects on wildlife. The Project footprint includes several facilities and infrastructures associated with the road and port. The terrestrial footprint for this Project is divided into the road and port footprints for ease of interpretation hereafter.

The road footprint includes:

- the road (8 m wide with an extra 4 m passing turnout every 1 km) from the port to Contwoyto Lake and the 39 quarry sites along the road that will be created during road construction;
- a 20-person camp (Contwoyto Camp) and services (*e.g.*, water, sewage and electrical generation); and
- a truck parking area at Contwoyto Camp.

The port facility footprint includes:

- a wharf to serve large vessels delivering fuel and bulk cargo to the port;
- a dock to handle barges serving the Kitikmeot communities of Kugluktuk, Bathurst Inlet, Cambridge Bay, Omingmaktok, Gjoa Haven and Taloyoak;
- a 150-person construction camp and related services (*e.g.*, water, sewage and electrical generation) (fewer personnel will be housed during operations);
- a diesel fuel tank farm;
- a truck and trailer maintenance shop; and
- a 1,200 m airstrip and associated heliport.

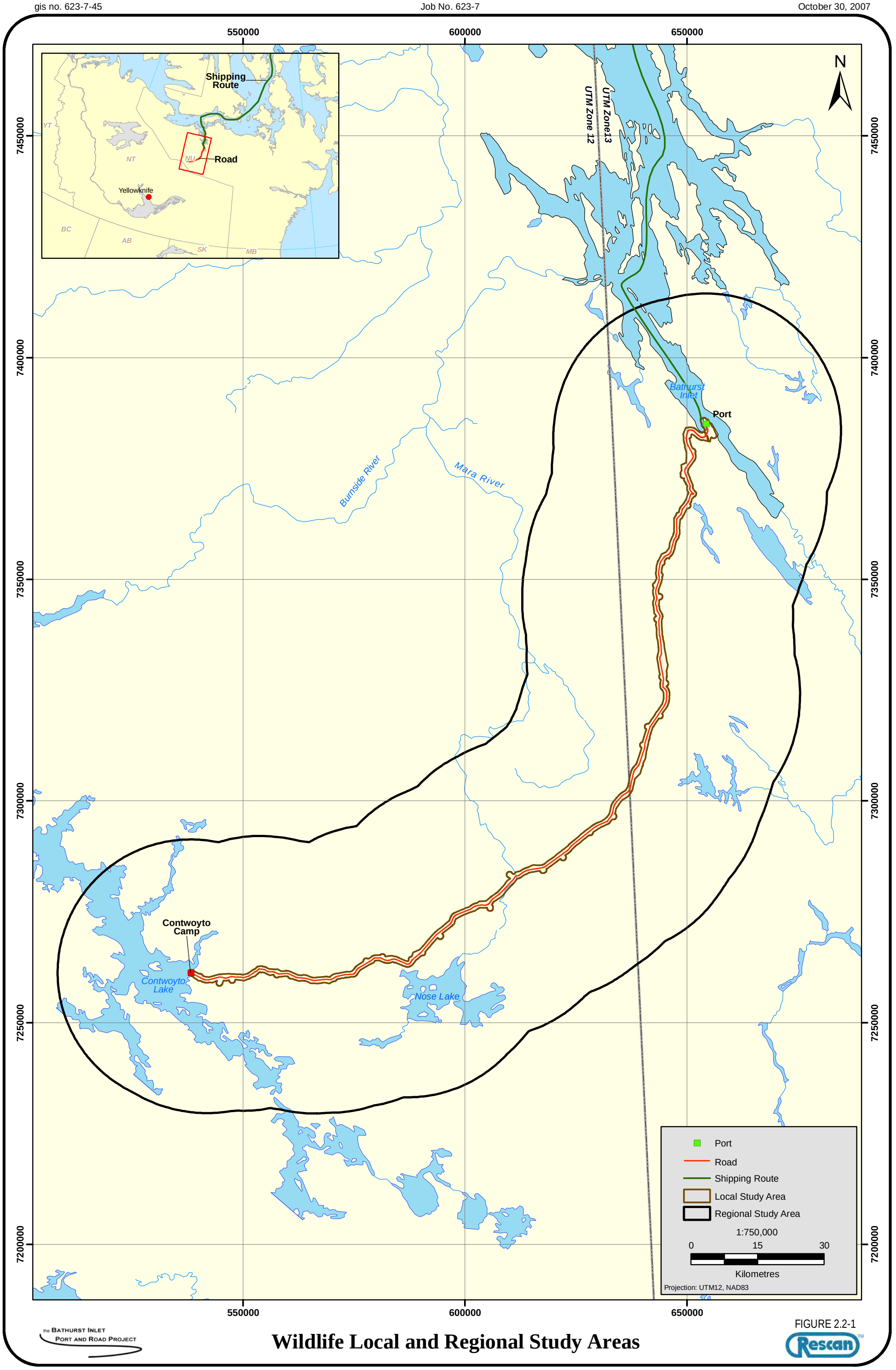
In total, the terrestrial footprint for the Project that will be lost is 417 ha; 38 ha for the Port facility and 379 ha for the road and Contwoyto camp.

2.2.4 Data Sources

2.2.4.1 Historical Studies

Wildlife surveys have been conducted in the Project area since at least the 1970s. Previous wildlife surveys have included descriptions and mapping or wildlife habitats, inventories of wildlife sightings and signs (*e.g.*, tracks, scat) collected during ground and helicopter reconnaissance trips, government radio-collar data, academic research projects and other historical work. Existing data sources from historical studies include:

- Canadian Endangered Species Conservation Council (CESCC) Status Reports;
- Committee on the Status of Endangered Species in Canada (COSEWIC) Assessment and Status Reports;
- Published literature on general ecology and population dynamics of wildlife species;



the Bathurst Inlet Port and Road Project

Wildlife Local and Regional Study Areas

FIGURE 2.2-1

Rescan™

- Satellite collar data from Bathurst caribou (West Kitikmeot/Slave Study (WKSS);
- Satellite-collar data from wolf studies (Walton *et al.*, 2001); and
- Satellite-collar data from barren-ground grizzly bears (Government of the Northwest Territories Department of Environment and Natural Resources (GNWT ENR), WKSS).

2.2.4.2 Inuit Traditional Knowledge

Several Inuit Traditional Knowledge studies include significant information for wildlife and wildlife habitats in the West Kitikmeot region of Nunavut. Inuit Traditional Knowledge on wildlife has been acquired from the Naonaiyaotit Traditional Knowledge Project (NTKP; Appendix F-5 of the DEIS), the Tuktu and Nogak Project (Thorpe *et al.*, 2001) and other sources (Thorpe *et al.*, 2001; Keith *et al.*, 2005; Zinifex, 2007).

The Naonaiyaotit Traditional Knowledge Project is a major source of knowledge for the assessment of Project effects on wildlife and wildlife habitat.

2.2.4.3 Current Field Studies

Rescan conducted Project specific baseline studies in 2001 and 2002, and in 2007.

- Baseline studies in 2001 and 2002 assessed wildlife found in the Project area throughout the year (Appendix D-7 of the DEIS). Baseline studies included: aerial surveys for ungulates, carnivores and carnivore dens, raptor nests and waterfowl. The majority of baseline work was conducted during the summer months. Ground-based work included assessments of carnivore dens, small mammal trapping, and a winter snowmobile survey for ungulates and sign of other large mammals.
- Baseline studies in 2007 assessed birds, caribou and muskox in the Project area (Appendices D-9 and D-10 of the DEIS). Work included aerial surveys for waterfowl and ungulates and ground-based variable range point counts for songbirds. In addition, carnivore dens identified in 2001 for the Project were revisited and reassessed for productivity. Also, carnivore den surveys conducted in the Hackett River Project Area were completed in proximity to the Project RSA.
- A habitat suitability ratings baseline was written in 2007 to characterize habitat quality for important wildlife inhabiting the RSA. A desk-based exercise was used to identify habitat requirements of wildlife during particular seasons. Maps were created based on suitability ratings given to various habitat types found within the LSA and the RSA. A detailed methodology is outlined in the habitat suitability ratings baseline (Appendix D-8 of the DEIS).

2.3 Ecological Overview

2.3.1 Ecozones

The Project is located within the Southern Arctic Terrestrial Ecozone, which is one of three Arctic ecozones in Nunavut (NRCan, 2007). Relative to the two other ecozones, the highest diversity of species (both plant and wildlife) and the most extensive vegetative cover is found in this ecozone.

The climate is characterized as cold, dry Arctic. Summers tend to be short and cool while winters are long and very cold (Environment Canada, 2005; Appendix D-4 of the DEIS). The LSA is situated within two terrestrial ecoregions of the Southern Arctic Terrestrial Ecozone. The Bathurst Hills Ecoregion encompasses the Bathurst Inlet port area and approximately the first 12 km of the road from the port. The Takijuq Lake Upland Ecoregion includes the remaining road south of Bathurst Inlet. The RSA includes two other ecoregions, the Queen Maud Gulf Lowland and Gary Lake Lowland, both on the northwestern margin of the RSA.

2.3.2 Identification of Ecosystem Units

The terrestrial environment that the Project occupies is predominately sub-Arctic tundra, which includes terrain features such as: esker complexes and associated lakes and riparian areas formed during glacial expansion and recession, exposed bedrock, boulder fields and expansive heath tundra habitat. Typical plant communities observed in the area include those of the Heath (*Ericaceae*) family (*e.g*., bearberry, blueberry, heather), various species of lichens, sedges and grasses and low growing species of trees and shrubs such as dwarf birch (*Betula nana*) and willow (*Salix herbacea*). Vegetation baseline studies were conducted by Geowest in 2001 to characterize the plant communities and plant species present in areas where development was planned. Field surveys were completed and an ecosystem map was developed (Appendix D-4 of the DEIS). Vegetated sub-Arctic habitats mapped in the LSA include:

- heath tundra;
- esker complex;
- saxifrage-blueberry communities;
- avens communities;
- lichen rock communities;
- birch seep communities;
- disturbance features;
- riparian shrub communities;
- sedge communities;
- snowbank; and
- communities.

Unvegetated habitat types found along the LSA include:

- beach materials;
- exposed soil;
- permanent snow;
- gravel bar;
- lake;
- pond;
- open water;
- river;
- cliff;
- bedrock outcrop; and
- boulder field.

Details on the description and identification of these communities can be found in the *Surficial Geology, Soils and Ecosystem Mapping* by Geowest (Appendix D-4 of the DEIS), as well as the *Habitat Suitability Ratings Baseline* (Appendix D-8 of the DEIS).

2.3.3 Regional Wildlife Values

The sub-Arctic region supports a wide variety of wildlife species; some like muskox, bears, and ptarmigan are year-round residents while others such as migratory birds, occur only during summer months. To better assess the potential wildlife occurrence in the Project area, the CESCC status report (2005) was used to identify species that could occur in the Project study areas.

The species list was grouped into five categories using field guides and wildlife databases (Species at Risk Canada (SARA) database, COSEWIC species listing database (2007b), Natureserve Explorer database (NatureServe, 2007), Birds of North America online database (2005), Sibley (2000), National Geographic (2006), Stebbins (2003)). The five categories were *Confirmed*, *Likely*, *Possible*, *Unlikely*, and *Very Unlikely*. *Confirmed* species were those that had been observed in the Project LSA or RSA during baseline studies (Appendices D-7 and D-10 of the DEIS). *Likely* species included those that are known to occur within the LSA or RSA from local sources or Inuit Traditional Knowledge, but were not documented during baseline work. *Possible* and *Unlikely* species were assessed according to range extent. *Possible* species were those with documented ranges coming to within 200 km or less of the LSA; species whose range fell outside of this 200 km extent were listed as *Unlikely*. *Possible* species have the potential to occur in the Project area, while *Unlikely* species would be rare. However, species ranges are constantly fluctuating and reliable species range information is often not available or based on very limited data. Therefore, the line between *possible* and *unlikely* is fluid. *Very Unlikely* species are those whose documentation in Nunavut has most likely resulted from a few anomalous or anecdotal observations, as their ranges do not normally extend into Nunavut. Full results of this species search can be found in Appendix 1.

A sixth category is *Shipping Route*. This category considers the caribou that may be encountered on the marine shipping route, the Dolphin and Union herd and the Peary caribou.

From the wildlife and bird baselines conducted in 2001, 2002 and 2007, 14 species of mammals and 48 species of birds were confirmed in the Project study areas (RSA and LSA). An additional 15 species were identified as *Likely*, the majority of which are birds. Another 26 species were identified as *Possible*, again the majority are birds. Wildlife species included in these categories are those that could potentially occur in the area and are listed in Tables 2.3-1 to 2.3-9. There are 57 species that are unlikely for the Project area (*Unlikely*) and nine species whose occurrence would be extremely rare (*Very Unlikely*). One species of caribou, represented by two distinct subspecies, falls into the *Shipping Route* category.

The Kitikmeot region has several species of conservation concern, as designated by national bodies. Three bird species—the Tundra peregrine falcon, the short-eared owl, and Eskimo curlew—are protected under SARA schedules. Three mammal species, the grizzly bear, wolverine and caribou (Dolphin and Union and Peary caribou), are listed by COSEWIC as species of special concern; the Peary caribou is listed as endangered. However, the CESCC, which provides more in-depth coverage of species occurring by province, designates an additional ten species of bird occurring in the Project area as sensitive and which may require special attention to prevent declines in population (CESCC, 2005).

Ungulates of the Kitikmeot region are species of cultural and economic importance. Caribou and muskox are highly valued by sport hunters and guided outfitters. As well, local Inuit rely on caribou and muskox as a major food and clothing source. Culturally, caribou occupy a significant role in traditional Inuit life, and knowledge of caribou and their relationship to the Inuit and the land is passed from generation to generation. Caribou are also important prey for

Table 2.3-1
Status of Carnivores Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Grey Wolf	*Canis lupus*	Secure	Not currently scheduled	Data Deficient	Confirmed
Arctic Fox	*Vulpes lagopus*	Secure	Not currently scheduled	Not assessed	Confirmed
Coloured Fox	*Vulpes vulpes*	Secure	Not currently scheduled	Not assessed	Confirmed
Grizzly Bear	*Ursus arctos*	Sensitive	Not currently scheduled	Special Concern	Confirmed
Wolverine	*Gulo gulo*	Secure	Not currently scheduled	Special Concern	Confirmed
Ermine	*Mustela erminea*	Secure	Not currently scheduled	Not assessed	Confirmed
Least Weasel	*Mustela nivalis*	Secure	Not currently scheduled	Not assessed	Likely
American Mink	*Mustela vison*	Undetermined	Not currently scheduled	Not assessed	Possible
Canada Lynx	*Lynx canadensis*	Undetermined	Not currently scheduled	Not at Risk	Possible

Table 2.3-2
Status of Ungulates Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Caribou (Peary subspecies)	*Rangifer tarandus pearyi*	unavailable	Not currently scheduled	Endangered	Shipping Route
Caribou (Dolphin and Union Herd)	*Rangifer tarandus groenlandicus*	Sensitive	Not currently scheduled	Special Concern	Shipping Route
Caribou (Bathurst herd)	*Rangifer tarandus groenlandicus*	Secure	Not currently scheduled	Not assessed	Confirmed
Caribou (Ahiak herd)	*Rangifer tarandus groenlandicus*	unavailable	Not currently scheduled	Not assessed	Likely
Muskox	*Ovibos moschatus*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-3
Status of Small Mammals Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Barrenground Shrew	*Sorex ugyunak*	Undetermined	Not currently scheduled	Not assessed	Likely
Arctic Hare	*Lepus arcticus*	Secure	Not currently scheduled	Not assessed	Confirmed
Arctic Ground Squirrel	*Spermophilus parryii*	Secure	Not currently scheduled	Not assessed	Confirmed
Northern Red-backed Vole	*Clethrionomys rutilus*	Secure	Not currently scheduled	Not assessed	Confirmed
Tundra Vole	*Microtus oeconomus*	Undetermined	Not currently scheduled	Not assessed	Confirmed
Meadow Vole	*Microtus pennsylvanicus*	Secure	Not currently scheduled	Not assessed	Possible
Northern Collared Lemming	*Dicrostonyx groenlandicus*	Secure	Not currently scheduled	Not assessed	Confirmed
Victoria Collared Lemming	*Dicrostonyx kilangmiutak*	Secure	Not currently scheduled	Not assessed	Possible
Brown Lemming	*Lemmus trimucronatus*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-4
Status of Raptors Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Bald Eagle	*Haliaeetus leucocephalus*	Undetermined	Not currently scheduled	Not assessed	Possible
Northern Harrier	*Circus cyaneus*	Undetermined	Not currently scheduled	Not at risk	Possible
Rough-legged Hawk	*Buteo lagopus*	Secure	Not currently scheduled	Not at risk	Confirmed
Golden Eagle	*Aquila chrysaetos*	Sensitive	Not currently scheduled	Not at risk	Confirmed
Merlin	*Falco columbarius*	Undetermined	Not currently scheduled	Not at risk	Possible
Peregrine Falcon (tundra)	*Falco peregrinus tundrius*	Secure	Schedule 3	Special Concern	Confirmed
Gyrfalcon	*Falco rusticolus*	Secure	Not currently scheduled	Not at risk	Confirmed
Great Horned Owl	*Bubo virginianus*	Undetermined	Not currently scheduled	Not assessed	Possible
Snowy Owl	*Bubo scandiacus*	Secure	Not currently scheduled	Not at risk	Likely
Northern Hawk Owl	*Surnia ulula*	Undetermined	Not currently scheduled	Not assessed	Possible
Short-eared Owl	*Asio flammeus*	Sensitive	Schedule 3	Special Concern	Confirmed
Common Raven	*Corvus corax*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-5
Status of Waterfowl Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Red-throated Loon	*Gavia stellata*	Secure	Not currently scheduled	Not assessed	Confirmed
Pacific Loon	*Gavia pacifica*	Secure	Not currently scheduled	Not assessed	Confirmed
Common Loon	*Gavia immer*	Secure	Not currently scheduled	Not at risk	Confirmed
Yellow-billed Loon	*Gavia adamsii*	Secure	Not currently scheduled	Not at risk	Confirmed
Greater White-fronted Goose	*Anser albifrons*	Secure	Not currently scheduled	Not assessed	Confirmed
Snow Goose	*Chen caerulescens*	Secure	Not currently scheduled	Not assessed	Confirmed
Ross's Goose	*Chen rossii*	Secure	Not currently scheduled	Not assessed	Likely
Canada Goose	*Branta canadensis*	Secure	Not currently scheduled	Not assessed	Confirmed
Cackling Goose	*Branta hutchinsii*	Secure	Not currently scheduled	Not assessed	Likely
Brant	*Branta bernicla*	Secure	Not currently scheduled	Not assessed	Likely
Tundra Swan	*Cygnus columbianus*	Secure	Not currently scheduled	Not assessed	Confirmed
Northern Pintail	*Anas acuta*	Secure	Not currently scheduled	Not assessed	Confirmed
Green-winged Teal	*Anas crecca*	Undetermined	Not currently scheduled	Not assessed	Confirmed
Greater Scaup	*Aythya marila*	Undetermined	Not currently scheduled	Not assessed	Confirmed
King Eider	*Somateria spectabilis*	Sensitive	Not currently scheduled	Not assessed	Likely
Common Eider	*Somateria mollissima*	Sensitive	Not currently scheduled	Not assessed	Likely
Surf Scoter	*Melanitta perspicillata*	Undetermined	Not currently scheduled	Not assessed	Possible
Long-tailed Duck	*Clangula hyemalis*	Secure	Not currently scheduled	Not assessed	Confirmed
Bufflehead	*Bucephala albeola*	Undetermined	Not currently scheduled	Not assessed	Possible
Common Merganser	*Mergus merganser*	Undetermined	Not currently scheduled	Not assessed	Confirmed
Red-breasted Merganser	*Mergus serrator*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-6
Status of Shorebirds Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Sandhill Crane	*Grus canadensis*	Secure	Not currently scheduled	Not assessed	Confirmed
Black-bellied Plover	*Pluvialis squatarola*	Sensitive	Not currently scheduled	Not assessed	Likely
American Golden-Plover	*Pluvialis dominica*	Sensitive	Not currently scheduled	Not assessed	Confirmed
Semipalmated Plover	*Charadrius semipalmatus*	Secure	Not currently scheduled	Not assessed	Confirmed
Common Ringed Plover	*Charadrius hiaticula*	Secure	Not currently scheduled	Not assessed	Possible
Lesser Yellowlegs	*Tringa flavipes*	Undetermined	Not currently scheduled	Not assessed	Possible
Spotted Sandpiper	*Actitis macularius*	Undetermined	Not currently scheduled	Not assessed	Confirmed
Eskimo Curlew	*Numenius borealis*	At Risk	Schedule 1	Endangered	Possible
Sanderling	*Calidris alba*	Sensitive	Not currently scheduled	Not assessed	Confirmed
Semipalmated Sandpiper	*Calidris pusilla*	Sensitive	Not currently scheduled	Not assessed	Confirmed
Least Sandpiper	*Calidris minutilla*	Secure	Not currently scheduled	Not assessed	Confirmed
White-rumped Sandpiper	*Calidris fuscicollis*	Secure	Not currently scheduled	Not assessed	Likely
Baird's Sandpiper	*Calidris bairdii*	Secure	Not currently scheduled	Not assessed	Confirmed
Pectoral Sandpiper	*Calidris melanotos*	Secure	Not currently scheduled	Not assessed	Likely
Stilt Sandpiper	*Calidris himantopus*	Secure	Not currently scheduled	Not assessed	Confirmed
Wilson's Snipe	*Gallinago delicata*	Sensitive	Not currently scheduled	Not assessed	Possible
Red-necked Phalarope	*Phalaropus lobatus*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-7
Status of Seabirds Potentially Occurring in the Project Area

Species	Scientific Name	Species Status			Occurrence
		Nunavut	SARA Designation	COSEWIC	
Pomarine Jaeger	*Stercorarius pomarinus*	Secure	Not currently scheduled	Not assessed	Confirmed
Parasitic Jaeger	*Stercorarius parasiticus*	Secure	Not currently scheduled	Not assessed	Confirmed
Long-tailed Jaeger	*Stercorarius longicaudus*	Secure	Not currently scheduled	Not assessed	Confirmed
Bonaparte's Gull	*Larus philadelphia*	Undetermined	Not currently scheduled	Not assessed	Possible
Mew Gull	*Larus canus*	Undetermined	Not currently scheduled	Not assessed	Possible
Herring Gull	*Larus argentatus*	Secure	Not currently scheduled	Not assessed	Confirmed
Glaucous Gull	*Larus hyperboreus*	Secure	Not currently scheduled	Not assessed	Confirmed
Arctic Tern	*Sterna paradisaea*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-8
Status of Gamebirds Potentially Occurring in the Project Area

		Species Status			
Species	**Scientific Name**	**Nunavut**	**SARA Designation**	**COSEWIC**	**Occurrence**
Spruce Grouse	*Falcipennis canadensis*	Undetermined	Not currently scheduled	Not assessed	Possible
Willow Ptarmigan	*Lagopus lagopus*	Secure	Not currently scheduled	Not assessed	Confirmed
Rock Ptarmigan	*Lagopus muta*	Secure	Not currently scheduled	Not assessed	Confirmed

Table 2.3-9
Status of Landbirds and Passerines Potentially Occurring in the Project Area

		Species Status			
Species	**Scientific Name**	**Nunavut**	**SARA Designation**	**COSEWIC**	**Occurrence**
Gray Jay	*Perisoreus canadensis*	Secure	Not currently scheduled	Not assessed	Possible
Horned Lark	*Eremophila alpestris*	Secure	Not currently scheduled	Not assessed	Confirmed
Cliff Swallow	*Petrochelidon pyrrhonota*	Undetermined	Not currently scheduled	Not assessed	Possible
Boreal Chickadee	*Poecile hudsonica*	Undetermined	Not currently scheduled	Not assessed	Possible
American Pipit	*Anthus rubescens*	Secure	Not currently scheduled	Not assessed	Confirmed
Gray-cheeked Thrush	*Catharus minimus*	Undetermined	Not currently scheduled	Not assessed	Confirmed
American Robin	*Turdus migratorius*	Secure	Not currently scheduled	Not assessed	Likely
Yellow Warbler	*Dendroica petechia*	Undetermined	Not currently scheduled	Not assessed	Confirmed
Yellow-rumped Warbler	*Dendroica coronata*	Undetermined	Not currently scheduled	Not assessed	Possible
Blackpoll Warbler	*Dendroica striata*	Undetermined	Not currently scheduled	Not assessed	Possible
Wilson's Warbler	*Wilsonia pusilla*	Undetermined	Not currently scheduled	Not assessed	Likely
American Tree Sparrow	*Spizella arborea*	Sensitive	Not currently scheduled	Not assessed	Possible
Savannah Sparrow	*Passerculus sandwichensis*	Secure	Not currently scheduled	Not assessed	Confirmed
Swamp Sparrow	*Melospiza georgiana*	Undetermined	Not currently scheduled	Not assessed	Possible
Harris's Sparrow	*Zonotrichia querula*	Sensitive	Not currently scheduled	Not assessed	Confirmed
White-crowned Sparrow	*Zonotrichia leucophrys*	Sensitive	Not currently scheduled	Not assessed	Confirmed
Dark-eyed Junco	*Junco hyemalis*	Undetermined	Not currently scheduled	Not assessed	Possible
Lapland Longspur	*Calcarius lapponicus*	Secure	Not currently scheduled	Not assessed	Confirmed
Smith's Longspur	*Calcarius pictus*	Secure	Not currently scheduled	Not assessed	Likely
Snow Bunting	*Plectrophenax nivalis*	Sensitive	Not currently scheduled	Not assessed	Likely
Common Redpoll	*Carduelis flammea*	Secure	Not currently scheduled	Not assessed	Confirmed
Hoary Redpoll	*Carduelis hornemanni*	Secure	Not currently scheduled	Not assessed	Confirmed

Nunavut Ranking (www.wildspecies.ca)

At Risk - Species for which a formal, detailed risk assessment (COSEWIC status assessment or provincial or territorial equivalent) has been completed and that have been determined to be at risk of extirpation or extinction (*i.e.* , Endangered or Threatened).

A COSEWIC designation of Endangered or Threatened automatically results in a Canada General Status Rank (Canada rank) of At Risk.

May be at Risk - Species that may be at risk of extirpation or extinction and are therefore candidates for a detailed risk assessment by COSEWIC, or provincial or territorial equivalents.

Sensitive - Species that are not believed to be at risk of immediate extirpation or extinction but may require special attention or protection to prevent them from becoming at risk.

Secure - Species that are not believed to belong in the categories Extirpated, Extinct, At Risk, May Be At Risk, Sensitive,

Undetermined - Species for which insufficient data, information, or knowledge is available with which to reliably evaluate their general status.

SARA Designation (www.speciesatrisk.gc.ca)

Schedule 1

Species listed in Schedule 1 are protected under SARA as of proclamation in June 2003. These species were assessed by COSEWIC using the revised assessment criteria. The list classifies the species as being either extirpated, endangered, threatened, or a special concern.

Schedules 2 and 3

Species listed in these schedules were assessed prior to October 1999, and require re-assessment using the revised criteria, following which the Governor in Council may, on the recommendation of the Minister, add the species to the Federal List of Wildlife Species at Risk.

COSEWIC Ranking (www.cosewic.gc.ca)

Endangered - A wildlife species facing imminent extirpation or extinction.

Threatened - A wildlife species likely to become endangered if limiting factors are not reversed.

Special Concern - A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.

Data Deficient - A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction.

Not At Risk - A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.

Occurrence Rank

Confirmed - Species observation confrimed from baseline studies

Likely - Occurs in project area but not detected during baseline studies

Possible - Range occurs within 200km buffer of project area

Shipping - Range occurs along marine shipping route

other wildlife species such as wolves, fox, wolverine and grizzly bear. Several herds of barren ground caribou can be found in the Kitikmeot region throughout the year: the Dolphin and Union herd, the Bathurst herd and the Ahiak herd, as well as a separate subspecies, the Peary caribou.

Since baseline studies have illustrated the significance of the Project area to ungulates, carnivores and birds, the biology of these groups will be explained in greater detail below.

2.4 Ungulates

2.4.1 Caribou

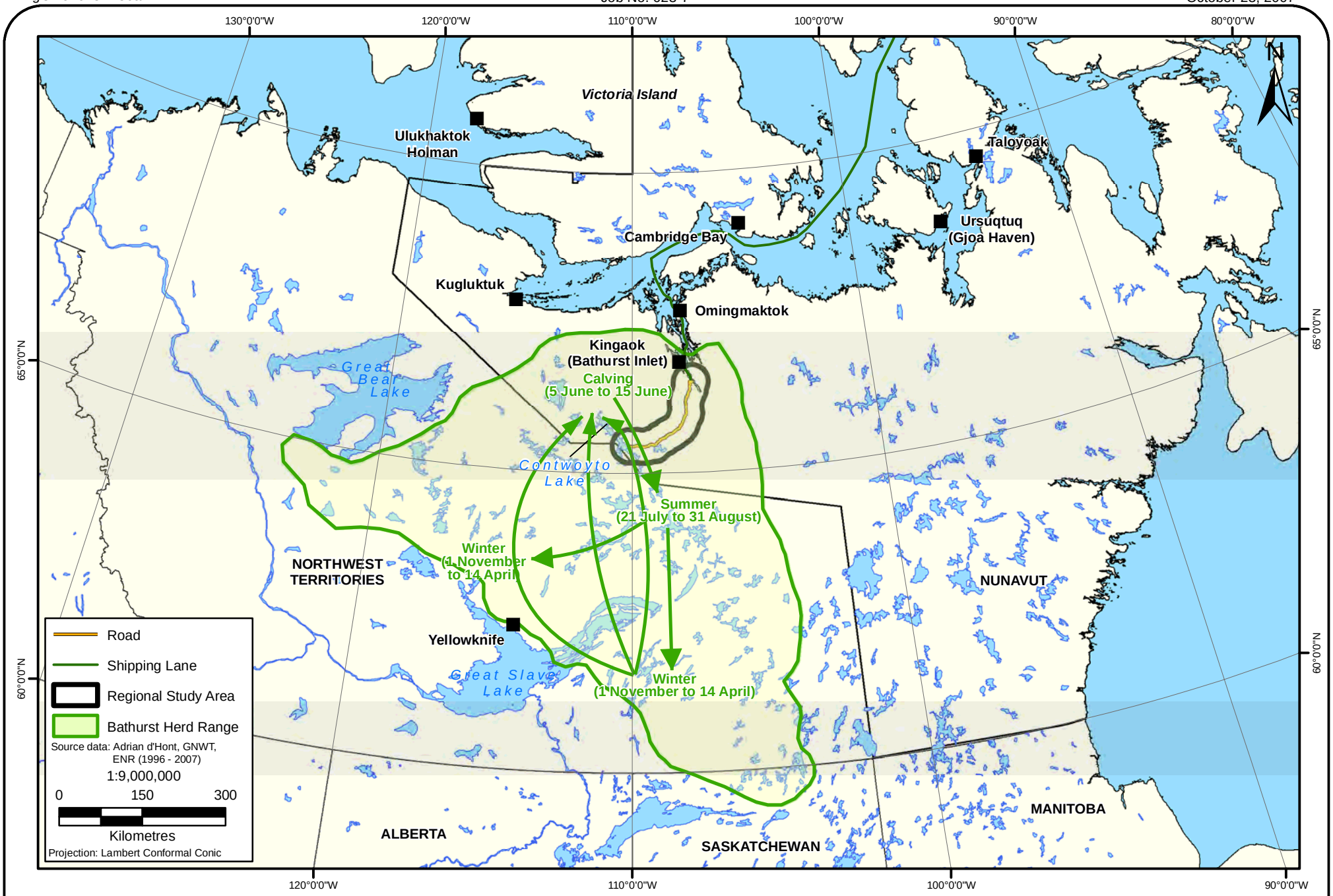
Caribou is a keystone species in the Arctic both biologically and culturally. Caribou are a main prey item of grizzly bears, wolves, wolverines, and other carnivores. Caribou also alter the Arctic landscape, altering the composition of plant communities and seasonal distribution of predators. Historically, the Inuit people have relied on caribou for food and clothing. Caribou, and caribou hunting, are central to Inuit culture, identity, recreation, and kinship. The Inuit have a long history of observing caribou behaviour, movement, and life cycle during their hunting activities. This environmental setting describes the caribou herds in the greater Project area using published accounts, satellite collar data, aerial surveys, and Inuit Traditional Knowledge.

Four caribou herds have been identified that may interact with the Project. Two herds—the Bathurst and Ahiak—are found during certain periods of the year within the RSA (Figures 2.4-1 and 2.4-2). In addition, the proposed shipping route crosses the ice bridge migration routes of the Dolphin and Union, and Peary caribou herd (Figures 2.4-3 and 2.4-4).

The following environmental setting provides background on the distribution, movement, habitat, and demographics of caribou in the Project area. Distribution and movement of caribou herds are described using Inuit Traditional Knowledge, satellite collar data and aerial surveys conducted over the Project area during key periods in the caribou yearly migration. In particular, the environmental setting provides details on six key potential interactions between caribou and the Project, which are later evaluated in the effects assessment.

Important aspects for the assessment include:

1. the location of the Bathurst caribou calving ground in relation to the Project;
2. the distribution of Bathurst caribou during the post-calving period;
3. the distribution of Bathurst caribou during the summer period;
4. the distribution of Ahiak caribou during summer and winter;
5. the location and timing of ice crossings between the mainland and Victoria Island by the Dolphin and Union caribou herd; and
6. the location and timing of ice formation along the shipping route and crossings by Peary caribou.



Bathurst Caribou Herd Range from 1996-2007 Satellite Collar Data

the Bathurst Inlet Port and Road Project

FIGURE 2.4-1

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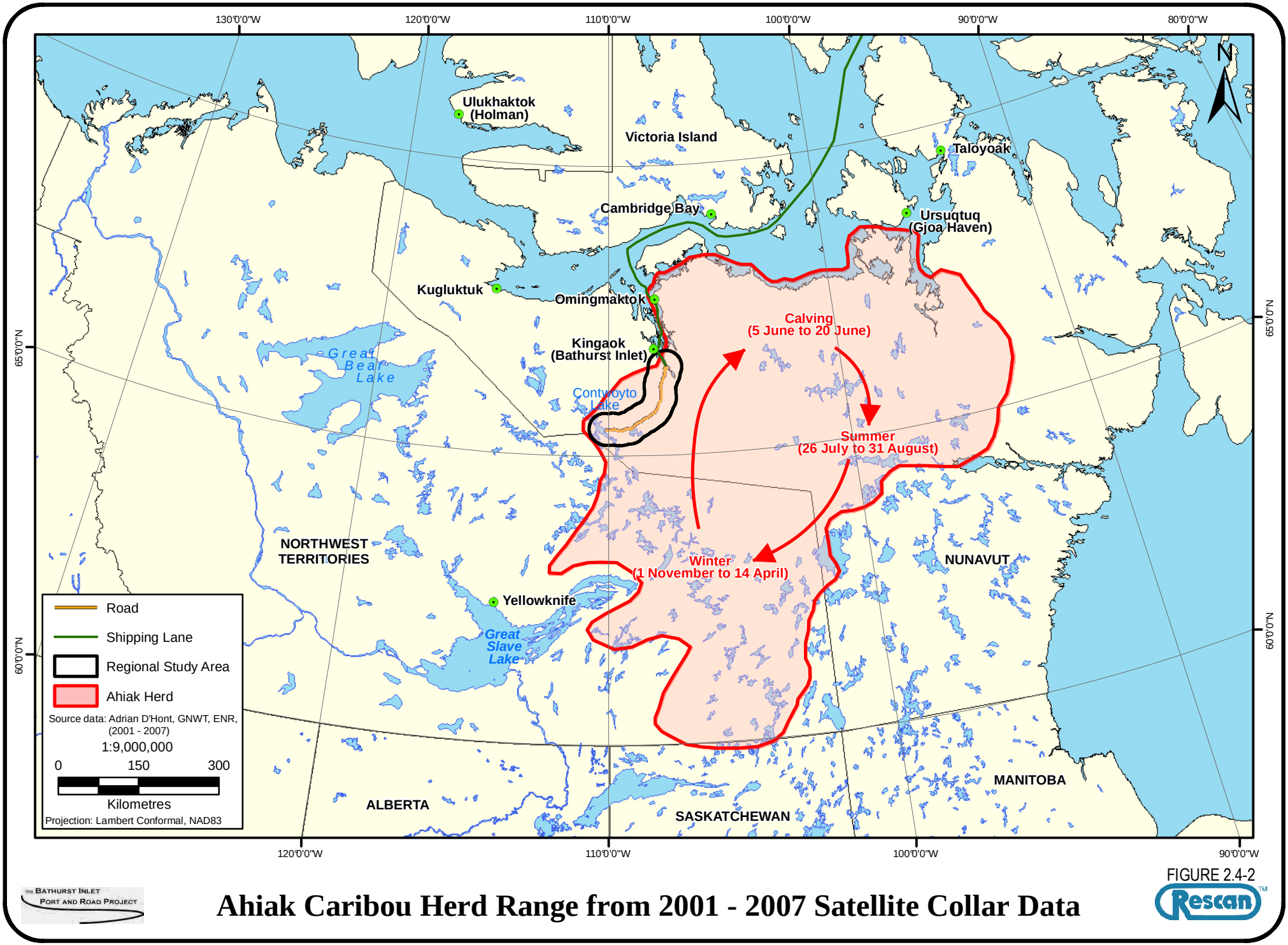
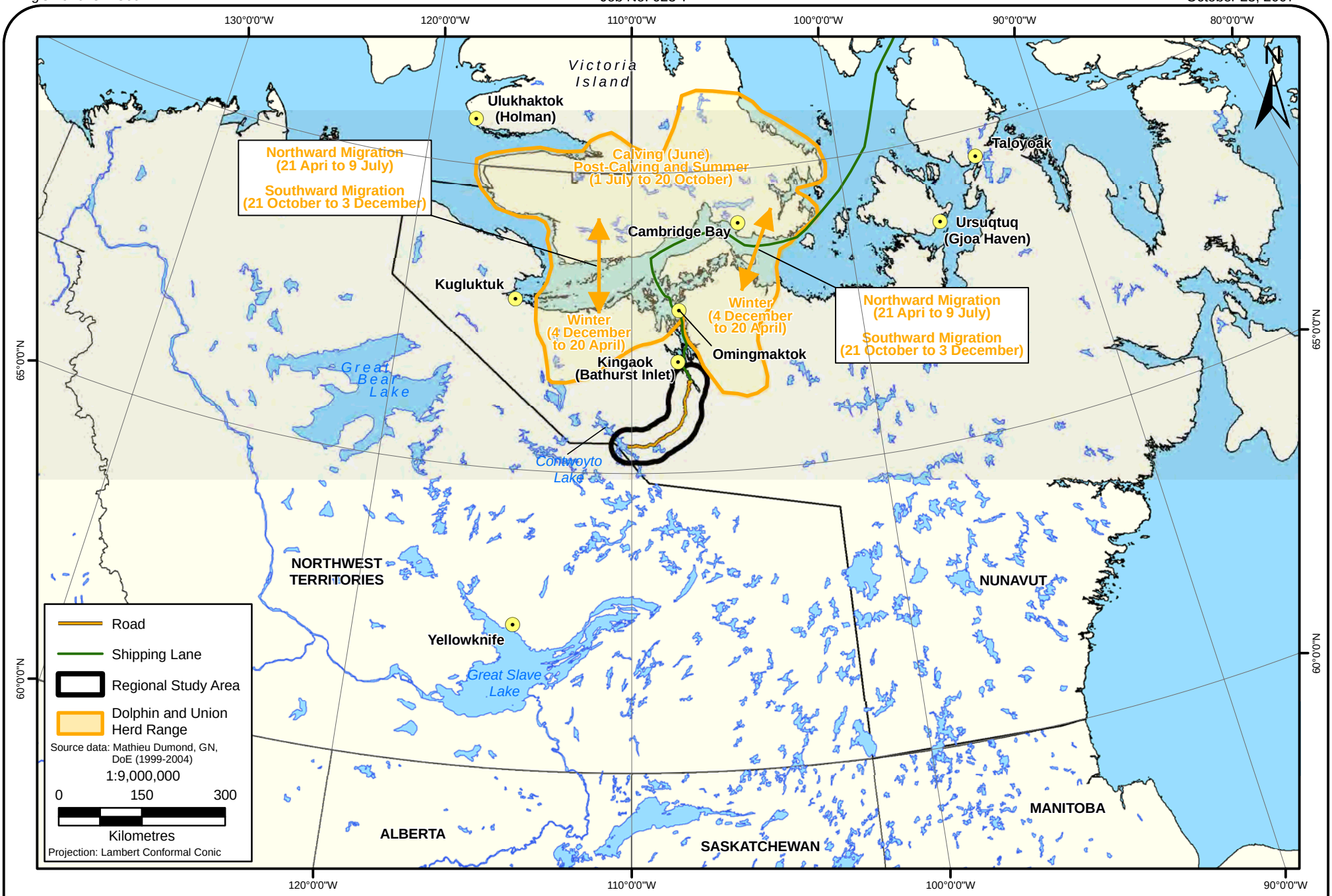


FIGURE 2.4-2

Ahiak Caribou Herd Range from 2001 - 2007 Satellite Collar Data



the Bathurst Inlet Port and Road Project

Dolphin and Union Caribou Herd Range from 1999-2004 Satellite Collar Data

FIGURE 2.4-3

Rescan™

the Bathurst Inlet Port and Road Project

FIGURE 2.4-4

Peary Caribou Range

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2.4.1.1 Bathurst Caribou

Introduction

The Bathurst caribou herd is the largest of the four caribou herds in the region surrounding the Project area. Although the Bathurst herd is ranked as secure in Nunavut, the Northwest Territories has ranked the herd as sensitive due to recent population declines (Table 2.3-2; Working Group on General Status of NWT Species, 2006). The Bathurst herd has not yet been assessed by COSEWIC.

Population Trends

The Bathurst caribou population has declined from 472,000 ± 72,900 animals in 1986 (Heard and Williams, 1991) to 186,005 ± 40,146 animals in 2003 (Gunn *et al.*, 2005b). These estimates are based on calving ground surveys of breeding females and they suggest an average annual decline of 5% per year since 1986 (Boulanger *et al.*, 2004; Gunn *et al.*, 2005b). Survey results from 2006 suggest that the decline is continuing at 5% per annum with a herd size estimated at 128,000 ± 27,300 (Ray Case, GNWT ENR, *personal communication*). Annual monitoring of calf survival indicates that mean winter calf survival and calf-cow ratios for the Bathurst herd have declined by almost 50% in 2001-2004 compared with 1985-1996 (Gunn *et al.*, 2005a). Caribou abundance is thought to fluctuate with a periodicity between 40 and 70 years (Gunn, 2003). While the decline in the Bathurst caribou numbers may be a consequence of natural population cycles, the current low numbers make the population vulnerable to human harvest, disturbance, weather and other factors (BCMPC, 2004; GNWT ENR, personal communication).

Harvest Rates and Management

Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut. Most northern communities, including Bathurst Inlet, Kugluktuk and Omingmaktok, harvest Bathurst caribou during spring migration and post-calving (GNWT ENR, 2007). Data from Inuit hunters indicates that between 1996 and 2001, the average number of caribou harvested annually by Inuit hunters (by community) were: 93 (Bathurst Inlet Lodge), 1,575 (Kugluktuk) and 176 (Omingmaktok) (Priest and Usher, 2004). However, these data include harvests of caribou from the Dolphin and Union herd and the Bluenose-east herd. The Inuit do not have restrictions on the number of caribou they can harvest for their own use. However, there is a limit on the number of caribou that can be harvested for commercial sale (GNWT ENR, 2007). Resident hunters of the NWT, including Inuit hunters, may hunt a maximum of two male barren-ground caribou per year for commercial sale. Non-resident hunters may harvest a maximum of two caribou per year and require a licensed outfitter (GNWT ENR, 2007).

Movements and Distribution

Introduction

The Bathurst caribou herd migrates over a large area (>400,000 km^2) from their wintering range below the tree line in the Northwest Territories to their calving grounds near Bathurst Inlet. Seasonal movements of the herd were tracked from 1996 to 2007 using satellite collars on cows (between 10 to 29 animals per year) (Gunn *et al.*, 2002; GNWT ENR, unpublished data). The yearly distribution and movements of caribou can be classified into six distinct periods: winter,

spring migration, calving, post-calving, summer, and fall migration (Table 2.4-1). Typically, the calving period is considered the period when cows give birth plus the three to five weeks following calving.

Table 2.4-1
Annual Cycle Stage Dates for Bathurst Caribou

Cycle Stage	Start Date	End Date
Spring Migration	April 15[1]	June 4
Calving[2]	June 5	June 15
Post-calving	June 16	July 20[3]
Summer	July 21	August 31[4]
Fall Migration[5]	September 1	October 31
Winter[6]	November 1	April 14

1: Spring migration start date used for Bathurst herd in Gunn *et al.* (2002) and Johnson *et al.* (2005) use April 16 as spring migration start date for analyses on satellite-collared cows from Bathurst herd.
2: Peak of calving for the Bathurst herd based on (Russel *et al.*, 2002).
3: Five weeks post-calving, based on the conservative definition in (Russel *et al.*, 2002).
4: Summer end date used for Bathurst herd in (Johnson *et al.*, 2005).
5: Fall migration period used for Bathurst herd in (Johnson *et al.*, 2005).
6: Winter period similar to that used in (Gunn *et al.*, 2002).

For the purposes of this assessment, this period is further divided into two stages: the calving period when cows are giving birth (defined by the peak of calving), and a five week post-calving period which extends until calves are weaned. A five-week post-calving period follows the more conservative definition used by Russel *et al*. (2002) (Table 2.4-1) . These periods are defined separately in this environmental setting because the Project may influence caribou differently during the calving and post-calving periods. The dates for the calving period are defined by the peak of calving (the date when 50% of the calves are born) and by the spatial movements of cows, which are rapid and extensive before and after calving (Gunn and D'Hont, 2002; Gunn *et al.*, 2002).

The RSA overlaps the range of the Bathurst herd during spring migration, calving, post-calving, and summer (Figures 2.4-5, 2.4-6 and 2.4-7; Gunn *et al.*, 2002; Russel *et al.*, 2002). The Naonaiyaotit Traditional Knowledge Project (NTKP; Appendix F-5 of the DEIS) and the Tuktu and Nogak Project (Thorpe *et al.*, 2001), support these data. The Bathurst herd winters to the south of the RSA, below tree line in the Northwest Territories and northern Saskatchewan (Figure 2.4-5). During the spring, Bathurst caribou migrate north from the wintering grounds and pass through the southern end of the RSA on their way to the calving grounds in the northern tundra near Bathurst Inlet (Figure 2.4-5). In recent years, cows have calved northeast of Contwoyto Lake, between the Hood and Burnside Rivers (Figure 2.4-6; Sutherland and Gunn, 1996; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). Cows return to the same general area to calve every year. However, the calving ground shifts over longer periods. The Bathurst herd calving ground has gradually shifted from the western side of Bathurst Inlet (in the 1950s) to the eastern side (1960s to mid-1980s) and in recent years it has shifted back to the western side (Figure 2.4-8; Sutherland and Gunn, 1996; Thorpe *et al.*, 2001; Gunn and D'Hont, 2002; Appendix F-5 of the DEIS). Cows disperse to the

southeast during the post-calving and summer seasons and pass through the RSA (Figure 2.4-6 and 2.4-7; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). After several months, they begin the fall migration south towards the wintering grounds (Figure 2.4-7; Gunn *et al.*, 2002; Appendix F-5 of the DEIS).

The following section describes the seasonal movements of the Bathurst herd in relation to the RSA. Particular emphasis is put on major migration corridors, calving grounds, areas where post-calving aggregations and movements occur, and important water crossings. The draft West Kitikmeot Regional Land Use Plan (WKRLUP) (NPC, 2005) identified these as key habitats for caribou and provides measures for avoiding disturbance of caribou in these habitats. Caribou are most sensitive to population-level impacts during calving and post-calving when calves are most susceptible to predation and disturbance (Russel *et al.*, 2002). The winter season is not discussed, since Bathurst caribou are not found in the RSA during this time (Figure 2.4-5).

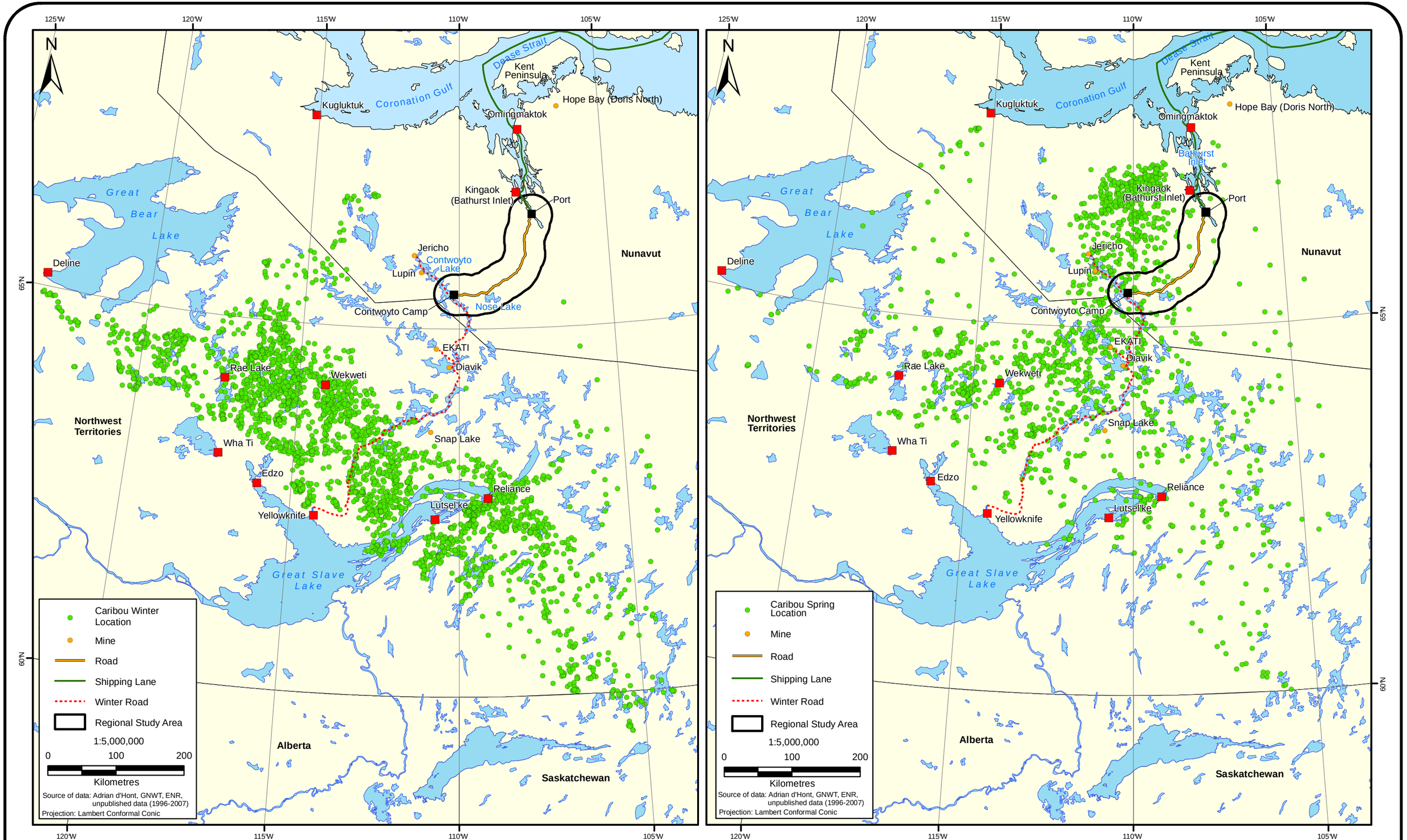
Spring Migration (April 15 to June 4)

In the spring, Bathurst caribou migrate north from the winter range to the calving ground during a relatively short period of time. Satellite collar data indicates that a significant portion of the herd crosses the proposed road route, mainly at the southern end of the road (Figure 2.4-5; Gunn *et al.*, 2002). Pregnant cows are the first to migrate to the calving grounds, while bulls and juveniles follow later in the spring, but do not travel as far as the calving grounds. Movement corridors vary depending on the distribution of caribou on the wintering grounds (Gunn *et al.*, 2002). However, spring migration routes in relation to the calving ground are relatively predictable (Gunn *et al.*, 2002).

Inuit Traditional Knowledge and satellite collar data show that Bathurst caribou migrate northwards across the entire length of the proposed road route (Figures 2.4-1 and 2.4-5; Thorpe *et al.*, 2001; Gunn *et al.*, 2002; NTKP: Appendix F-5 of the DEIS). Major migration routes within the RSA occur along the southern portion of the proposed road between Contwoyto Lake and Nose Lake. Important ice crossings for spring migration occur on Contwoyto Lake (including in proximity to Contwoyto Camp), Nose Lake, the southern end of Bathurst Inlet (including the proposed port site), and Bathurst Lake (Thorpe *et al.*, 2001; Gunn *et al.*, 2002; Appendix F-5 of the DEIS; NPC, 2005).

Calving (June 5 to June 15)

Inuit Traditional Knowledge indicates that the traditional calving grounds of Bathurst caribou are located near Bathurst Inlet (Thorpe *et al.*, 2001; Appendix F-5 of the DEIS), after which the herd is named. The "traditional calving grounds" is the area encompassed by yearly and long-term shifts in the calving grounds and so defines a larger area than the year-to-year calving area. Inuit Traditional Knowledge studies have identified traditional calving grounds in the RSA at Contwoyto Lake (on the eastern and southwestern sides of the lake), Nose Lake (including a 50 km by 40 km area that overlaps the road north of Nose Lake), and along the Bathurst Inlet coastline, mainly to the east, including the port site (Figure 2.4-8; Thorpe *et al.*, 2001; Appendix F-5 of the DEIS). There is also some evidence that Bathurst caribou will calve while en route to



Locations of Satellite - Collared Bathurst Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 1996 - 2007

FIGURE 2.4-5

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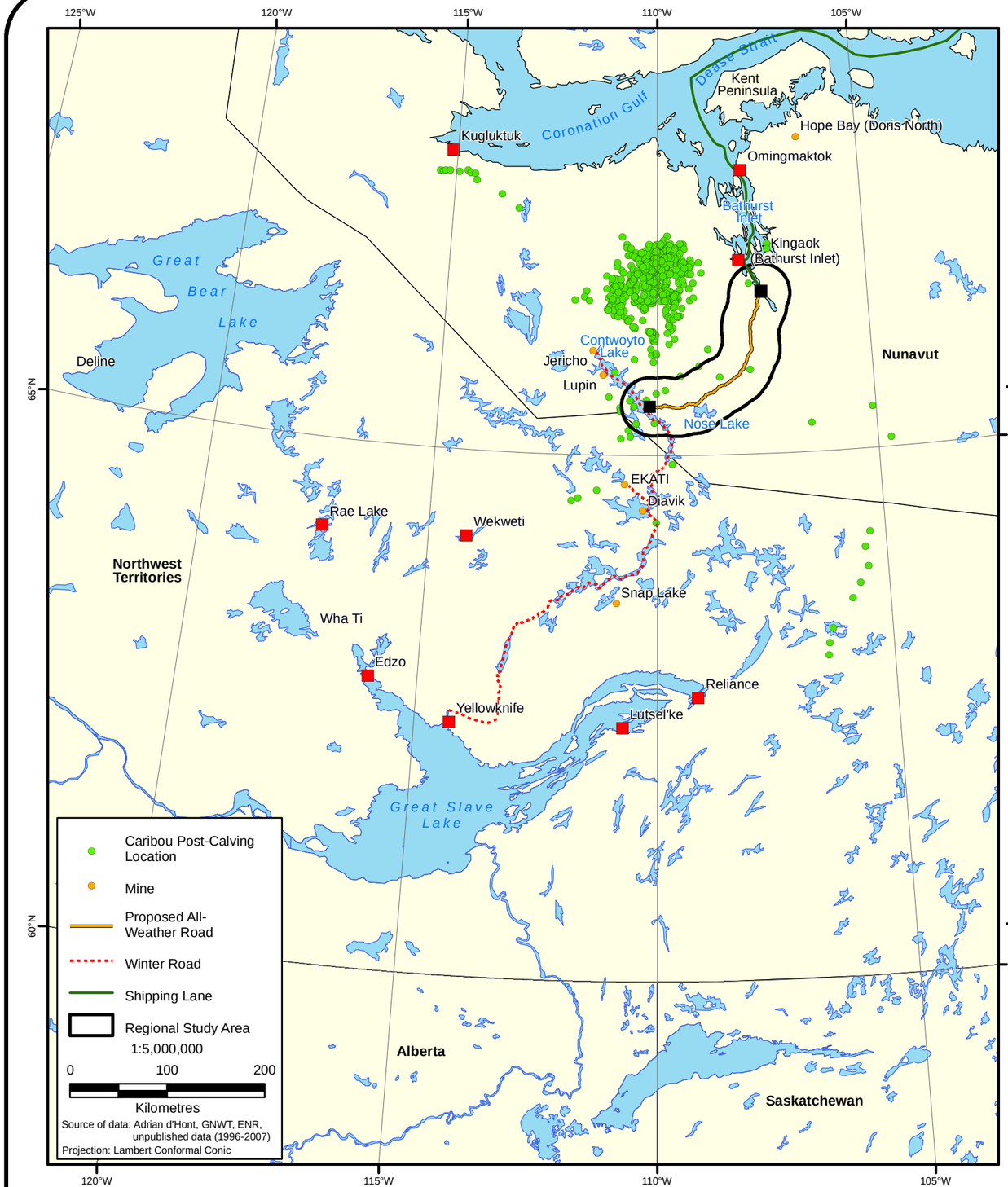

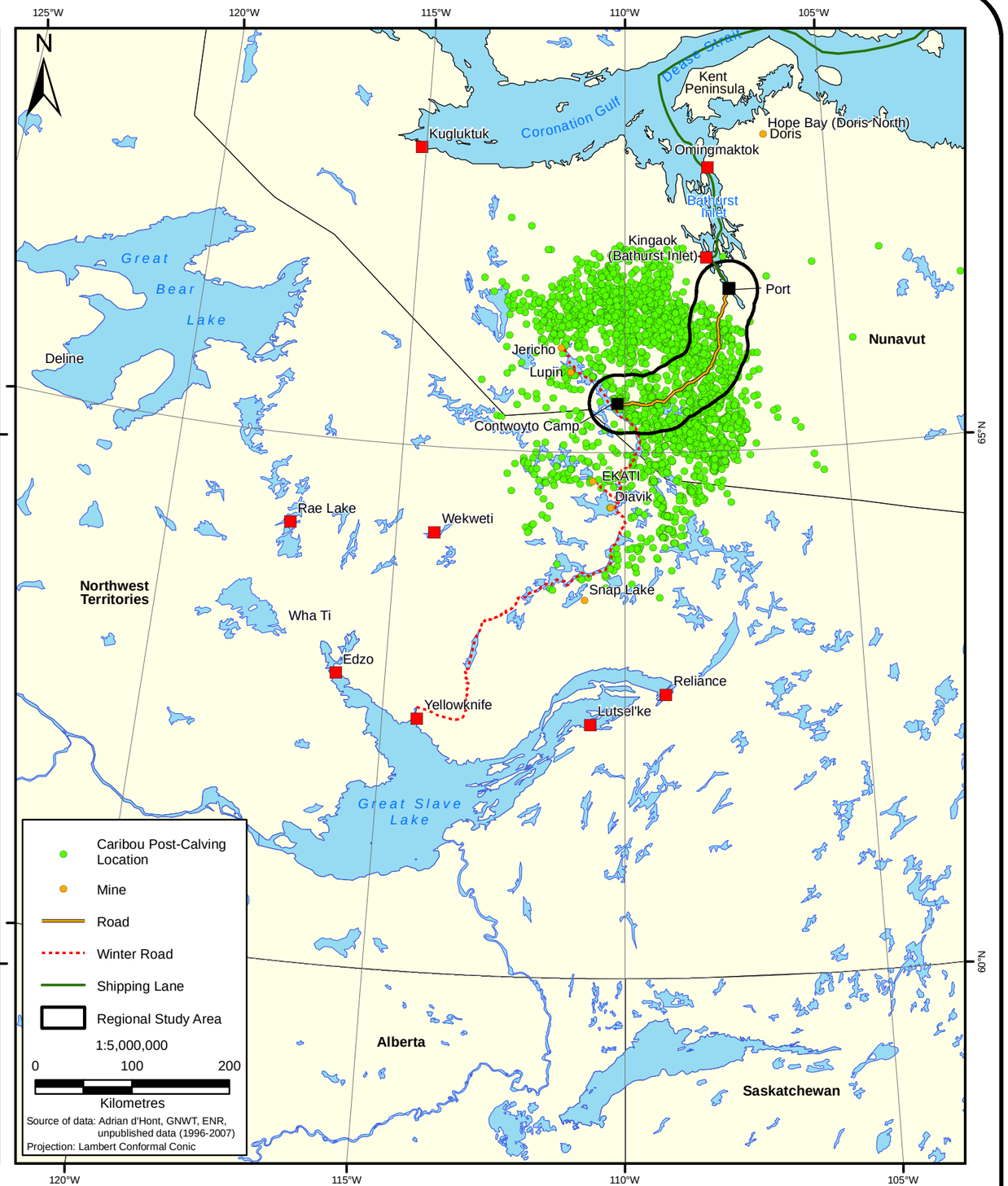

Locations of Satellite - Collared Bathurst Caribou during Calving (5 June to 15 June) and Post-Calving (16 June to 20 July), 1996 - 2007

FIGURE 2.4-6

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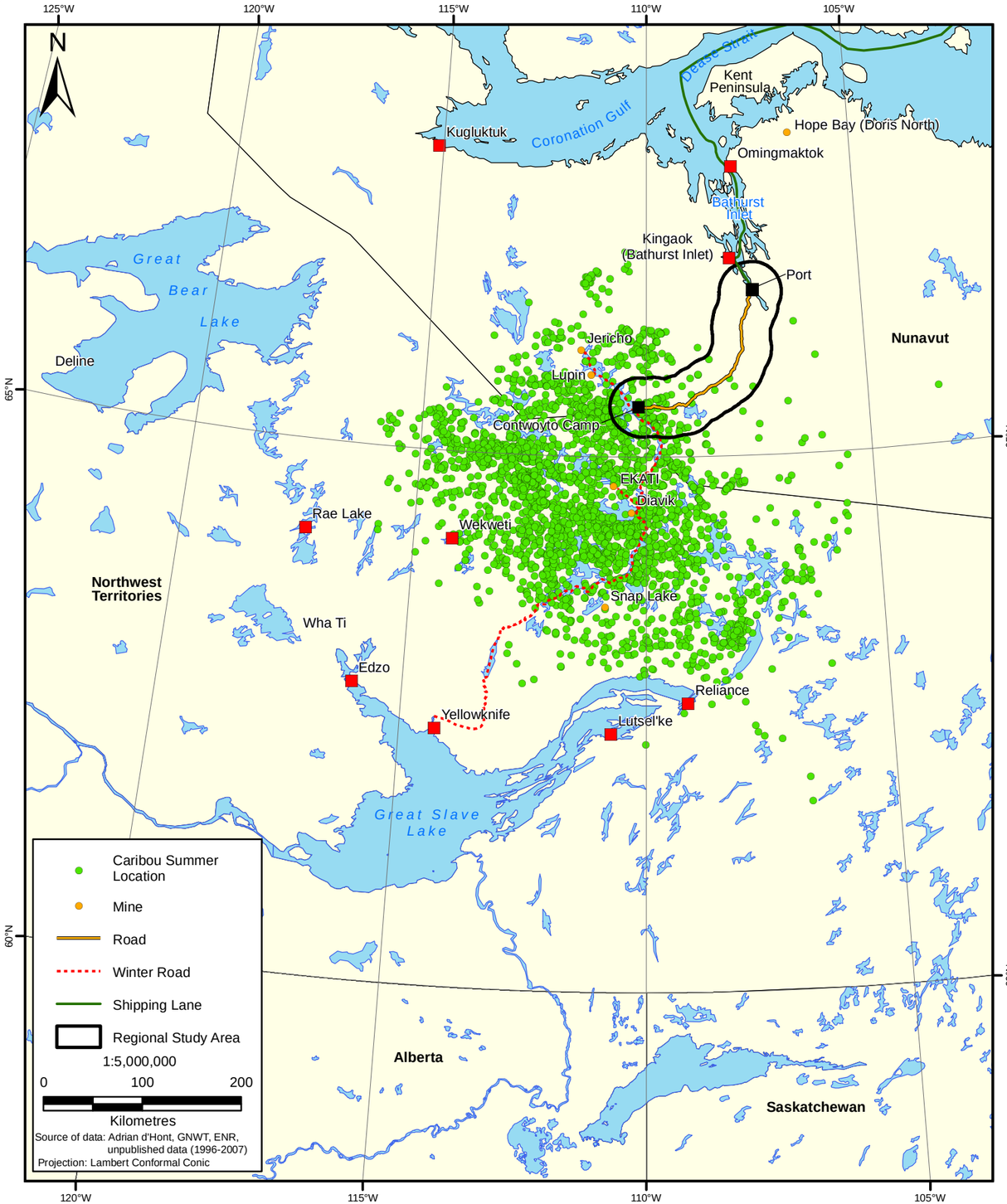

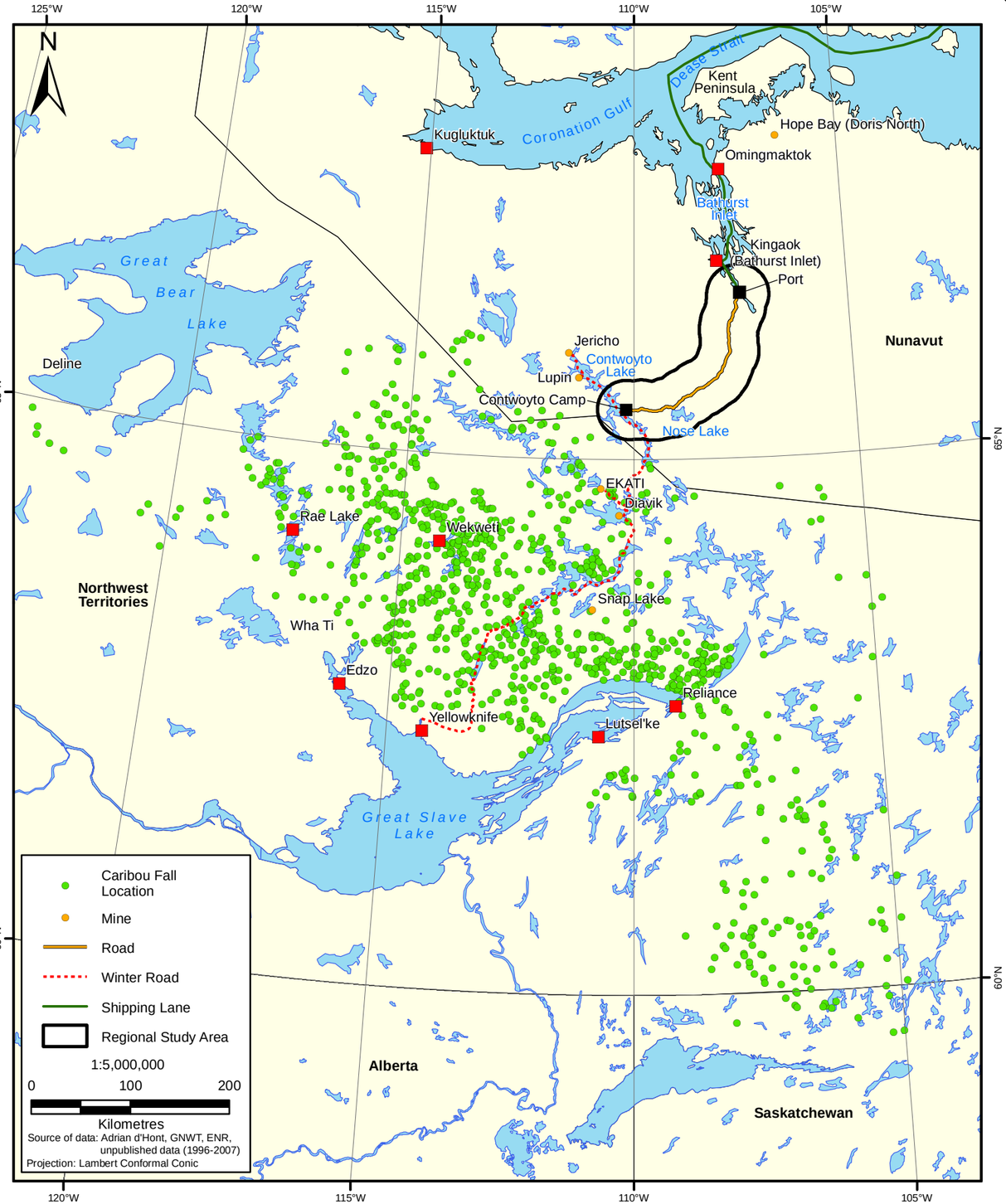

FIGURE 2.4-7

Locations of Satellite - Collared Bathurst Caribou during Summer (21 July to 31 August) and Fall Migration (1 September to 31 October), 1996 - 2007

the Bathurst Inlet Port and Road Project

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the calving grounds (Appendix F-5 of the DEIS). This suggests that some calving may occur outside the calving area.

Satellite collar caribou data and aerial surveys indicate that since the early 1990s, the Bathurst caribou calving grounds have been concentrated between the Hood and Burnside Rivers at the peak of calving (Figure 2.4-6; Sutherland and Gunn, 1996; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). This area is northwest of the RSA.

Although the annual calving grounds have shifted between the east and west sides of Bathurst Inlet in the past, there was no consistent shift between 1996 and 2001 (Gunn *et al.*, 2002) or 2001 and 2007 (Adrian D'Hont, GNWT, ENR, *unpublished data*). The mechanisms and reasons for calving ground movement are poorly understood (Gunn and D'Hont, 2002).

Post-Calving (June 16 to July 20)

After calving, satellite-collared cows of the Bathurst herd disperse southeast between Bathurst Inlet and the east side of Contwoyto Lake as they make their way towards the summer range (Figure 2.4-9). During the post-calving period, Bathurst caribou are found throughout the RSA, including the road, Contwoyto Camp, and the port site (Figure 2.4-6; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). It is during this period that the RSA is used most heavily by Bathurst caribou (Figure 2.4-10) and annual fidelity to post-calving areas is high (Gunn *et al.*, 2002). However, in 1996 and 1997, satellite-collared cows mainly moved west of Contwoyto Lake (Gunn *et al.*, 2002).

Inuit Traditional Knowledge indicates that specific post-calving areas are located along Contwoyto Lake (including the Contwoyto Camp), Nose Lake, and a portion of the proposed road near Bathurst Inlet (Appendix F-5 of the DEIS). Major post-calving movement corridors are also reported along Contwoyto Lake, between Contwoyto Lake and Nose Lake, and along the Bathurst Inlet coastline (including the proposed port site).

Summer (July 21 to August 31)

During the summer, most of the Bathurst caribou pass the southern end of Contwoyto Lake and move south, west, and then northwest in a clockwise direction across the summer range (Gunn *et al.*, 2002). Movement rates of caribou slow during this time (Gunn *et al.*, 2002). Satellite-collared cows are mainly found throughout the southern portion of the RSA, between Contwoyto and Nose Lakes (Figure 2.4-7). Inuit Traditional Knowledge indicates that Bathurst caribou also use coastal areas in the summer, including the port site (Thorpe *et al.*, 2001; Appendix F-5 of the DEIS). Annual fidelity to the summer range is high, with animals using the same general area year after year (Gunn *et al.*, 2002).

Fall Migration (September 1 to October 31)

During the fall, Bathurst caribou migrate towards the winter range, which is located at or below the treeline. Satellite-collared cows did not occur within the RSA during the fall (Figure 2.4-7; Gunn *et al.*, 2002). However, caribou were observed in the RSA in September 2001 during aerial surveys conducted by Rescan (Figure 2.4-15; Appendix D-7 of the DEIS). Inuit

Traditional Knowledge indicates that caribou migrate across the RSA in the fall, especially along the southern portion near Contwoyto Lake (Appendix F-5 of the DEIS).

Field Data for Bathurst and Ahiak Caribou in RSA

2001 and 2002 Aerial Surveys

Aerial surveys for caribou (and other large mammals) were conducted in 2001 and 2002 within a 5 km buffer of the road (Appendix D-7 of the DEIS). During 2001, seven aerial surveys were undertaken; on July 21 and 29, August 9 and 21, September 7 and 20, and November 7. During 2002, four aerial surveys were undertaken; on March 22, May 28, June 7, and July 7. The flights in 2001 correspond with the summer, fall migration and early winter periods (Table 2.4-1). The flights in 2002 correspond with the late winter, spring migration, calving and post-calving periods (Table 2.4-1). Ahiak caribou are included in this section because during the 2001 and 2002 surveys, caribou from the Bathurst and Ahiak herds were not differentiated; therefore, caribou from both herds may have been counted during surveys.

Aerial surveys in 2001 and 2002 found caribou in the study area throughout most of the year (Figures 2.4-11, 2.4-12, 2.4-13, 2.4-14, and 2.4-15). The locations of caribou observed in the RSA during baseline studies confirm or improve knowledge of the distribution of caribou based on satellite collar data. Satellite-collared Bathurst caribou are a small proportion of the entire Bathurst herd. Collared caribou are meant to represent movements of the entire herd; however, a sampling bias may affect results if the animals collared show seasonal variations that are significantly different compared to animals not collared. Caribou with collars are adult cows which may not represent mean movement patterns of the general herd.

Aerial surveys conducted during calving indicate that adult caribou are found in the RSA more than would be expected from satellite-collar data (Figure 2.4-12). However, no cows with calves were observed during aerial surveys. Aerial surveys showed that caribou are found within the RSA during fall migration when satellite-collar data (adult cows) again did not indicate the presence of animals (Figure 2.4-15).

2007 Aerial Surveys

During 2007, five survey flights were undertaken; on May 16, June 11, July 12, July 29 and September 7. These flights correspond with the spring migration, calving, post-calving, summer, and fall migration periods respectively. The first three flights covered the northern two-thirds of the RSA, while the fourth and fifth surveys covered the full length of the RSA (Appendix D-9 of the DEIS).

The spring migration survey found 540 caribou in the RSA, near the port facility. These animals were identified as Ahiak animals. The calving period survey found only 13 caribou in the RSA, all at the western end of the survey transects (Figure 2.4-17). This observation suggests that the RSA is outside the current calving grounds for the Bathurst caribou. The post-calving survey found the highest number of caribou in the RSA (1,662 caribou). These animals were identified as Bathurst caribou and are likely indicative of the post-calving migration through the RSA in

115°0'0"W 110°0'0"W 105°0'0"W

68°0'0"N 67°0'0"N 66°0'0"N 65°0'0"N

N

Coronation Gulf

Omingmaktok

Kingaok (Bathurst Inlet)

Port

Napaktolik Lake

Contwoyto Lake

Contwoyto Lake Camp

Nose Lake

TK Calving Area
Calving Locations
TK Calving Area
Shipping Lane
TK Calving Area
Road
Regional Study Area

TK Source: Naonaiyaotit Traditional Knowledge Project (2006)
Collar data source: Adrian d'Hont, GNWT, ENR, unpublished data (1996 - 2007)

1:1,500,000
0 25 50
Kilometres

Projection: Lambert Conformal Conic

115°0'0"W 110°0'0"W 105°0'0"W

the BATHURST INLET PORT AND ROAD PROJECT

Calving Area for Bathurst Caribou from Satellite Collar Data and NTKP

FIGURE 2.4-8

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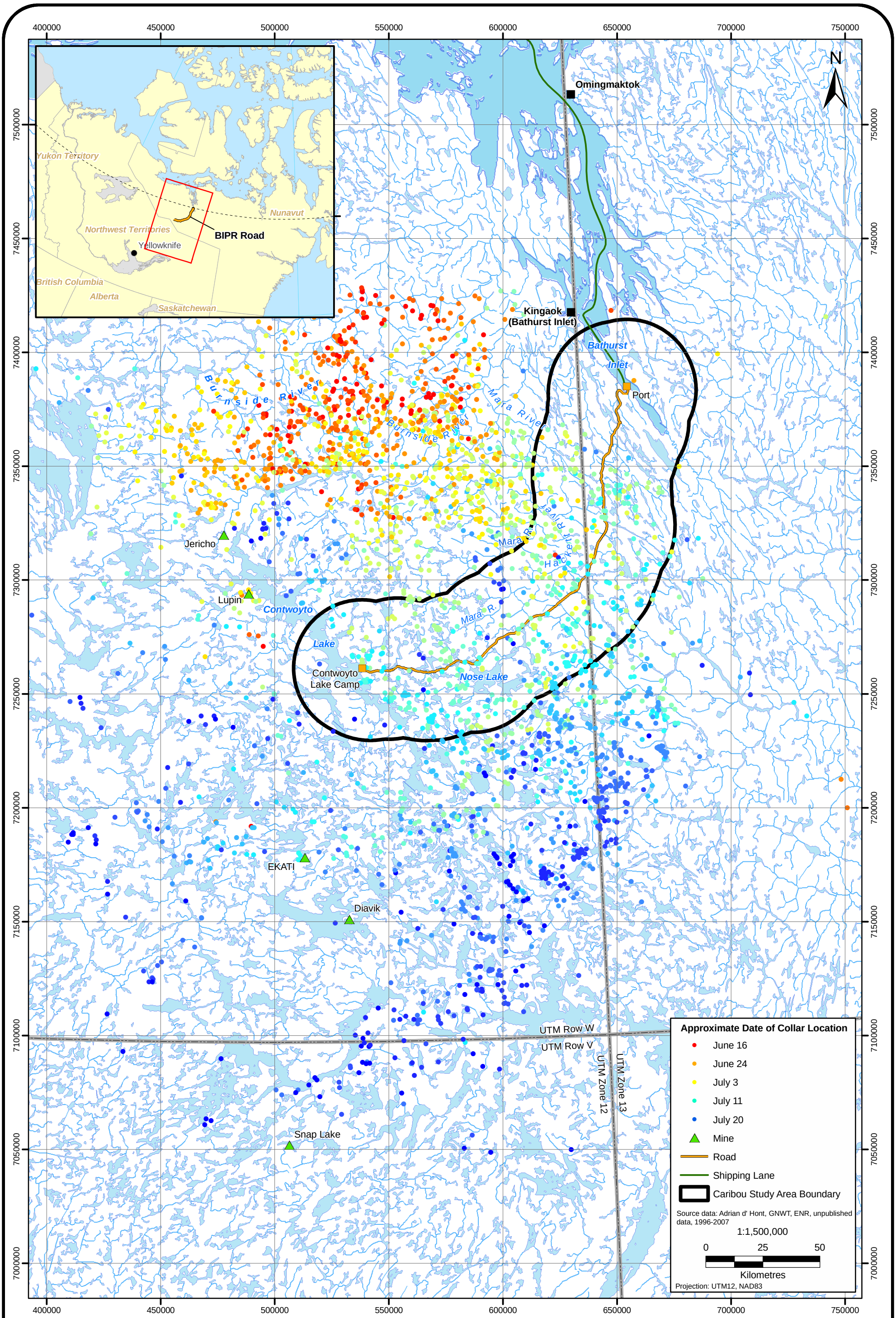

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Movement Patterns of Post-Calving Bathurst Caribou from 1996-2007 Satellite Collar Data

FIGURE 2.4-9

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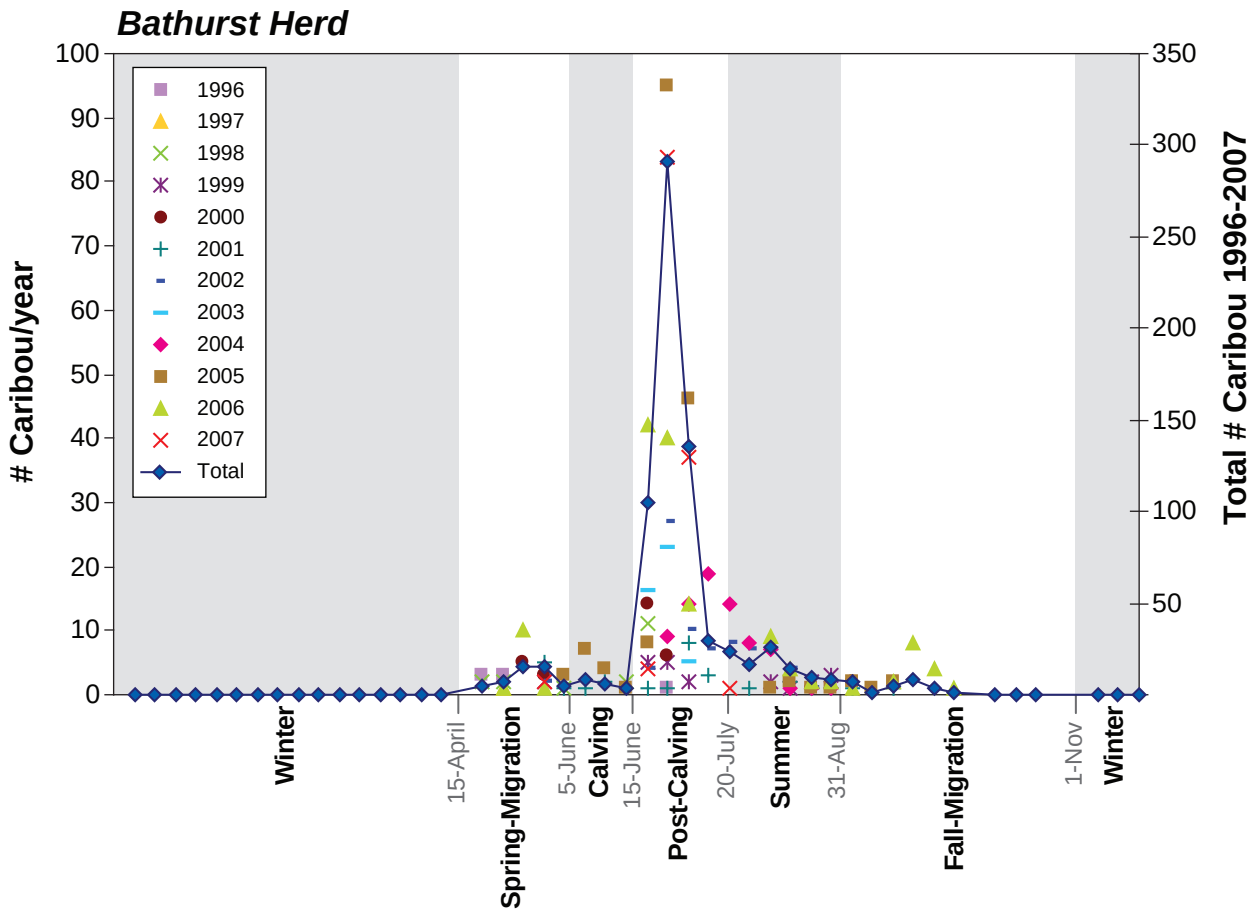

Source of data: Adrian d'Hont, GNWT, ENR, unpublished data (1997-2007)

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Number of Collared Caribou in the Regional Study Area by Date and Caribou Migration Stage

FIGURE 2.4-10

Rescan™

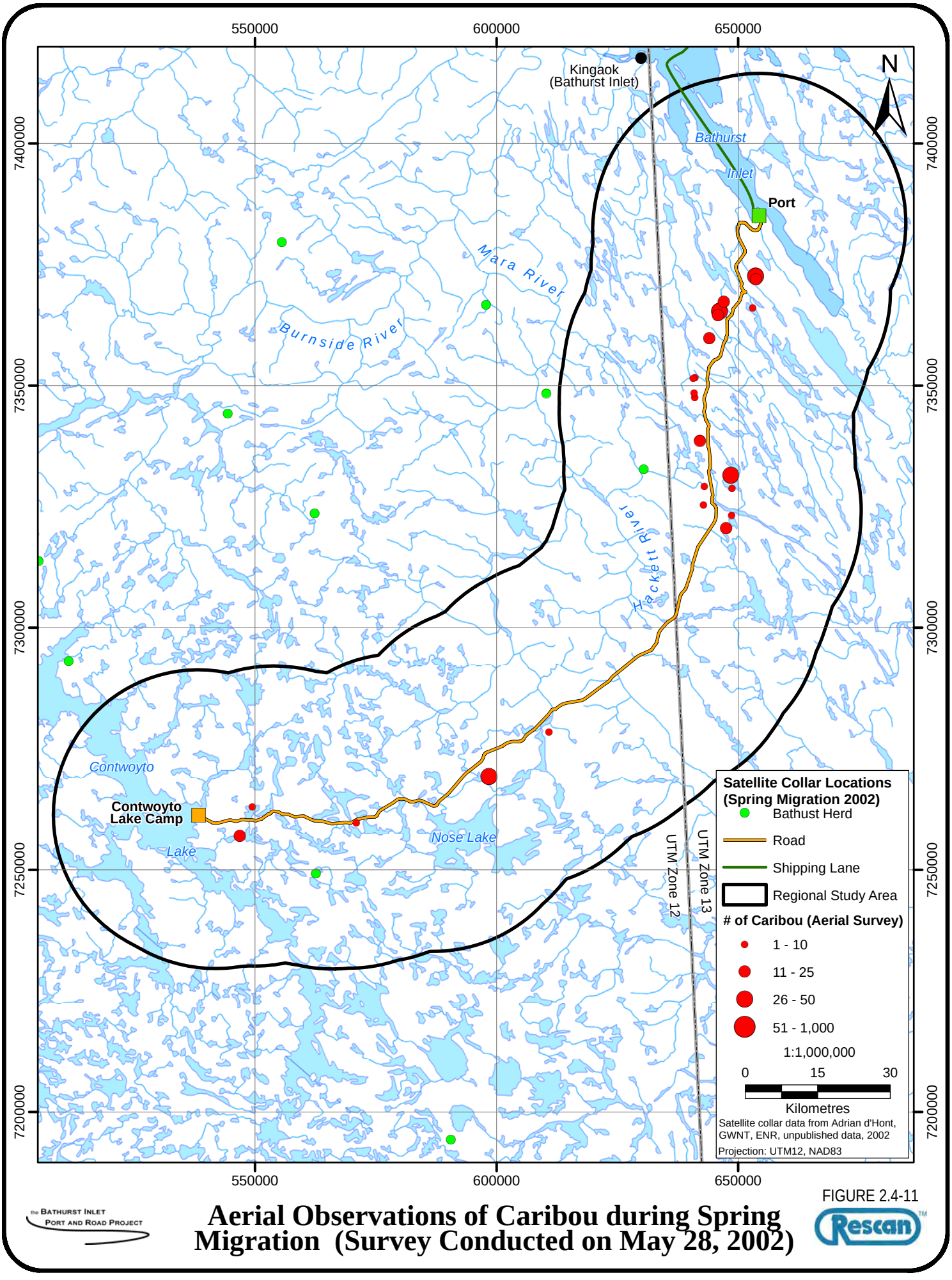

FIGURE 2.4-11

Aerial Observations of Caribou during Spring Migration (Survey Conducted on May 28, 2002)

the Bathurst Inlet Port and Road Project

Rescan™

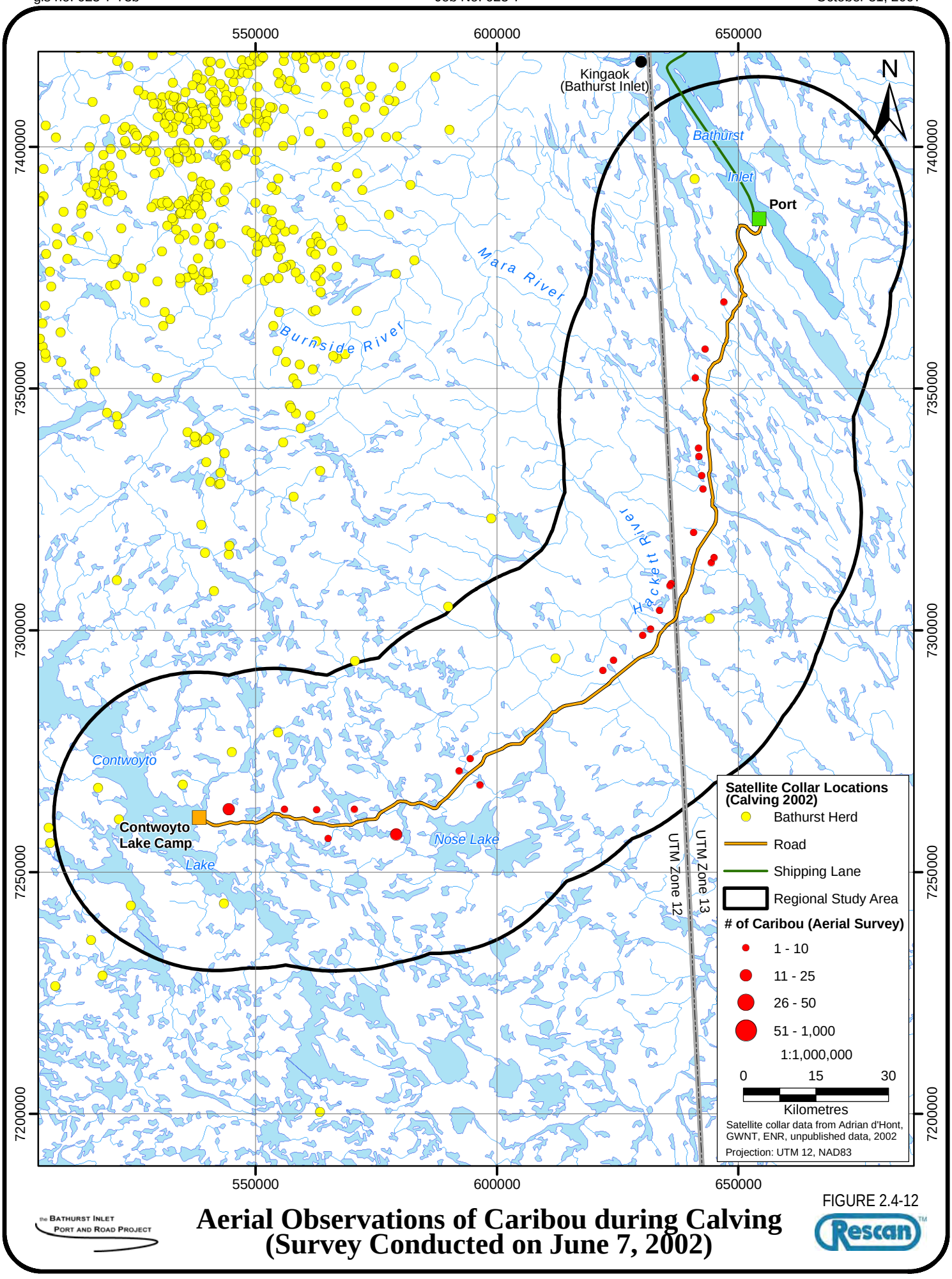

FIGURE 2.4-12

Aerial Observations of Caribou during Calving (Survey Conducted on June 7, 2002)

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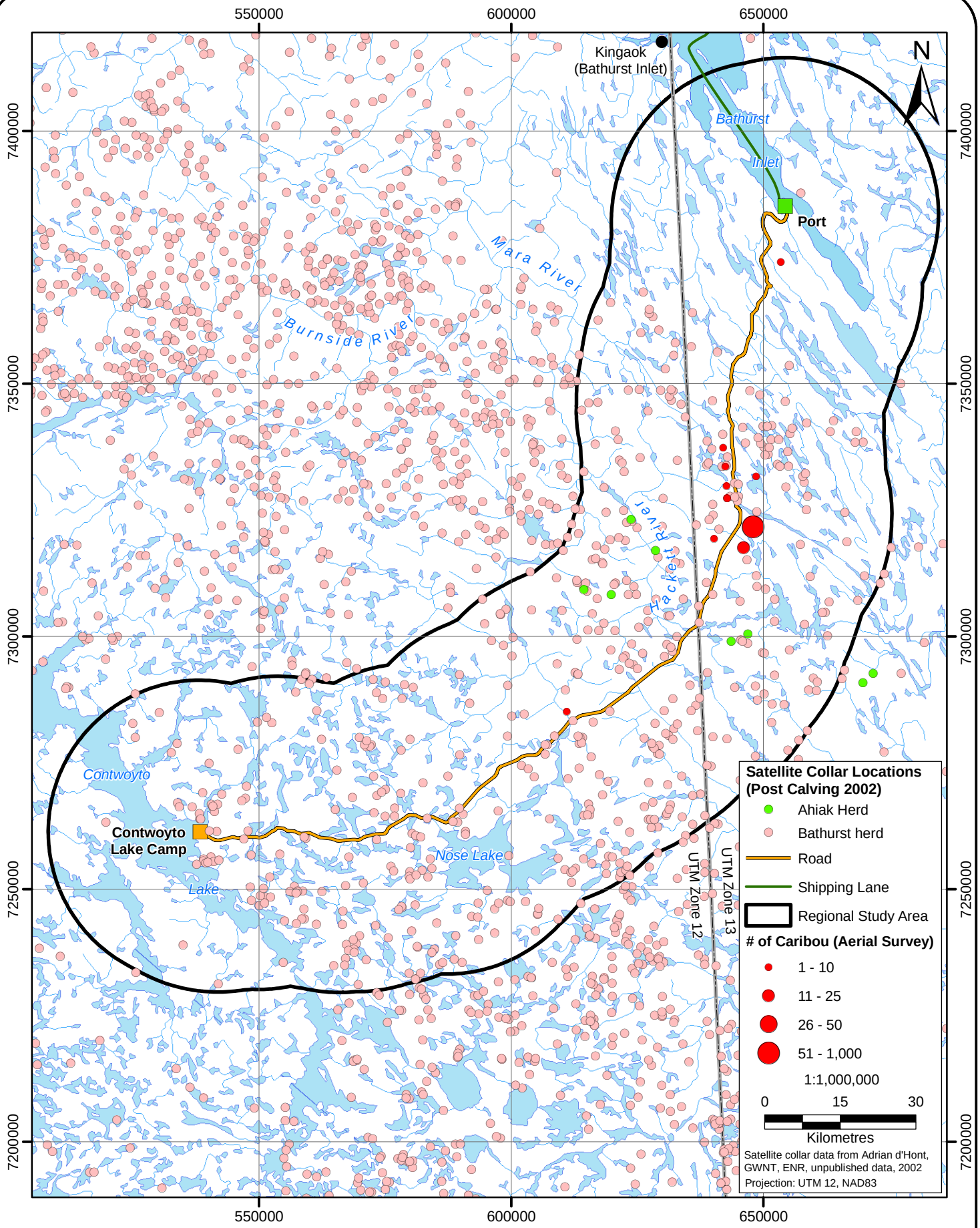

FIGURE 2.4-13

Aerial Observations of Caribou during Post-Calving (Survey Conducted on July 7, 2002)

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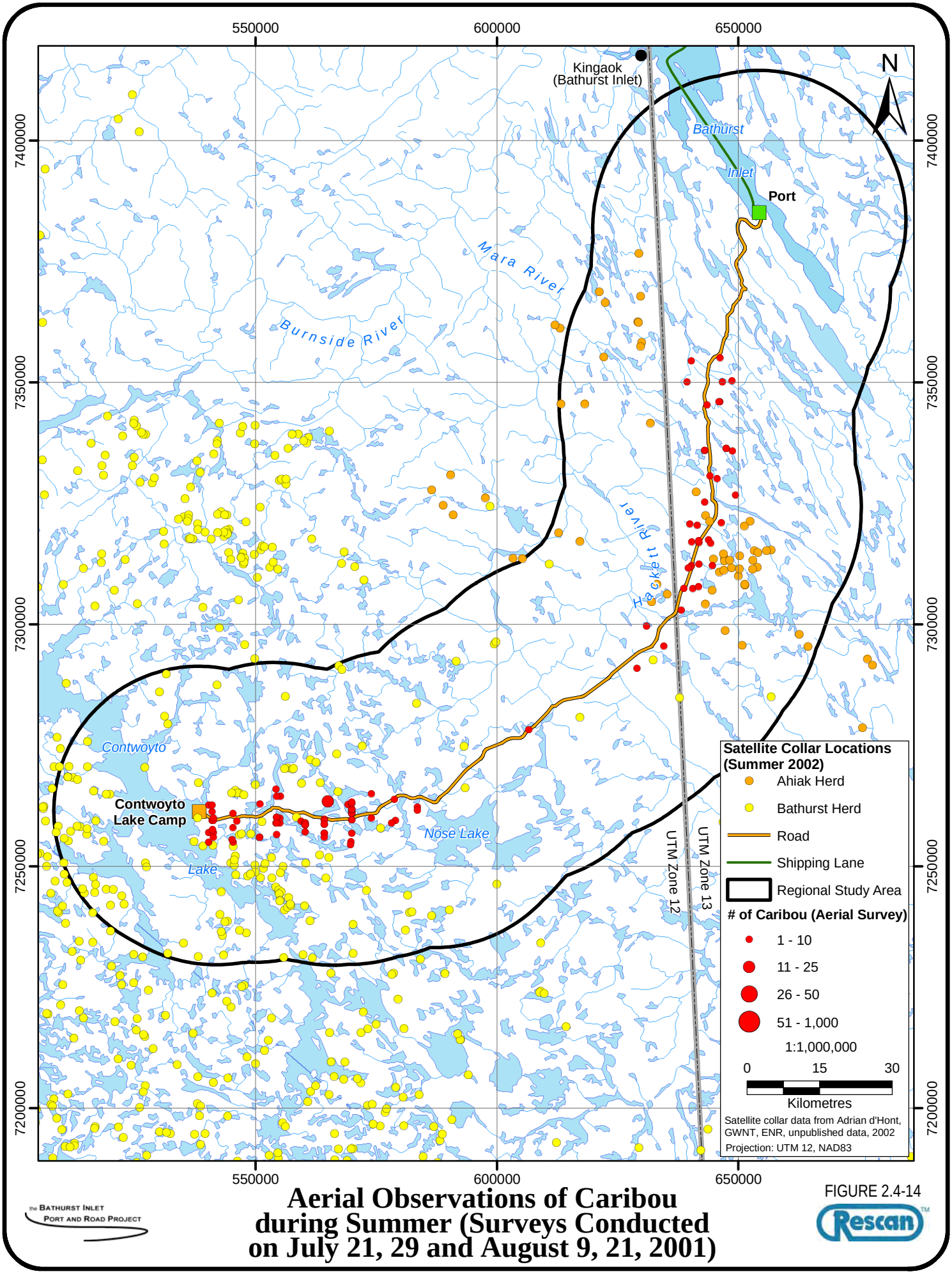

Aerial Observations of Caribou during Summer (Surveys Conducted on July 21, 29 and August 9, 21, 2001)

FIGURE 2.4-14

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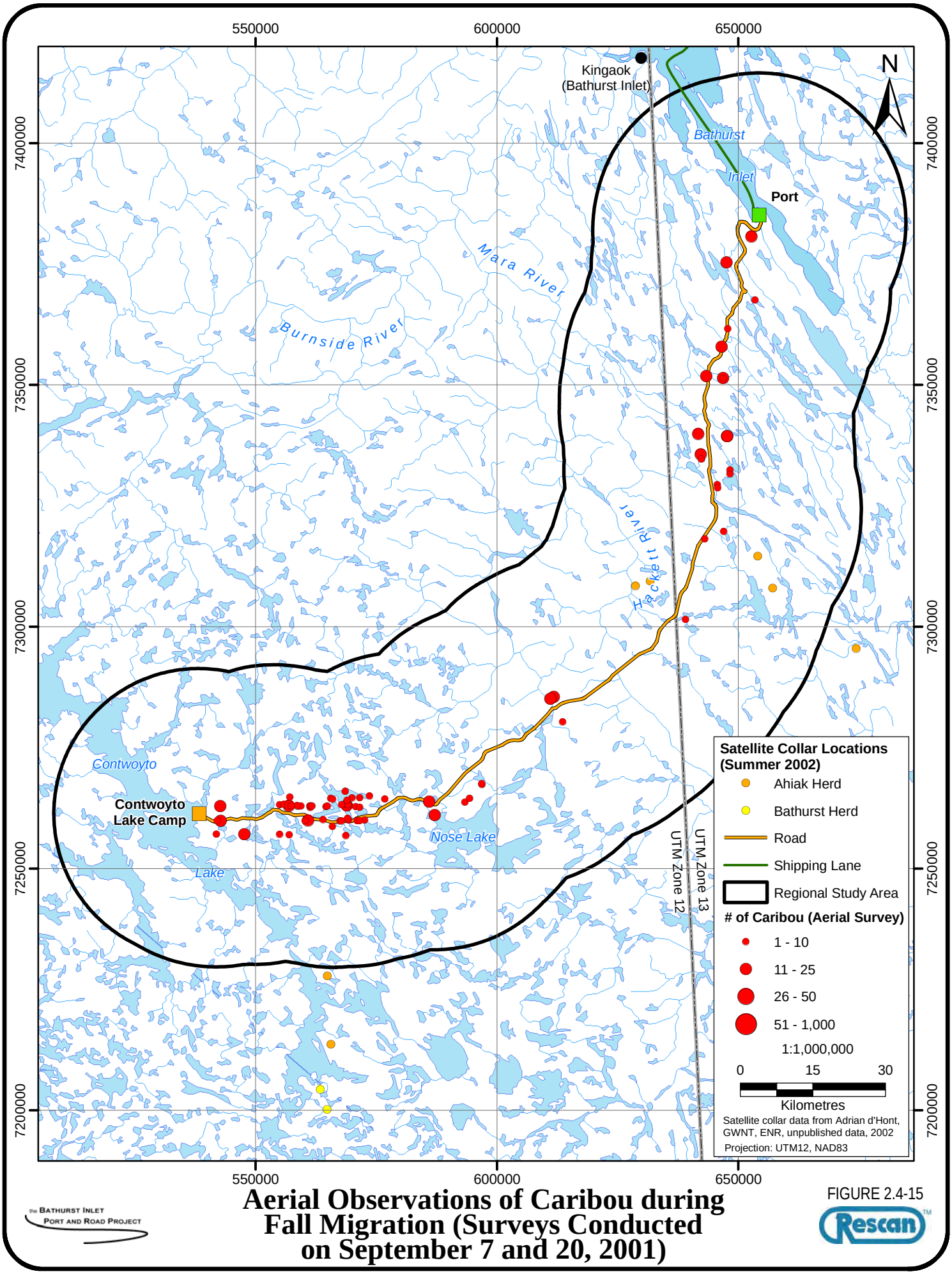

Aerial Observations of Caribou during Fall Migration (Surveys Conducted on September 7 and 20, 2001)

FIGURE 2.4-15

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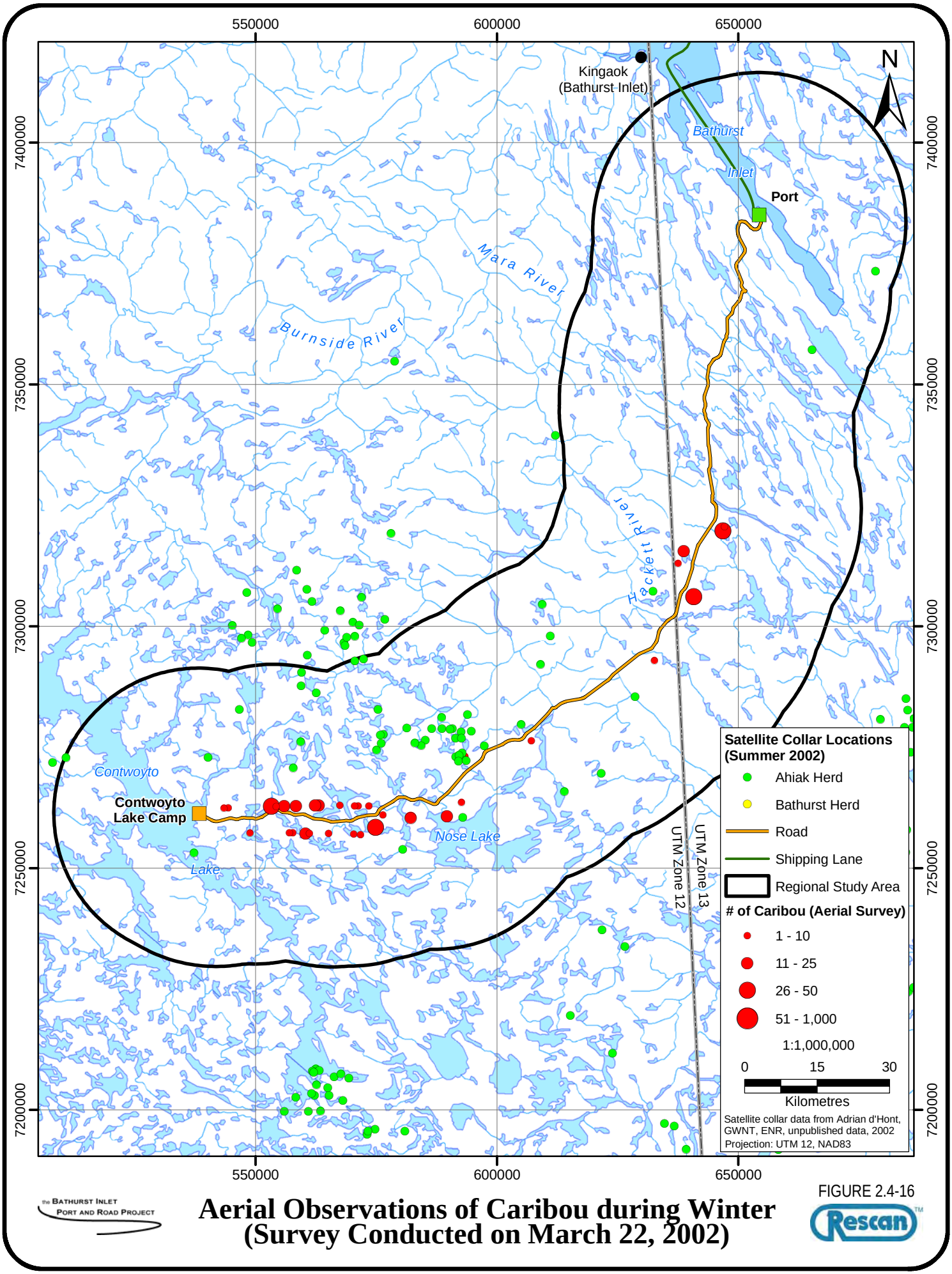

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Aerial Observations of Caribou during Winter (Survey Conducted on March 22, 2002)

FIGURE 2.4-16

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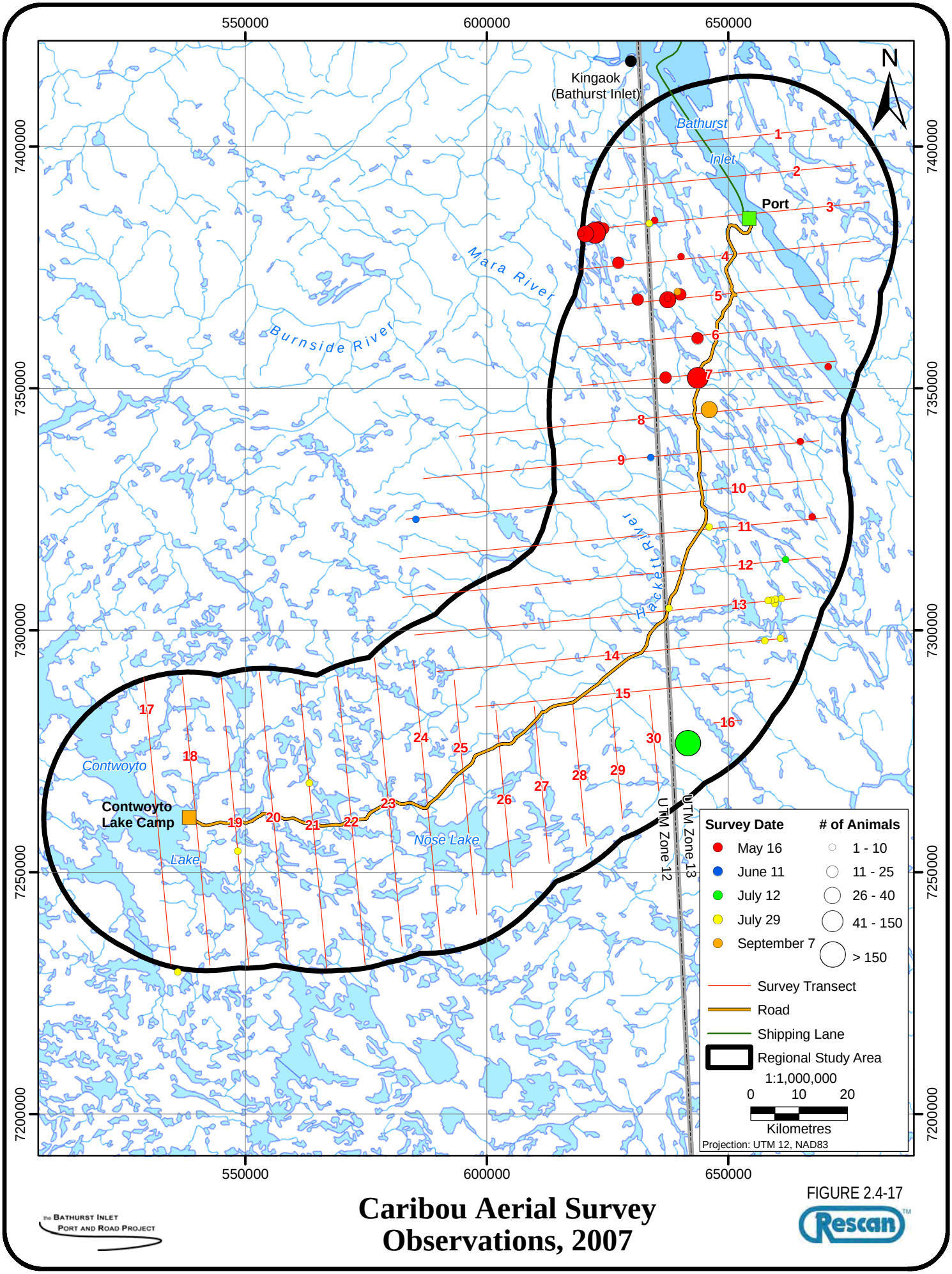

Caribou Aerial Survey Observations, 2007

FIGURE 2.4-17

the Bathurst Inlet Port and Road Project

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early July. The late July/summer survey again found few caribou (14), as the Bathurst caribou had moved to their summer range to the southeast. Finally, the fall migration survey found few caribou (36), but was only a partial survey due to bad weather. These data support the seasonal distribution data provided by the satellite collars for Bathurst and Ahiak caribou.

Habitat Use and Diet

Overview

Few data exist on the habitat requirements of Bathurst caribou. Habitat selection by caribou is mainly dictated by their nutritional requirements and the distribution and availability of suitable forage (Calef, 1981; Russel, 1998). Other factors include predator avoidance, ease of travel (Thorpe *et al.*, 2001) and insect avoidance in late June and July (Curatolo, 1975; Russel, 1998). The following sections outline habitat requirements of Bathurst caribou during the periods when they are found in the RSA. The post-calving and summer periods have been combined because habitat selection by caribou is similar during these two periods.

Spring Migration (April 15 to June 4)

During spring migration, Bathurst caribou typically migrate along frozen lakes and rivers, eskers, and open snow-free uplands that facilitate travel (Thorpe *et al.*, 2001). Bathurst caribou feed mainly on lichen during this time since green vegetation is not available (Griffith *et al.*, 2001). Habitats preferred by caribou include lichen veneer, heath tundra, sites with low shrub-like willows or birches, eskers, and ridges and other high points where snow is relatively shallow (Griffith *et al.*, 2001; Thorpe *et al.*, 2001; Russel *et al.*, 2002; Johnson *et al.*, 2005).

Calving (June 5 to 15)

The calving grounds of the Bathurst herd are located on flat, open terrain at relatively high elevations with abundant lichen and green vegetation. These areas facilitate predator avoidance and fulfill the high energetic requirements of lactating females (Griffith *et al.*, 2001; Thorpe *et al.*, 2001). The vegetation classifications of the calving grounds are Lichen Heath and Moist Shrub (Griffith *et al.*, 2001; Johnson *et al.*, 2005). Wet graminoid vegetation is also used during the calving period (Griffith *et al.*, 2001). Griffith *et al.* (2001) suggest that caribou select calving grounds that provide a diversity of vegetation types in close proximity and that provide variable benefits depending on the timing of green-up. Lichen is the dominant dietary item of Bathurst caribou prior to the relatively protein-rich green early spring vegetation, including sedges, mosses, grasses, and shrubs becoming available. The timing of snowmelt and green-up determines the proportion of lichen and green vegetation that is consumed by caribou. Bathurst cows appear to compensate for low nitrogen intake on the calving grounds by digging for nitrogen-rich *Oxytropis* rhizomes (Griffith *et al.*, 2001; Thorpe *et al.*, 2001).

Post-calving and Summer (June 16 to August 31)

During post-calving and summer, Bathurst caribou require habitat that provide nutritious forage, salt and escape from heat, insects, and predators. The post-calving and summer season is a time when calves are growing and, in the late summer, when animals are fattening-up for the winter. The post-calving and summer diets of Bathurst caribou mainly consist of willows, grasses,

sedges and other green vegetation (Griffith *et al.*, 2001; Thorpe *et al.*, 2001). Inuit Traditional Knowledge indicates that cotton grass is an important forage for newly weaned calves (Thorpe *et al.*, 2001). Caribou select cool, moist areas where vegetation is abundant, primarily riparian shrub communities, sedge wetlands, or along ocean and lake shorelines (Griffith *et al.*, 2001; Thorpe *et al.*, 2001; Johnson *et al.*, 2005). Post-calving areas have a high level of green plants available at the peak of lactation, which occurs at approximately June 21 (Thorpe *et al.*, 2001). Heath tundra, the most abundant habitat type, is also used by caribou during this period (Thorpe *et al.*, 2001). Ocean shorelines have the added benefit of providing a source of salt to compensate for caribou's sodium-poor diet (Thorpe *et al.*, 2001).

Caribou also select habitats that provide relief from insects and heat. Insects are abundant on warm days when wind speeds are low (Boulanger *et al.*, 2004) especially for the two weeks spanning late June or early July (Thorpe *et al.*, 2001). Insect harassment can interfere with foraging behaviour, increase energy expenditures, cause calf-cow separation and can contribute to over-heating if caribou run for long periods to avoid insects (Mörschel and Klein, 1997; Thorpe *et al.*, 2001). Caribou select cool, windy or shaded areas, which provide relief from both insects and heat; such habitats include eskers, riparian communities and the shores of lakes, rivers and the ocean (Murphy and Curatolo, 1987; Russel *et al.*, 1993; Thorpe *et al.*, 2001; Gunn *et al.*, 2002). Caribou are often seen swimming in lakes to escape the heat and insects (Thorpe *et al.*, 2001).

Bathurst caribou also require habitats that provide protection from predators. Caribou often gather along lake shorelines, especially late in the day, because they can enter the water to escape predators such as wolves when necessary (Thorpe *et al.*, 2001). Habitats with extensive shrub cover (*e.g.*, riparian shrub communities) may increase the vulnerability of caribou to predation because they conceal predators (Curatolo, 1975; Heard and Gray, 1989); however, caribou select these habitats for the relatively high quality of forage they provide (AXYS Environmental Consulting Ltd. and Penner and Associates Ltd., 1998).

Fall Migration (September 1 to October 31)

During the fall, Bathurst caribou require habitats that provide abundant forage and facilitate travel. Caribou breed in the fall during the rut but implantation of the fertilized egg is delayed and can be aborted if animal condition is poor during the winter. Hence, high quality forage is important in the fall. Green forage becomes less available as the fall progresses and Bathurst caribou choose lichen veneer for foraging (Johnson *et al.*, 2005). Sedge wetland and riparian tall shrub habitats may also be used depending on the availability of green forage. However, a habitat modelling study by Johnson *et al.* (2005) indicated that caribou may avoid areas dominated by sedge, peat bog, and heath tundra during the fall. Eskers, ridges, and other high points are selected for easy travel (Thorpe *et al.*, 2001).

Habitat Suitability Ratings

Habitat requirements for all barren-ground caribou are similar. As such, the Bathurst caribou herd, the most abundant herd in the Project area during the calving and post-calving/summer seasons, was the focus of habitat suitability ratings during those seasons.

The majority of the habitat occurring in the RSA and LSA in both seasons was moderate quality habitat (Table 2.4-2; Appendix D-8 of the DEIS). There is a higher proportion of high quality habitat within the LSA compared to the RSA for calving and post-calving/summer seasons. Conversely, there is a higher proportion of low quality habitat in the RSA compared to the LSA.

Table 2.4-2
Area and Proportion of High, Moderate, Low and Nil-quality Habitat within the LSA and RSA for Bathurst Caribou

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Calving Season				
High	3,414	12.90	12,455	0.83
Moderate	21,151	79.98	1,120,953	73.94
Low	1,789	6.79	368,277	25.23
Nil	84	0.33	0	0
Post-Calving/Summer Season				
High	7,538	28.52	286,977	19.1
Moderate	17,294	65.46	738,316	49.2
Low	1,521	5.69	476,391	31.7
Nil	85	0.33	0	0

2.4.1.2 Ahiak Caribou

Introduction

Few data exist on the Ahiak caribou herd and the ecology of this herd has not been described. The range of the Ahiak herd is generally to the east of the RSA with wintering grounds to the southeast of the RSA and calving grounds on the coast of Queen Maud Gulf (Figure 2.4-2). Some Ahiak caribou occur in the RSA during most seasons as the RSA is part of the western extent of their annual range.

Population Trends

The Ahiak herd has increased from between 40,000 and 60,000 animals in 1986 to roughly 200,000 animals in 1996, based on aerial calving area surveys along the Queen Maud Gulf (Gunn *et al.*, 2000). The current population trend is unknown.

Movements and Distribution

Introduction

The Ahiak herd winters over a broad area from Bathurst Inlet to northern Saskatchewan and migrates north to the Arctic coast on Queen Maud Gulf for calving and summer foraging. The timing of migrations and calving are similar to Bathurst caribou, although the calving season is thought to be longer, stretching to June 20 instead of June 15 (Table 2.4-3; Gunn *et al.*, 2000). Ahiak caribou are found in the RSA during spring migration, post-calving, summer, fall

migration and winter (Figure 2.4-18, 2.4-19, 2.4-20). The RSA overlaps the edge of the Ahiak herd's range during these periods; most of the herd's range is located east or southeast of the RSA. The herd is not found in the RSA during calving (Gunn *et al.*, 2000; Adrian D'Hont, GNWT, ENR, unpublished data; Appendix F-5 of the DEIS).

Table 2.4-3
Annual Cycle Stage Dates for Ahiak Caribou

Cycle Stage	Start Date	End Date
Spring Migration	April 15	June 4
Calving	June 5	June 20
Post-calving	June 21	July 25
Summer	July 26	August 31
Fall Migration	September 1	October 31
Winter	November 1	April 14

As with the Bathurst Caribou, the calving season has been divided into two stages: the calving period when cows are giving birth (defined by the peak of calving), and a five week post-calving period which extends until calves are weaned (Table 2.4-3).

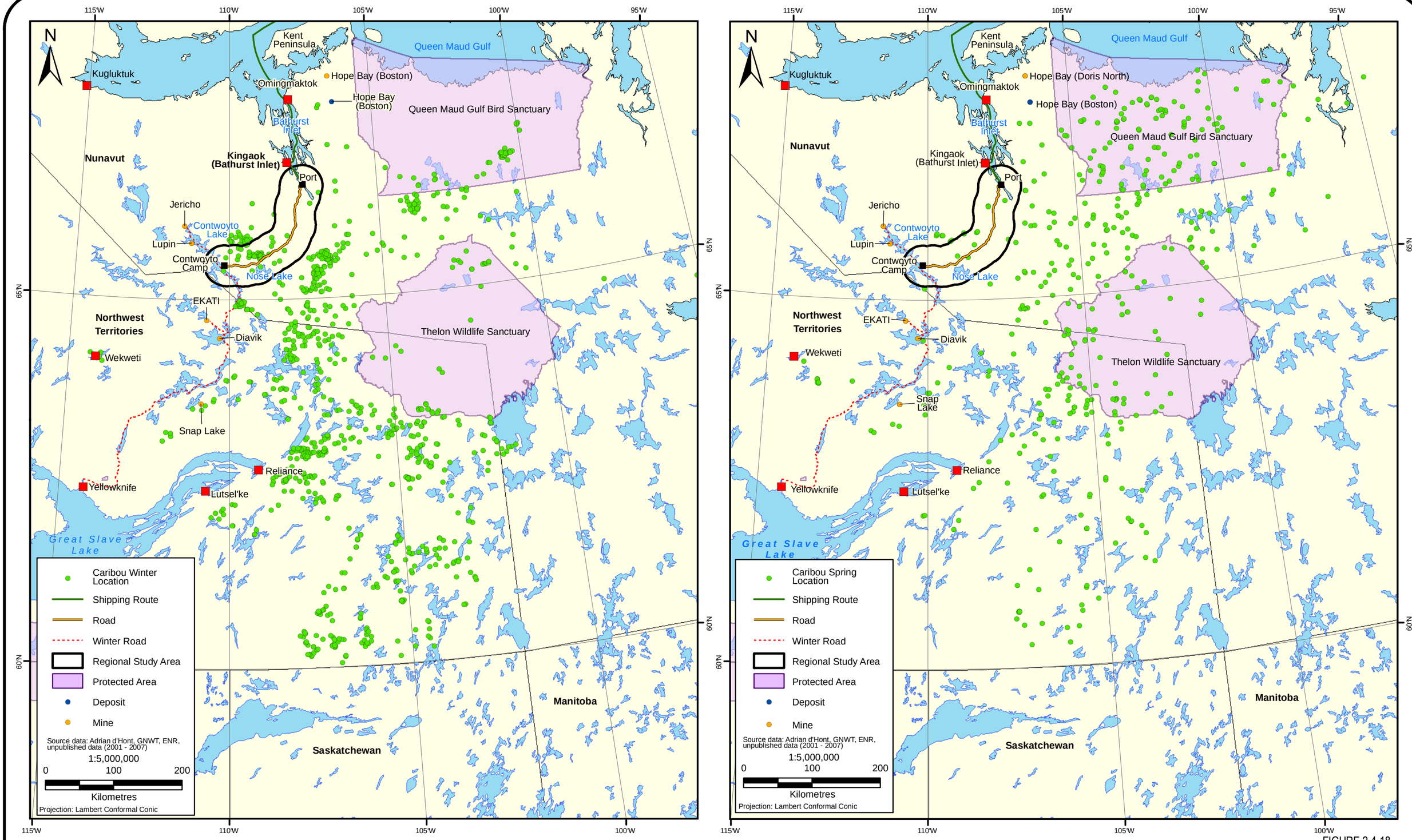
Relatively few data exist on the seasonal distribution and movements of the Ahiak caribou herd. Data sources include Inuit Traditional Knowledge (Appendix F-5 of the DEIS), aerial calving ground surveys in 1986, 1996 and 2002 (Gunn *et al.*, 2000; Gunn and D'Hont, 2002), satellite collar data from five cows between 1996 and 1998 (Gunn *et al.*, 2000) and satellite collar data from 16 cows between 2001 and 2007 (GNWT ENR, 2007). The following sections describe the Ahiak herd's seasonal distribution and movements.

Spring Migration (April 15 to June 4)

During spring migration, Ahiak caribou migrate northwards from their wintering grounds to the calving grounds along Queen Maud Gulf (Figure 2.4-2). Satellite collar data indicate that some Ahiak animals are found in the RSA during spring migration (Figure 2.4-18; Appendix D-9 of the DEIS).

Calving (June 5 to 20)

Ahiak caribou calve along the Queen Maud Gulf coast, on the east side of Bathurst Inlet, in the Queen Maud Gulf Migratory Bird Sanctuary (Figure 2.4-19; Gunn *et al.*, 2000; Gunn and D'Hont, 2002; Appendix F-5 of the DEIS; Adrian D-Hont, GNWT ENR, unpublished data). The name Ahiak is derived from the location of the herd's calving grounds, the Ahiak region west of Perry River. In recent years, the calving grounds of the Ahiak herd have overlapped the traditional (but not current) calving grounds of the Bathurst herd on the east side of Bathurst Inlet (Gunn *et al.*, 2000; Gunn and D'Hont, 2002; Appendix F-5 of the DEIS). Ahiak caribou are not found in the RSA during calving. Caribou typically have high site fidelity to calving grounds from year to year (Gunn *et al.*, 2000; Russel *et al.*, 2002).



Locations of Satellite - Collared Ahiak Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 2001 - 2007

FIGURE 2.4-18

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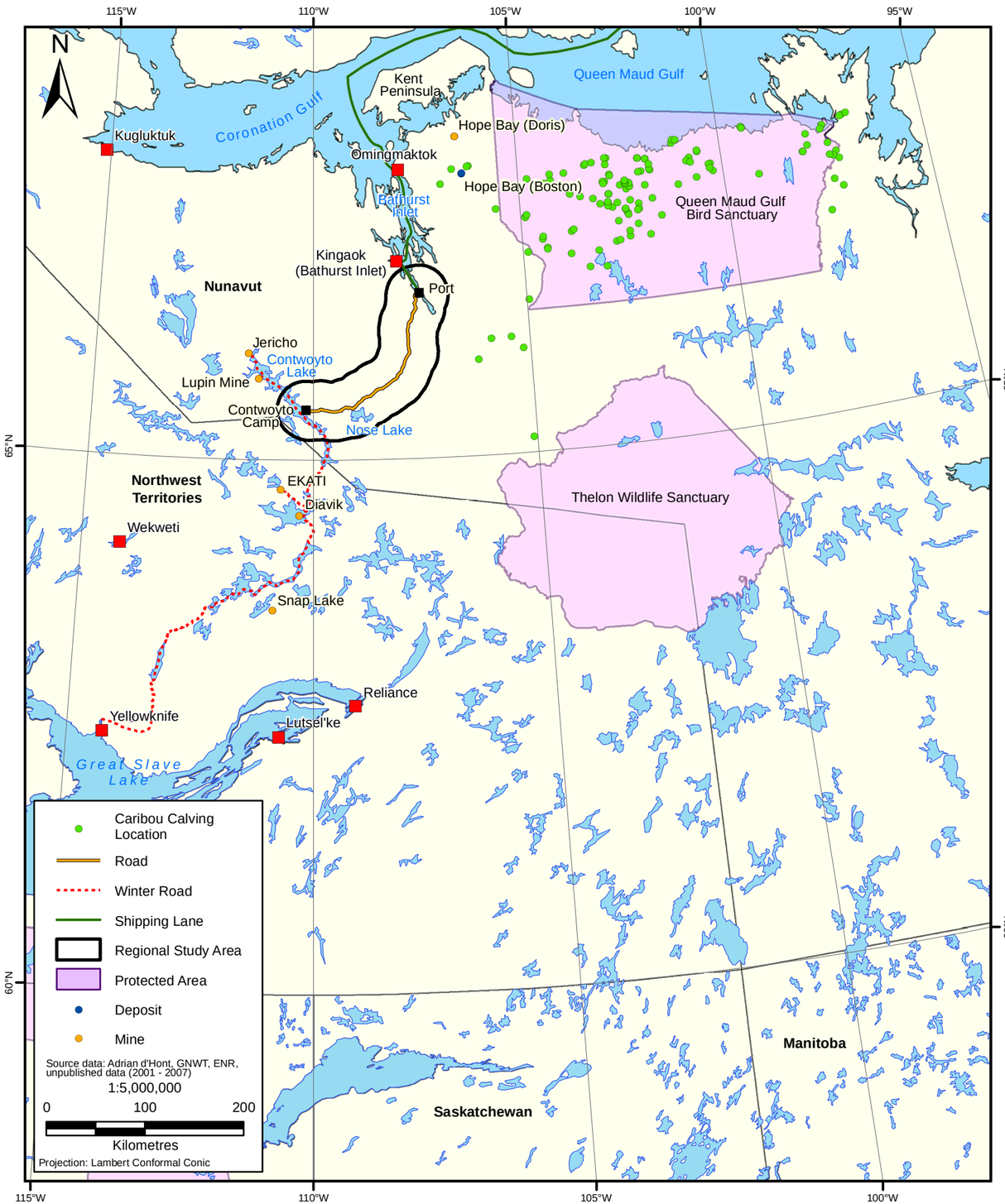

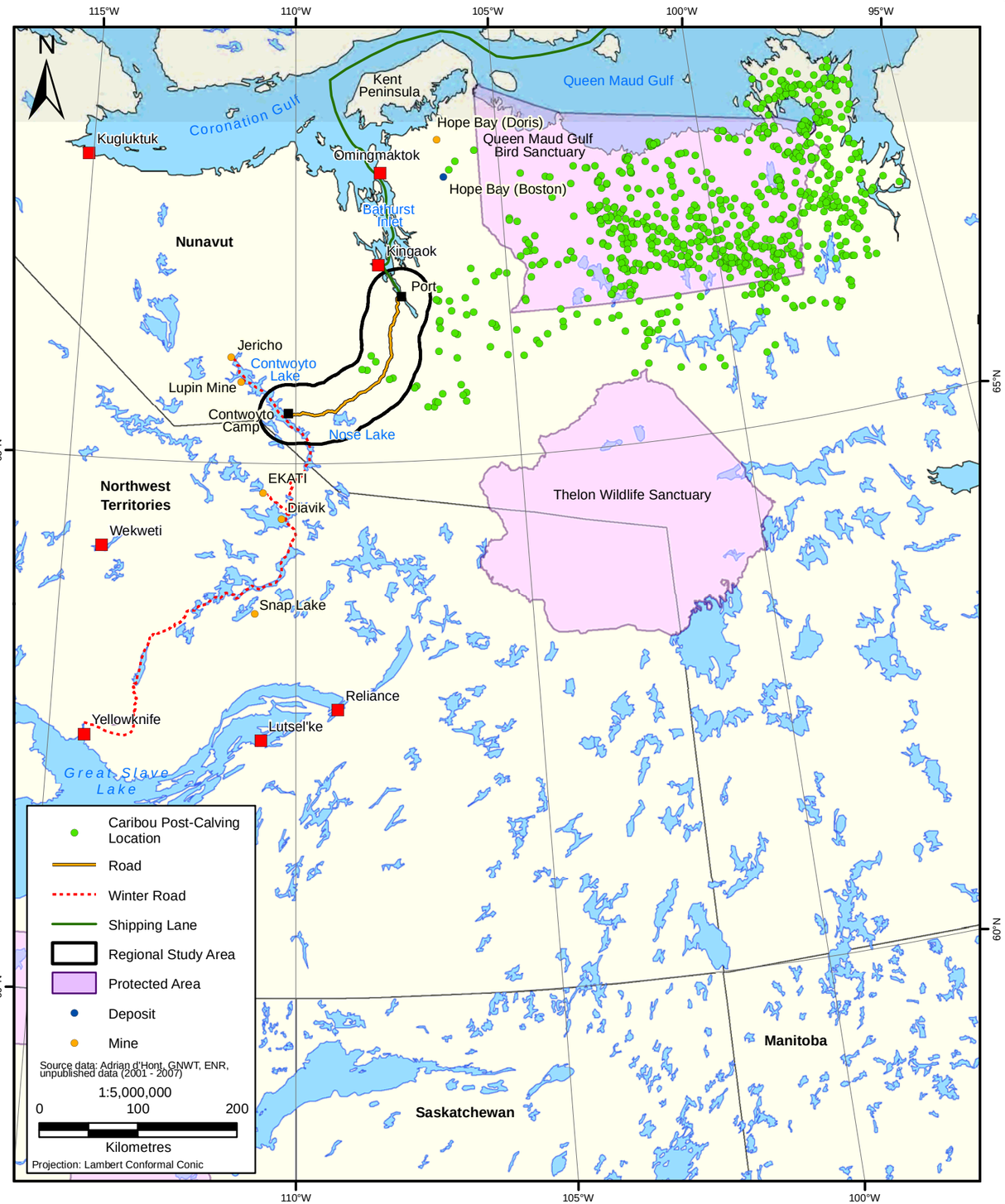

Locations of Satellite - Collared Ahiak Caribou during Calving (5 June to 20 June) and Post-Calving (21 June to 25 July), 2001 - 2007

FIGURE 2.4-19

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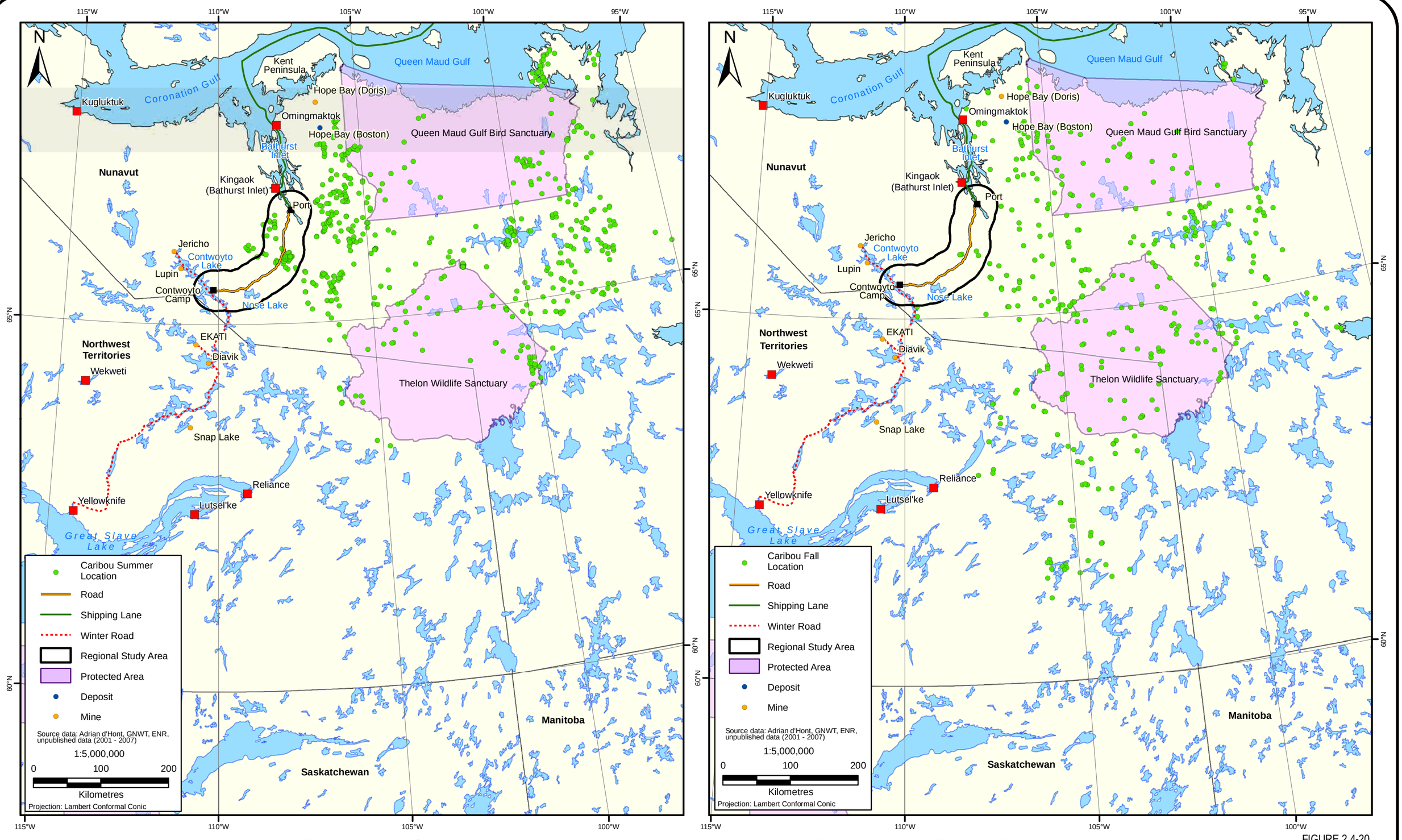

115°W
110°W
105°W
100°W
95°W
N
Kugluktuk
Coronation Gulf
Kent Peninsula
Queen Maud Gulf
Hope Bay (Doris)
Omingmaktok
Hope Bay (Boston)
Queen Maud Gulf Bird Sanctuary
Bathurst Inlet
Nunavut
Kingaok (Bathurst Inlet)
Port
Jericho
Contwoyto Lake
Lupin
Contwoyto Camp
Nose Lake
EKATI
Diavik
Northwest Territories
Wekweti
Thelon Wildlife Sanctuary
Snap Lake
Reliance
Yellowknife
Lutsel'ke
Great Slave Lake
Manitoba
Saskatchewan
65°N
60°N
Caribou Fall Location
Road
Shipping Lane
Winter Road
Regional Study Area
Protected Area
Deposit
Mine
Source data: Adrian d'Hont, GNWT, ENR, unpublished data (2001 - 2007)
1:5,000,000
0 100 200
Kilometres
Projection: Lambert Conformal Conic

Locations of Satellite - Collared Ahiak Caribou during Summer (26 July to 31 August) and Fall Migration (1 September to 31 October), 2001 - 2007

FIGURE 2.4-20

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Post-Calving and Summer (June 21 to August 31)

Ahiak cows disperse south and southwest after calving to occupy post-calving and summer ranges (Figures 2.4-19 and 2.4-20). The western edge of the post-calving and summer ranges overlaps the RSA. Unlike Bathurst cows, Ahiak cows do not depart immediately from the calving area; therefore, there is some overlap in areas used for calving and post-calving (Gunn *et al.*, 2000; Gunn and D'Hont, 2002). It is during the post-calving period that most Ahiak caribou are found in the RSA (Figure 2.4-21).

Fall Migration (September 1 to October 31)

During the fall, Ahiak caribou continue migrating south towards the Thelon Game Sanctuary, located on the NWT/Nunavut border east of Great Slave Lake, where the rut occurs (Figure 2.4-20; Gunn *et al.*, 2000). One collared caribou was observed in the RSA (Appendix D-7 of the DEIS), suggesting that caribou from this herd use the RSA during the fall migration.

Winter (November 1 to April 14)

After rutting, Ahiak caribou disperse northwest or south for the winter (Gunn *et al.*, 2000). Ahiak wintering grounds extend from Bathurst Inlet south to the area east of Great Slave Lake and the Saskatchewan border (Figure 2.4-18). The winter range of the Ahiak herd overlaps that of the Bathurst and Beverly herds. In some years, Ahiak caribou are found in the southern portion of the RSA.

Field Data for Ahiak Caribou in RSA

See discussion of field data for Bathurst and Ahiak caribou in Section 2.4.1.1.

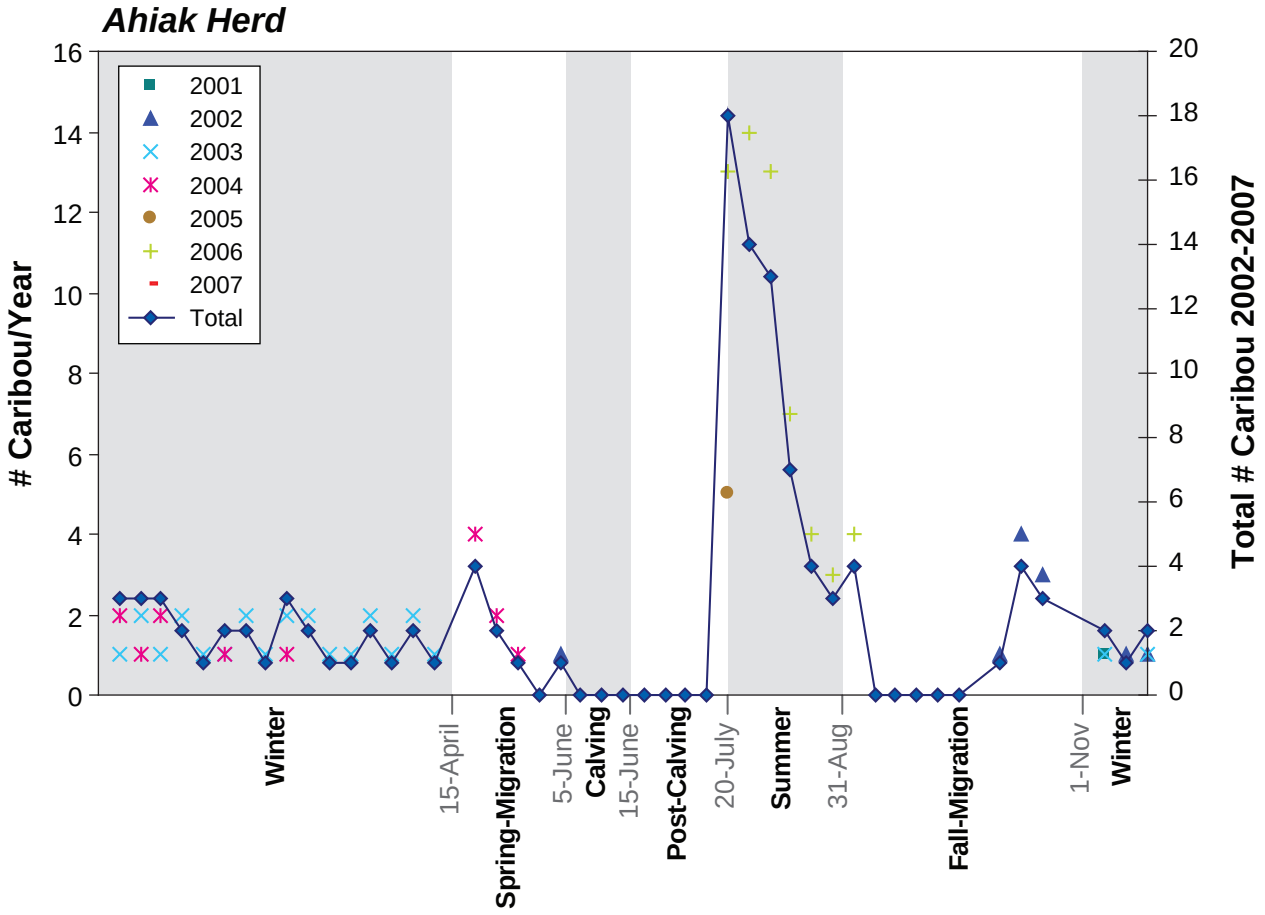
Habitat Suitability Ratings

During the winter season, the Ahiak caribou herd is the only herd that has been abundant in the Project area. Therefore, Ahiak caribou were the focus of winter habitat suitability ratings.

The majority of the habitat occurring in the RSA and LSA in the winter season was high quality habitat (Table 2.4-4; Appendix D-8 of the DEIS). There is a higher proportion of high quality habitat within the LSA compared to the RSA for the winter season. Conversely, there is a higher proportion of low and moderate quality habitat in the RSA compared to the LSA.

Table 2.4-4
Area and Proportion of High, Moderate, Low and Nil-quality Habitat within the LSA and RSA for Ahiak Caribou

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Winter Season				
High	17876	67.6	746662	49.7
Moderate	591	2.2	191720	12.8
Low	7971	30.2	563303	37.5
Nil	0	0	0	0



Source of data: Adrian d'Hont, GNWT, ENR, unpublished data (2001-2007)

2.4.1.3 Dolphin and Union Caribou

Introduction

Dolphin and Union caribou winter on the Nunavut mainland along the Coronation Gulf, on the Kent Peninsula, and along the western extent of the Queen Maud Gulf (Figure 2.4-3; COSEWIC, 2004; Appendix F-5 of the DEIS). This herd migrates across the sea ice to its calving grounds on Victoria Island. During migration, the herd requires ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (Figure 2.2-22; COSEWIC, 2004). The Dolphin and Union caribou herd crosses the shipping route in Dease Strait and the Queen Maud Gulf during the spring and fall migrations. Satellite collar data do not show any locations of Dolphin and Union caribou within the RSA (Figures 2.4-23, 2.4-24, 2.4-25, and 2.4-26; Mathieu Dumond, GN DOE, *unpublished data*).

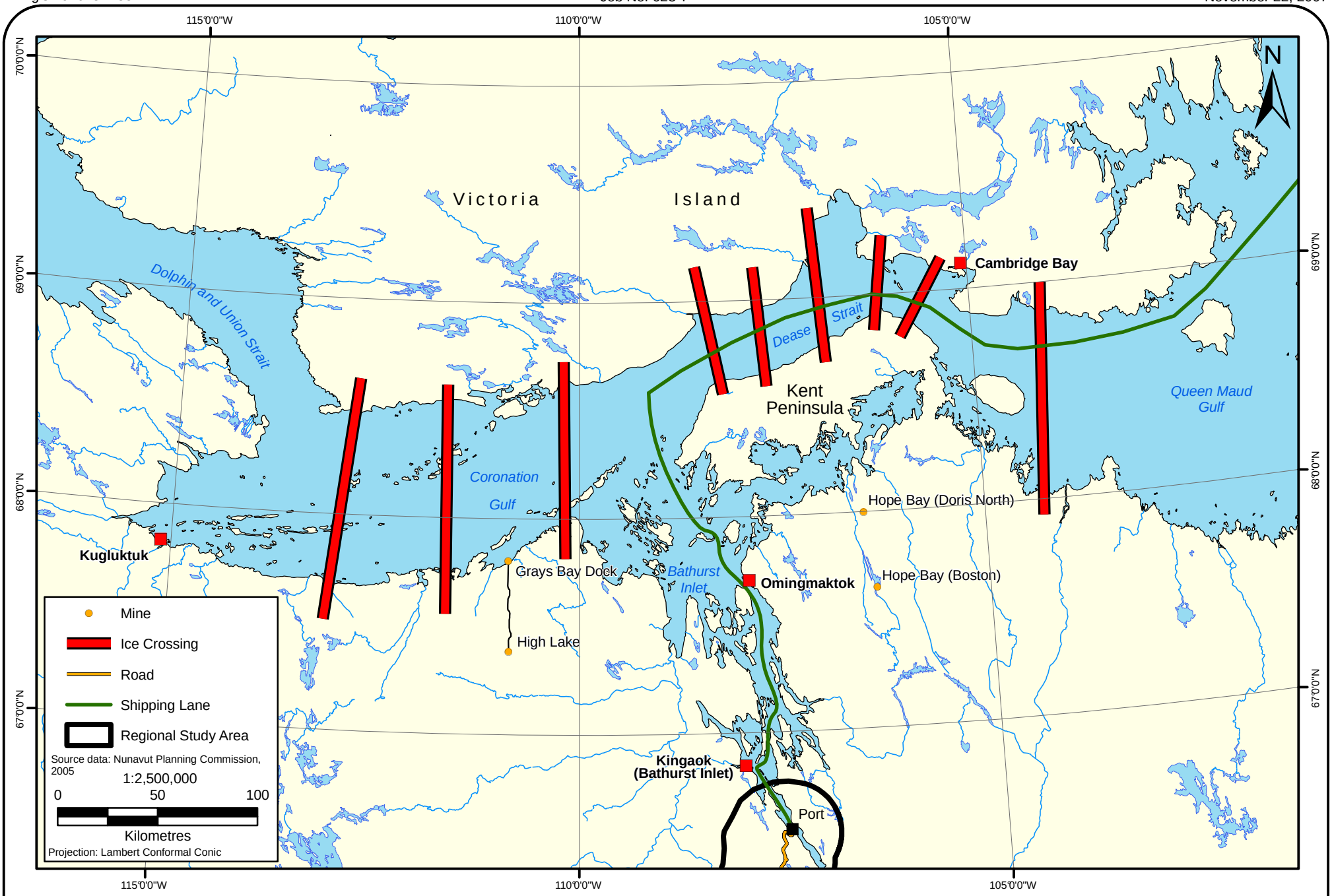
Dolphin and Union caribou have recently been recognized as a genetically distinct population from Peary caribou and barren-ground caribou (COSEWIC, 2004). COSEWIC has designated the Dolphin and Union herd as a sub-population of Special Concern due to high harvests without recent population estimates (COSEWIC, 2004). COSEWIC highlights potential threats to this herd due to climate warming and shipping activity along the herd's migration route (COSEWIC, 2004). Climate warming may shorten the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Furthermore, if shipping activity breaks ice in Dease Strait or the Queen Maud Gulf, Dolphin and Union caribou migration may be blocked or animals may fall through the recently broken ice. COSEWIC states that shipping and icebreaking make

Dolphin and Union caribou "vulnerable to die-offs similar to those that have affected Peary caribou" (COSEWIC, 2004). The draft WKRLUP also expresses concern for caribou at ice crossings between Victoria Island and the mainland, and stipulates that shipping "may not take place outside the normal open water season between July 1 and October 15" (conformity requirement 6.2; NPC, 2005). The herd is pending addition to Schedule 1 of SARA.

The following sections discuss the demography and distribution of the Dolphin and Union caribou herd with emphasis on timing and migratory routes across sea ice. Habitat requirements and diet are not discussed since the herd does not occur near the road or port site.

Population Trends

In the early 1900s, the Dolphin and Union caribou herd was estimated at 100,000 animals (COSEWIC, 2004). Overhunting caused a population crash between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland (Gunn, 2005). In the late 1980s and early 1990s, the Dolphin and Union herd had recovered to the point where they resumed their historic migrations between Victoria Island and the mainland (Gunn *et al.*, 1997). Approximately 7,200 Dolphin and Union caribou were counted prior to migration in spring 1993 (Gunn *et al.*, 1997). In 1997, the Dolphin and Union herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn, 2004), which puts the herd at about one-third of its historic size. The herd is thought to be increasing (COSEWIC, 2004; Appendix F-5 of the DEIS), although population trends are tentative.



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Ice Crossings by Dolphin and Union Caribou

FIGURE 2.4-22

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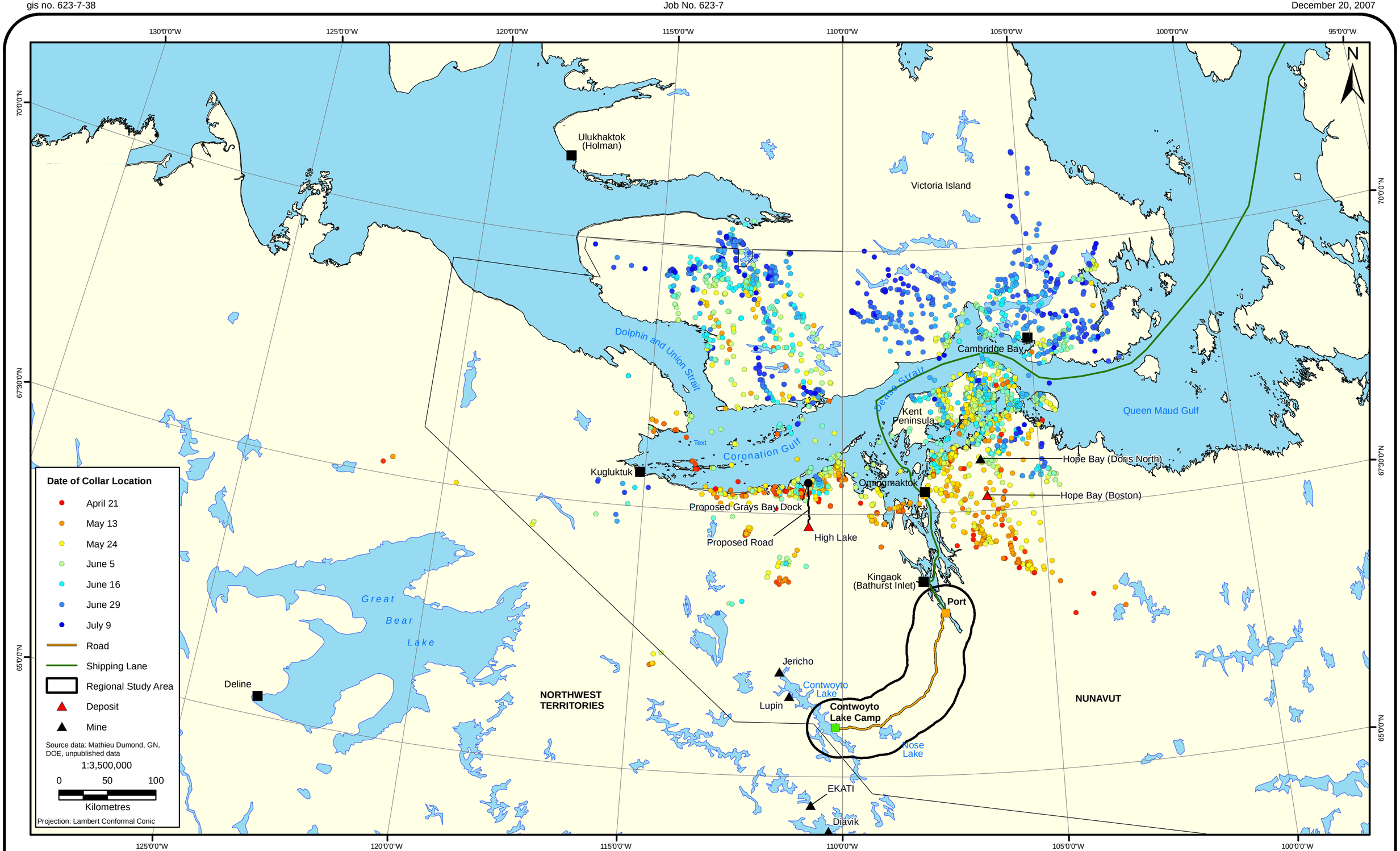

FIGURE 2.4-23

Locations of Satellite-Collared Dolphin and Union Caribou During the Northward Spring Migration (21 April to 9 July), 1999 to 2004

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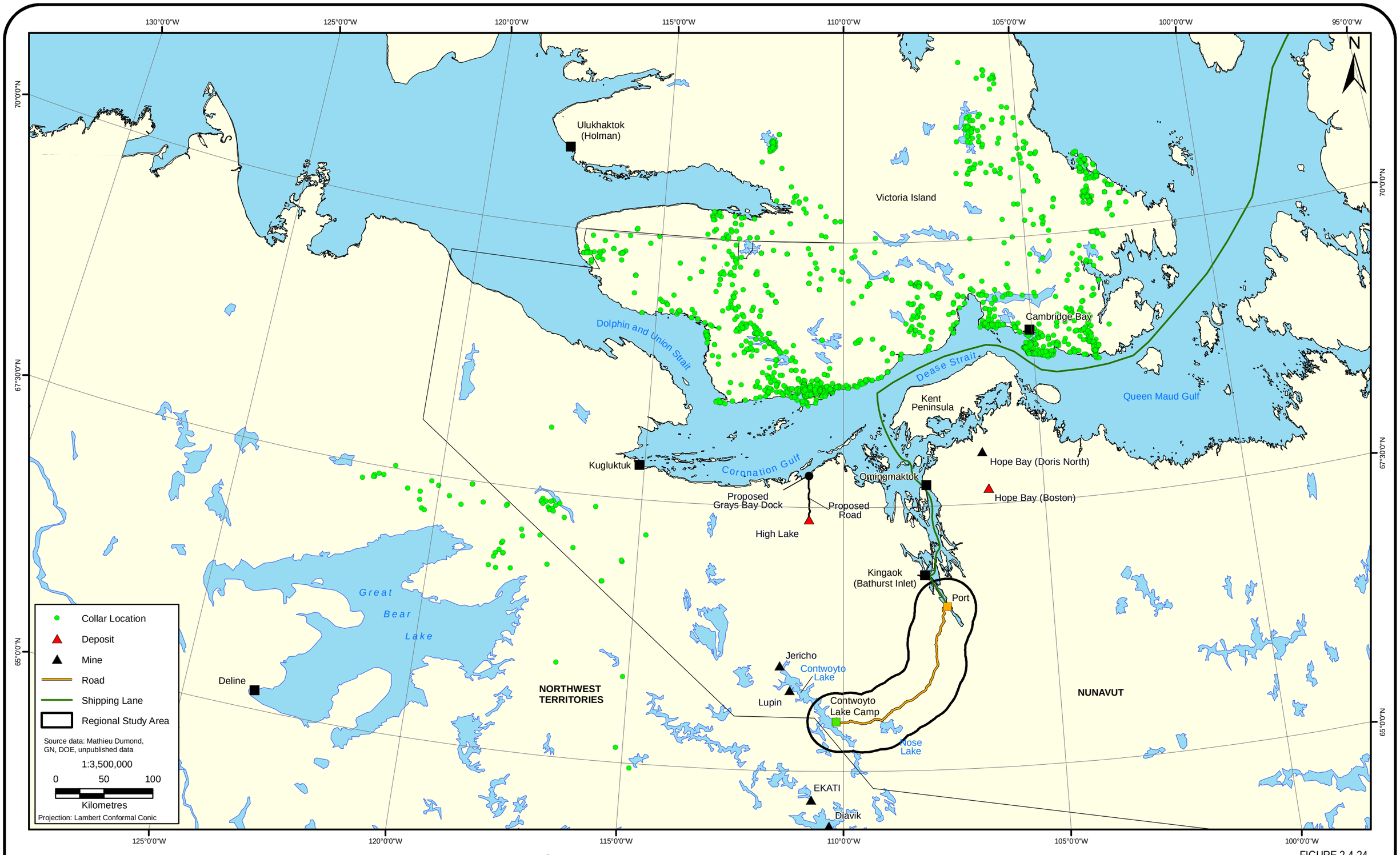

Locations of Satellite-Collared Dolphin and Union Caribou During Summer (10 July to 20 October), 1999 to 2004

FIGURE 2.4-24

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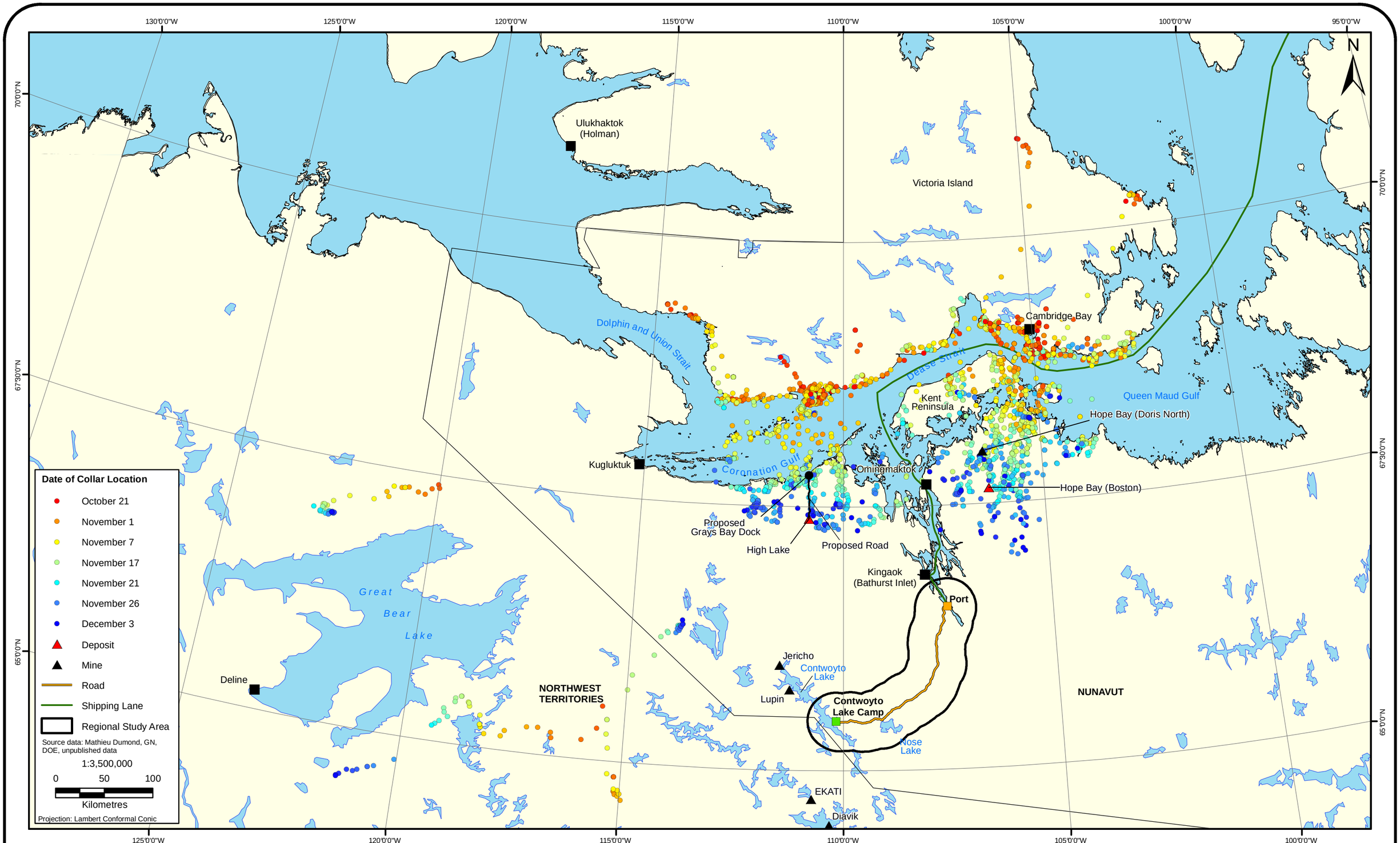

FIGURE 2.4-25

Locations of Satellite-Collared Dolphin and Union Caribou During the Southward Fall Migration (21 October to 3 December), 1999 to 2004

The Bathurst Inlet Port and Road Project

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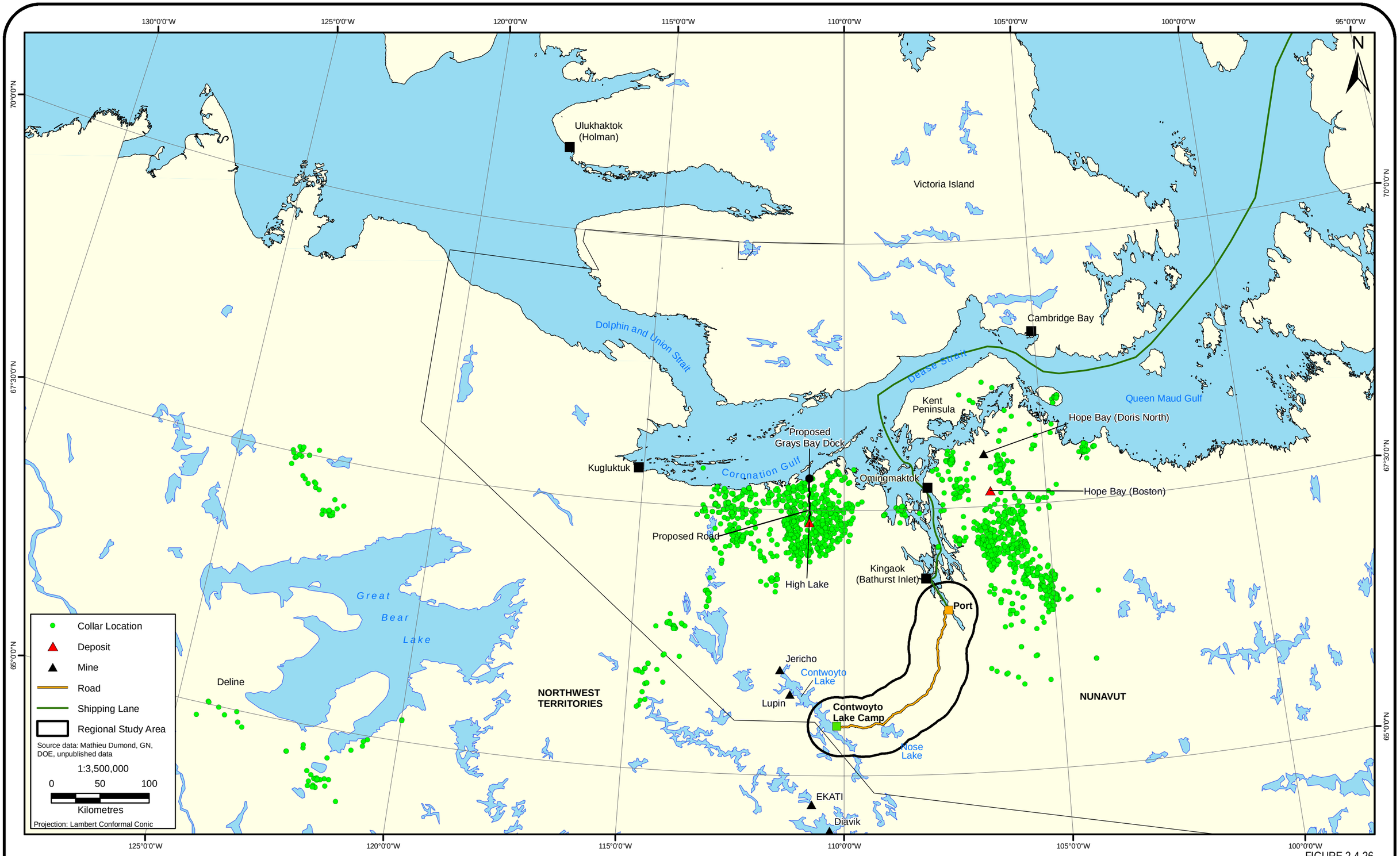

FIGURE 2.4-26

Locations of Satellite-Collared Dolphin and Union Caribou During Winter (4 December to 20 April), 1999 to 2004

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Seasonal Distribution of the Dolphin and Union Herd

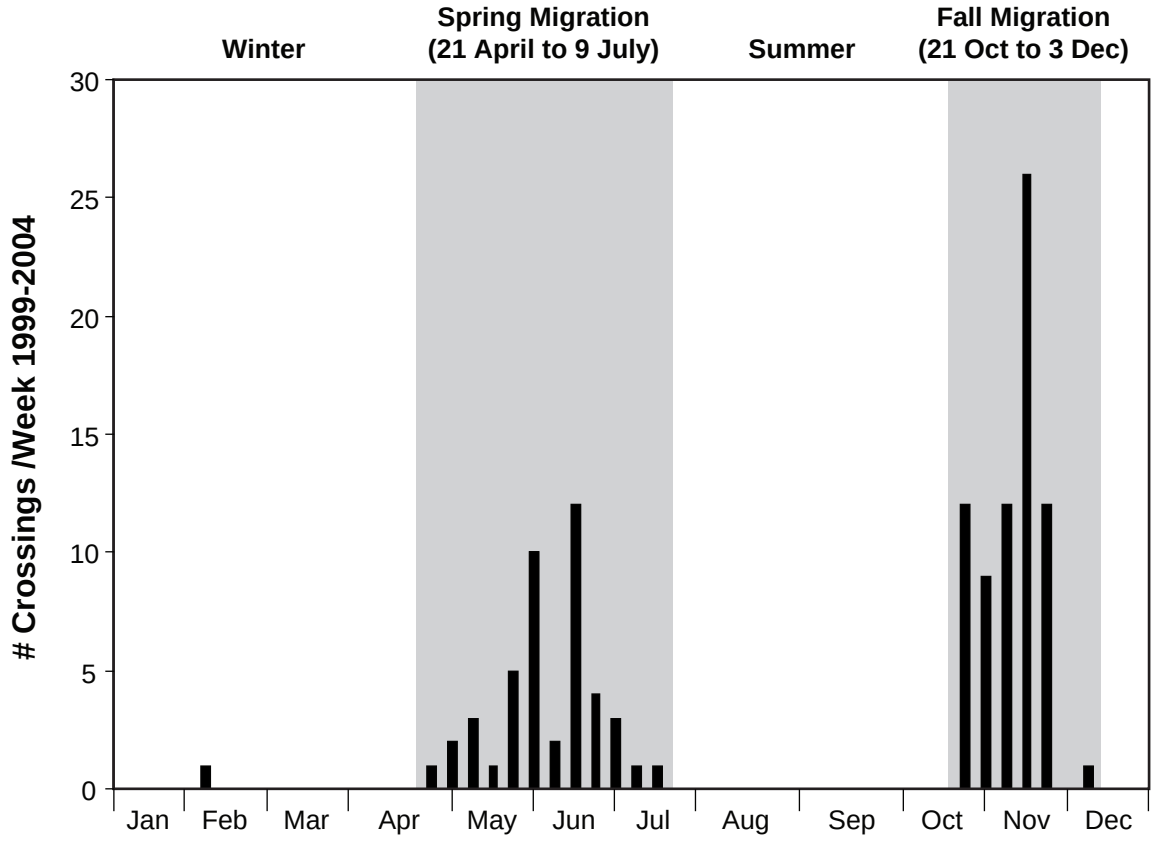
The Dolphin and Union caribou herd crosses the proposed shipping route in Dease Strait and Queen Maud Gulf during the spring and fall migrations between Victoria Island and the mainland (Table 2.4-5; Figure 2.4-22; COSEWIC, 2004; Appendix F-5 of the DEIS). Dolphin and Union caribou calve and summer on Victoria Island, and winter on the mainland (Figures 2.4-24 and 2.4-26; COSEWIC, 2004; Appendix F-5 of the DEIS). Analysis of satellite collar data from Dolphin and Union caribou indicates that spring migration occurs from approximately 21 April to 9 July (Figure 2.4-23), and fall migration occurs from 21 October to 3 December (Figure 2.4-25; Mathieu Dumond, GN DOE, *unpublished data*). During the spring migration, the majority of animals cross the sea ice northward from mid-May to late June (Figure 2.4-27). Calving occurs in June (Gunn *et al.*, 2000; Nishi, 2000). There is overlap in dates for spring migration and calving because males and non-breeding cows continue to migrate across the shipping route after breeding females have arrived on Victoria Island. During the fall migration, the majority of animals cross the sea ice southward from late October to mid-November (Figure 2.4-27). Caribou cannot cross south to the mainland until ice has formed, and cannot cross north to Victoria Island once the sea ice has melted. Ice-breaking in Dease Strait or the Queen Maud Gulf has the potential to disrupt caribou migrations or cause caribou die-offs (COSEWIC, 2004). Satellite-collared Dolphin and Union caribou have not been found in the RSA during winter (Figure 2.4-26).

The migration and calving seasons for Dolphin and Union caribou are not as well known as those for Bathurst caribou, which have been studied more intensively and for longer. Migration dates across the shipping route contain some uncertainty because dates vary from year to year depending on ice freeze-thaw cycles and other environmental factors. Furthermore, the small number of Dolphin and Union caribou which were collared may not accurately represent the timing of movements for the entire herd. The calving season of this herd is also poorly defined and is given as the month of June, rather than specific dates. Hence, all dates should be considered estimates and may vary between years by several days or weeks.

Table 2.4-5
Annual Cycle Stage Dates for Dolphin and Union Caribou

Cycle Stage	Start Date	End Date
Spring Migration	April 21[1]	July 9
Calving	June[2]	
Post-Calving and Summer	July 1[3]	October 20
Fall Migration	October 21[1]	December 3
Winter	December 4[4]	April 20

[1] Spring and fall migration dates defined as the periods when satellite-collared Dolphin and Union caribou crossed the Coronation Gulf, Dease Strait, and the Queen Maud Gulf from 1999 to 2004.
[2] General calving period (Gunn *et al.*, 2000; Nishi, 2000); specific dates not given due to limited data.
[3] Post-calving and summer defined as the period after calving and before fall migration.
[4] Winter defined as the period when satellite-collared caribou were located on the Nunavut mainland, between fall and spring migrations.



Source: Mathieu Dumond, GN, DOE, unpublished data (1999-2004)

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Number of Ice Crossings by Satellite-Collared Dolphin and Union Caribou per Week

FIGURE 2.4-27

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2.4.1.4 Peary Caribou

Introduction

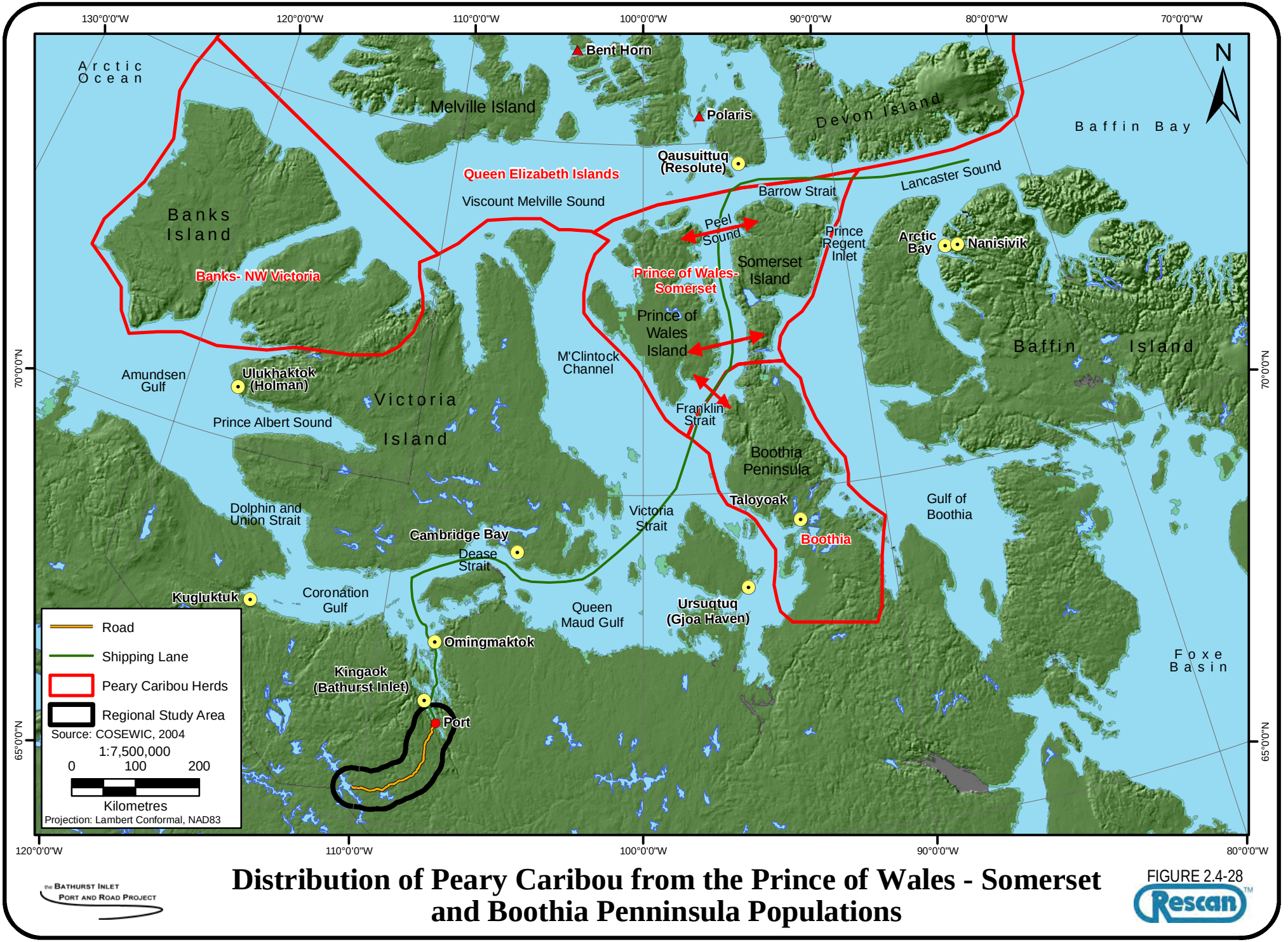
Peary caribou (*Rangifer tarandus pearyi*) are a subspecies of caribou that inhabit the islands of the Canadian Arctic archipelago (COSEWIC, 2004). In the high Arctic, these caribou (along with muskox) occupy the margins of the range for herbivores. This caribou is less well studied than the other herds in the Project area, but is known to undergo seasonal migrations on the ice between the islands of the Arctic Archipelago.

The Peary caribou population is made up of four genetically distinct metapopulations, or groups of a species that are geographically separated but interact on some level (COSEWIC, 2004) (Figure 2.4-28): 1) Queen Elizabeth Islands; 2) Banks Island and northwestern Victoria Island; 3) Prince of Wales Island and Somerset Island; and 4) Boothia Peninsula. Peary caribou from the Prince of Wales-Somerset and Boothia Peninsula groups cross the shipping route at Peel Sound and Franklin Strait, between calving areas on Prince of Wales Island, and wintering areas on Somerset Island and the Boothia Peninsula (COSEWIC, 2004; Miller *et al.*, 2005). Inuit groups and biologists have expressed concern over the effects of shipping and ice breaking on the inter-island movements of Peary caribou (Miller and Gunn, 1978, 1980; COSEWIC, 2004). During the spring migration, the majority of Peary caribou cross Peel Sound and Franklin Strait from May through June over ice (COSEWIC, 2004; Miller *et al.*, 2005). However, data are not available for the period when caribou cross Peel Sound and Franklin Strait during the fall migration. Traffic from the proposed shipping route was mentioned as a specific concern by Inuit hunters at meetings of the Kitikmeot Hunters and Trappers Association (COSEWIC, 2004). Peel Sound and Franklin Strait remain over 50% ice-covered for most of the year, only breaking up from mid-August to mid-October in some years (Figures 2.4-29 and 2.4-30). If ice-breaking occurs in Peel Sound or Franklin Strait, even simply by virtue of use of ice-tolerant ships, Peary caribou migration may be disrupted and animals are at risk of drowning (COSEWIC, 2004).

Peary caribou are listed as Endangered by COSEWIC and are at imminent risk of extinction due to continuing population declines and changing weather patterns (COSEWIC, 2004). COSEWIC (2004) reports that the population has declined by about 72% since 1980. Die-offs are thought to be the result of severe icing events, which make forage inaccessible to caribou, causing the animals to starve. Although Peary caribou are not scheduled by SARA, the World Conservation Union assessed these caribou as endangered in 1996.

Population Trends

The total Peary caribou population has declined 72% since 1980, from 28,140 animals to 7,890 animals in 2001 (COSEWIC, 2004). Peary caribou from the Prince of Wales-Somerset population have suffered the most serious declines in the last three decades. The population has declined 99%, from 6,043 animals in 1980 to 60 ± 20 animals in 2001 (Gunn and Dragon, 1998; COSEWIC, 2004). The 2001 population estimate is based on a survey that was conducted on Prince of Wales Island in 1995. This survey was motivated by Inuit concern for declining numbers of Peary caribou; caribou were more difficult to find during winter hunts. Biologists



Distribution of Peary Caribou from the Prince of Wales - Somerset and Boothia Penninsula Populations

the Bathurst Inlet Port and Road Project

FIGURE 2.4-28

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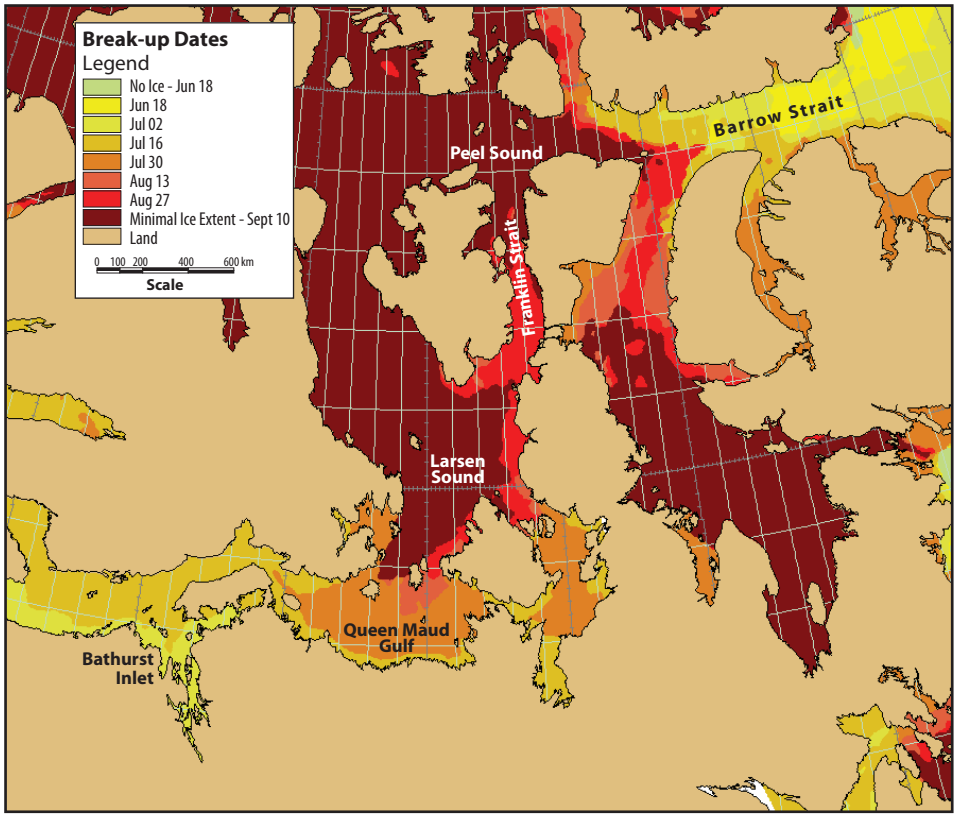

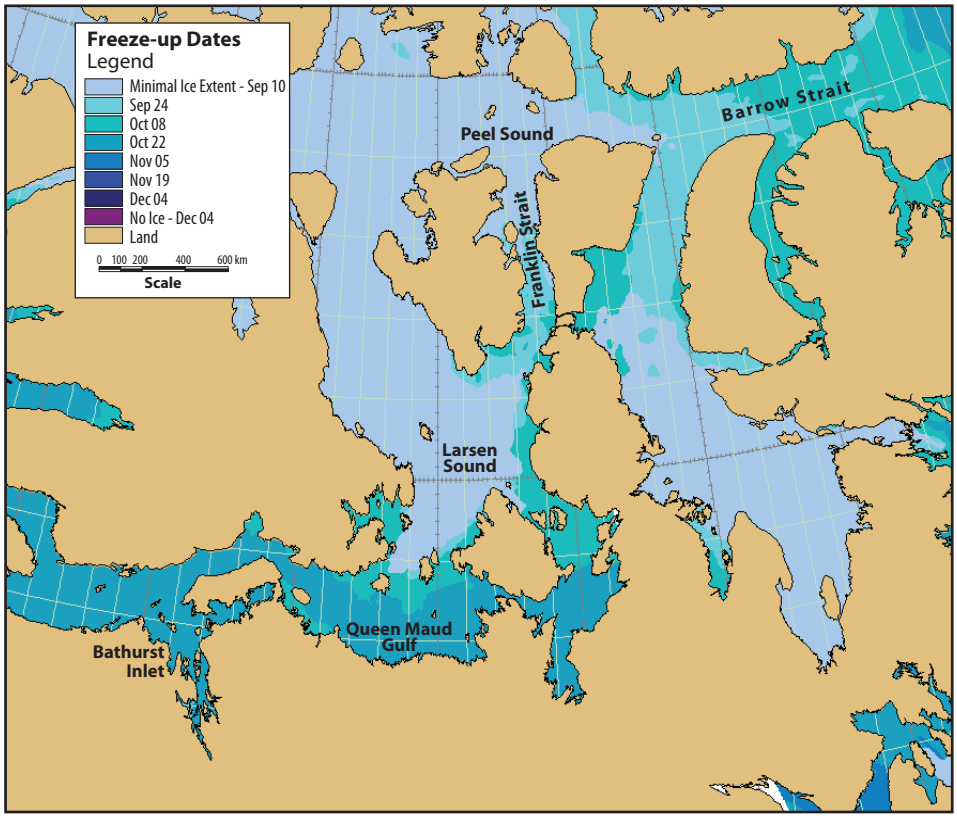

Source: Environment Canada (2007)

the BATHURST INLET PORT AND ROAD PROJECT

Average Ice Break-up and Freeze-up Dates, 1971 to 2000

FIGURE 2.4-29

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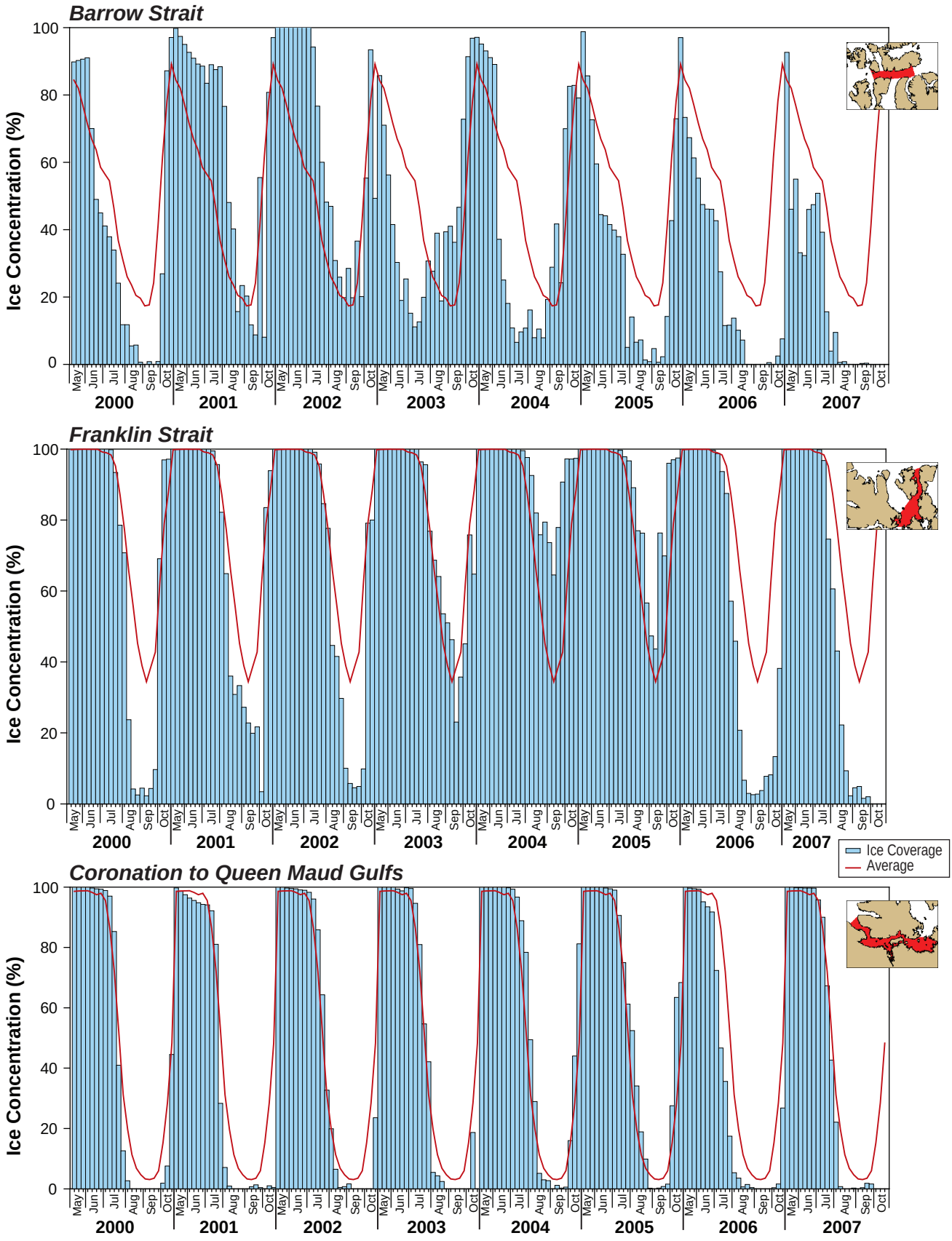

Note: Red line indicates 1971 to 2000 average
Source: Environment Canada (2007)

the BATHURST INLET PORT AND ROAD PROJECT

Historical Weekly Ice Coverage, 2000 to 2007

FIGURE 2.4-30

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and an experienced Inuit hunter counted only seven caribou during the survey (Gunn and Dragon, 1998). COSEWIC used a 2001 population estimate of 60 ± 20 animals for the Prince of Wales-Somerset population after consulting a prominent Peary caribou biologist because meaningful population estimates could not be derived from a count of seven animals (COSEWIC, 2004).

Peary caribou from the Boothia Peninsula population appear to be increasing from their population decline in the 1940s and 1950s, during which no animals were observed migrating through the Boothia Isthmus (Gunn, 1998a; COSEWIC, 2004). From surveys conducted by Fisher and Duncan (1976) in 1974 and 1975, COSEWIC has calculated that the Boothia Peninsula population of Peary caribou was 556 and 1,890 animals, respectively. In 1980, the population was estimated at 3,022 animals, and in 2001 it was estimated at 3,329 animals (COSEWIC, 2004).

Movements and Distribution

Large scale east–west movements involving hundreds of caribou have been documented between winter ranges on Somerset Island and calving areas on Prince of Wales Island (Figure 2.4-28). These movements do not involve all the caribou and the use of the various satellite islands, such as Pandora and Vivian Islands, varies from year to year (Miller and Gunn, 1978, 1980; Miller and Killiaan, 1981; Miller *et al.*, 1982; Miller, 1990; Miller, 1991; Miller, 1997).

Caribou tracks on the sea ice of Franklin Strait also point to smaller-scale spring migrations directly from Boothia Peninsula to Prince of Wales Island and from Somerset Island to Prince of Wales Island (Miller and Gunn, 1978, 1980; Miller *et al.*, 1982; Miller, 1990). These migrations permit those caribou to spend the winter on Somerset Island and/or Boothia Peninsula, then summer and calve primarily on Prince of Wales Island but also on Somerset Island and Russell Island.

Peary caribou occur on the Boothia Peninsula, calving on the northwest side and then also spending the summer in this area or moving to southern Somerset Island or Prince of Wales Island. The Peary herd returns to the Taloyoak area of the Boothia Peninsula for the winter (Gunn, 1998a). In the winter, Inuit from Taloyoak hunted Peary caribou from Taloyoak to Thom Bay and Nalluqtaq Inlet to Brentford Bay (David Tucktoo, 1986 *personal communication*, cited by Gunn, (1998b)). Gunn *et al.* (2000) found that Peary caribou on northwestern Boothia Peninsula occurred throughout the peninsula in the course of the year and wintered on the mainland at least 350 km south of the Boothia Peninsula, near the Hayes River.

Peary caribou of the Prince of Wales-Somerset and Boothia populations have been documented calving in numerous areas. These include the Wrottesley Inlet area on northwestern Boothia Peninsula, the Aston Bay area on the northwest coast of Somerset Island, the southwestern Arrow Smith Plains, the northeastern coastal area from Young Bay to Inner Browne Bay, the northwest coast and the Mount Clarendon ‘peninsula-like’ area of northwestern Prince of Wales Island and western Russell Island (Fischer and Duncan, 1976; Miller and Gunn, 1978, 1980; Miller and Killiaan, 1981; Miller *et al.*, 1982). Gunn and Dragon (1998) stated that a significant number of Peary caribou from Somerset Island would cross to Prince of Wales Island to calve.

2.4.2 Muskox

2.4.2.1 Introduction

Muskox (*Ovibos moschatus*) are distributed across most of the Kitikmeot region of Nunavut (Gunn and Adamczewski, 2003), including the RSA (Appendices D-7 and D-9 of the DEIS). Muskox are the only other large ungulate species aside from caribou that occupy tundra habitats year round. Unlike caribou, muskox do not migrate long distances.

Muskox are an important prey item for carnivores and are highly valued by the Inuit as a source of food, leather and the commercial export of meat. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing. Muskox were close to extinction in the late nineteenth and early twentieth centuries due to overhunting (Fournier and Gunn, 1998; Campbell and Setterington, 2001), but numbers have generally increased over the last three decades and the historic range has been recolonized (Fournier and Gunn, 1998; Campbell and Setterington, 2001). The Inuit have also remarked on the expansion in distribution and numbers of muskox since the 1960s (Appendix F-5 of the DEIS). Muskox are presently designated as Secure in Nunavut (CESCC, 2005).

Muskox are a particularly sensitive species to disturbance during the calving season (late March through May), disturbance to herds that culminate in stampeding behaviour can cause calves to be trampled or abandoned (Gunn and Case, 1984).

2.4.2.2 Population Trends

Muskox in Nunavut and the Northwest Territories were estimated at 140,000 animals in 1997 (Fournier and Gunn, 1998). Nineteen-thousand of these animals were from mainland populations, while the remainder were from populations inhabiting the Canadian Arctic Islands. In 2001, muskox numbers in Canada were estimated at 166,000 animals (Gunn and Adamczewski, 2003).

The number of muskox between northeast Contwoyto Lake and southwestern Bathurst Inlet, an area that includes the RSA, was estimated at 3,400 ± 460 animals during a 1986 systematic strip transect survey (Gunn, 1990). Although the proportion of calves relative to total muskox was low (12.0%), it is consistent with counts from other northern mainland muskox populations (10% and 15%) (Gunn and Case, 1984; Gunn and Fournier, 2000).

Muskox in the RSA are from the MX/14 (central mainland) population, which lies within the MX14 and MX19 management zones (Dumond, 2006). In August 2005, the Government of Nunavut conducted a thorough muskox survey in the area between Coppermine River and Bathurst Inlet (Dumond, 2007). During this survey, 374 muskox were estimated for a 20,302 km^2 area that overlapped the RSA (Dumond, 2007). The proportion of calves to total muskox was estimated at 6.1%. Muskox in and around the RSA were clustered near Contwoyto Lake and along the northern half of the proposed road. Although the abundance of muskox in the Kitikmeot region has been increasing over the past 3 decades (Fournier and Gunn, 1998), mainland populations have experienced recent declines and calf production has been low (Dumond, 2006).

2.4.2.3 Harvest Rates and Management

The Department of Environment in Nunavut (2005) recommends a total annual harvest (TAH) of 4% for the MX14 muskox population, meaning that a maximum of 240 muskox from this population may be harvested annually (Dumond, 2007). On the West Kitikmeot mainland, Bathurst Inlet harvests of muskox for subsistence or sport hunts are between 20 and 30 animals annually (M. Dumond, GN DOE, *personal communication*). Kugluktuk harvests of muskox are between 35 and 50 animals annually. Harvest statistics from Bathurst Inlet and Kugluktuk include muskox hunts near Contwoyto Lake and Pellat Lake.

2.4.2.4 Movements and Distribution

Muskox are found throughout the RSA where they occur at relatively low densities (Gunn, 1990; Dumond, 2007). These animals have relatively small home ranges since they migrate short distances between calving, rutting and wintering areas (Reynolds, 1998). In the winter, muskox home range size varies from 27 to 70 km^2 and in the summer the average home range size is 223 km^2 (Reynolds, 1998). Inuit Traditional Knowledge indicates that muskox are distributed around Contwoyto Lake, Nose Lake, northeast of Nose Lake and at the south end of Bathurst Lake (Appendix F-5 of the DEIS).

2.4.2.5 Field Data for Muskox in the RSA

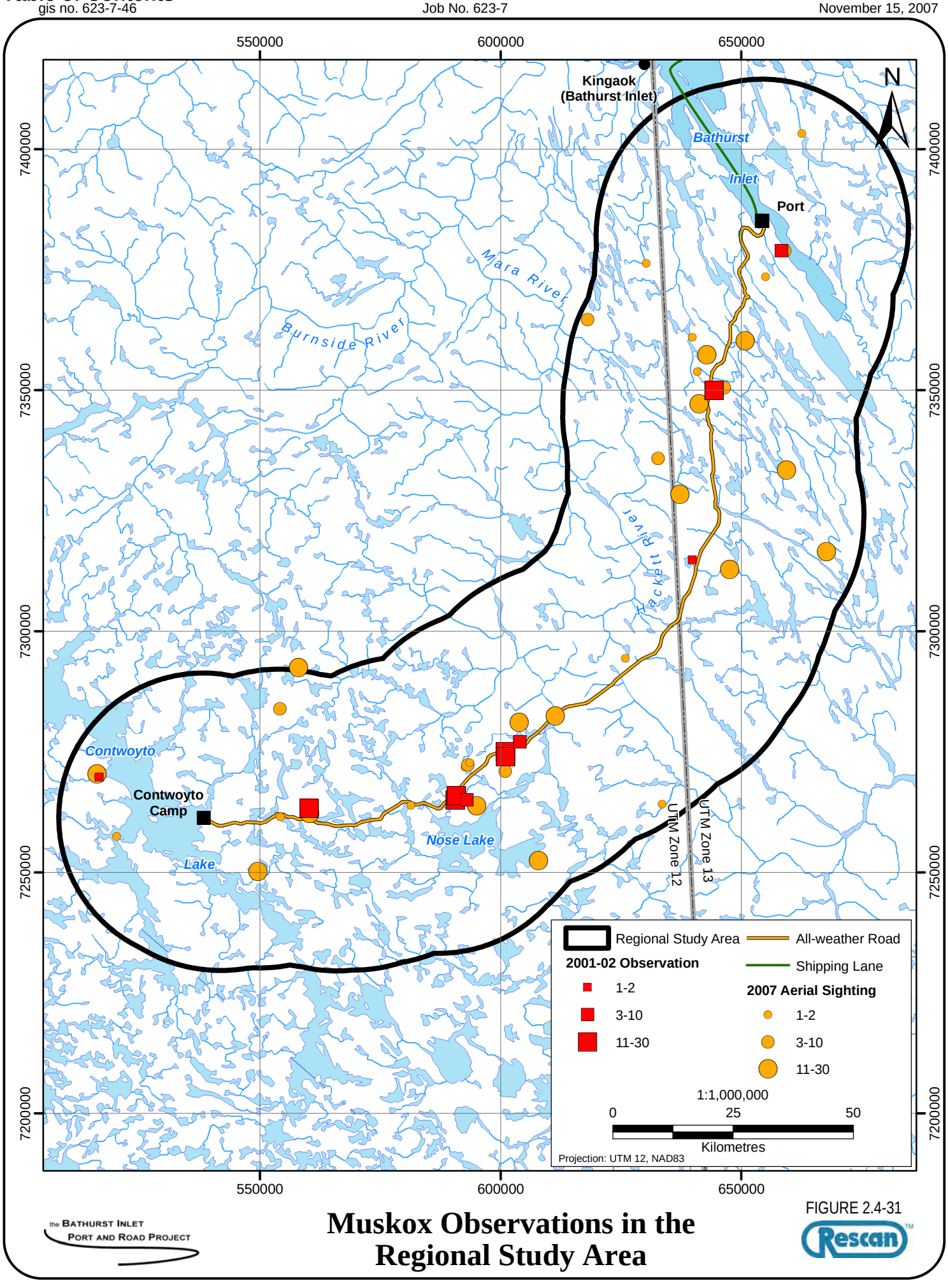
Muskox observations were recorded within a 5 km buffer of the proposed road during aerial and ground surveys in 2001 and 2002. During 2001, aerial surveys were undertaken in July, August, September, and November. During 2002, aerial surveys were undertaken in March, June, and July. Muskox were observed during each survey. A total of 275 animals were recorded. Muskox were found throughout the survey area at relatively low densities (Figure 2.4-31; Appendix D-7 of the DEIS).

Five survey flights were undertaken within the RSA in May, June, July, and September 2007. Muskox observations noted group size and location along with the number of adults and juveniles within each group. Muskox were observed throughout the RSA at low densities; a total of 152 animals were observed, comprised of 133 adults and 19 calves/juveniles (Figure 2.4-31). Muskox were observed in the RSA in May, June, and July, but not in September (Appendix D-9 of the DEIS).

2.4.2.6 Habitat Use and Diet

Habitat selection by muskox is dependent on the availability of forage due to snow conditions, as well as forage quality and abundance as the season progresses (Gunn and Adamczewski, 2003).

During the summer season, muskox primarily forage on sedges (*Carex* and *Eriophorum spp.*) and willows (*Salix spp.*) (Gunn and Sutherland, 1997). Forbs are also consumed by muskox, but to a lesser extent than other vegetation. Muskox use heath tundra and moist areas where this vegetation is abundant, including sedge wetlands, birch seep and riparian shrub areas (Gunn and Sutherland, 1997). The summer and early fall seasons are critical for muskox, as they must accumulate sufficient fat reserves to survive the winter during this time (Reynolds *et al.*, 2002).



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Muskox Observations in the Regional Study Area

FIGURE 2.4-31

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Furthermore, there is evidence that the likelihood of pregnancy and successful parturition are positively related to the fat reserves a female accumulates during the summer and early fall (Adamczewsk *et al.*, 1998).

During the winter, snow reduces the availability of forage for muskox (Jingfors, 1980). Muskox feed on grasses, sedges, and woody plants during this time. These animals use lowland meadows or windblown ridges and bluffs with shallow snow cover that allows access to these dietary items (Heard, 1992; Ihl, 1999)

2.4.2.7 Habitat Suitability Ratings

For muskox, habitat suitability was assessed for late winter/early spring (April to June) and rutting/ autumn seasons (August through September). The life requisites assigned to late winter/early spring were *Living* and *Reproducing*, while the only life requisite assigned to rutting/autumn habitat was *Living*.

The majority of the habitat in the RSA and LSA during both seasons was moderate quality habitat (Table 2.4-6; Appendix D-8 of the DEIS). There is a higher proportion of high quality habitat within the LSA compared to the RSA for both late winter/early spring and rutting/autumn seasons. Conversely, there is a higher proportion of low quality habitat in the RSA compared to the LSA.

Table 2.4-6
Area and Proportion of High, Moderate, Low, and Nil-quality Habitat within the LSA and RSA for Muskox

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Late Winter/Early Spring				
High	5,647	21.4	58,996	4
Moderate	19,719	74.57	1,250,519	83
Low	987	3.7	191,720	13
Nil	85	0.33	450	0.03
Rutting/Autumn				
High	22,062	83.5	794,948	52.37
Moderate	3,014	11.37	340,788	22.6
Low	1,277	4.8	365,499	25
Nil	85	0.33	450	0.03

2.5 Carnivores

2.5.1 Grizzly Bear

2.5.1.1 Introduction

Grizzly bears (*Ursus arctos*) occur throughout the Southern Arctic Terrestrial Ecozone (NRCan, 2007) and are known to occur in the RSA from satellite-collar data and observations made

during baseline studies (Figure 2.5-1). Nationally, grizzly bears are a species of Special Concern (particularly sensitive to human activities or natural events but not endangered or threatened); (COSEWIC, 2002). In the NWT and Nunavut, grizzly bears have been designated as Sensitive (CESCC, 2005; Working Group on General Status of NWT Species, 2006). Grizzly bears have low ecological resiliency, are sensitive to human activity and are frequently displaced by industrial developments (McLellan, 1990; Weaver *et al.*, 1996; Ross, 2002). Bears living in the central Canadian Arctic may be at relatively elevated risk of disturbance because they naturally occur at low densities and because they may be more vulnerable to disturbance on the open tundra landscape (R. Mulders, GNWT ENR, personal communication; Ross, 2002).

There have been numerous studies investigating the effects of development, specifically roads, on the movements and ecology of grizzly bears (Archibald *et al.*, 1987; McLellan and Shackleton, 1988, 1989; Mace *et al.*, 1996; Benn and Herrero, 2002; Wielgus *et al.*, 2002; Johnson *et al.*, 2005; Waller and Servheen, 2005). McLellan and Shackleton (1989) studied bears in the Rocky Mountains, and found that roads did not have a severe effect on grizzly bear movements; however, they concluded that roads placed in high quality habitat, such as berry patches used for foraging, could increase human and vehicle interactions with bears. Other studies (Mace *et al.*, 1996; Benn and Herrero, 2002; Wielgus *et al.*, 2002; Waller and Servheen, 2005) concluded that bears avoid habitats near roads, up to 500 m (Waller and Servheen, 2005). The aforementioned studies also concluded that avoidance was correlated with road traffic frequency; bears avoided roads more strongly with more traffic. Benn and Herrero (2002) studied grizzly bear mortality in Banff and Yoho National Parks from 1971 to 1998. The results from this study illustrate that a major source of grizzly bear mortality occurs near (within 200 m) of roads, with vehicle-bear interactions accounting for 19% of all deaths. The destruction of problem bears was the greatest cause of mortality for this study (71%), which is another problem with increased access to pristine habitats. Increased hunting was another issue raised in many of these studies, where roads increased access created opportunities for illegal hunting (McLellan and Shackleton, 1988).

2.5.1.2 Population Trends

Barren-ground grizzly bears inhabit the northern edge of the grizzly bear range in North America. Habitats at these high latitudes are relatively low in productivity and quality. As a result, barren-ground grizzly bears utilize large home ranges and exist at low densities compared to other grizzly bear populations in more productive ecosystems. Average home range sizes vary from 2,100 km^2 for females to 7,245 km^2 for males, and home range overlap is relatively high (McLoughlin *et al.*, 2000).

Barren-ground grizzly bears inhabiting the central Canadian Arctic are grouped into three spatially distinct population clusters, located in the Kugluktuk region, Bathurst Inlet region and North Slave region (McLoughlin *et al.*, 2002a). Grizzly bears in the Project area belong to the Bathurst Inlet population cluster (GN DOE, 2005). The overlap and exchange rates among population clusters imply poor population closure; therefore, it has been suggested that barren-ground grizzly bears should be managed as one continuous population (McLoughlin *et al.*, 2002a).

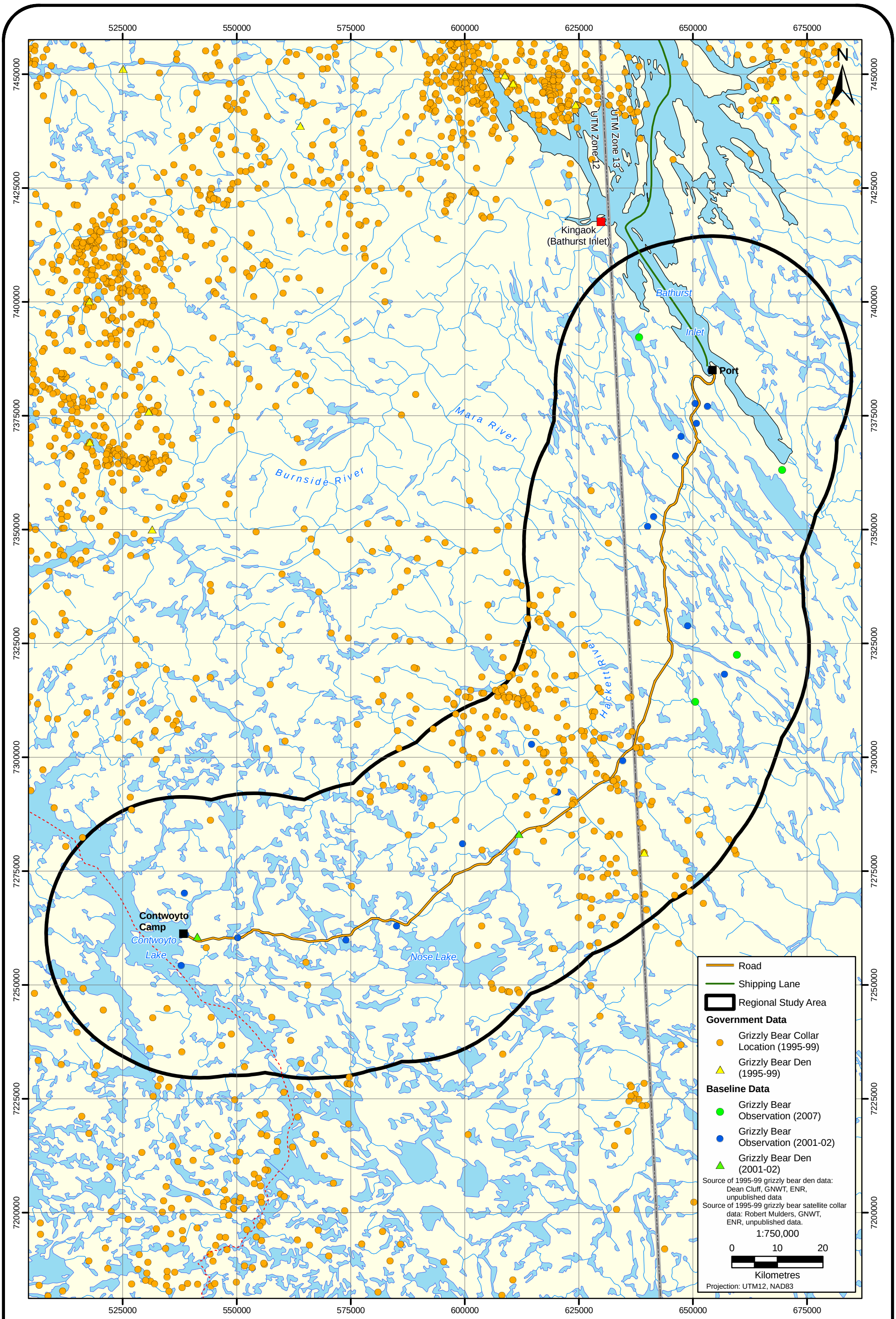

FIGURE 2.5-1

Grizzly Bear Satellite Collar Locations (1995 to 1990), Field Observations, and Den Locations

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Grizzly bears exhibit low reproductive rates due to a late age of maturity, small litter sizes and long intervals between litters. Barren-ground grizzly bears would be expected to have relatively lower reproductive rates because they occupy areas of low productivity and high seasonality (Ferguson and McLoughlin, 2000; McLoughlin *et al.*, 2000). However, while barren-ground grizzly bears have a later age of maturity than other grizzly bear populations, they have larger litter sizes and higher birth rates (Case and Buckland, 1998; McLoughlin *et al.*, 2003a). Furthermore, barren-ground grizzly bears have shorter intervals between litters than most northern populations and similar intervals to southern interior populations (McLoughlin *et al.*, 2003a).

There is no official estimate on grizzly bear population sizes for the West Kitikmeot region of Nunavut. However, a crude estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which includes the Project area (Ross, 2002). This estimate assumed a density of 4 bears per 1,000 km^2 based on grizzly bear densities in nearby areas (Ross, 2002). The Draft WKRLUP (NPC, 2005) suggests that there are approximately 500 grizzly bears in the West Kitikmeot region, which exist at an average density of 3.5 bears per 1,000 km^2.

The barren-ground grizzly bear population is stable or slightly increasing, but is considered vulnerable to decline from increased adult mortality (McLoughlin *et al.*, 2003a; McLoughlin *et al.*, 2003b). Modeling studies using demographic data of bears in the region show that even slight increases in mortality can precipitate a negative population trend (McLoughlin *et al.*, 2003a).

2.5.1.3 Harvest Rates and Management

The Nunavut Department of Environment (2005) recommends a total annual harvest (TAH) of six grizzly bears, including problem kills, from the Bathurst Inlet population. Grizzly bears may be harvested in a ratio of two males to one female, but harvest is not recommended for females accompanied by cubs given poor survival rates of orphaned cubs (GN DOE, 2005). An average of 13.4 bears per year was reported as harvested between 1958 and 2000 in the central Canadian Arctic (McLoughlin *et al.*, 2003b). The locations and causes of 265 grizzly bear kills were recorded in the West Kitikmeot between 1981 and 2004, and indicate an annual known harvest of 11.0 bears per year (Mathieu Dumond, Government of Nunavut, *unpublished data*). These data indicate that 29% of the reported kills occurred in the Bathurst Inlet region, including Omingmaktok and Kingoak. The majority of bears were killed by sport hunting (36%), or as problem kills (34%). Twenty-six percent were harvested for subsistence (no tag required) or for the sale of the hide with a tag. The remainder (4%) died of natural or unknown causes. Most problem kills occurred in June, July, or August, whereas most sport hunts occurred in May. The majority of bears killed (41%) were adult males. Thus, recorded kills in the Bathurst Inlet region are below the TAH; however, this may be an underestimate of actual kills. Within the RSA, grizzly bear harvests were recorded near Bathurst Inlet and Contwoyto Lake (Figure 2.5-2); however, the mapped data do not represent all the grizzly bear harvests recorded for Bathurst Inlet since several GPS locations for the area were missing from the data set.

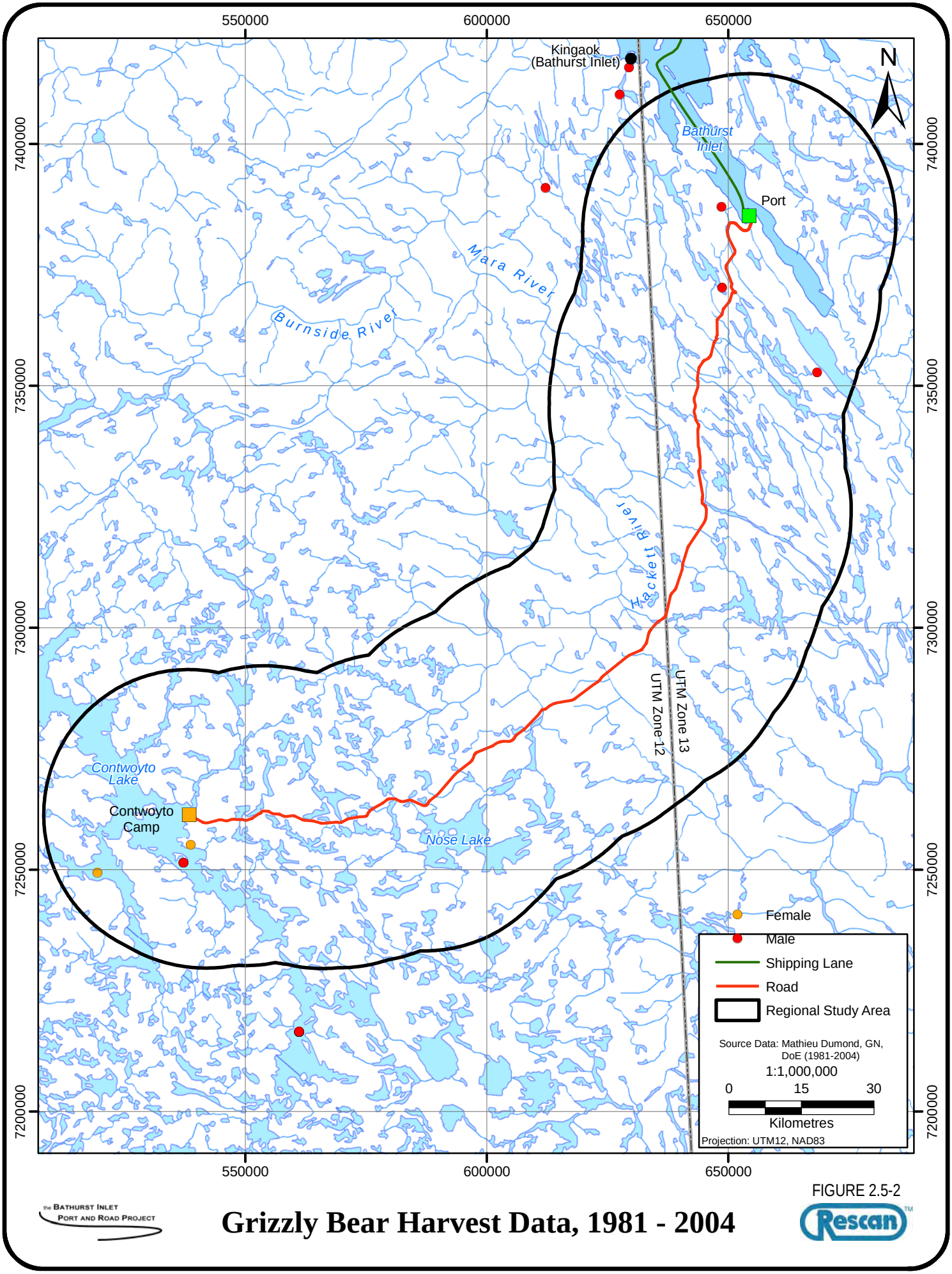

FIGURE 2.5-2

Grizzly Bear Harvest Data, 1981 - 2004

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2.5.1.4 Movements and Distribution

Inuit Traditional Knowledge indicates that grizzly bears are found throughout the RSA (Appendix F-5 of the DEIS). Inuit consultants identified major grizzly bear movements in the RSA, especially in association with major river systems, watersheds and coastal areas (Thorpe *et al.*, 2001; Appendix F-5 of the DEIS). Consultants identified west Bathurst Inlet, including the proposed port site, as a major denning area for grizzly bears. A specific den site was identified on the road footprint near Nose Lake.

Between 1995 and 1999, 81 grizzly bears across the Southern Arctic Terrestrial Ecozone were captured and fitted with satellite radio-collars and >8,000 telemetry locations were recorded from collared animals (McLoughlin *et al.*, 2000). Fourteen collared bears (17% of the collared bears), consisting of ten males and four females, used areas in the RSA near the proposed road (Figure 2.5-1). Of these, at least 12 satellite-collared grizzly bears (nine males and three females) crossed the proposed road at least 59 times. It is important to note that these bears are not necessarily a representative sample of the bear population and represent a small portion of the grizzly bears which may reside in the vicinity of the Project area (R. Mulders, GNWT ENR, *personal communication*). Other uncollared bears were known to frequent the Project area and the proposed port site, where no bears happened to be captured for collaring purposes (R. Mulders, GNWT ENR, *personal communication*; and observations from this study). Based on this information, there were likely more interactions between grizzly bears and the proposed road route than are indicated in Figure 2.5-1.

Grizzly bear den locations in the Southern Arctic Terrestrial Ecozone were also identified (McLoughlin *et al.*, 2000). One den was located within the RSA along the centre portion of the proposed road, east of Nose Lake (Figure 2.5-1).

2.5.1.5 Field Data for Grizzly Bears in the RSA

Grizzly bears were observed in the RSA during field surveys in 2001, 2002 and 2007 (Appendix D-7 of the DEIS; Gartner Lee, *unpublished data*, 2007). Aerial surveys and incidental observations indicate that grizzly bears are distributed at low densities throughout the RSA (Figure 2.5-1). Bear sightings were recorded at the proposed port site and at Contwoyto Camp.

Two grizzly bear dens were found during den surveys in 2001 (Appendix D-7 of the DEIS); one was located in the bank of the Mara River (northeast of Nose Lake) and the other was on a slope leading to a lake near the southern end of the proposed road (Figure 2.5-1). The first den had probably been excavated in 2000, based on the condition of the disturbed vegetation, but had never been used. The den near the road terminus had been excavated beneath a large rock and because the entrance tunnel had a downward slope, it may not have been used as an overwintering den.

2.5.1.6 Habitat Use and Diet

Introduction

Habitat selection by barren-ground grizzly bears mainly reflects the availability and abundance of a wide variety of food items (McLoughlin *et al.*, 2002a). Habitat selection occurs at two spatial

scales. On the landscape scale, grizzly bears select home ranges that have a higher proportion of eskers, tussock/hummock tundra, lichen veneer, birch seep, and riparian tall shrub habitat than surrounding areas. Habitat selection within the home ranges of grizzly bears varies by season, sex and reproductive status (McLoughlin *et al.*, 2002a). Research on the dietary patterns of barren-ground grizzly bears indicates that five time periods correlate with seasonal changes in resource selection (Table 2.5-1; Gau *et al.*, 2002): spring, summer, late summer, fall and denning.

Table 2.5-1
Timing of Grizzly Bear Resource Selection

Season	Start Date	End Date
Spring	May 16	June 20
Summer	June 21	July 31
Late Summer	August 1	September 9
Fall	September 10	October 15
Denning	October 16	May 15

Note: Dates used in habitat suitability modelling by Johnson *et al.* (2005). Dates reflect shifts in grizzly bear diet throughout the season.

Barren-ground grizzly bears are opportunistically omnivorous, meaning that they eat a variety of vegetation and meat items depending on their availability and the physiological requirements of the bear. Caribou is the primary food item of barren-ground grizzly bears and grizzly bears may be proficient hunters of caribou (Gau *et al.*, 2002). Berries (*e.g.* crowberry, *Empetrum nigrum*; blueberry, *Vaccinium uliginosum*; cranberry, *V.vitis-idaea*) are mostly consumed in spring and late summer when they are abundant. The summer diet of grizzly bears consists largely of emergent vegetation. Ground squirrels have varying importance in the diets of grizzly bears, depending on the time of year (Gau *et al.*, 2002).

Habitat selection by barren-ground grizzly bears reflects the abundance and availability of the aforementioned food items. Overall, grizzly bears prefer eskers and riparian tall shrub habitats throughout the year (McLoughlin *et al.*, 2002a). Lichen veneer is selected by bears in the spring and fall seasons. Males prefer tussock/hummock tundra at varying times during the year. Females with cubs tend to avoid habitats that are ranked the highest for males in spring (*e.g.*, tussock/hummock tundra), late summer (*e.g.*, esker) and autumn (*e.g.*, riparian tall shrub) (McLoughlin *et al.*, 2002a), which may be to avoid completion with males, or to protect cubs from occasional infanticide committed by males (McLellan, 1994). The latter argument is supported by the fact that females *without* cubs tend not to avoid habitats preferred by males in the way that females with cubs do (McLoughlin *et al.*, 2002a).

Spring (May 14 to June 20)

Spring habitat is important because it provides the first forage for grizzly bears following winter hibernation. Upon emerging from dens, barren-ground grizzly bears feed primarily on caribou migrating north to their calving grounds (Gau *et al.*, 2002). Overwintered berries and Arctic ground squirrels are also important food sources during this period, but are consumed to a lesser extent than are caribou (Gau *et al.*, 2002).

Grizzly bears, including males, females with cubs and females without cubs, show the greatest preference for esker habitat during the spring. Lichen veneer and exposed bedrock habitats are also preferred by grizzly bears during this time (McLoughlin *et al.*, 2002a; Johnson *et al.*, 2005). These habitat types provide relatively abundant sources of caribou, Arctic ground squirrel and over-wintered berries. Migrating caribou select eskers and lichen veneers for ease of travel and forage and Arctic ground squirrels preferentially burrow in eskers. Over-wintered berries are most accessible in eskers and exposed bedrock habitat because these habitats are the first to become snow-free in the spring. Male grizzly bears show an additional preference for tussock/hummock tundra, while females without cubs show additional preference for riparian tall shrub habitat (McLoughlin *et al.*, 2002a; Johnson *et al.*, 2005).

Summer (June 21 to September 9)

The summer diet of barren-ground grizzly bears is highly variable. Early in the season, when caribou are scarce, grizzly bears feed primarily on horsetails, Arctic cottongrasses, and sedges. By mid-summer, caribou becomes the primary component of the grizzly bear diet as post-calving herds move southward. However, vegetation is still an important source of food. Grizzly bears resume consumption of Arctic ground squirrels in mid-summer (Gau *et al.*, 2002).

During the summer, female grizzly bears (with and without cubs) show preference for eskers and riparian tall shrub habitat. Riparian tall shrub habitat is selected for its abundant vegetation and caribou. Females with young also prefer heath tundra. Males continue to show preference for tussock/hummock tundra in the summer (McLoughlin *et al.*, 2002a). A habitat modelling study by Johnson *et al.* (2005) shows that grizzly bears select esker and low shrub habitats in the summer.

In late summer, barren-ground grizzly bears increase foraging in order to fatten up for the winter denning season (Gau, 1998). During this time, berries are the primary component of the grizzly bear diet and are essential for fat deposition. Caribou continue to be an important source of food during the late summer and Arctic ground squirrels are consumed to some extent (Gau *et al.*, 2002).

Barren-ground grizzly bears prefer eskers and riparian tall shrub habitat in late summer (McLoughlin *et al.*, 2002a; Johnson *et al.*, 2005). These habitats provide an abundance of fresh berries and caribou. Differences in habitat use among males, females with cubs and females without cubs are pronounced in late summer. Females with cubs select heath bedrock and tussock/hummock tundra, while males and females without cubs avoid these habitats. Inversely, males and females without cubs prefer eskers, while females with cubs avoid eskers (McLoughlin *et al.*, 2002a). Therefore, females with cubs are highly segregated from other demographic groups during the late summer period.

Autumn (September10 to October 15)

Autumn is a critical season for barren-ground grizzly bears because individuals must gain weight rapidly in order to survive winter hibernation (Zager and Jonkel, 1983). The autumn and spring diets of grizzly bears are similar to the spring diet. Barren-ground grizzly bears feed primarily on caribou that are migrating south towards the treeline for winter. Arctic ground squirrels are

also an important food source. However, fewer berries are consumed in autumn compared to the spring and summer seasons (Gau *et al.*, 2002).

Important grizzly bear habitat in autumn includes riparian tall shrub habitat (although females with young significantly avoid this habitat), lichen veneers and heath tundra. These habitats provide grizzly bears with a relatively abundant source of caribou, and their habitat selection is strongly influenced by the occurrence of caribou (Johnson *et al.*, 2005). However, females with cubs significantly avoid riparian tall shrub habitat and select bedrock habitats, which are avoided by males. Females without young continue to prefer eskers in autumn (McLoughlin *et al.*, 2002a). A habitat modelling study by Johnson *et al.* (2005) shows that fall habitat selection by grizzly bears is strongly influenced by the presence esker, heath rock, low shrub, and peat bog vegetation types.

2.5.1.7 Denning Ecology

The West Kitikmeot Slave Society funded research on grizzly bear denning ecology in the general region of the Project area (McLoughlin *et al.*, 2002b). For this research, 81 satellite-collared grizzly bears were followed to determine den site locations and timing of entrance into and emergence from dens. The locations permitted the researchers to visit each den site, once inactive, to record physical characteristics of the den site such as the presence of vegetation and soil characteristics.

McLoughlin *et al.* (2002b) visited 56 grizzly bear den sites. Most den sites (60%) were located in heath tundra and heath-boulder habitats, with most of the remaining dens in riparian tall shrub and birch seep habitats. Although eskers accounted for only seven of 56 den sites studied, this habitat type was selected more than expected, given its low availability in the central Arctic.

Grizzly bear den sites in the study most commonly faced south (25), followed by west (13), and east (10); only eight faced north (McLoughlin *et al.*, 2002b). Others (Reynolds *et al.*, 1976; Banci and Moore, 1997) who have studied denning in Arctic grizzly bears have also found a pronounced tendency for den sites to have a more southerly aspect. The benefit of a southern exposure may be insulation (*i.e.*, warmth) at emergence in the spring (and possibly at denning in the fall) or the accumulation of an insulating layer of snow that would result from the prevailing northerly winds.

Grizzly bears also select den sites based on the slope of the topographic feature that they wish to den in. McLoughlin *et al.* (2002b) found that grizzly bears chose den sites on relatively steep slopes, averaging 25°. Steep slopes may permit the bears to construct horizontal or even upward-sloping tunnels, which would result in a warm air "trap" in the hibernation chamber (Harding, 1976).

The substrates of den sites are well-drained and contain a large amount of sand and coarse material, including cobble- and boulder-sized stones (McLoughlin *et al.*, 2002b). The structural integrity of den sites is maintained through root mats from dwarf birch and other shrubby vegetation located in the ceilings of dens (McLoughlin *et al.*, 2002b). The grizzly bear dens studied by McLoughlin *et al.* (2002b) did not last long; by mid-summer, about 80% (44/56) had partially or completely collapsed. Thus, it appears that bears usually dig new dens each year.

2.5.1.8 Habitat Suitability Ratings

Barren ground grizzly bears spend about 7.5 months in winter torpor (not true hibernation). This lengthy period of winter lethargy, during which they are essentially inactive, restricts their active season to 4.5 months. Within the 4.5 months that grizzly bears are active, they must find enough food to store energy reserves to survive winter. Females that are pregnant require additional stores for gestation and lactation requirements of their cubs, which are born in the den during the winter.

The majority of habitats in the RSA and LSA during spring green-up and summer was of moderate quality (Table 2.5-2; Appendix D-8 of the DEIS). However, during the autumn and winter seasons, the highest quality habitat was also the most abundant in both the RSA and the LSA (Appendix D-8 of the DEIS). In all seasons, there is a greater proportion of high quality habitat within the LSA compared to the RSA. Conversely, there is a higher proportion of low/nil quality habitat in the RSA than in the LSA, though this difference is minimal during the winter season.

Table 2.5-2
Area and Proportion of High, Moderate, Low, and Nil-quality Habitat within the LSA and RSA for Grizzly Bears

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Spring				
High	1,010	3.86	8,346	0.60
Moderate	21,286	80.5	1,126,935	74.34
Low	3,371	12.71	365,954	25.03
Nil	771	2.930	450	0.03
Summer				
High	5,467	20.7	58,960	3.63
Moderate	17,123	64.86	738,316	48.94
Low	1,735	6.5	506,221	34.00
Nil	2,113	7.94	198,188	13.43
Autumn				
High	18,297	69.3	752,644.00	49.94
Moderate	4,706	17.8	50,650.00	3.03
Low	1,804	6.76	506,221.00	34
Nil	1,631	6.14	192,170.00	13.03
Winter/Denning				
High	17,275	65.40	740,644	49.14
Moderate	784	2.90	197,738	13.4
Low	5,210	19.72	57,082	3.46
Nil	3,169	11.97	506,221	34

2.5.2 Wolverine

2.5.2.1 Introduction

The wolverine (*Gulo gulo*) is a solitary mustelid with a range that extends throughout most of northern and western Canada, including the West Kitikmeot region of Nunavut (COSEWIC, 2003). The wolverine is ranked as secure in Nunavut (CESCC, 2005), while the western Canadian wolverine population (which includes Nunavut) is listed as a species of Special Concern (COSEWIC, 2003). In 2004, it was proposed that wolverines be listed under Schedule 1 of SARA. However, they were not added to the list as further consultation with the Nunavut Wildlife Management Board was required on their demography and ecology.

Wolverines are an important cultural and economic resource for the Inuit. Wolverines are highly respected by Inuit people for their cunning and ability to fool hunters (Thorpe *et al.*, 2001; Appendix F-5 of the DEIS). Wolverine pelts are also highly valued for their frost-resistant properties. The Inuit use wolverine pelts as trim and lining for their clothing, including parkas and mitts.

Wolverines are found in the RSA (Mulders, 2000; Appendices D-7 and F-5 of the DEIS).

2.5.2.2 Population Trends

Wolverines in the central Arctic appear to be stable, and may serve as a source population that provides for harvest of wolverines in adjacent areas (COSEWIC, 2003). However, the resiliency of wolverines is low because these animals have low reproductive rates, occur at low densities, have large home ranges which can increase their interactions with humans, and require large tracts of undisturbed land to maintain viable populations (COSEWIC, 2003). Wolverines in the Arctic may be especially vulnerable to hunting due to high visibility and snowmobile access. Wolverine numbers in Nunavut have been estimated at 2,000 to 2,500 (COSEWIC, 2003).

2.5.2.3 Harvest Rates and Management

Wolverines are vulnerable to population declines due to over-harvesting (GN DOE, 2005). The wolverine population in the RSA lies within the W/01-KT management area, and constitutes an abundant breeding population (GN DOE, 2005). The Nunavut Department of Environment (2005) recommends a TAH of 160 wolverines for the W/01-KT management area.

The locations of 1,714 wolverine kills were recorded in the West Kitikmeot between 1986 and 2005, and indicate an annual known harvest of 85.7 wolverines per year (Mathieu Dumond, GN DOE, *unpublished data*). These data indicate that 4% of the reported kills occurred in the Bathurst Inlet region. The majority of wolverines killed in the Bathurst Inlet region were males (60%). Wolverines aged two years or younger were the most likely to be harvested: 26% of Bathurst Inlet harvests were of juveniles (*i.e.*, animals less than one year old), 40% were of yearlings, and 21% were of two-year old animals. The remaining 13% of harvests were of animals between the ages of three and nine years. Within the RSA, wolverine harvests were recorded near Bathurst Inlet and Contwoyto Lake (Figure 2.5-3).

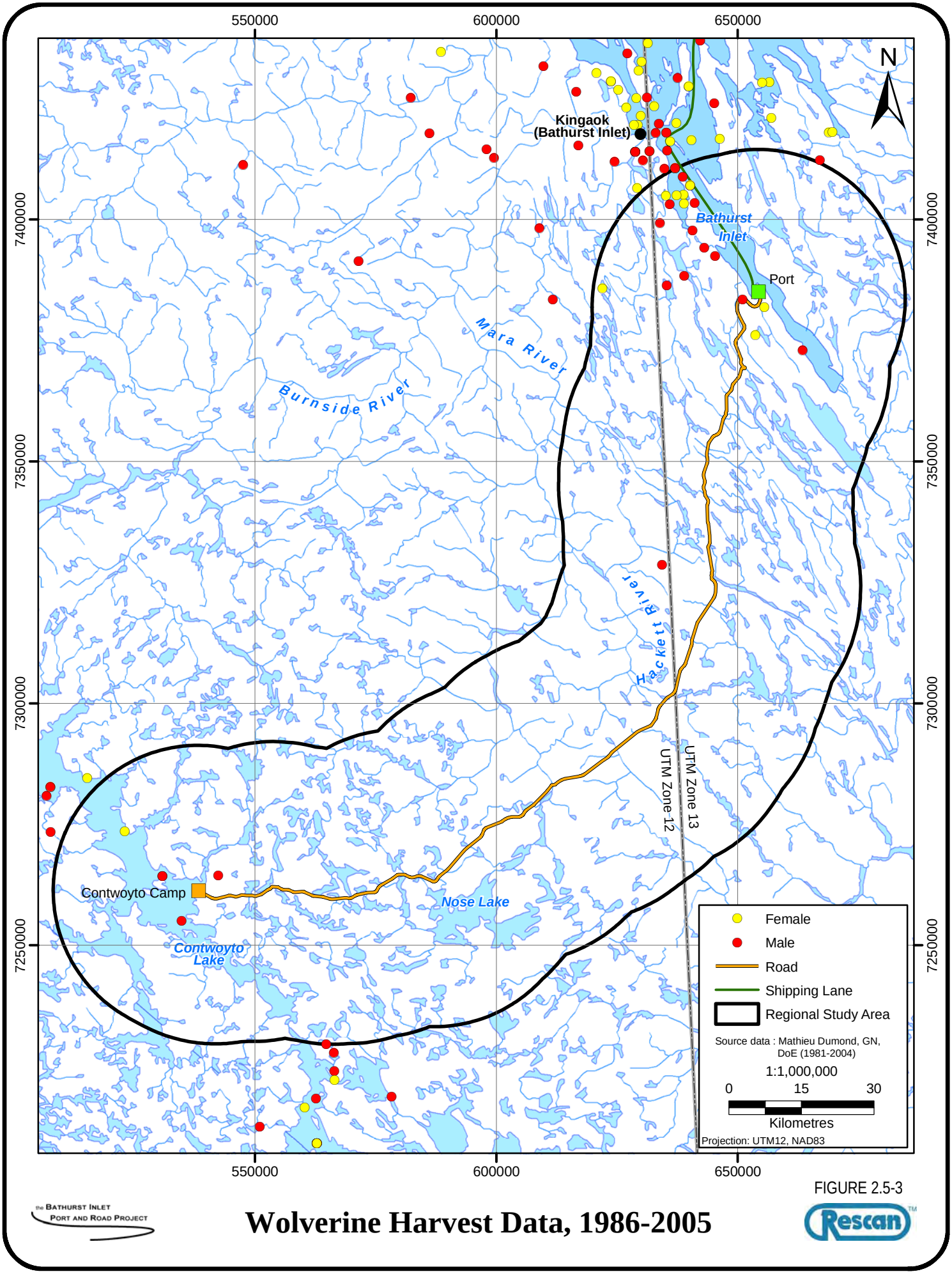

FIGURE 2.5-3

Wolverine Harvest Data, 1986-2005

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The Nunavut Department of Environment has recommended that wolverines not be harvested from April to November in order to minimize the harvest of young wolverines. Wolverines give birth in natal dens in March and April, and young emerge from the den to accompany the mother on foraging trips at 10 to 12 weeks of age. By six to seven months of age (*i.e.*, from September to November), the young have reached adult size and disperse from the female. Specifically, it is recommended that wolverine trapping in the W/01 management area be restricted to the November 1 to April 15 period. Shooting wolverines in this management area should be restricted to between November 1 and April 30 (GN DOE, 2005).

2.5.2.4 Movements and Distribution

Inuit Traditional Knowledge indicates that wolverines use the Project area extensively (Figure 2.5-4; Appendix F-5 of the DEIS). The southern end of the RSA near Contwoyto Lake, including the Contwoyto camp site, is an important area for wolverines because of the presence of caribou, which are a main prey item for wolverine. Inuit hunting of wolverines is concentrated in this area. Wolverines are also known to use the southern end of Bathurst Inlet (Appendix F-5 of the DEIS). Natal denning areas are described around Contwoyto Lake, near the Contwoyto camp site (Figure 2.5-5).

Data from wolverine harvests indicate that Bathurst Inlet, including the proposed port site, is one of the main sites for wolverine hunting in the West Kitikmeot (Mulders, 2000). Hunting locations were identified around Contwoyto Lake, in the vicinity of Contwoyto Camp site (Mulders, 2000). Data indicate that wolverines are relatively abundant in these areas.

2.5.2.5 Field Data

Wolverine and evidence of wolverine presence were detected during aerial and ground surveys of the RSA in 2001 and 2002. Six wolverines were observed, and six wolverine tracks were encountered within the RSA in both years. Because of the wolverine's relatively small size, they are probably difficult to detect from the air, except when the ground is snow-covered. Therefore, more wolverines may have been present, but were not seen during aerial surveys.

During low-level aerial surveys of the Project area in 2001, a single wolverine den was found at the southern end of the proposed road. The den was located in a jumble of rocks at the top of a hill and was surrounded by caribou remains. Tunnels were dug in amongst the rocks (Plate 2.5-1). This site is similar to that described by Lee and Niptanatiak (1996) at a location southeast of Kugluktuk. These authors visited this denning area during late winter in three consecutive years and found it occupied in each year. Magoun and Copeland (1998) also describe similar denning areas and behaviours for wolverines in northwestern Alaska. Thus, it might be expected that this den site would continue to be used by wolverine in future years.

2.5.2.6 Habitat Use and Diet

Wolverines are both scavengers and predators, and opportunistically feed on a wide variety of prey items and carrion throughout the year. Wolverines range over large tracts of land in search of food, and occupy a variety of habitats (Mulders, 2000; Thorpe *et al.*, 2001; COSEWIC, 2003). Wolverines are able to survive periods of food scarcity by feeding on cached food items (Magoun, 1987).

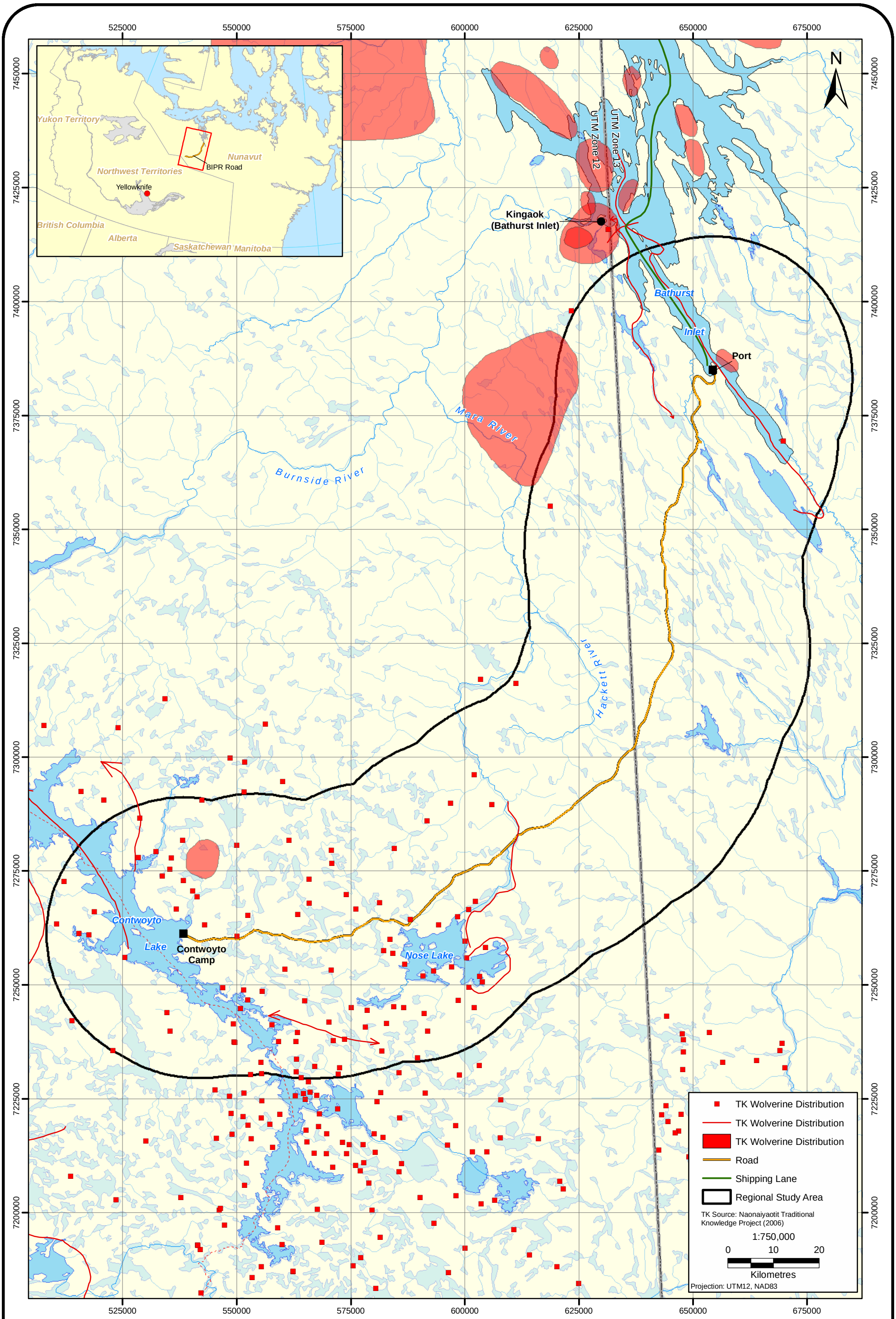

FIGURE 2.5-4

Distribution of Wolverine and Hunting Areas Based on NTKP

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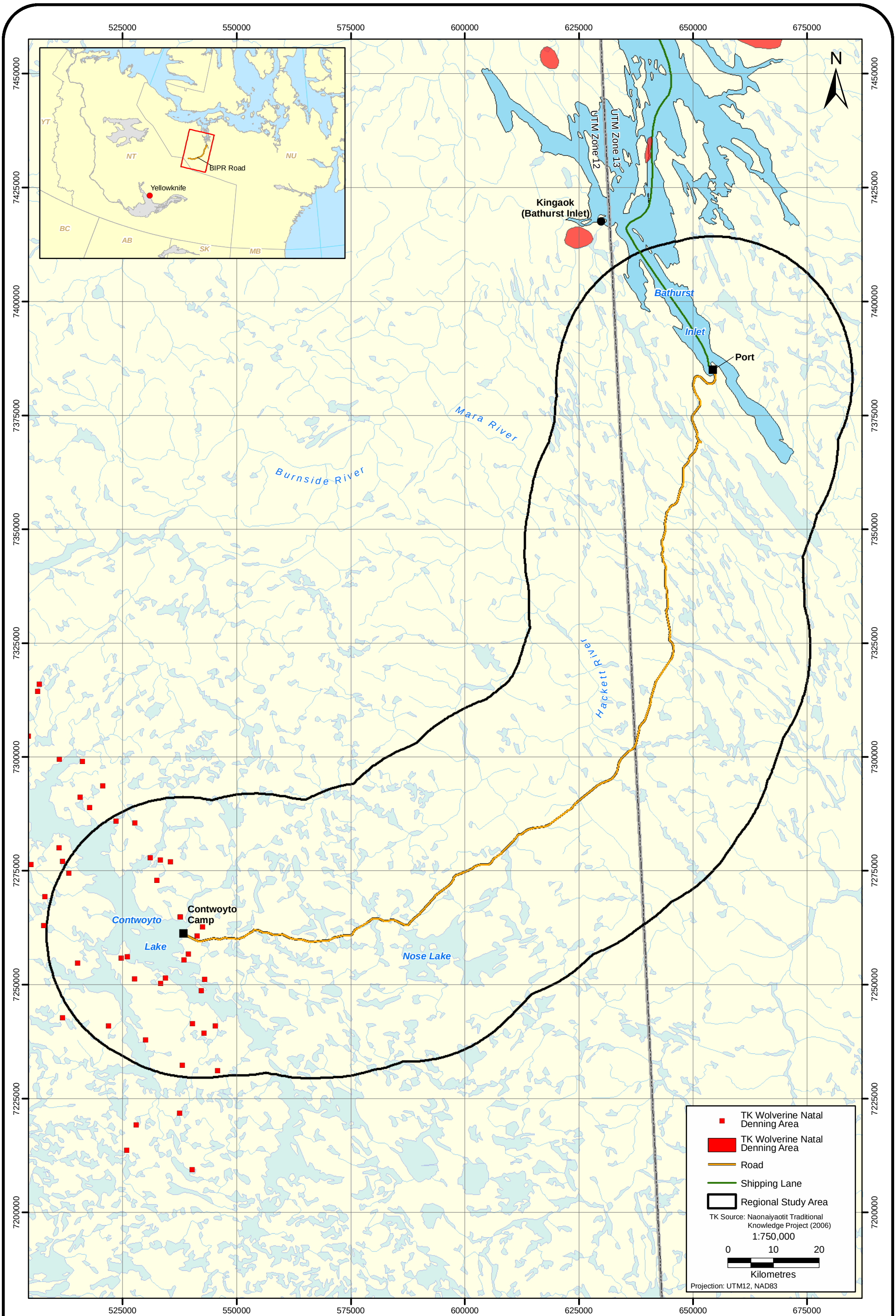

FIGURE 2.5-5

Wolverine Natal Denning Areas Based on NTKP

the Bathurst Inlet Port and Road Project

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Plate 2.5-1. Wolverine den in rocks.

Food availability is the driving factor influencing movement patterns and home range selection by wolverines, although habitat use patterns of adult males are also influenced by breeding activities (Banci, 1994). Wolverines in the Arctic feed primarily on caribou, but also feed on rodents, hares, and young muskox. Wolverine densities appear to be the highest where caribou are abundant and where wolf predation on caribou is high and creates scavenging opportunities (COSEWIC, 2003).

According to Magoun (1987), the summer diet of wolverines is more varied than their winter diet and contains more freshly killed prey. During the summer, Arctic ground squirrels are the main prey item taken. Wolverines also prey on birds, Arctic hares, young ungulates and small mammals such as lemmings and voles. Plant material such as berries is consumed to some extent (Magoun, 1987; Mulders, 2000). Small mammals are especially important during kit-rearing; survival of young wolverines was significantly higher in years when small mammal populations were also high (Pulliainen, 1968). During the summer, wolverine occurrence is strongly related to the presence of sedge habitat, with little use of areas dominated by heath rock, heath tundra and lichen veneer (Johnson *et al.*, 2005). Eskers, where small mammals and caribou are relatively abundant, may also be important for wolverines.

During the winter, wolverines rely heavily on scavenged and cached food (Magoun, 1987; Mulders, 2000; Thorpe *et al.*, 2001). Wolverines feed primarily on caribou carrion, although muskox carrion and cached Arctic ground squirrels are also important. Reviews of literature indicate that wolverine occurrence is correlated with sedge communities, heath rock and rock associations (Johnson *et al.*, 2005).

2.5.2.7 Denning Ecology

Wolverines use dens for reproduction, resting, or as a congregation site for females and their weaned kits. Denning occurs from February through April (Magoun and Copeland, 1998). Reproductive dens may be classified as either natal or maternal. Natal dens are used during parturition, while maternal dens are used subsequent to the natal den and before weaning (Magoun and Copeland, 1998). The availability of natal den sites does not appear to be a limiting factor for wolverines in the West Kitikmeot region (Mulders, 2000). However, maternal den sites may be limiting as they must be located near eskers or riparian areas where small prey items (*e.g.*, small mammals and birds) are available for growing kits.

Wolverines have specific habitat requirements for den sites and often use den sites for consecutive years (Lee and Niptanatiak, 1996). Dens used for reproduction are found in rocky outcrops or snowdrifts; these areas must maintain a deep insulating layer of snow throughout the denning period (February to April). A den consists of snow tunnels within boulder fields terminating in a crevice (Magoun and Copeland, 1998; Appendix F-5 of the DEIS). Denning sites are located away from predators such as grizzly bears, wolves and other wolverines. Proximity to kit-rearing habitat is also an important factor in den site selection (Magoun and Copeland, 1998).

In winter, wolverines use snow dens or burrows dug in snow for resting. These winter resting dens are used by males and females and should not be confused with natal dens (Appendix F-5 of the DEIS).

2.5.2.8 Habitat Suitability Ratings

The majority of the habitat during the late winter/denning and early winter seasons within both study areas was assessed as moderate quality habitat (Table 2.5-3; Appendix D-8 of the DEIS). However, during the growing/kit rearing season, the majority of the habitat is of low quality (Appendix D-8 of the DEIS). For all seasons, there is a higher proportion of high quality habitat within the LSA than within the RSA. The low quality habitat is proportionally higher in the LSA than in the RSA during the growing/kit rearing season. The low quality habitat is proportionally lower, however, in the LSA than in the RSA during the early winter season, and is approximately proportional during the late winter/denning season.

Table 2.5-3
Area and Proportion of High, Moderate, Low, and Nil-quality Habitat within the LSA and RSA for Wolverine

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Late Winter/Denning				
High	482	1.80	6,018	0.4
Moderate	22,700	85.87	1271243	84.57
Low	2,195	8.30	50,195	3
Nil	1,061	4.03	174229	12.03

(continued)

Table 2.5-3
Area and Proportion of High, Moderate, Low, and Nil-quality Habitat within the LSA and RSA for Wolverine (completed)

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Growing/Kit Rearing				
High	459.00	1.80	2,328	0.20
Moderate	5,472.00	20.57	586,357	38.80
Low	19,446.00	73.60	738,771	48.97
Nil	1,061.00	4.03	174,229	12.03
Early Winter				
High	459	1.8	2,328	0.20
Moderate	24918	94.17	1,325,128	87.77
Low	0	0	0	0.00
Nil	1,061	4.03	174,229	12.03

2.5.3 Wolf

2.5.3.1 Introduction

The largest member of the *Canis* genus and relative of the domestic dog, the grey wolf (*Canis lupis*) was once abundant over much of North America and Eurasia; however, its range has contracted due to habitat destruction and hunting. The wolf is still widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. Populations are stable or increasing within their Canadian range, except in northern Alberta and some parts of the NWT (Hayes and Gunson, 1995)

The wolf is listed as secure in Nunavut (CESCC, 2005), and is not nationally listed (COSEWIC, 2007b). The annual home ranges of wolves in the Arctic are considerably larger than in more southern latitudes due to the fact that wolves in the Arctic rely on migratory (*i.e.*, barren-ground caribou) prey rather than resident prey (Walton *et al.*, 2001; Cluff *et al.*, 2002). Their patterns of distribution, densities, territory boundaries and dispersal movements are influenced by prey abundance and distribution and also interactions between packs.

2.5.3.2 Population Trends

Wolves are still found in 90% of their original range in Canada, which is home to an estimated 60,000 individuals (Walton *et al.*, 2001). In Nunavut and parts of the NWT, wolf populations are stable or increasing within their range (Hayes and Gunson, 1995). Estimates of wolf numbers in Nunavut have not been attempted recently.

2.5.3.3 Movements and Distribution

Wolves in the Canadian Arctic behave differently than wolves inhabiting the rest of North America because they make long seasonal migrations every year to follow barren-ground caribou (Heard and Williams, 1992; Walton *et al.*, 2001; Frame, 2005). Satellite-collared wolves in the central

Arctic showed a distinct migratory pattern: they leave the tundra denning areas in the autumn and move over large areas throughout the winter, before returning to the tundra to give birth in the early spring (Walton *et al.*, 2001). Wolves follow the caribou for most of the year, except from parturition (mid to late May) until pups are able to travel with their mother (September to October). Between those periods, wolf movements are restricted to areas surrounding den site and individuals may travel large distances in search of prey (Frame *et al.*, 2004).

A study in the central Canadian Arctic estimated annual home range sizes of approximately 63,000 km^2 for males, and 45,000 km^2 for females (Walton *et al.*, 2001). Winter ranges are much larger than summer ranges and show a clear seasonal separation from summer denning areas (Walton *et al.*, 2001). Home ranges of wolves that prey on migratory caribou are much larger than other North American wolves that prey on resident species.

Data from the Government of Nunavut shows wolf dens concentrated near Contwoyto Lake and Bathurst Inlet (Figure 2.5-6).

2.5.3.4 Field Data for Wolves in the RSA

During baseline studies in 2001 (July, August, September, and November) and 2002 (March, May, June, and July), wolves and wolf dens were identified within a 5 km buffer of the proposed road (the 'study area') (Appendix D-7 of the DEIS). A total of 34 wolves were observed throughout the study area from aerial surveys and incidental observations (Figure 2.5-6). In 2001, 11 active wolf dens were located, along with 1 inactive den and one unknown.

In 2007, aerial surveys for mammal dens were conducted in the northern two-thirds of the BIPR RSA to collect baseline data for the Hackett River and Back River projects (Gartner Lee, *unpublished data*, 2007). These surveys identified 18 dens within the RSA where a total of 11 adult wolves and seven pups were observed (Figure 2.5-6). Of the dens, seven were confirmed as active due to the presence of adult wolves, pups or recent prey remains (Gartner Lee, *unpublished data*, 2007). All dens in the study area were located in esker habitats.

2.5.3.5 Habitat Use and Diet

A study recently conducted in the region surrounding the Project found that the annual home range of wolves contained proportionally more esker habitat, followed by heath tundra (McLoughlin *et al.*, 2004). In addition to these two habitat types, wolves selected areas with heath boulder, heath bedrock, bedrock, tussock/hummock, wetland, lichen, tall shrub and birch seep (McLoughlin *et al.*, 2004). McLoughlin *et al.* (2004) found that boulder fields were much less preferred and that within the selected home ranges, exposed bedrock was the most preferred habitat type. These results clearly show that wolves have a strong habitat association with eskers.

The primary prey of wolves inhabiting the study area is barren-ground caribou, which they follow for hundreds of kilometres every year (Frame, 2005). Caribou in the Canadian Arctic are the only species that occur at densities sufficient enough to support the wolf population (Walton *et al.*, 2001). Wolves on the tundra also feed on muskox. Although wolves primarily hunt larger animals, their diets also contain small mammals such as hares, foxes, rodents, and even small amounts of plant material.

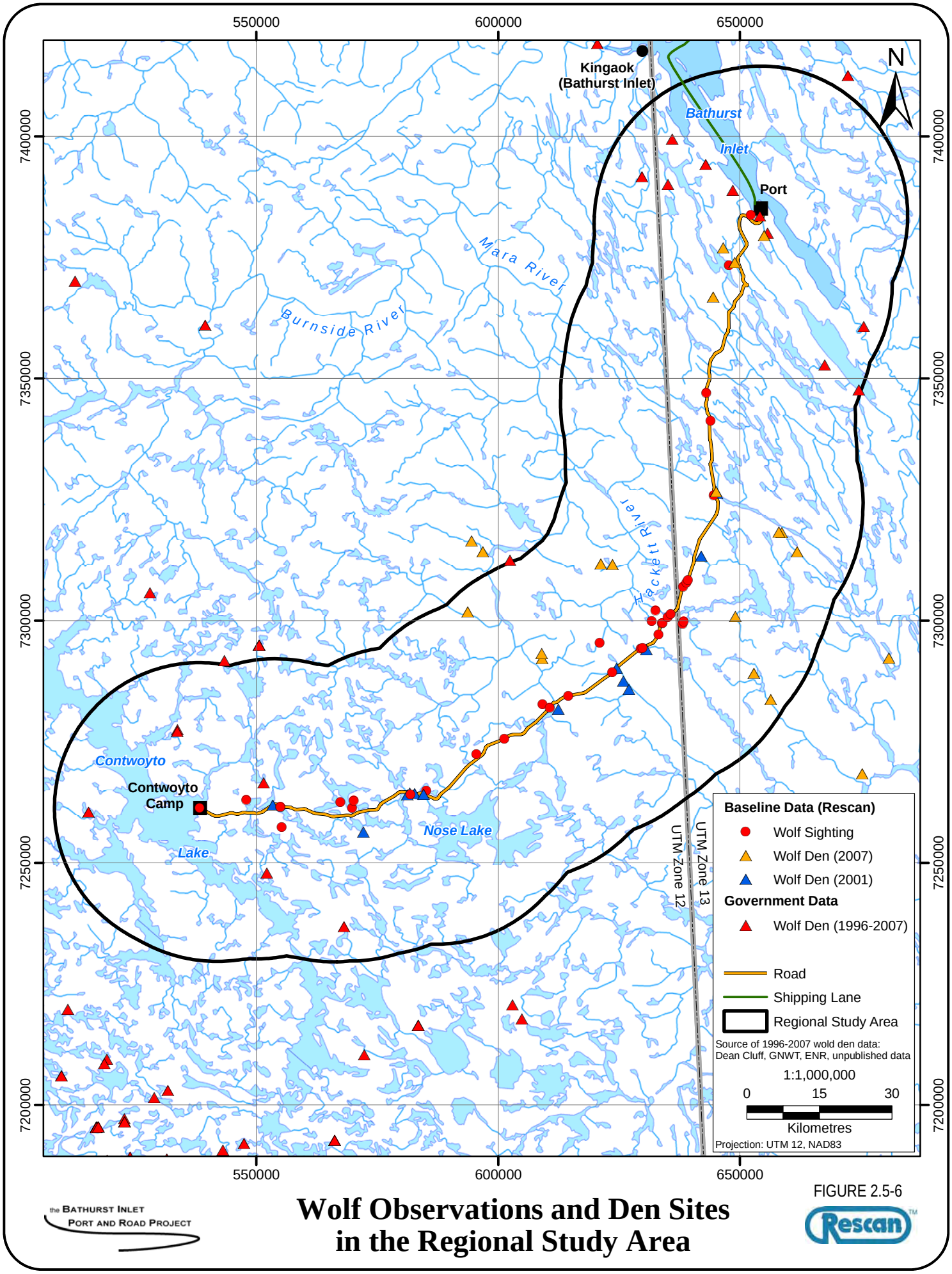

FIGURE 2.5-6

Wolf Observations and Den Sites in the Regional Study Area

the Bathurst Inlet Port and Road Project

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2.5.3.6 Denning Ecology

Wolves arrive at denning sites in mid- to late- May and give birth shortly thereafter. Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually in September or October (Walton *et al.*, 2001). After migrating long distances to follow caribou, wolves often return to the same den in subsequent years (Ballard and Dau, 1983; Mech and Packard, 1990).

Eskers are the preferred habitats for wolf den construction. Esker habitats are granular and sandy, likely facilitating soil excavation for dens in a landscape dominated by bedrock, boulders, standing water, and permafrost (McLoughlin *et al.*, 2004). In the tundra of the Canadian Arctic, esker habitat only comprises 1-2% of the landscape (McLoughlin *et al.*, 2004). Therefore, suitable denning habitat for wolves inhabiting northern tundra is likely a limiting factor and areas containing eskers should be considered ecologically sensitive (McLoughlin *et al.*, 2004).

2.5.3.7 Habitat Suitability Ratings

The majority of the habitat during all seasons and within both study areas was assessed as moderate quality habitat (Table 2.5-4; Appendix D-8 of the DEIS). There is a higher proportion of high quality habitat within the LSA than within the RSA for all seasons. Conversely, there is a higher proportion of low quality habitat in the RSA than in the LSA for all seasons.

Table 2.5-4
Area and Proportion of High, Moderate, Low, and Nil-quality Habitat within the LSA and RSA for Wolves

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Denning/Pup Rearing				
High	347	1.12	2,328	.16
Moderate	62	.2	<450	<.03
Low	782	2.53	191,720	12.8
Nil	29,696	96.15	1,307,187	87.01

2.5.4 Fox

2.5.4.1 Introduction

In the study region, two species of fox occur: the coloured fox, often referred as the red fox (but may also be called the silver fox or cross fox based on fur colour patterns) and the Arctic fox. Both the coloured and Arctic fox are used by the local Inuit for their fur (Zinifex, 2007). As such, traditional knowledge is an important source of information on fox ecology in the Project area. The Arctic fox is particularly suited for the tundra: it's coat turns white during the winter to camouflage with the snow and possesses a thick coat and furry feet to help conserve body heat when the temperature drops (Forsyth, 1985).

2.5.4.2 Field Data for Foxes in the RSA

The 2001-2002 baseline studies focused on identifying fox dens and carried out surveys around identified dens (Appendix D-7 of the DEIS). Only two fox dens were identified, one of a coloured fox and the other of an Arctic fox (Figure 2.5-7). The coloured fox den was dug into an esker and the Arctic fox den was situated on the edge of a drained lake. As with wolf dens, the fox dens were dug in soils that contained a large amount of sand. Prey remains found around fox dens were of caribou (especially calves), ptarmigan and Arctic ground squirrel. Caribou remains were the most abundant. During aerial and ground surveys in 2001-2002, incidental observations of foxes were made, and indicated that foxes inhabit the Project area throughout the year (Appendix D-7 of the DEIS).

In 2007, aerial surveys for mammal dens were conducted in the northern two-thirds of the BIPR RSA to collect baseline data for the Hackett River and Back River projects (Gartner Lee, *unpublished data*, 2007). These surveys identified seven fox dens within the RSA where eight adult foxes with nine pups were observed (Figure 2.5-7). Of these dens, five were confirmed as active due to the presence of adult foxes, pups or recent prey remains (Gartner Lee, *unpublished data*, 2007). Inuit Traditional Knowledge supports the baseline studies in 2001, 2002 and 2007 (Figure 2.5-7). Foxes and fox dens were identified throughout the RSA but were concentrated near Contwayto Lake. All dens in the study area were located in or near eskers.

2.5.4.3 Population Trends

There is a strong tie between primary prey abundance and small carnivore population abundance. Elton (1942) observed that fox pelt returns for the Hudson Bay Co. fluctuated on a four-year cycle. The cyclic nature of fox populations roughly correlates with known small mammal population cycles (Krebs, 1964; Krebs *et al.*, 2002), and correlations between Arctic fox and lemming populations have been studied (Chitty, 1950; MacPherson, 1969; Speller, 1972). The population sizes of Arctic and coloured foxes for the region are unknown.

2.5.4.4 Habitat Use and Diet

Inuit elders have reported that foxes use little hills and flat areas for denning, but also use soft ground along river banks for dens (Zinifex, 2007). Eskers are also favoured for denning by foxes, as the substrate is primarily loose and presumably conducive to den construction. Dens may be used repeatedly over the years, some sites have had documented use up to 60 years (Forsyth, 1985).

Primary prey items for coloured and Arctic foxes include small mammals (*e.g.*, voles and lemmings), but foxes also eat juvenile birds, eggs, ground squirrels, hares and berries (Englund, 1965; Kapel, 1999). Foxes also opportunistically scavenge on grizzly bear and wolf kills. In winter, Arctic foxes can move great distances in search of food. Some foxes leave the barrens and move out to the coast and on to the sea ice, where they scavenge seal kills made by polar bears. Arctic foxes may also follow caribou herds, feeding on the remains of caribou killed by wolves (Clarke, 1940; Forsyth, 1985).

2.5.5 Other Mustelids

2.5.5.1 Introduction

Mustelids commonly refers to the weasel family (*mustelidae*) and several species likely inhabit the RSA including the ermine, least weasel and American mink (the wolverine, the other mustelid occurring in the RSA, has been described above (Section 2.5-2)). The American mink, least weasel, and ermine are all solitary, nocturnal animals and active year-round. Heat loss is a problem for mustelids because they have a high surface area to volume ratio, *i.e.* their long and skinny body promotes heat loss. To counteract heat loss, Arctic mustelids will increase their metabolic rate from resting (Forsyth, 1985). The least weasel is an extreme case, elevating its metabolic rate to 400 times the average, which means it must eat almost half its body weight each day to survive (Forsyth, 1985). The thick fur of mustelids has been valuable for traditional Inuit clothing (Appendix F-5 of the DEIS). None of the three mustelids covered in this section have been listed by COSEWIC (COSEWIC, 2007b).

2.5.5.2 Field Data for Other Mustelids in the RSA

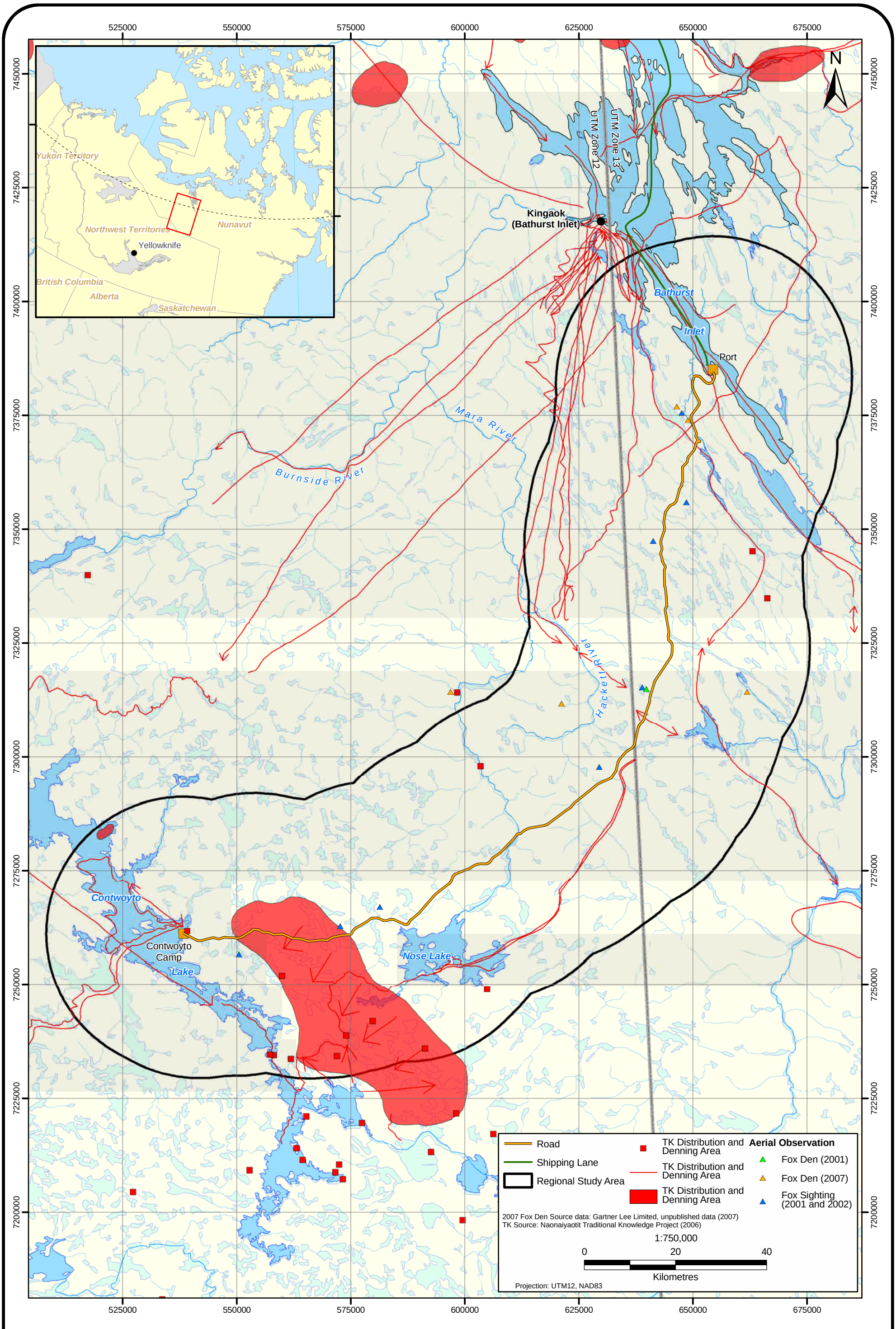
Baseline studies in the RSA have observed weasels, although the exact species are unknown (Appendix D-7 of the DEIS), and mustelid tracks have been sighted during winter surveys (H. Bears, Rescan, *personal communication*).

2.5.5.3 Population Trends

The American mink, least weasel and ermine are ubiquitous species in North America, and are widely distributed across Canada (Reid, 2006). Current population statuses in the RSA, and indeed the Arctic are unavailable; however, Canadian population of these three mustelids are in the thousands (NatureServe, 2007).

2.5.5.4 Habitat Use and Diet

The ermine, least weasel and American mink all feed on small mammals *e.g.*, lemmings and voles, but also on birds, eggs and other small creatures (Reid, 2006). The American mink is also an aquatic hunter and eats primarily fishes while in the water (Forsyth, 1985). Mustelids are known for their ferocity, and will often take on prey larger than themselves (Mulders, 2000; Reid, 2006). In the Arctic, least weasels and ermine choose territories primarily in open areas, due to the availability of rodent burrows used for dens; lowland marsh habitats are typical habitat selected for by American minks (Forsyth, 1985; Reid, 2006). The hunting strategies for the smaller mustelids, *i.e.* the weasels, are to utilize their body shape to attack prey in their burrows. Burrows are then used by the weasels for dens, and prey item fur is used to insulate dens, another strategy for these animals to conserve heat in the Arctic (Forsyth, 1985). The least weasel and ermine may have several different dens within territories (Reid, 2006), which are typically on the order of a few acres (Forsyth, 1985). American minks are more active predators, and patrol areas where prey is likely to be found (Forsyth, 1985). Territory size for American minks is larger, males may have territories on the order of 760 ha, and female territory size is smaller (Reid, 2006).



the Bathurst Inlet Port and Road Project

Distribution and Denning Areas of Arctic and Red Foxes based on Aerial Observations and NTKP

FIGURE 2.5-7

Rescan™

2.6 Small Mammals

2.6.1 Introduction

Small mammals are an integral part of the Arctic ecosystem. Although species diversity in this area is low for small mammals, abundance is often high. Small mammals (especially voles and lemmings) are the primary prey of the smaller carnivores, such as foxes and weasels and can be important dietary items for wolves and wolverines, particularly for young.

Species of small mammals expected to occur in the RSA include: Arctic ground squirrels, Arctic hare, barren-ground shrew, northern collared lemmings, brown lemmings and northern red-backed, tundra and meadow voles (Table 2.3-3). The Victoria collared lemming may possibly occur in the RSA.

Snowshoe hares would be rare in the RSA, as their range more or less follows the northern treeline, and preferred habitat types do not include tundra (Reid, 2006). Carrière (1998) documented deer and jumping mice during annual small mammal trapping, but these incidences were south of the RSA, and consultation with field guides confirms that no other rodent species would be observed north of the treeline (Reid, 2006).

2.6.2 Field Data for Small Mammals in the RSA

During the 2001 and 2002 baseline studies, only two species were caught during small mammal trapping, northern red-backed and tundra voles. However, nests belonging to two lemming species, the brown and northern collared lemming, were found in the RSA. Additionally, Arctic ground squirrels *colloq*. "sik-sik" and Arctic hares were observed. Small mammal populations were probably at their cyclic low (Krebs *et al.*, 2002) during baseline studies and common species were not abundant enough to be caught.

During 2001 surveys most small mammals were caught in rocky heath tundra and predominantly rocky areas. Lower numbers of animals were trapped in riparian, birch and dry heath habitats. No animals were caught in fen habitats. Similar results have been documented in the High Lake Area (Zinifex, 2007).

2.6.3 Population Trends

Elton (1942) was one of the first to recognize that Arctic small mammal populations can undergo large, regular cycles of abundance. He deduced this cycle from the fluctuations in fur returns to Hudson's Bay Company trading posts in the Arctic, which showed a pattern of high numbers of furbearers, such as foxes, every four years. These fluctuations occurred synchronously over large areas and have stimulated a lot of research by ecologists about the mechanisms that regulate animal population size (Krebs, 1964). Among the species that become conspicuously more abundant when lemmings are abundant are snowy owls and Arctic foxes. Baseline studies in 2001 (Appendix D-7 of the DEIS) recorded low small mammal numbers, suggesting that populations in the RSA were at their nadir (low).

2.6.4 Habitat Use and Diet

Important habitats for small mammals include: eskers and rocky heath tundra. Arctic ground squirrels will use eskers for burrows; Arctic hares prefer rocky areas for their burrows (Appendix

F-5 of the DEIS). Rocky heath tundra usually have well drained soils, and provide good habitat for shrew and vole burrows, as well as lemming foraging habitat (Reid, 2006). In addition, lower habitats with more moisture content and greater vegetation are important foraging habitats for some small mammals. Wet meadow and marsh areas with greater vegetation are frequented by tundra and meadow voles (Reid, 2006). Riparian and sedge grass associations are used by *Sorex* species, and lower areas with denser vegetation are important to lemming species during the winter (Reid, 2006).

Small mammals are primarily herbivores. Lemming species utilize a wide variety of Arctic vegetation during the summer, whereas in the winter moss and *Salix* species constitute important food sources for the brown and northern-collared lemmings, respectively (Reid, 2006). Vole species rely on roots, seeds, plant matter and occasionally berries (when available), and tundra voles will cache seeds and roots for the winter (Reid, 2006). The food habits of barren-ground shrew are poorly known in the RSA, but *Sorex* species' diet usually includes invertebrates and plant matter. The Arctic hare and ground squirrel have a larger diet. Berries, *Salix* species, leaves and other green vegetation, roots, bark all contribute to the overall diet of these two species. However, Arctic ground squirrels are opportunistic, and will eat insects or scavenge meat from carnivore kills or wastes from camps associated with development (Reid, 2006; H. Bears, Rescan, personal communication).

2.7 Birds

2.7.1 Migratory Birds

2.7.1.1 Introduction

The majority of breeding birds within the Kitikmeot region are migratory and winter in areas extending from the treeline to the southern tip of South America. This diverse group includes small passerines (*e.g.,* sparrows, warblers, longspurs and redpolls), shorebirds (in this context referring to sandpipers, plovers, phalaropes and cranes), seabirds (including jaegers and terns), raptors (*e.g*., falcons, hawks, eagles and owls) and waterfowl (referring to ducks, geese, swans, loons and grebes) (Tables 2.3.4 to 2.3.9). Three species, the gyrfalcon, ptarmigan and raven, are resident in the region, but make short local migrations depending on weather conditions (Holder and Montgomerie, 1993; Clum and Cade, 1994; Hannon *et al.*, 1998; Boarman and Heinrich, 1999; Appendix F-5 of the DEIS).

The *Canadian Migratory Bird Convention Act* (1994) protects avian species that migrate between countries. The *Canada Wildlife Act* (1982) provides birds, especially raptors, with additional protection. The *Species At Risk Act* (SARA) protects three bird species that potentially occur in the Project area: the Eskimo curlew, ivory gull, and Ross's gull. COSEWIC lists two bird species observed in the Project area as species of Special Concern under SARA: the tundra peregrine falcon and short-eared owl. Birds are respected in Inuit culture (Appendix F-5 of the DEIS), and species such as ducks, geese and cranes were an important food source for the Inuit when caribou were not available (Thorpe *et al.*, 2001; Appendix F-5 of the DEIS; Zinifex, 2007). The Inuit stress the importance of conserving significant bird habitat in the Draft West Kitikmeot Land Use Plan (NPC, 2005; Appendix F-5 of the DEIS). Several bird species observed in the Project area, including the American golden plover, American tree sparrow,

golden eagle, Harris's sparrow, semipalmated sandpiper, short-eared owl and white-crowned sparrow are listed as sensitive in Nunavut (CESCC, 2005), meaning that there is concern in the long-term for these species due to declines. Finally, the relatively high abundance of birds enables the statistical detection of changes in diversity and abundance in disturbed compared to undisturbed habitats and between pre- and post-disturbance phases over time. Tracking birds during long term monitoring programs can be valuable for this reason.

Migratory birds in the RSA have been grouped in order to identify general population trends, habitat associations and sensitive periods during the breeding season. Raptors and waterfowl are addressed in separate sections (2.7.2, 2.7.3, and 2.7.4). Seabirds found along the shipping route are also evaluated in a separate section with polar bears (Appendix E-4 of the DEIS), as these groups are both relevant for assessing the impacts of the shipping route. The remaining migratory birds, including small passerines, shorebirds and gulls, are addressed below.

2.7.1.2 Field Data

Forty-one bird species were identified in the LSA between 18 and 25 June, 2007, using variable range point count surveys (VRPCs) (Table 2.7-1; Appendix D-10 of the DEIS). The timing of surveys was ideal for songbirds, as many of the species observed had nests with eggs; however, some sandpipers and waterfowl may have arrived later in the season after a greater proportion of ice had melted from waterbodies. Many of the same species have been recorded by the Inuit in traditional knowledge studies (Appendix F-5 of the DEIS).

2.7.1.3 Population Trends

Population trend data for Arctic-nesting migratory birds are lacking. There are two major programs for monitoring broad-scale bird populations in North America, the Breeding Bird Survey (BBS) and the Christmas Bird Count (CBC). The BBS surveys are limited to areas with road access; therefore, data on birds nesting in the Project area are not available. The CBC surveys birds on their wintering grounds, but it only partially samples birds that breed in the Arctic because neotropical wintering areas are not covered. A third monitoring program, the Northwest Territories/Nunavut Bird Checklist Survey, is volunteer-based and collects limited data on northern bird populations. The scientific literature and government-sponsored research provide some additional information.

Species listed as sensitive in Nunavut, which were observed during the 2007 bird surveys included white-crowned sparrow, Harris' sparrow, American tree sparrow, American golden plover, and semipalmated sandpiper. The listings for Nunavut are relatively new, and Nunavut is generally understudied. Therefore, the listings for Nunavut are likely to be updated in the near future as more information becomes available. All of the species listed for Nunavut were relatively common in the Project LSA. For example, Harris' sparrows, American golden plovers and white-crowned sparrows were the 15th, 14th and 13th most common species observed and the American tree sparrow was the 4th most common species. Therefore, some of the current Nunavut rankings may be questionable in relation to the LSA. It should be noted that the golden eagle, which is listed in the Nunavut ranking system, has been observed during surveys of the Hackett River Project (Rescan, *unpublished data*). There is the potential for golden eagles to occur along the proposed road, although they were not observed during 2007 surveys, and their listing in the Nunavut ranking system may reflect a genuine rarity.

Table 2.7-1
Species Observed during VRPCs along the Proposed Road, June 2007

Avian Group	Species	No. Observations	Breeding Confirmed
Waterfowl and Geese	Canada Goose	7	N
	Long-tailed Duck	3	Y (Nest with eggs)
	Red-breasted Merganser	0	N
	Pacific Loon	0	N
	Yellow-billed Loon	0	N
	Tundra Swan	0	N
	Great White-fronted Goose	0	N
	Northern Pintail	2	N
	Greater Scaup	0	N
Gruids	Willow Ptarmigan	2	N
	Rock Ptarmigan	15	N
	Sandhill Crane	1	N
Corvids	Common Raven	0	Y (Nest)
Gulls	Herring Gull	1	Y (Nest nearby in Hackett)
	Galucous Gull	0	N
	Parasitic Jaeger	2	N
	Pomarine Jaeger	0	N
	Long-tailed Jaeger	13	Y (Nest with eggs)
	Arctic Tern	0	N
Songbirds	Lapland Longspur	295	Y (Nest with eggs
	Horned Lark	57	N
	Savannah Sparrow	114	Y (Nest with eggs)
	Common Redpoll	103	Y (Nest with eggs)
	American Tree Sparrow	36	Y (Nest with eggs)
	Hoary Redpoll	15	Y (Nest with eggs)
	Gray-cheeked Thrush	12	Y (Nest with eggs)
	American Pipit	15	Y (Nest with eggs)
	Yellow Warbler	8	Y (Nest with eggs)
	Harris' Sparrow	11	Y (Nest with eggs)
	White-crowned Sparrow	12	Y (Nest with eggs)
Shorebirds	American Golden-plover	8	Y (Aggressive defence behaviour)
	Semipalmated Plover	16	N
	Sanderling	0	N
	Semipalmated Sandpiper	16	N
	Least Sandpiper	7	N
	Stilt Sandpiper	2	N
	Red-necked Phalarope	4	N
Raptors	Rough-legged Hawk	0	N
	Peregrine Falcon	0	N
	Gyrfalcon	0	N
	Short-eared Owl	0	N

***Grouped by class, numbers observed, and whether or not they were confirmed as breeding between 18-25 of June. Species with 0 breeding observations were seen outside of the 100 m VRPC point count radii or were seen incidentally between transects.**

Seven species of shorebirds were detected during point-count surveys of the RSA: American pipit, American golden plover, Baird's sandpiper, least sandpiper, semipalmated sandpiper, semipalmated sandpiper and stilt sandpiper (Appendix D-10 of the DEIS). Shorebird populations have been persistently declining in the Northwest Territories and Nunavut (CWS, 2001). Breeding populations have been declining in the low Arctic (Churchill, Manitoba; Gratto-Trevor, 1994), mid Arctic (Rasmussen Lowlands, Nunavut; Gratto-Trevor *et al.*, 1998) and High Arctic (Devon Island and Ellesmere Island; Gould, 1988; Pattie, 1990).

2.7.1.4 Breeding Chronology

The general breeding period for birds in the Arctic is from May through August. Breeding among species of birds tends to be highly synchronous due to the short breeding and growing season in northern latitudes, as in other "extreme" environments (Bears *et al.*, 2003). Hatching and fledging is often timed to correspond to dates of insect emergence, as insects are the primary food item for newly hatched and nestling songbirds. Synchronous breeding was also observed along the proposed road; many species had nests with eggs at the same phenology stage at the same time during the survey period. Further, insects began to emerge by *ca*. 24 June, corresponding to the dates at which many of the nests hatched or were forecasted to hatch by known, species-specific incubation schedules.

2.7.1.5 Habitat Use

Variable range point count surveys (VRPCs) were conducted between 18 and 25 June, 2007, within the LSA (Appendix D-10 of the DEIS). Species richness and equitability values varied considerably between VRPC plots within the LSA, which allowed for a limited extrapolation of habitat characteristics associated with high and low species diversity. Songbird diversity and abundance in other studies were positively correlated with increased vegetative diversity and structural heterogenetity (*e.g.*, vertical stratification of vegetation; (Whelan, 2001)), shrubby buffer areas along water or where two habitat types transition (Peak and Thompson, 2006) and/or the availability of diverse food resources (Whelan, 2001). These data show that VRPC transects that hosted the highest songbird abundance and diversity were also located in habitats with the greatest vertical stratification of vegetation (Riparian shrub and Birch Seep) and near water (Riparian shrub). Inversely, habitats with little to no vertical stratification or vegetation, such as lichen rock and avens habitats, hosted the lowest diversity of songbirds.

2.7.1.6 Habitat Suitability Ratings

Cluster analysis of baseline data indicated three main migratory bird communities, which again were: 1) heath tundra and boulder habitats, 2) riparian shrub and birch seep and 3) sedge wetlands (Appendix D-10 of the DEIS). Habitat suitability rating results were designated for each of those three communities separately (Tables 2.7-2, 2.7-3 and 2.7-4).

Habitat ratings for migratory birds (except Peregrine Falcons), were assessed as either usable or unusable, based on life requirements of the birds during spring and summer seasons (Figure 2.7-1). While heath tundra/boulder and sedge habitats are relatively common along the proposed road alignment, structured vegetation such as riparian shrub and birch seep are relatively low in availability. Furthermore, the vertical vegetation structure found in riparian

shrub and birch seep habitats are unique across the tundra landscape, making the shrub and birch seep community assemblage most sensitive to habitat loss.

Heath Tundra Community

Table 2.7-2
Area and Proportion of Associated and Not Associated Habitat within the LSA and RSA for Migratory Birds

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Heath Tundra Community - Spring/Nesting and Summer/Fledgling				
Heath Tundra Community Habitat	19,446	73.60	738,771	48.97
Non-Heath Tundra Community Habitat	6992	26.4	762,914	51.03

Riparian Shrub Community

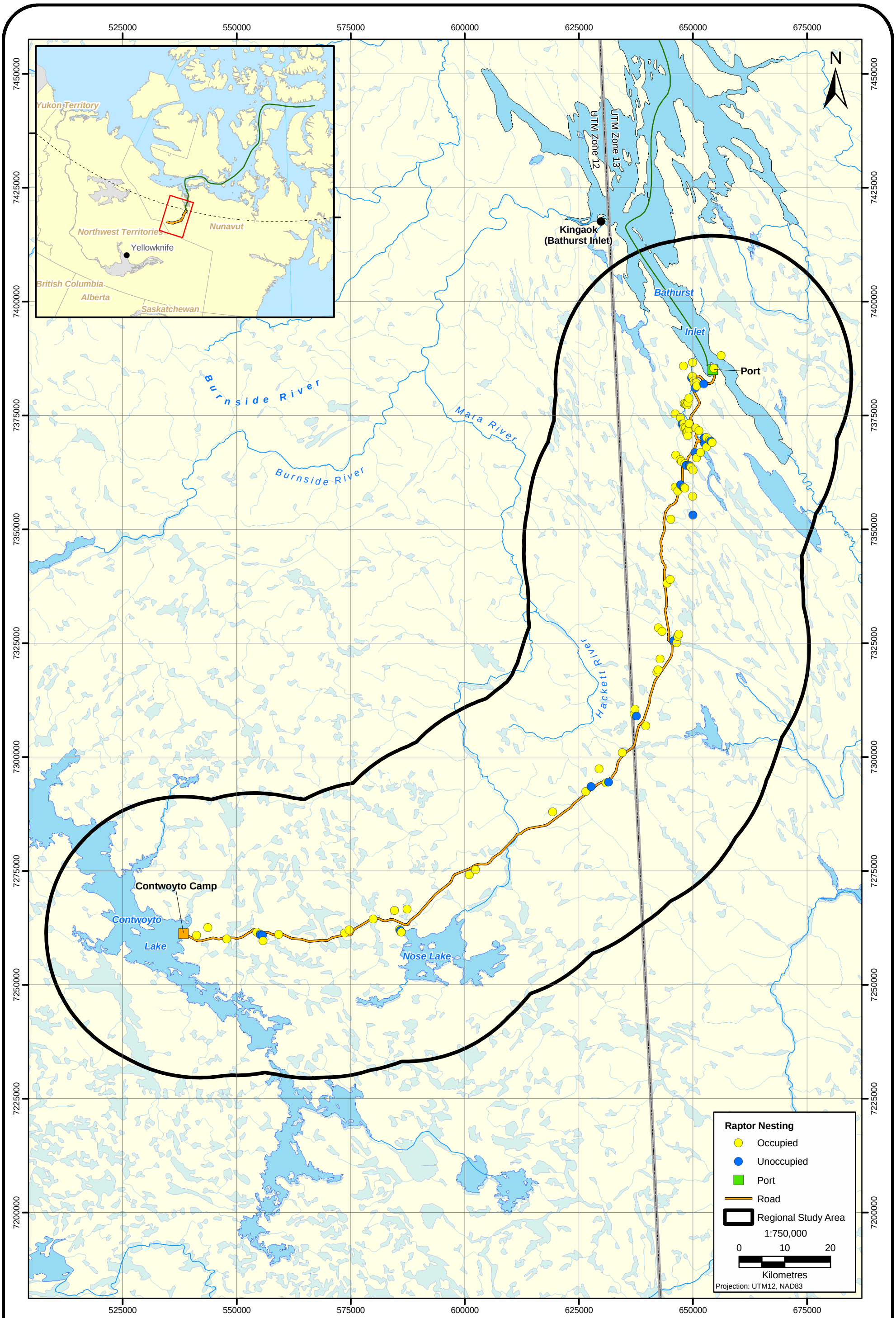
Table 2.7-3
Area and Proportion of Associated and Not Associated Habitat within the LSA and RSA for Migratory Birds

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Riparian Shrub Community – Spring/Nesting and Summer/Fledgling				
Riparian Shrub Community Habitat	490	1.86	338,424	22
Non-Riparian Shrub Community Habitat	25,948	98.14	1,163,261	77.6

Sedge Community

Table 2.7-4
Area and Proportion of Associated and Not Associated Habitat within the LSA and RSA for Migratory Birds

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Sedge Community – Spring/Nesting and Summer/Fledgling				
Sedge Community Habitat	2,195	8.30	50,195	3
Non-Sedge Community Habitat	24243	91.7	1451490	97



the Bathurst Inlet Port and Road Project

Raptor Nest Locations within the Regional Study Area, 2001 to 2002

FIGURE 2.7-1

Rescan™

2.7.2 Cliff-Nesting Raptors

2.7.2.1 Introduction

Raptors are top predators and often considered ideal 'indicator species' because their health and reproductive success potentially reflect the health of their associated food chains. For example, declines in peregrine falcon and other raptor populations in the 1960s and 1970s signalled the negative ecological impacts of dichloro-diphenyl-trichloroethane (DDT) and other persistent pesticides. Of the nine species of raptors potentially present in the RSA, the following six form a distinct guild that nest on steep cliff ledges (Poole and Bromley, 1988): the golden eagle, bald eagle, gyrfalcon, peregrine falcon, rough-legged hawk, and common raven. As aforementioned, raptors are protected under the *Wildlife Act* (Nunavut), but not under the *Migratory Bird Convention Act* (Canada) even though they migrate north from Central and South America to breed above treeline in Alaska, Canada and Greenland (White *et al.*, 2002). The Arctic provides raptors with critical breeding habitat, and supports a large proportion of the breeding population of gyrfalcon, rough-legged hawk and peregrine falcon (*tundrius* subspecies). Although common ravens are passerines, they are considered "functional raptors" because they compete with raptors for nesting sites on cliffs (Poole and Bromley, 1988), and feed on live prey and carrion (Boarman and Heinrich, 1999). Bald eagles are accidental in the Project area, which is outside their established range.

The *tundrius* subspecies of peregrine falcon (*Falco peregrinus tundrius*; the subspecies most likely to occur in the Project area) is listed by COSEWIC (COSEWIC, 2007a) as a species of Special Concern under the Species at Risk Act. Peregrine falcons are globally threatened with extinction due to trade (Convention on the International Trade of Endangered Species (CITES)), and are ranked as G4 status by Natureserve (2007), meaning that there is concern in the long-term for this species due to broad scale declines. Peregrine falcons, like all raptors, are highly respected in Inuit culture (Appendix F-5 of the DEIS). The draft WKRLUP (NPC, 2005) also prohibits the disturbance of nesting falcons during the breeding season. Finally, more data exist for the peregrine falcon than for other raptor species breeding in the North.

2.7.2.2 Field Data

A low-level helicopter survey of potential raptor nests was conducted in July 2002 (Appendix D-7 of the DEIS). A total of 61 raptors of five species were observed: rough-legged hawk (33), peregrine falcon (21), gyrfalcon (3), raven (3) and bald eagle (1). Golden eagles were observed in the 2001 survey (Rescan, 2007a) and incidentally during 2007 terrestrial bird surveys (Appendix D-10 of the DEIS). A total of 136 raptor nest sites were detected along the proposed road alignment. The highest concentration of nests was at the northern end of the proposed road near Bathurst Inlet (Appendix D-8 of the DEIS). During the songbird survey in 2007, peregrine falcons were detected incidentally in proximity to wetlands (Appendix D-10 of the DEIS). On one occasion, an adult falcon was seen hunting shorebirds along a partly frozen lake, confirming that this species uses shorebirds as prey. Rough-legged hawks and gyrfalcon were also observed during the survey.

2.7.2.3 Population Trends

Relatively few long-term data sets are available on raptor populations breeding in the North. Long-term data are necessary for evaluating raptor population trends locally, because numbers fluctuate cyclically in response to prey availability. Raptors that rely on birds (*e.g.* peregrine falcons), fish (*e.g.*, bald eagles) or a wide variety of prey (*e.g.* gyrfalcon), have more stable populations than those that rely on small mammals (*e.g.,* rough-legged hawk), which undergo large, regular cycles of abundance every 3 to 4 years (Krebs, 1964; Gunn, 2003)

Peregrine falcon populations in the North declined dramatically in the 1970s as a result of bio-accumulation of polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT (Hickey and Anderson, 1968). In 1978, COSEWIC classified the tundra peregrine falcon as threatened (Martin, 1979). Populations began recovering in the 1980s after DDT was banned in North America, and have increased considerably in the last two decades (COSEWIC, 2007a). The tundra subspecies of peregrine falcon was re-classified as vulnerable in 1992 (COSEWIC, 2007a) and is currently listed as a species of Special Concern (White *et al.*, 2002; COSEWIC, 2007a). An estimated 1500 to 2000 pairs occur in the Canadian Arctic and the breeding population appears to have reached pre-collapse numbers (COSEWIC, 2007a). However, the population is relatively small, making tundra peregrine falcons vulnerable to human disturbance and natural events.

2.7.2.4 Nesting and Nesting Habitat

Raptors nest occurs from April through August in the Arctic (Poole and Bromley, 1988). In the central Arctic, the tundra peregrine falcon nests predominately on south facing cliffs and outcrops adjacent to or near bodies of water, most frequently on rocky cliffs along rivers or lakes. The availability of suitable cliffs for nesting is likely the most critical feature of its breeding habitat and the same cliffs can be occupied and used for decades by this species (Sinclair *et al.*, 2003). The second most important component of this species' breeding habitat in the Arctic is the proximity to wetlands and riparian areas where waterfowl and shorebirds, the main prey species of peregrine falcons, are common (Sinclair *et al.*, 2003). Data from the Northwest Territories and Nunavut Raptor Data Base indicate that peregrine falcon nests are concentrated along Bathurst Inlet and overlap the proposed port and road (COSEWIC, 2007a). Additionally, raptor nesting sites have been identified in traditional knowledge studies in the RSA, occurring on the margins of Contwoyto Lake and near Bathurst Inlet (Appendix F-5 of the DEIS).

2.7.2.5 Habitat Suitability Ratings

Five avian species have been found nesting on cliffs within the RSA (Appendix D-7 of the DEIS). These species are: gyrfalcon, peregrine falcon, rough-legged hawk, common raven and Canada goose. Habitat suitability modelling for cliff-nesting birds was based on habitat quality ratings assigned to peregrine falcons, since suitable habitat for peregrine falcon will represent suitable habitat for other cliff-nesting raptor species as well.

Due to the difficulty in distinguishing bedrock cliffs along water (preferential habitat for cliff-nesting raptors) from aerial photos and topographic maps, high quality habitat was only assigned to areas of known nest sites, considering locations of all cliff-nesting raptors (Appendix D-8 of

the DEIS). At least one cliff nesting raptor was located on most suitable cliff faces, thus identifying areas of high quality habitat. However, the method used will inevitably underestimate the amount of high-quality habitat as some cliffs that could support cliff-nesting raptors will be missed if a nest was not found.

2.7.3 Ground-Nesting Raptors

2.7.3.1 Introduction

Two ground-nesting raptor species inhabit the Arctic: the short-eared owl and snowy owl. The short-eared owl is found throughout the Eastern and Western hemispheres (Wiggins *et al.*, 2006). The snowy owl is found only in the northern hemisphere (Parmelee, 1992). Short-eared and snowy owls are more diurnal than most owl species, they may be seen at any time of day, but are especially active from late afternoon until dark, or at dawn. The *Canada Wildlife Act* protects these two species; however, they are not protected under the *Migratory Bird Convention Act* (White *et al.*, 2002).

2.7.3.2 Field Data

Short-eared owls were incidentally observed during field surveys conducted in 2001 and 2002 (Appendix D-7 of the DEIS), as well as during point count surveys in 2007 (Appendix D-10 of the DEIS). No active nests or breeding activity were observed during either of these field surveys. No snowy owls were observed during baseline studies, but are expected to occur in the RSA.

2.7.3.3 Population Trends

The short-eared owl is classified as a species of 'species of special concern' in Canada by COSEWIC due to a national trend of declining numbers and due to its sensitivity to human disturbance in its habitat (COSEWIC, 2007b). Canadian populations may have decreased by 43% from 1966 to 1989 (GNWT ENR, 2007), however more research is needed to identify current population trends. In the Northwest Territories and Nunavut, the species is designated as sensitive (Working Group on General Status of NWT Species, 2006)). In the Arctic, populations of short-eared owl are known to fluctuate, concomitant with populations of lemmings which have a cyclic population cycle of high to low abundance every 3 to 4 years (Krebs, 1964).

The snowy owl is designated as not at risk by COSEWIC in 1995 because this species is widespread and there is no evidence of population declines (COSEWIC, 2007b). Kirk *et al.* (1995) estimated that approximately 30,000 pairs of snowy owls occurred in Canada in the early 1900s, current population trends for the RSA are unavailable. However, populations of snowy owl are known to fluctuate with lemming population cycles (Parmelee, 1992).

2.7.3.4 Nesting and Nesting Habitat

Short-eared and snowy owls arrive on the tundra by April-May, snowy owls typically arriving earlier than short-eared owls (Parmelee, 1992; Wiggins *et al.*, 2006). Both species of owl will raise one brood per season. Female short-eared owls make a nest by lining a scrape in the ground with a few leaves, feathers, or bits of grass (Wiggins *et al.*, 2006). Nests are concealed in dense vegetation, under low shrubs, reeds and grasses, and often located near water (Wiggins *et*

al., 2006). Snowy owls construct their nests in a similar fashion to the short-eared owl; however, they do not insulate their nest depressions (Parmelee, 1992). Habitats chosen for nesting are dense, hummocky, dwarf shrub meadows (Parmelee, 1992). Short-eared owls will often choose a breeding site that is adjacent to more open habitats used for hunting; typical prey specie include voles and small mammals (Wiggins *et al.*, 2006). Habitats chosen by the snowy owl for their breeding territory include mildly rugged terrain attributes, such as rocky outcrops that serve as perches and low lying wet meadows used for hunting (Parmelee, 1992). Lemmings are the primary prey for the snowy owl, with other small mammals and bird species taken less frequently (Parmelee, 1992).

2.7.3.5 Habitat Suitability Ratings

Only one species of ground-nesting raptor was found within the RSA: the short-eared owl.

The majority of the habitat during both seasons and within both study areas was assessed as usable habitat (Table 2.7-5). There is a greater proportion of not usable habitat within the RSA than within the LSA during both seasons (Appendix D-8 of the DEIS).

Table 2.7-5
Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Short-eared Owl - Spring/Nesting and Summer/Fledgling				
Suitable	24,497	92.70	1,129,718	75.00
Not Suitable	1,941	7.30	371,967	25.43

2.7.4 Waterfowl

2.7.4.1 Introduction

Waterfowl are defined as ducks, geese, swans, loons, and grebes. Waterfowl breed in freshwater or marine habitats and feed on fish, invertebrates, and/or plant material. Waterfowl health and productivity may be impeded if the integrity of their food sources is compromised. For example, waterfowl are susceptible to bio-accumulation of contaminants (Rönkä *et al.*, 2005; Mallory *et al.*, 2006). The presence of waterfowl is an indicator of the availability of functional wetland habitat, which is important to species such as grizzly bears and caribou as well. The migratory nature of Arctic waterfowl affords special protection to species through the *Migratory Bird Convention Act* (1994) and the *Canada Wildlife Act* (1982) during the breeding season.

The Arctic is important to waterfowl as it provides critical breeding habitat for one-third of the world's waterfowl population, including two-thirds of all geese (Zöckler, 1998). Several species, such as the Tundra swan and the yellow-billed loon only breed in the Arctic (Limpert and Earnst, 1994; North, 1994). The long-tailed duck is a commonly observed species in the Arctic (Appendices D-7 and D-10 of the DEIS) and may be sensitive to environmental impacts such as

oil spills (Mallory and Fontaine, 2004). Furthermore, many species of waterfowl congregate in the Arctic during staging, breeding and the flightless moulting period, which increases the vulnerability of the local population to predation, human disturbance, and inclement weather.

Additionally, waterfowl are an important food species for the Inuit (Appendix F-5 of the DEIS). Waterfowl hunting areas used by the Inuit in the RSA occur on the margins of Contwoyto Lake (Appendix F-5 of the DEIS), where significant numbers of Canada geese have been documented during baseline studies (Appendix D-7 of the DEIS). As well, there has been recorded hunting at Nose Lakel (Appendix F-5 of the DEIS).

2.7.4.2 Field Data

Aerial surveys were conducted for waterfowl in 2001 as part of the 2001 and 2002 wildlife baseline studies. In 2007, variable range point counts for terrestrial land birds and aerial surveys for waterfowl were conducted as part of the bird baseline. Canada geese were the most abundant and commonly observed waterfowl species along the proposed road route. In 2001, over 600 Canada geese were recorded on an aerial survey in September, with numerous other incidental sightings throughout the summer months. As well, one Canada goose was observed nesting on a cliff (Appendix D-7 of the DEIS). Other observed species in 2001 and 2007 included three species of loons, greater scaup, green-winged teal, greater white-fronted goose, red-breasted merganser and tundra swans. There were many other observations where the species could not be identified and accounts were narrowed down to families (*i.e.*, unspecified duck, goose).

2.7.4.3 Population Trends

Relatively few data are available on waterfowl populations breeding in the Arctic because individuals are distributed across a vast area that is difficult and expensive to survey. Data compiled to date indicate that population trends for Arctic-breeding waterfowl vary by species. For example, lesser snow goose (*Chen caerulescens caerulescens*) populations have been growing exponentially since the 1970s and now number in the millions (Mowbray *et al.*, 2000; CWS Waterfowl Committee, 2006). Common and king eider populations nesting in the Arctic, on the other hand, have declined by more than 50% in the last few decades (Goudie *et al.*, 2000; Suydam, 2000), and in the western and central Canadian Arctic are estimated at 37,000 and 200,000 individuals, respectively (Dickson *et al.*, 1997; CWS Waterfowl Committee, 2006). The most abundant waterfowl species observed in the RSA is the Canada Goose, which has been increasing on Victoria and Banks Islands over the past few decades (CWS Waterfowl Committee, 2006). Populations of Canada Geese have increased an average of 7% per year since 1998 on the Northwest Territories mainland (USF WS, 2006); however, wintering ground surveys indicate a decline in populations. Another common species, the long-tailed duck, has been fluctuating in number the Arctic. The Nunavut ranking system (CESCC, 2005) lists the long-tailed duck as secure, while the NWT ranking system (Working Group on General Status of NWT Species, 2006) lists it as sensitive.

2.7.4.4 Breeding

Breeding Habitat

Waterfowl arrive in the Arctic from mid to late May. Egg-laying and incubation generally occur from June to late July. Early in the breeding season, before lakes have thawed, females of some

waterfowl species rely on endogenous fat reserves to lay and incubate eggs. Hatching occurs from late June to late August and young and adults generally leave for migration from August through September (Bellrose, 1976). During baseline studies, nests were observed in the Project area for Canada goose and long-tailed ducks in July 2001 and June 2007, respectively

Breeding habitat for Arctic waterfowl typically consists of wetlands and lakes associated with sedge communities. Waterfowl in the Project area generally nest within 50 m of water (*e.g.*, long-tailed duck (Robertson and Savard, 2002), tundra swan (Limpert and Earnst, 1994), Canada goose (Mowbray *et al.*, 2002), greater scaup (Kessel *et al.*, 2002), loons (McIntyre and Barr, 1997; Barr *et al.*, 2000; Russell, 2002). Nests, including those of the long-tailed duck, are often located on small inland islands since these offer protection from most terrestrial predators. The depth of water preferred by breeding waterfowl varies by species. For example, common and yellow-billed loons (North, 1994; McIntyre and Barr, 1997) use deeper lakes for brood-rearing while long-tailed ducks (Robertson and Savard, 2002) and northern pintails (Austin and Miller, 1995) prefer shallow ponds for this purpose. Many species of waterfowl exhibit fidelity to specific nest sites and territories (philopatry) from year-to-year.

Post-breeding Habitat

Waterfowl exhibit broad fidelity to regional nesting and moulting areas and several major congregation sites exist along the proposed shipping route. The Queen Maud Gulf, which is located along the shipping route, is one of the most important waterfowl habitats in the Arctic. It provides critical breeding habitat for *ca*. 15% of Canadian lesser snow geese and >90% of the world population of Ross's geese. Significant breeding populations of greater white-fronted geese, cackling geese, brant, tundra swans, king eiders and northern pintails also occur in this area (Latour *et al.*, 2006).

2.7.4.5 Diet

The diets of waterfowl are varied but can be generalized as follows. Swans, geese, and dabbling ducks (*e.g.*, northern pintail, green-winged teal) feed primarily on aquatic plants, including seeds, stems, and tubers of submergent and emergent vegetation. Geese may also graze on terrestrial vegetation, the Inuit have reported that Canada geese will feed on berries (Appendix F-5 of the DEIS). Breeding females of these species take more animal prey, including aquatic insects and invertebrates, to prepare for egg laying and incubation; their young also rely heavily on animal prey. Loons, grebes, and diving ducks (*e.g.*, long-tailed ducks, mergansers, eiders) that winter on salt water and generally breed in freshwater habitats, mainly take animal prey such as small fish, aquatic insects and invertebrates.

Waterfowl productivity varies throughout the Arctic. Coastal wetlands, especially those that span from northern Alaska to the eastern Northwest Territories, host the highest concentrations of breeding waterfowl in the Arctic. Fewer waterfowl breed on the inland Arctic wetlands associated with the Precambrian Shield because these areas tend to be oligotrophic (nutrient poor) and of relatively low productivity for vegetation and invertebrates. Low densities of waterfowl were observed along the proposed road alignment during field surveys, despite the abundance of potential breeding lakes and ponds (Appendices D-7 and D-10 of the DEIS). Waterfowl surveys conducted in similar habitat near the High Lake and Jericho mine sites also found that the productivity and density of waterfowl was low (Hubert and Associates Ltd., 2002; Zinifex, 2007).

2.7.4.6 Habitat Suitability Ratings

The majority of the habitat for breeding waterfowl was assessed as not suitable in both the LSA and the RSA (Table 2.7-6). Although waterfowl will nest on the Tundra, they will move away from possible nesting locations to raise their broods on waterbodies as soon as their young hatch. There is a higher proportion of water found in the RSA compared to the LSA, therefore, suitable habitat is proportionally greater within the RSA.

Table 2.7-6
Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA for Waterfowl

Habitat Rating	Area in LSA (ha)	Percent of LSA	Area in RSA (ha)	Percent of RSA
Waterfowl - Spring/Nesting and Summer/Brood Rearing				
Suitable	4,711	17.753	388,619	25.4
Not Suitable	21,727	82.247	1,113,066	34.6

3. METHODOLOGY

3. Methodology

3.1 Valued Ecosystem Component Approach

When assessing the potential adverse effects of a proposed Project on wildlife, there is a need and utility in focusing on VECs. VECs have the greatest relevance to the final environmental assessment decision. The protection of certain VECs will preserve other species with similar habitat requirements that fall within the range of these VECs. Furthermore, wildlife VECs are those species or guilds that are of greatest concern to regional wildlife officials, Inuit, and the public and include species of conservation concern, keystone species, or species of economic or cultural significance.

Species or groups were considered as potential wildlife VECs for the Project by considering one or more of the following criteria:

- species at risk or of conservation concern (*i.e.*, species listed by COSEWIC or under SARA, or by CESCC;
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies: Nunavut Department of the Environment and Canadian Wildlife Service (CWS);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and/or umbrella species; and
- species identified as being culturally, socially and/or economically important to the community, including Inuit.

3.1.1 Species at Risk or of Regulatory Importance

The following sources were consulted to identify species at risk or of conservation concern, as well as species or focal groups of particular interest to regulatory agencies:

- COSEWIC;
- SARA;
- CESCC;
- *Migratory Birds Convention Act*, 1994;
- *Nunavut Wildlife Act*, 1995;
- CWS.

3.1.2 Keystone, Indicator or Umbrella Species

Biological characteristics that were considered during the VEC selection process included the role that a species plays in the health of its local ecosystem as a keystone, indicator, or umbrella species.

Keystone species are species with a disproportionately high influence on the structure of an ecosystem, and play a major role in maintaining the integrity and balance of the ecosystem (Helfield and Naiman, 2006). For example, caribou are considered biologically important as a keystone species, as they are highly capable of modifying the local landscape and ecology. Many species of carnivores, as well as the local Inuit, depend on caribou as their main food source (Walton *et al.*, 2001; COSEWIC, 2003).

The composition and/or fitness of an ecosystem can also be assessed by analyzing the presence, fitness or changes occurring in an indicator species population (Niemi and McDonald, 2004). For example, migratory birds which occupy a certain habitat during the breeding season have been commonly used as indicator species to assess overall species diversity (Fleishman *et al.*, 2005). In addition, species such as ducks and geese, which occupy wetland habitats during the breeding season, may not only be indicators of biodiversity, but also of wetland health, as they depend on productive wetland habitat for multiple life-history stages (*e.g.*, nesting, moulting, feeding, raising young). Wolverines and grizzly bear are good examples of indicator species, as their ranges are typically large and their habitat requirements change throughout the year (COSEWIC, 2002, 2003; Johnson *et al.*, 2005). Wolverine and grizzly bear population fluctuations could be a signal of habitat quality or other factors operating at multiple scales. Changes in population levels of indicator species can be used as indicators of larger impacts on ecosystem integrity.

Another consideration in the selection of VECs was the importance of umbrella species. Umbrella species are species whose conservation and management is thought to conserve and management a wide variety of other species. Grizzly bears are often considered an umbrella species because efforts expended on their management often protect many other smaller-ranging species (Roberge and Angelstam, 2004).

3.1.3 Species of Cultural, Social or Economic Importance

The wildlife of the Arctic region is of tremendous socio-economic importance. The Inuit of Nunavut place special emphasis on wildlife, not only as sources of food and clothing, but for cultural identity and economic livelihood. Wildlife species, such as caribou and waterfowl, are staples for inland and coastal Inuit, providing sustenance in the form of food and clothing and economic opportunities. Foxes and wolves are used extensively in clothing and are also sold for their pelts. Small mammals, including the Arctic hare and ground squirrel, are important sources of food and clothing when larger species such as caribou are unavailable (*i.e.*, during the winter when the caribou migrate south) (Appendix F-5 of the DEIS). Since the Inuit are ecologically connected to the land, their traditional knowledge, which has been collected for generations, is of the foremost importance. As well, Inuit guides and outfitters in Nunavut offering sport-hunting opportunities depend on healthy wildlife populations to provide significant economic benefits to local residents in and around the Project area.

3.2 Valued Ecosystem Component Selection

Each potential VEC was screened for inclusion in the environmental assessment through an evaluation of the results of baseline studies, conservation status, biological importance, regulatory, cultural, social or economic significance and the potential for each to be affected by

the Project. The VECs that were chosen for the Project and the rationale for their inclusion are presented in Table 3.2-1.

Foxes, mustelids and small mammals were not designated as VECs for the purposes of this effects assessment because their populations are not at risk (Sections 2.5.4, 2.5.5 and 2.6). Foxes and mustelids are smaller carnivores, and the designation of larger carnivores such as the wolf and wolverine as VECs in this assessment will act as umbrellas to cover the effects that could be experienced by smaller carnivores. Finally, certain species of birds were excluded if their habitat and potential Project-related effects are covered by other VECs.

3.2.1 Identification of Potential Effects on Wildlife VECs

The effects assessment for wildlife was designed to address the wildlife issues raised in Section 4.7.3 of the Final EIS Guidelines (NIRB, 2004), as follows:

- habitat loss;
- disturbance to feeding, nesting, denning or breeding;
- disruption to movement;
- features acting as an attractant;
- mortality (direct and indirect); and
- reduction in wildlife productivity.

Each issue is addressed in a separate section below. The assessment of physical barriers and disruption, blockage, impediment or disturbance of movements is combined in one section, Disruption to Movement.

3.2.1.1 Habitat Loss

Some wildlife habitat will be directly modified (*e.g.*, vegetation removal and/or soil disturbance) during Project development and therefore is a direct habitat loss to species using those areas. In addition, wildlife habitat may be reduced in value and sometimes effectively lost through indirect means such as habitat avoidance as a result of human disturbances and other activities (*e.g.*, traffic) associated with construction and operation. For some species, the effects of indirect habitat loss may be greater than those attributed to direct habitat loss (Jalkotzy *et al.*, 1997). The effects of direct and indirect habitat loss on wildlife will vary according to the Project phase and component as well as the availability, quality and use of habitats affected. The causes of indirect habitat loss include noise, human presence and activity, and other disturbances. These issues are primarily addressed in Section 3.2.1.3 later in this chapter.

Table 3.2-1
Wildlife Valued Ecosystem Components Included in the Environmental Assessment

VEC	Scientific Name	Reference	Rationale for Inclusion
Grizzly Bear	*Ursus arctos horribilis*	COSEWIC Public scoping Inuit Traditional Knowledge Draft WKRLUP Government of Nunavut, Department of Environment Scientific Literature Project Scientists	• Species of special concern under COSEWIC • Listed as sensitive in Nunavut • Culturally significant to the Inuit • Potential for grizzly bear-human interactions • Sensitive indicator species due to low reproductive rate and low population densities
Caribou Bathurst Herd Ahiak Herd Dolphin and Union Herd Peary Herd	*Rangifer tarandus*	COSEWIC Public Scoping Inuit Traditional Knowledge Draft WKRLUP Government of Nunavut, Department of Environment Scientific Literature Project Scientists	• Peary caribou listed as endangered by COSEWIC • Dolphin and Union herd listed as special concern by COSEWIC • Dolphin and Union herd listed as sensitive in Nunavut • Bathurst herd has undergone recent population declines and is vulnerable to disturbance • Keystone species • Caribou and caribou hunting are central to Inuit culture, identity, recreation and kinship • Peary and Dolphin and Union caribou at risk of die-offs if ice bridge migration routes disrupted by shipping activity
Muskox	*Ovibos moshatus*	Inuit Traditional Knowledge Draft WKRLUP Scientific Literature Project Scientists	• Culturally significant to the Inuit • Important role in Arctic food webs – prey source for carnivores and affect vegetation dynamics • Sensitive to disturbance, especially during calving
Wolverine	*Gulo gulo*	COSEWIC Public Scoping Inuit Traditional Knowledge Draft WKRLUP Scientific Literature Project Scientists	• Species of special concern under COSEWIC • Culturally significant to the Inuit • Valuable economic fur-bearing species • Sensitive indicator species due to low reproductive rate and low population densities
Wolf	*Canis lupus*	Inuit Traditional Knowledge Draft WKRLUP Scientific Literature Project Scientists	• Culturally significant to the Inuit • Environmental health indicator – main predator of caribou and muskox, and den in eskers. • Wolf kills sustain wolverine population • Valuable economic fur-bearing species
Migratory Birds (excluding raptors and waterfowl)		SARA COSEWIC Public Scoping (Eskimo curlew) Inuit Traditional Knowledge Draft WKRLUP Government of Nunavut, Department of Environment Federal Regulators Scientific Literature Project Scientists	• Eskimo curlew listed as Schedule 1 under SARA • Eskimo curlew listed as endangered by COSEWIC • Several species observed in the RSA are listed as sensitive in Nunavut (see Table 2.3-6, 2.3-9, 2.7-1) • Protected under the *Migratory Birds Convention Act* (1994) • Protected under Federal *Wildlife Act* , Section 34 (1982) • Culturally important to the Inuit • Biodiversity indicators of environmental health • Relatively high numbers enable statistical detection of changes in populations or communities in relation to development
Cliff-Nesting Raptors (tundra peregrine falcon selected as representative)	*Falco peregrinus tundrius*	SARA COSEWIC Public Scoping Inuit Traditional Knowledge Draft WKRLUP Federal Regulators Scientific Literature Project Scientists	• Listed as Schedule 3 under SARA • Listed as special concern by COSEWIC • Protected under Federal *Wildlife Act* , Section 34 (1982) • G4 Status (Natureserve) • Globally threatened with extinction via trade (CITES) • Culturally important to Inuit • Indicators of environmental quality – occupy an upper trophic level and are sensitive to disturbance (especially during breeding) • Proxy for cliff-nesting raptors such as eagles, rough-legged hawks and gyrfalcons
Ground-Nesting Raptors (short-eared owl selected as representative)	*Asio flammeus*	SARA COSEWIC Public Scoping Inuit Traditional Knowledge Draft WKRLUP Government of Nunavut, Department of Environment Federal Regulators Scientific Literature Project Scientists	• Listed as Schedule 3 under SARA • Listed as special concern by COSEWIC • Listed as sensitive in Nunavut • Protected under Federal *Wildlife Act* , Section 34 (1982) • Culturally important to Inuit • Proxy for ground-nesting raptors such as snowy owls
Waterfowl (long-tailed duck selected as representative)	*Clangula hyemalis*	Public Scoping Inuit Traditional Knowledge Draft WKRLUP Government of Nunavut, Department of Environment Federal Regulators Scientific Literature Project Scientists	• Listed as secure in Nunavut • Protected under *Migratory Bird Convention Act* (1994) • Protected under Federal *Wildlife Act* , Section 34 (1982) • Culturally important to Inuit • Important source of food for Inuit

3.2.1.2 Disturbance to Feeding, Nesting, Denning or Breeding

The responses of wildlife to human presence and activities vary by species. Some species become acclimated, some react to each disturbance but remain in the area and others avoid areas with frequent disturbances. When animals react to disturbances, they may avoid important habitats and/or take time away from key behaviours such as feeding, breeding or watching for predators, which can ultimately lead to reduced reproductive productivity and/or mortality. The following sections describe the potential sources of disturbance for selected wildlife VECs and assess the possible effects of these disturbances on habitat use and/or key behaviours.

Construction activities, particularly vegetation removal, site levelling and blasting, may disturb wildlife. The potential for, as well as the significance of effects due to construction depend on the timing of construction relative to sensitive periods (*e.g.*, breeding) for each VEC. For example, vegetation removal during the migratory bird breeding period could result in mortality of both adults and young in the nest and reduce reproductive productivity, whereas habitat removal would have a much lesser impact during the non-breeding season. Disturbances during construction are expected to be short-term in duration and localized in extent.

Of greatest concern is the potential for continuous disturbance of wildlife VECs beginning at construction and continuing throughout operations and maintenance, potentially extending into decommissioning and closure. The potential sources of disturbance during these phases include human presence, noise and traffic along the road and industrial noise associated with development and operations, including drilling and blasting. The potential effects of these disturbances are assessed within the relevant spatial scale for each VEC.

3.2.1.3 Disruption to Movement

Most wildlife species exhibit two types of movement: short range and long range. Short-range movements are day-to-day activities within a particular season and the extent of these daily movements defines the seasonal home ranges of these species. Some species have a single home range all year, while others have separate summer and winter home ranges. Long-range wildlife movements are typically passages between winter and summer ranges, or dispersal of young individuals to new territories. Moving between summer and winter ranges is critical when one habitat cannot support a species in both seasons. Similarly, dispersal (movement away from birthplace) is critical for the maintenance of many populations and dispersal distances can be many times home range distances. Typically, the greatest risks to wildlife populations occur as a result of disruption, blockage and impediments to seasonal and dispersal movements.

A concern on this Project is the effect from the proposed all-weather road between Bathurst Inlet and Contwoyto Lake. Potential effects of roads on animal populations are: (1) creation of a barrier that wildlife will not or cannot cross, (2) avoidance of habitats adjacent to roads as a result of traffic, noise and human presence, and (3) mortality as a result of vehicle-wildlife interactions (Forman and Deblinger, 2000), or due to increased human access for hunting and poaching (Jalkotzy *et al.*, 1997; Jackson, 2000). Each of these effects are inter-related, particularly 1 and 2, as avoidance can create the "barrier." The potential for disruption of movements are discussed for each VEC.

3.2.1.4 Features Acting as an Attractant

Features or materials that are of interest or provide resources to wildlife are considered to be wildlife attractants. Attractants may include regenerating vegetation on road verges that creates desirable forage, or travel corridors such as roads that facilitate movement through otherwise difficult terrain or vegetation. Attractants can also take the form of refuge, shelter, nesting or roosting habitat provided by physical structures. Smells and food sources associated with food, incinerators, garbage or sewage associated with anthropogenic activity around the Project footprint and in camps can also act as wildlife attractants.

Project development will include both features (*e.g.*, the all-weather road) and materials (*e.g.*, food associated wastes) that have the potential to attract wildlife. Project aspects that may act as attractants are discussed for each VEC. Inevitably, wildlife attractants increase the risk of direct or indirect mortality for wildlife. Where mortality is identified as a risk in association with wildlife attraction to the road, the significance of this effect is discussed in the Mortality sections. Often, the issue of attraction for wildlife can indirectly lead to changes in distribution and habitat selection, leading to a host of problems, such as the creation of human habituated or aggressive animals, alterations in distribution and habitat selection, changes in predator-prey dynamics and shifts in the spatial distributions of animals. Since the issue of attraction can lead to such a wide array of responses and problems, the issue is discussed separately from direct and indirect mortality where relevant; however, features acting as attractants most commonly become problems if they lead to direct and indirect mortality.

3.2.1.5 Mortality (Direct and Indirect)

This section assesses the potential for, and effects of, direct mortality for wildlife VECs as a result of Project development. Direct mortality could occur during construction of the port site and associated facilities, the all-weather road or as a consequence of issues such as the road acting as an attractant as discussed in the section above. All of the wildlife VECs are potentially at risk of collisions with vehicles, which may be exacerbated if attractants increase the prevalence of animals along the road (*e.g.*, due to increased presence of carrion that carnivores forage on, waste attractants, or if the road is preferentially used for travel). Indirect mortality may result from increased poaching and hunting pressure, which may increase if the road provides vehicular access that makes it easier to remove large game that has been shot.

3.2.1.6 Reduction in Wildlife Productivity

Wildlife productivity, also known as reproductive success, is the number of young that each female reaching reproductive age produces. Often, effects such as habitat loss and disturbance do not cause mortality of adults, but may reduce their physical condition and their reproductive success (e.g., decrease birth rate). This section assesses the potential for the effects of Project development, as described in sections above, that result in changes to reproductive success for wildlife VECs.

There are three key components to reproductive success; female survival, birth rate (the ratio of total live births to total population) and survival of young. The number of years a female survives determines how many young she will reproduce, and small changes in female lifespan can result in rapid population changes. Birth rate and juvenile survival depend on good female

condition, and environmental and biological effects affecting juveniles. For instance, females in good condition will often have healthier offspring with an increased chance of surviving to adulthood, while females in poor condition will produce fewer or lower-quality young. When adult females are displaced into lower-quality habitat, the young may be subject to lower feeding rates and thus lower body mass. Poor quality habitats with little refuge from predators may also increase juvenile mortality, as juveniles are often preferred prey.

3.2.2 The VEC-Based Approach

As opposed to assessing every issue for each VEC, the assessment focuses on those effects considered to be of greatest concern for the VEC in question. The duration and frequency of each potential effect were considered when determining which effects were of greatest concern. For example, an effect that occurs continuously throughout the life of the Project is of greater concern than a short-term effect that is confined to one discrete period in time. Each VEC-based section is subdivided according to the issues deemed to be of concern for that VEC. When applicable, potential issues are further discussed by Project component, such as port and road, or by development phase, such as construction and operations.

3.2.3 Assessing the Significance of Potential Effects

Within each VEC-based section, the likely impacts of the Project on wildlife VECs are predicted and discussed, and the significance of the effects of these impacts assessed. The definitions used to assess the significance of the potential wildlife effects are provided in Table 3.2-2. The definitions consider both the magnitude and geographic extent of potential Project effects on wildlife. Refer to Appendix A-5 of the DEIS for further details.

Table 3.2-2
Assessing the Significance of Residual Effects on Wildlife

Significance	Descriptor of Significance
High	Predicted to differ from wildlife baseline conditions so that there will be a detectable change beyond the range of natural variation (*i.e.*, change of state from baseline conditions). Effects at the population level.
Moderate	Differs from the average value for wildlife baseline conditions and approaches the limits of natural variation; effects could extend to the population level. Effect potentially extends beyond the RSA.
Low	Differs from the average value for wildlife baseline conditions, but within the range of natural variation. Effect is limited to within the RSA.
Negligible	No detectable change from wildlife baseline conditions. Effect is limited to the immediate Project footprint.

Biological systems are hierarchical and effects can occur at the individual (*e.g.*, individual behaviour, physiological condition and survival) and population level (*e.g.*, population size, distribution, mortality rate and reproductive fitness). Effects at the population level are of greater concern than those at the individual level. The exact geographic population boundaries for the VECs considered in this assessment may be unknown and/or dynamic, and the discussions in the sections that follow are therefore qualitative. Nevertheless, in addition to

assessing the magnitude and geographic extent of effects, the potential influences of the Project on wildlife are discussed and assessed at the individual and population level.

3.3 Boundaries

3.3.1 Spatial Boundaries

The Regional Study Area (RSA) for wildlife is defined as a 30 km wide corridor centred around the all-weather road, port facility and Contwoyto Camp (total area = 1,476,649 ha). The Local Study Area (LSA) was defined as a 500 m buffer zone around the road, port and Contwoyto Camp (total area = 26,438 ha; Environmental Setting, Section 2.2.2).

Wildlife species are described over a wide area in the Environmental Setting (Chapter 2) and Effects Assessment (Chapter 4) to put populations in the RSA into geographical or regional perspective. Spatial boundaries were established on a VEC-specific basis in the Effects Assessment as the LSA, RSA, or Greater Regional Area depending on species movement patterns, home range sizes, or migration patterns. For example, the muskox has a smaller home range than the barren-ground caribou which migrates over large areas among seasons. Species, such as geese, are primarily migratory and may travel thousand of kilometres from the Project area. Other animals, such as the wolverine, wolf and grizzly bear have large home ranges that may extend well beyond the RSA. Accordingly, unique spatial scales were considered for each VEC in this assessment.

When discussing the effects of habitat loss on each VEC, the spatial boundary was extended to the RSA. Evaluation of habitat lost as a result of the Project was based on the Habitat Suitability Ratings Baseline Report (Appendix D-8 of the DEIS).

3.3.2 Temporal Boundaries

The temporal boundaries of this assessment stretch from the construction phase (2.5 years), through a 19 year operations phase, decommissioning (1 year) and into the far future (greater than 100 years). Some VECs display seasonal migration patterns (*e.g.*, caribou, waterfowl), while others are resident in the Project area. Hence, the impact of the assessed effects will vary temporally for each species and these are discussed when applicable.

3.4 Approach to Effects Assessment

3.4.1 Overview

Unless otherwise stated, sub-components composing the road, port, Contwoyto Camp and shipping route are assessed collectively as part of the structures they compose. In other words, small sub-components, such as fuel storage sheds, may not be assessed on their own if deemed too small to significantly affect a VEC, but are instead considered as part of the collective sub-components that make up each of the four main Project components. However, if a smaller sub-component is predicted to have an independent effect on wildlife and could require special consideration for specific mitigation or management measure, it is assessed separately and this is stated explicitly in the text. Further, some Project components are irrelevant for certain VECs

and the effects of those components in such cases are not addressed. For example, effects due to the shipping route are not assessed for grizzly bears, as grizzly bears are not distributed along the shipping route. Potential effects are assessed for the construction phase and the operation phase of the Project development, as the predicted effects during those periods are expected to be different for many VECs. In addition, the decommissioning phase of the Project that is scheduled to occur after 19 years of operations is assessed if effects are expected to be relevant. For each assessment the magnitude, spatial extent, frequency, reversibility, ecological context (resiliency), influence on resource capacity, probability of occurrence, significance and confidence limits are stated. In the following sections, the rationale for each assessment is provided and the significance of the residual effects are ranked as negligible, low, moderate or high (Table 3.2-2). A detailed description of the effects assessment methodology is provided in Appendix A-5.

A ***Negligible*** effect is one that is expected to result in a slight decline in the condition of a VEC in the study area for a very short temporal period (*e.g.*, construction phase), but the VEC should return to its baseline conditions. A ***Low*** effect may result in a slight decline in condition of the VEC in the study area during the life of the Project. Research, monitoring and recovery initiatives would not normally be required for ***Low*** effects. ***Moderate*** effects could result in a decline in condition of the VEC to lower than baseline, but stable levels in the Project area after Project closure and into the foreseeable future. Regional management actions, such as monitoring, may be required. ***High*** effects could threaten the sustainability of the VEC and should be considered a management concern. Monitoring should be considered. As a number of effects may be simultaneously experienced by each VEC that interact with a variety of Project components, a Conclusion section summarizes the expected overall significance of all residual effects combined on the VEC.

3.4.2 Limitations and Level of Certainty

The effects assessment is based on data available for the VEC of concern. For certain species or populations such as the Ahiak caribou, available data is scant and the level of uncertainty will therefore be greater. In order to more accurately reflect the limitations of existing data for the Project area and the VECs in question, the level of certainty is indicated in order to reflect limitations of existing data for making predictions. Whenever data are limited for making an assessment, the quality of data gathered and any limitations related to the conclusions that can be drawn from these data are acknowledged.

3.4.3 Habitat Suitability Rating

The Habitat Suitability Rating Baseline Report outlines the approach taken to assess baseline habitat conditions for each VEC (Appendix D-8 of the DEIS). Habitat suitability ratings identify areas that contain significant wildlife habitat and provide a quantitative way of evaluating the direct and indirect effects of development on wildlife habitat, which allows for the proportional loss or alteration of habitats to be placed into a local and regional context. Habitat suitability ratings will be used to determine changes in habitat units over time as the Project is developed. Detailed methodologies for conducting the wildlife habitat suitability ratings are outlined in the baseline report (Appendix D-8 of the DEIS).

4. EFFECTS ASSESSMENT

4. Wildlife Effects Assessment

This section evaluates the potential effects of the Project on wildlife. A preliminary scoping analysis, Inuit Traditional Knowledge and a review of scientific literature were used to identify VECs which had high cultural, conservation, or ecosystem importance. In some cases a species was chosen as a VEC to represent a group of similar species (*e.g.*, peregrine falcon chosen to represent cliff-nesting raptors).

The VECs evaluated in this assessment are:

- caribou (*Rangifer tarandus*);
- muskox (*Ovibos moshatus*);
- grizzly bear (*Ursus arctos horribilis*);
- wolverine (*Gulo gulo*);
- grey wolf (*Canis lupus*);
- migratory songbirds and shorebirds;
- tundra peregrine falcon (*Falco peregrinus tundrius*) for cliff-nesting raptors;
- short-eared owl (*Asio flammeus*) for ground-nesting raptors; and
- long-tailed duck (*Clangula hyemalis*) for waterfowl.

The potential effects of the Project are then evaluated against the habitat and biological processes for each VEC, including:

- terrestrial habitat loss;
- disturbance to feeding, breeding and denning or nesting;
- disruption to movement;
- features acting as attractants;
- increases in direct and indirect mortality; and
- reduction in reproductive productivity (recruitment rate) due to any preceding effects.

Each Project component is evaluated for each VEC for the construction, operations, decommissioning, and post-closure periods as described in Section 3 (Methodology) and are summarized at the end of this section in Table 4-1.

4.1 Caribou

Caribou have been identified as a VEC due to their importance to Inuit people, scientific studies, and their federal, territorial, and regional conservation status (Table 3.2-1). Inuit Traditional Knowledge, academic and monitoring studies have shown that caribou are susceptible to a variety of development-related disturbances that may result in shifts in distribution and

population declines (Cameron *et al.*, 1992; Nellemann and Cameron, 1998b; Thorpe *et al.*, 2001; Dyer *et al.*, 2002; Johnson *et al.*, 2005).

Four caribou herds have been identified that may enter the Project area: Bathurst, Ahiak, Dolphin and Union and Peary caribou herds (Appendices D-7 and D-9 of the DEIS; Environmental Setting, Section 2.4). Two of these herds, the Bathurst and Ahiak, are found in the RSA during certain periods of the year (Figure 4.1-1). The Dolphin and Union herd and Peary caribou use the shipping route as migration corridors on sea ice.

This section assesses the potential effects of the Project on Bathurst and Ahiak caribou herds. Effects included in the assessment are:

- direct habitat loss;
- disturbance to feeding and/or breeding;
- disruption to movement;
- features that act as an attractant;
- increases in mortality (direct and indirect); and
- reduction in productivity due to the preceding effects.

This section also assesses the potential effects of shipping on caribou that use sea-ice for seasonal migrations, including:

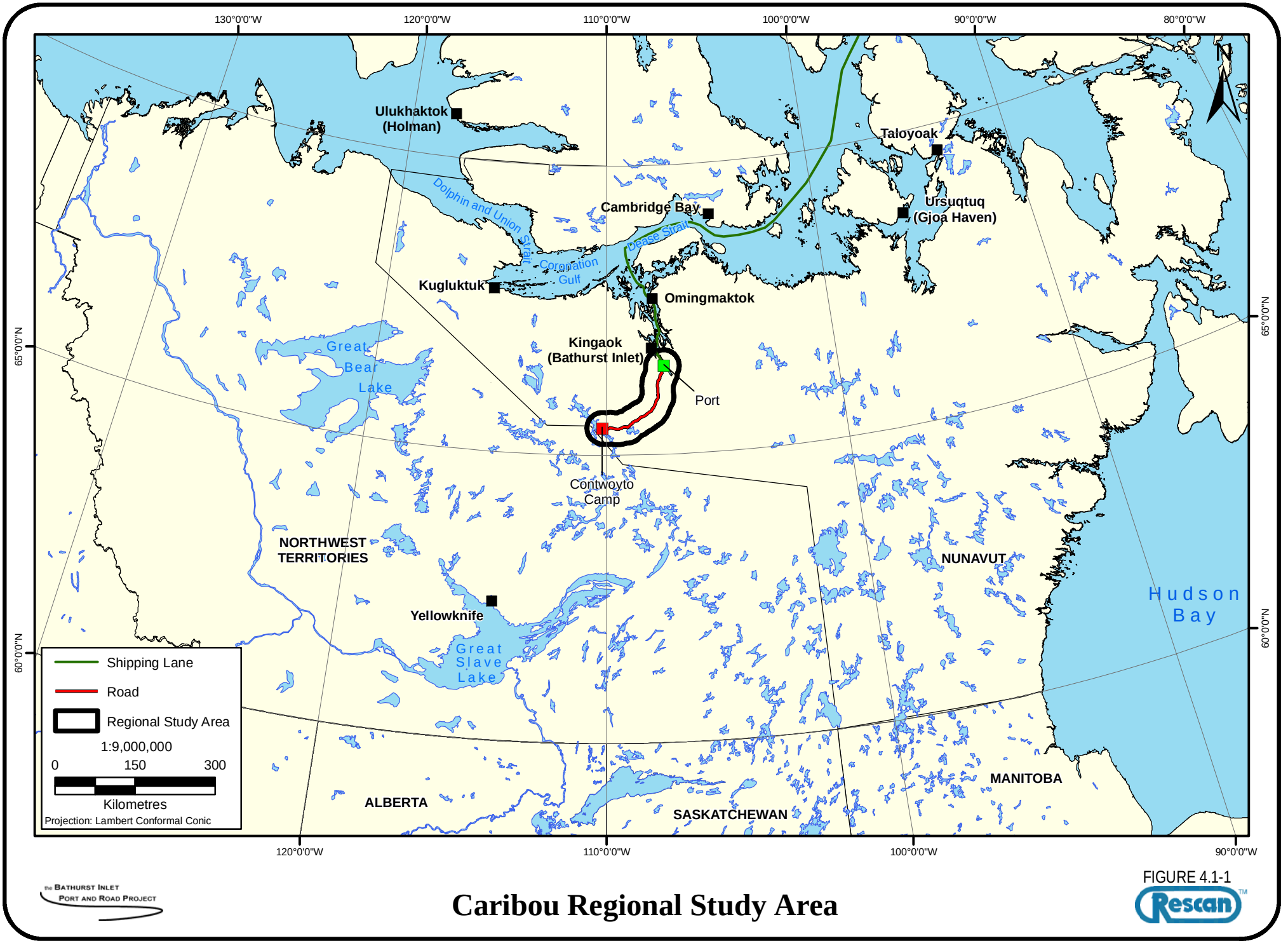
- disruption to movements of Dolphin and Union caribou across the shipping route in the Dolphin and Union Strait and Queen Maud Gulf; and
- disruption to movements of Peary caribou across the shipping route through Peel Sound and Franklin Strait.

Detailed information on the distribution, seasonal habitats and observations of caribou in the RSA are available in the Environmental Setting (Section 2). The effects of the Project on caribou are discussed within the context of the spatial boundaries determined for each herd and have the potential to affect the long-term stability of these caribou herds.

4.1.1 Spatial Boundary

The spatial boundary of the effects assessment for Bathurst and Ahiak caribou herds covers the RSA which extends for 30 km around the road, port, and camp (Figure 4.1-1). For some effects, such as disturbance and behavioural changes, the effects of the Project may be limited to the RSA. Due to the wide seasonal movements of caribou, other effects such as disruption of movement and reduction in productivity, are evaluated for the long-term stability of these herds as a whole.

The spatial boundary for the Dolphin and Union and Peary caribou herds includes the areas where the shipping route intersects the seasonal migration routes of these herds in Dolphin and Union Strait, Queen Maud Gulf, Peel Sound and Franklin Strait. The potential effects of the Project are rated for the long-term stability of these caribou herds.



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Caribou Regional Study Area

FIGURE 4.1-1

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4.1.1.1 Protected Areas near the Project Area

There are several designated environmental areas within the West Kitikmeot planning region, including a National Park, Territorial Parks, and Conservation Zones. None of these areas overlap with the caribou RSA, but are outlined here to complete the overview of the spatial boundaries of the Project.

The Port Site is approximately 50 km SE of Wilberforce Falls, a designated conservation zone, and approximately 75 km to the west, across the inlet, from the Hiukitak River conservation zone. The area is traditional harvesting area, and the river supports healthy populations of fish and wildlife.

The shipping route passes within 50 km of several conservation areas:

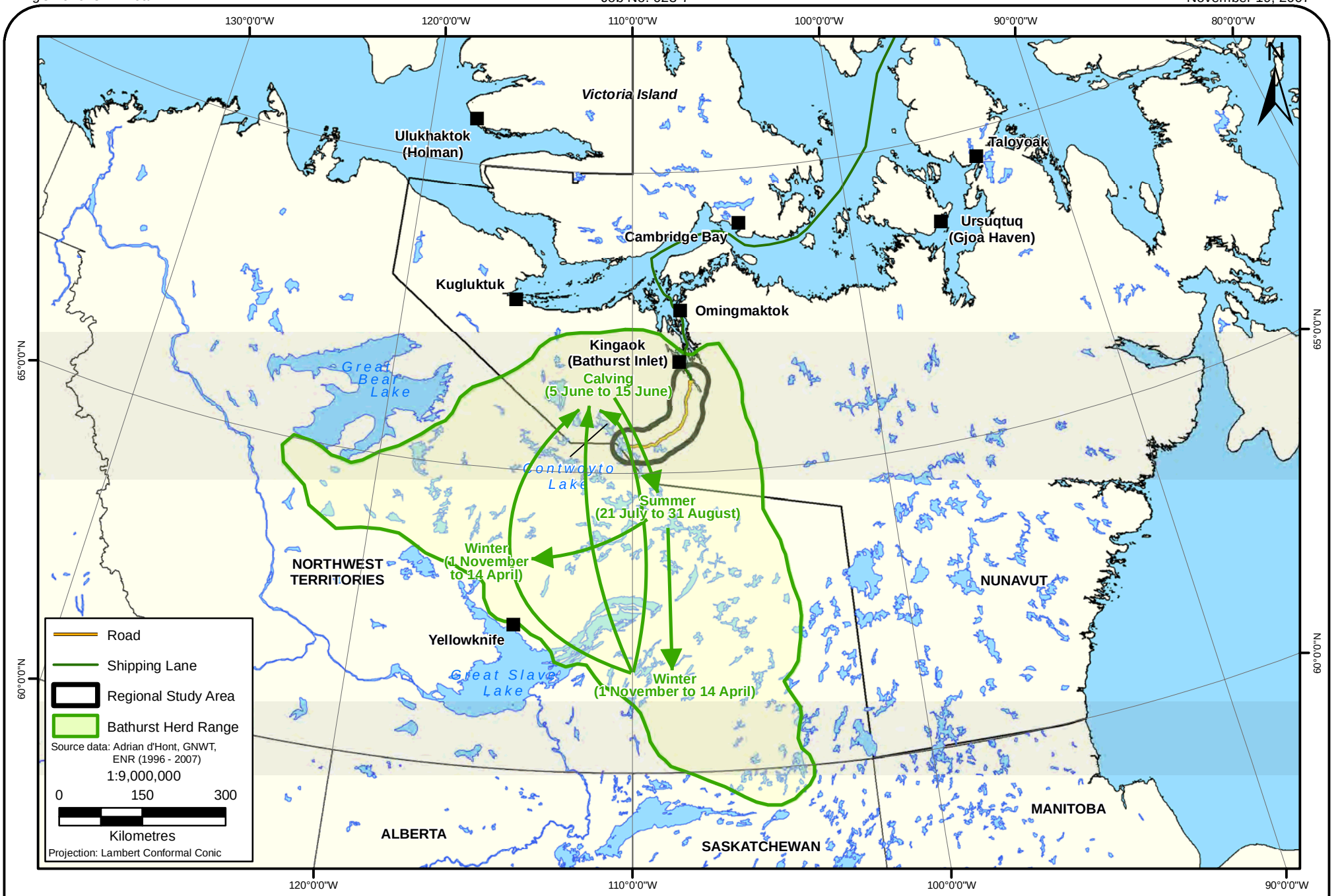
- Mount Pelly (Uvajuq). Territorial Park in Cambridge Bay. Important for tourism; viewing area for landscape and wildlife;
- Queen Maud Gulf Migratory Bird Sanctuary (Iluilik Sanctuary). Also a Ramsar wetland site. The Ahiak caribou also breed largely within this bird sanctuary;
- Jenny Lind Island. Critical migratory bird nesting area, especially for lesser snow geese;
- Polar Bear Denning conservation zones. Small islands off the southeastern coast of Victoria Island;
- Prince Leopold Island Bird Sanctuary (North Baffin Regional Area). Important for seabird species, and hosts the 4th largest seabird colony in Arctic Canada; and
- Sirmilik National Park (North Baffin Regional Area). Important as the most diverse bird community in the high Arctic during the summer; hosts over 70 species of birds, including 45 species of breeding birds. This NP is adjacent to Lancaster Sound, an area for marine species.

4.1.2 Introduction

The following are brief introductions to the caribou herds present in the region and that may be affected by the Project. The current distribution of caribou herds and possible future scenarios of caribou distributions in the region are also discussed.

4.1.2.1 Bathurst Herd

The Bathurst herd winters south of the tree line in the Northwest Territories and northern Saskatchewan. Bathurst caribou migrate north in the spring and calve to the northwest of the RSA between Hood and Burnside Rivers (Figure 4.1-2). After calving, the herd travels to the southeast, crossing the road en route to their summer range. During the fall, Bathurst caribou migrate south, back to their winter range. Thus, this herd is found within the RSA during spring migration, calving, post-calving, summer and fall migration (April 15 to October 31) with a peak during the post-calving period (June 16 to July 20) (Gunn *et al.*, 2001; Adrian D'Hont, GNWT, unpublished data). The Bathurst caribou population has been declining over the past two decades (Boulanger *et al.*, 2004; Gunn *et al.*, 2005b) but is still within the range of natural variation (Gunn, 2003). This herd may be vulnerable to human disturbance due to its declining population trend (R. Case, NWT ENR, *personal communication*).



Bathurst Caribou Herd Range from 1996-2007 Satellite Collar Data

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FIGURE 4.1-2

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4.1.2.2 Ahiak Herd

The Ahiak herd winters to the south of the RSA and migrates north during the spring to their calving grounds in the Queen Maud Gulf Migratory Bird Sanctuary to the northwest of the RSA (Figure 4.1-3). During post-calving and summer seasons, these caribou remain on the calving grounds or disperse to the south. Unlike the Bathurst herd, Ahiak caribou do not cross the road; however, some are found in low numbers in the RSA during spring migration, post-calving, summer, fall migration and winter (Gunn *et al.*, 2000; Adrian D'Hont, GNWT, unpublished data). The size of the Ahiak caribou herd appears to be increasing (Gunn *et al.*, 2000).

4.1.2.3 Dolphin and Union Herd

The Dolphin and Union herd winters to the northwest and northeast of the RSA along the coast (Figure 4.1-4). During spring migration, this herd crosses the Dolphin and Union Strait and the Queen Maud Gulf en route to their calving and summer grounds on Victoria Island, and returns to the mainland during fall migration. This herd migrates across the shipping route at Dease Strait from April 21 to July 9, and from October 21 to December 3 (Mathieu Dumond, Government of Nunavut, *unpublished data*). COSEWIC has designated the Dolphin and Union herd as a sub-population of Special Concern due to high harvests without recent population estimates (COSEWIC, 2004). Over the last several decades, the Dolphin and Union herd has been recovering from near extinction in the early 1900s (Gunn, 2005); however, this herd is vulnerable to changes that alter its migration routes across the ice, including warming weather and shipping that breaks ice or delays ice formation (COSEWIC, 2004; NPC, 2005).

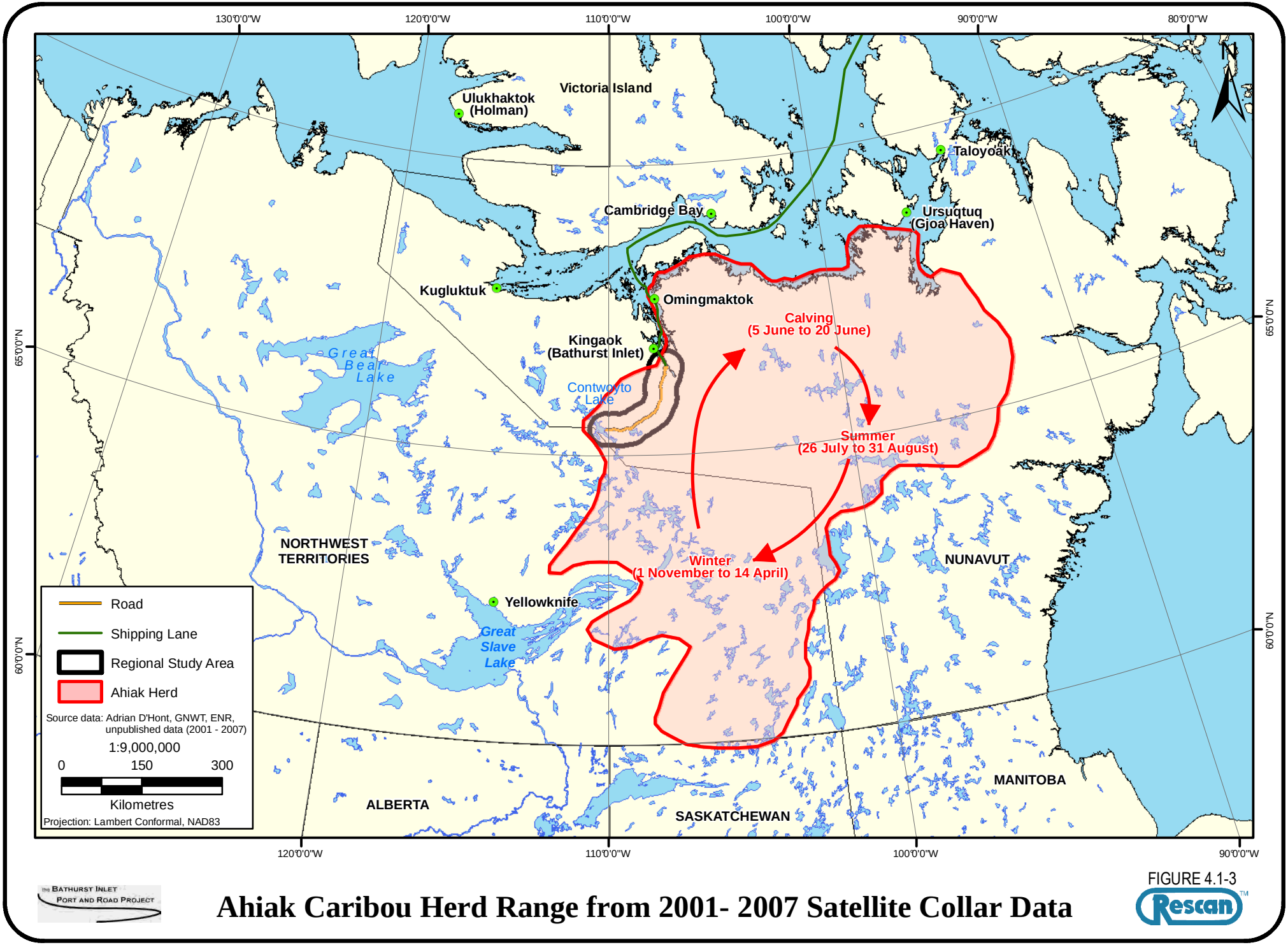
4.1.2.4 Peary Herd

Peary caribou from the Prince of Wales-Somerset and Boothia Peninsula migrate across the shipping route in Franklin Strait and Peel Sound from May through June and during the fall (Figure 4.1-5). However, timing of fall migration is unknown (COSEWIC, 2004). Peary caribou are listed as Endangered by COSEWIC and are at imminent risk of extinction due to continuing population declines and changing weather patterns (COSEWIC, 2004). Peary caribou from the Prince of Wales-Somerset population are at critically low numbers and those from the Boothia Peninsula appear to be increasing (COSEWIC, 2004).

4.1.2.5 The Current Distribution of Caribou Relative to the RSA

A quantitative estimate of the importance of potential displacement of caribou by the Project can be provided by calculating the total area used by caribou herds during calving, post-calving and summer periods (seasonal home ranges) and then calculating the percentage of the home range for each season that is taken up by the RSA (Table 4.1-1).

The home ranges of Bathurst and Ahiak caribou were calculated for each season. Seasonal home ranges can be calculated using different statistical methods. One common method, which has the advantage of being a conservative overestimate of range size, is to calculate the two standard deviation ellipse around satellite collar position data. Satellite position data were first divided into calving, post calving and summer seasons as discussed earlier in the effects assessment. These three seasons were used because caribou are known to be present in the RSA during these times (Environmental Setting, Section 2).



Ahiak Caribou Herd Range from 2001- 2007 Satellite Collar Data

FIGURE 4.1-3

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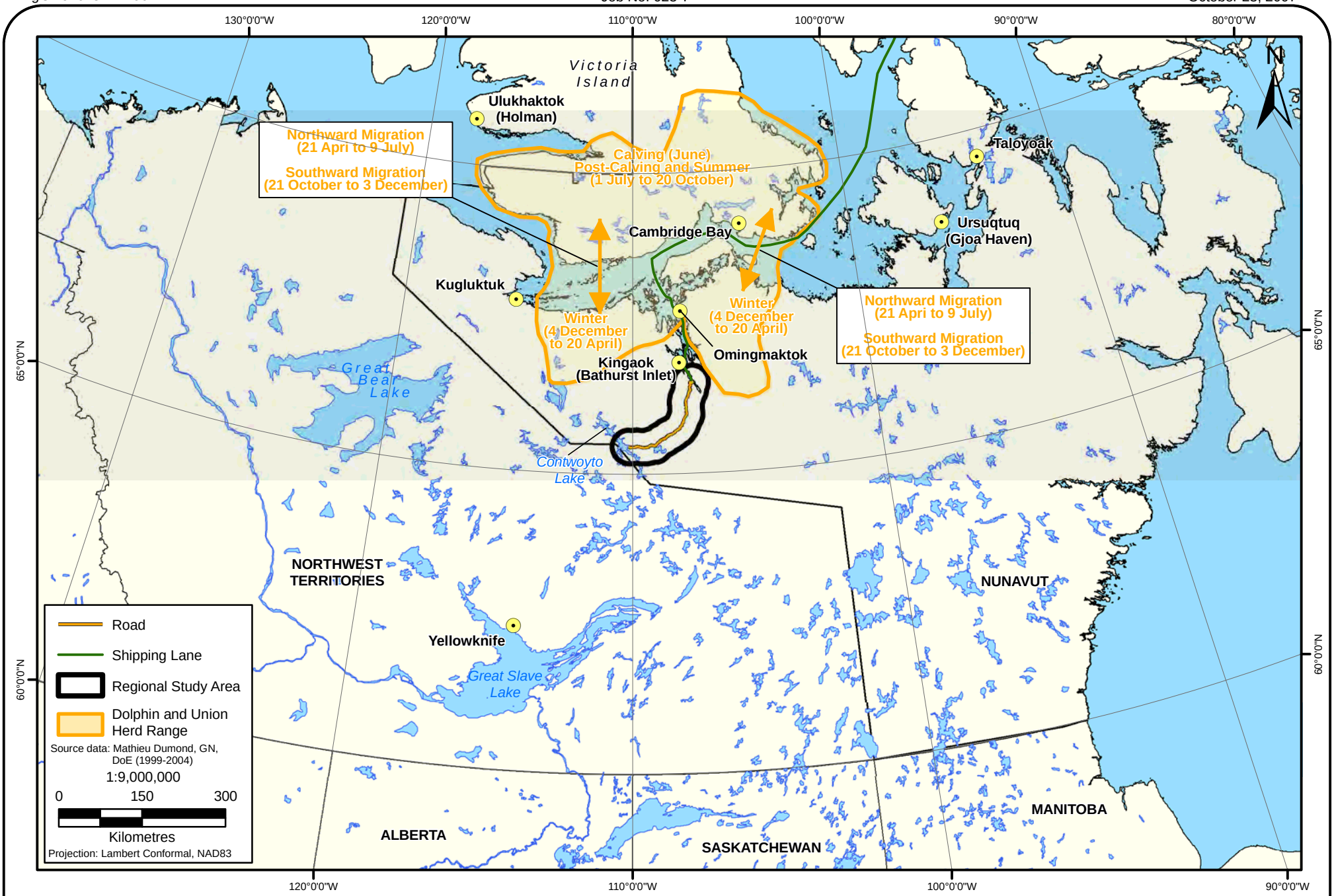

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Dolphin and Union Caribou Herd Range from 1999-2004 Satellite Collar Data

FIGURE 4.1-4

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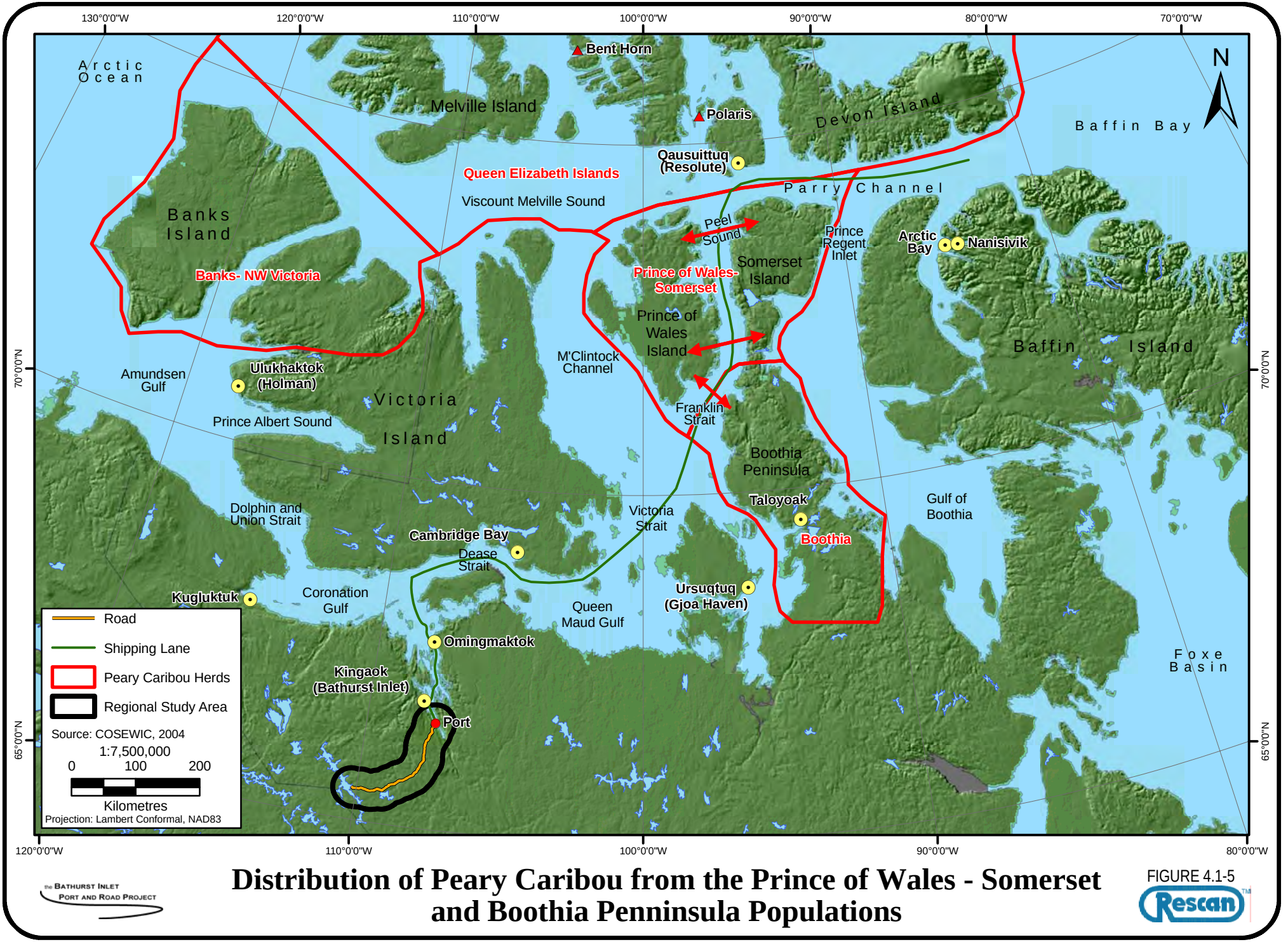

Distribution of Peary Caribou from the Prince of Wales - Somerset and Boothia Penninsula Populations

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FIGURE 4.1-5

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Table 4.1-1
Seasonal Caribou Range, Overlap with RSA, and the Proportion of Each Range Occupied by the RSA

Herd	Season	Total Area (km^2)[1]	Area Overlapping (km^2)	RSA/Range (%)
Bathurst	Calving	55,883	12,347	22.1
Bathurst	Post-Calving	113,872	14,773	13.0
Bathurst	Summer	168,595	9,231	5.5
Ahiak	Calving	105,171	2,710	2.6
Ahiak	Post-Calving	180,899	740	0.4
Ahiak	Summer	471,495	14,773	3.1

[1] **Calculated as the elliptical extent (within 2 SD) of satellite telemetry locations, using the Directional Distance function in ArcGIS 9.2.**

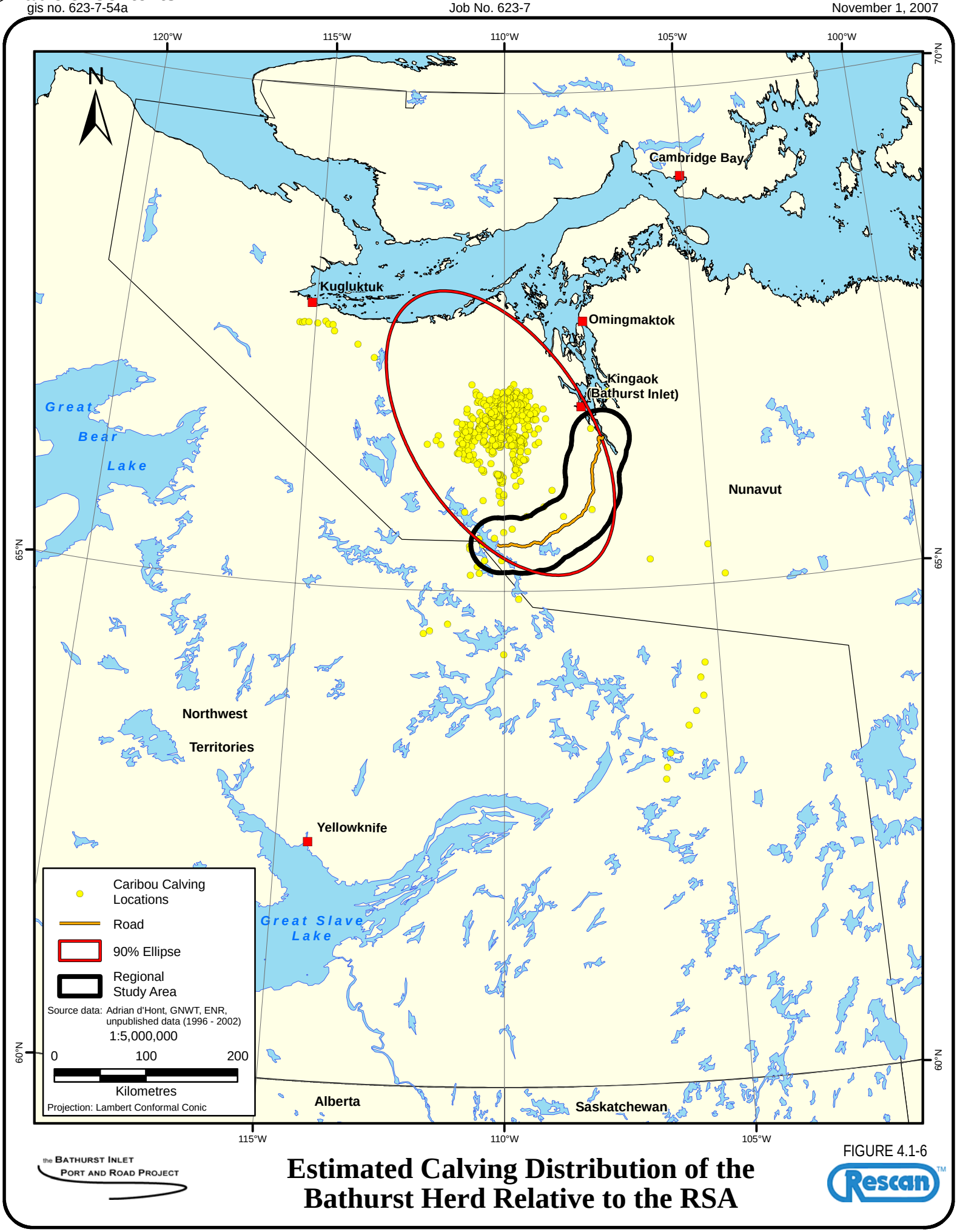
The seasonal home range ellipse for each season is determined by first calculating the distances of each collar location from the centre of each seasonal dataset in the X (east-west) and Y (north-south) directions. For each direction, the second standard deviation (encompassing 90% of the data) of the distribution of distances from the centre was calculated and those values were used to establish the major and minor axes of the ellipse. The ellipse was subsequently rotated such that its major axis was aligned with the direction of maximum spatial variance. The purpose of this calculation is two-fold; the size of the ellipse indicates the spatial range of the data and its orientation indicates any directional bias. The elliptical shape may provide an overestimate of the total area and should therefore be viewed as a conservative estimate of range sizes for each season.

The analysis described above indicates that the RSA lies in the inferred seasonal home range of the Bathurst and Ahiak caribou herds during the calving, post-calving and summer periods (Table 4.1-1, Figures 4.1-6 to 4.1-11). In particular, the RSA occupies a relatively large portion of the Bathurst herd calving, post-calving and summer inferred home ranges (22.1%, 13.0%, and 5.5% respectively) (Figures 4.1-6 to 4.1-8). The inferred range of the Bathurst herd calving ground also includes the calving grounds near Nose Lake documented by Inuit traditional knowledge as documented by the NTKP study.

The RSA occupies a small portion of the Ahiak calving, post-calving and summer inferred ranges (2.6%, 0.4% and 3.1% respectively) (Figures 4.1-9 to 4.1-11). However, it is questionable whether the RSA occupies a portion of the Ahiak calving grounds since collared animals were not observed in the RSA during this time.

4.1.2.6 Possible Future Scenarios for the Distribution of Caribou Relative to the RSA

Inuit Traditional Knowledge has identified historic patterns in caribou distribution, including calving grounds. Several historic calving areas are recognized for the Bathurst caribou, including a large calving ground east of Bathurst Inlet and two areas which overlap the RSA to



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Estimated Calving Distribution of the Bathurst Herd Relative to the RSA

FIGURE 4.1-6

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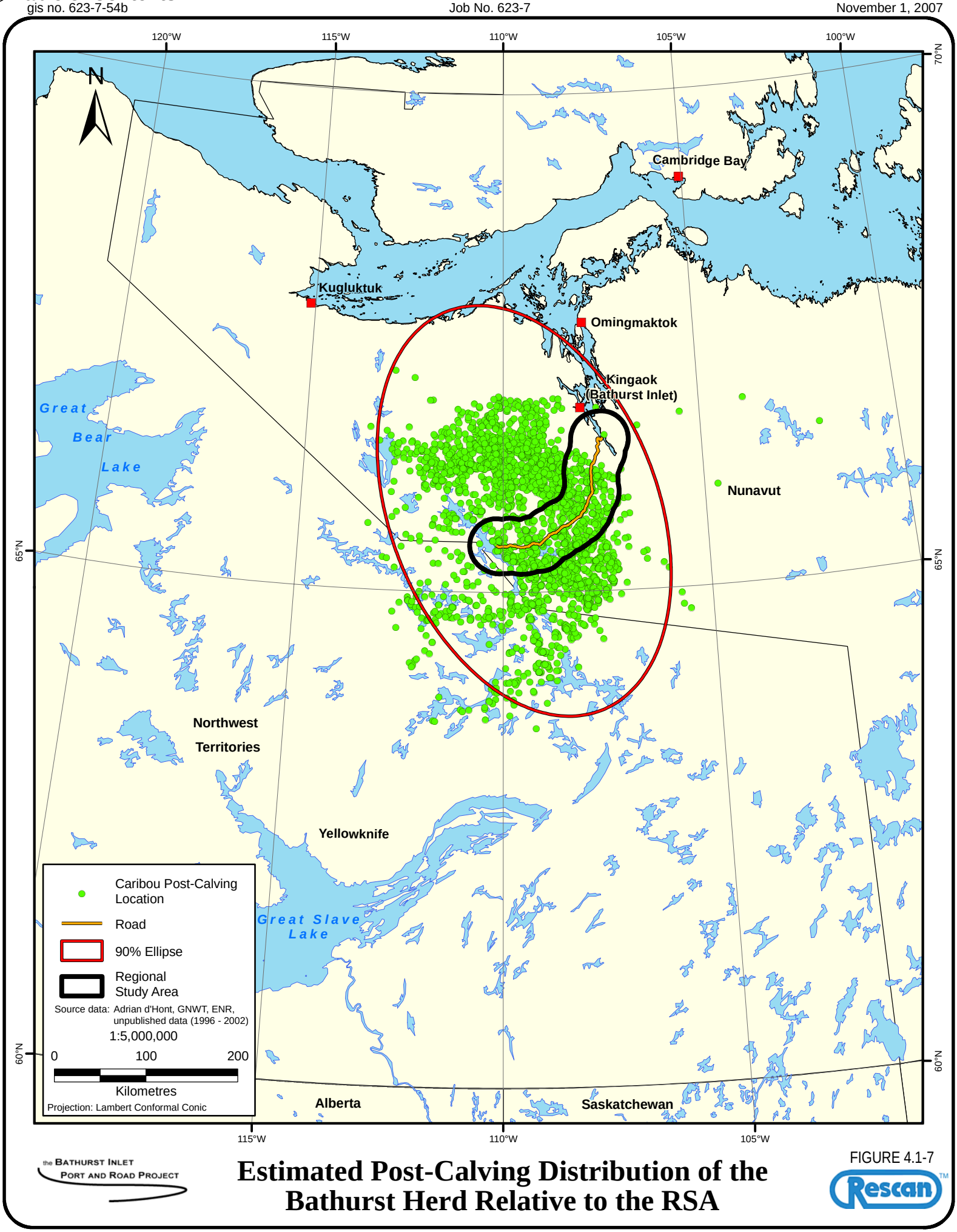

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Estimated Post-Calving Distribution of the Bathurst Herd Relative to the RSA

FIGURE 4.1-7

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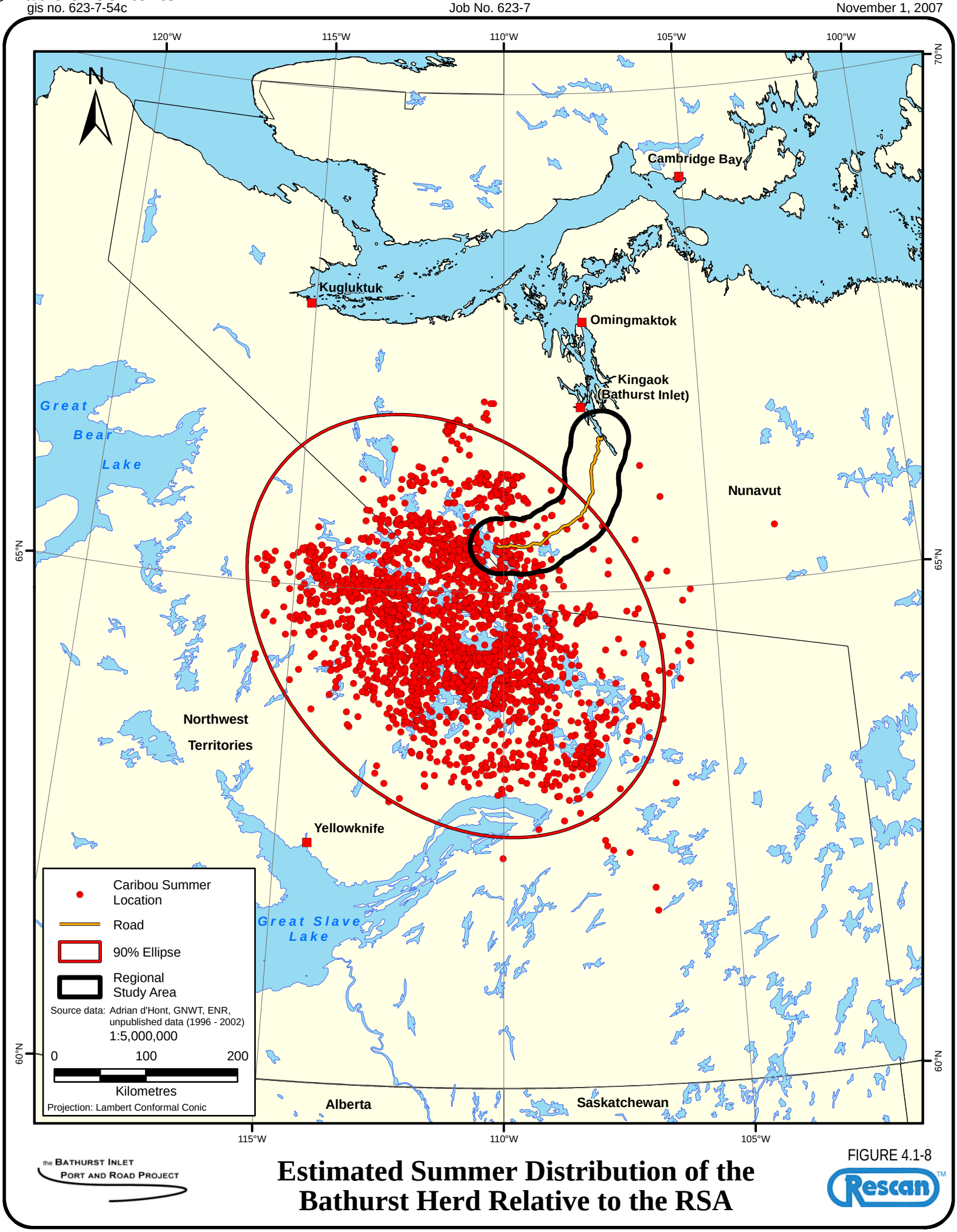

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Estimated Summer Distribution of the Bathurst Herd Relative to the RSA

FIGURE 4.1-8

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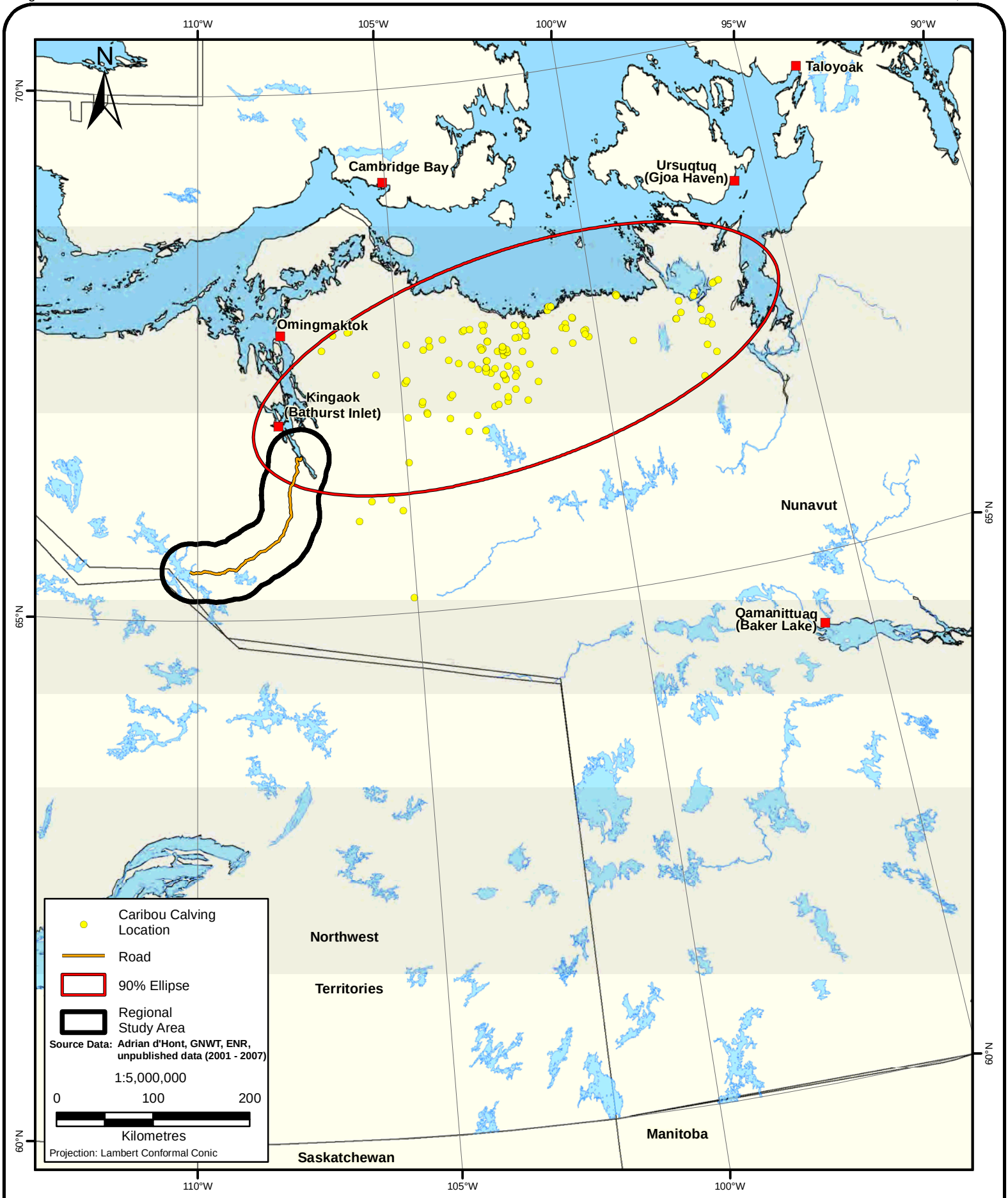

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Estimated Calving Distribution of the Ahiak Herd Relative to the RSA

FIGURE 4.1-9

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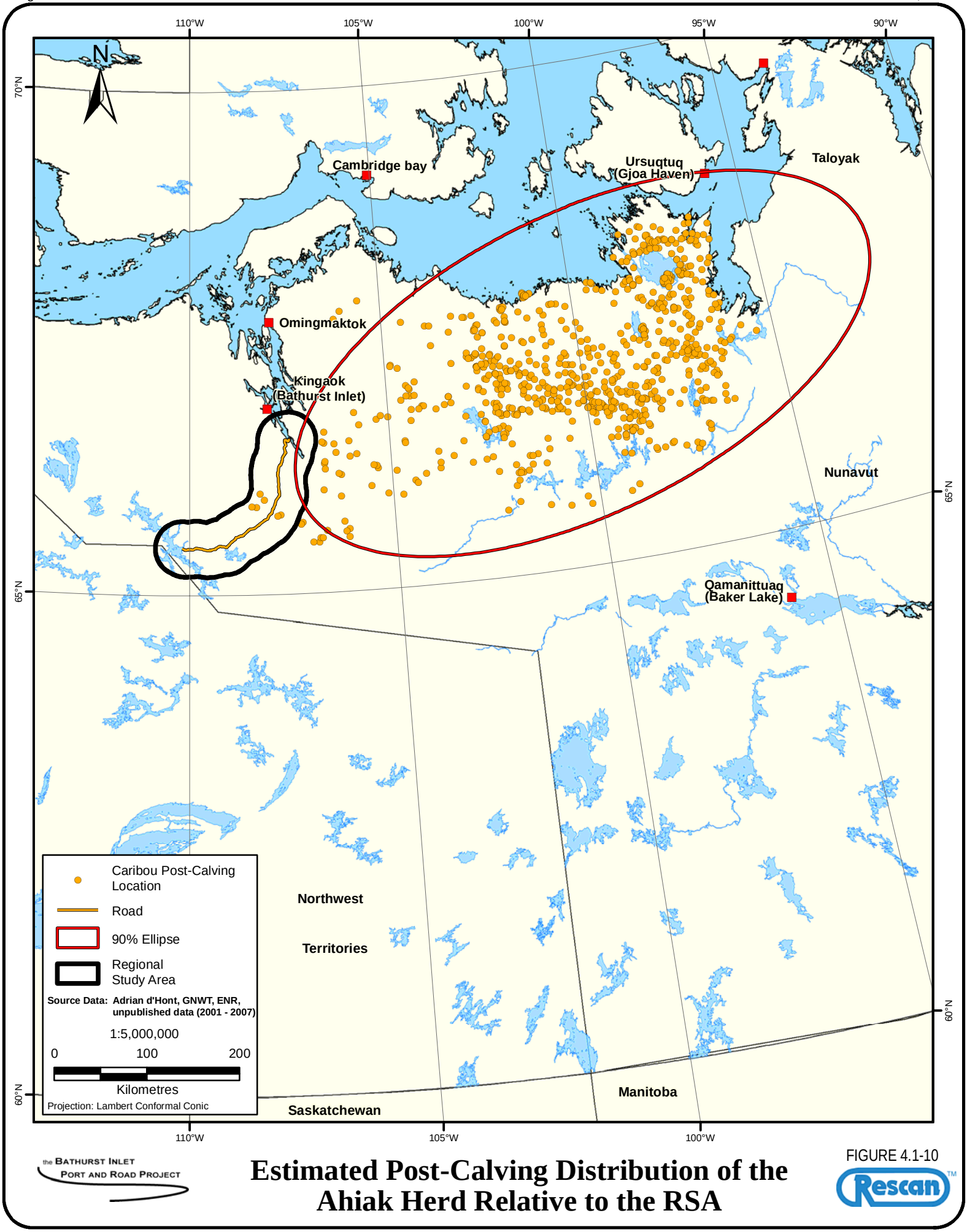

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Estimated Post-Calving Distribution of the Ahiak Herd Relative to the RSA

FIGURE 4.1-10

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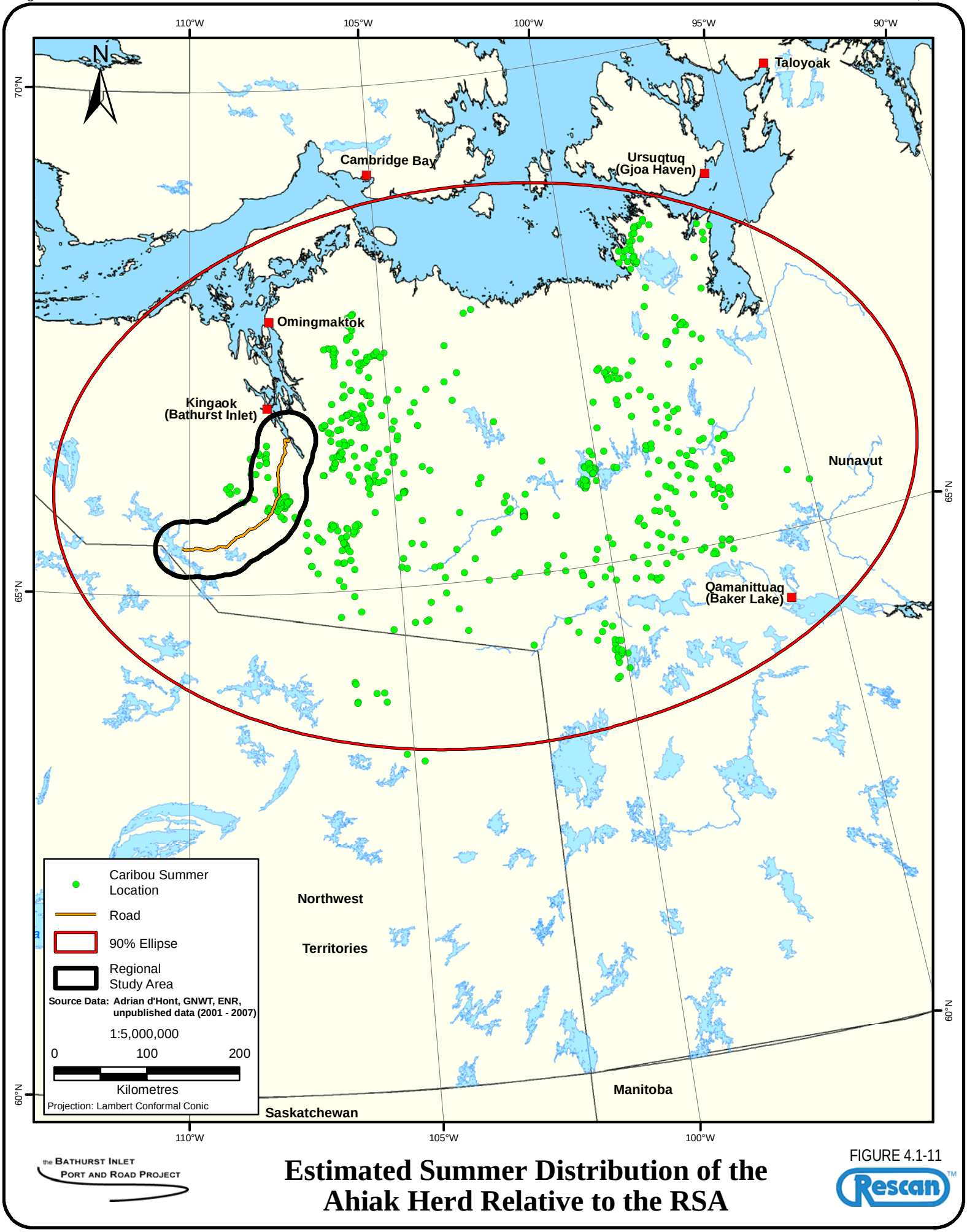

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Estimated Summer Distribution of the Ahiak Herd Relative to the RSA

FIGURE 4.1-11

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the north of Contwoyto and Nose Lakes (Figure 4.1-12; Thorpe *et al.*, 2001; Rescan, 2007c; Appendix F-5 of the DEIS). Migration paths to and from the calving grounds have historically followed a general NNE by SSW trend (Figures 4.1-13 and 4.1-14). Aerial surveys and satellite collar data support these data, indicating that the calving grounds have shifted between the east side of Bathurst Inlet and the Contwoyto and Nose Lakes over the last 30 years (Heard and Williams, 1986; Gunn *et al.*, 2001; Thorpe *et al.*, 2001; Russell, 2002). The Bathurst herd calving ground has gradually shifted from the western side of Bathurst Inlet (in the 1950s) to the eastern side (1960s to mid-1980s) and in recent years it has shifted back to the western side (Figure 2.4-8; Sutherland and Gunn, 1996; Thorpe *et al.*, 2001; Gunn and D'Hont, 2002; Appendix F-5 of the DEIS).

Satellite collar and aerial survey data indicate that, since the early 1990s, Bathurst caribou calving grounds have been concentrated between the Hood and Burnside Rivers at the peak of calving to the northwest of the RSA (Figure 4.1-12; Sutherland and Gunn, 1996; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). This area is outside the areas identified by Inuit Traditional Knowledge and may represent a new calving ground for the Bathurst herd. Alternately, most traditional Inuit travel routes between Contwoyto Lake and Bathurst Inlet were to the south of the current calving area, which may have reduced the chances of caribou being observed in these areas (Figure 4.1-2; Thorpe *et al.*, 2001; Rescan, 2007c; Appendix F-5 of the DEIS).

The causes of calving ground movements are poorly understood (Gunn and D'Hont, 2002) but may be influenced by forage availability, predator numbers, or herd size. The Bathurst herd has been declining in recent years (Adrian D'Hont, GNWT, ENR, *unpublished data*). Hence, it is not possible to predict if and when the calving area for the Bathurst herd will move again. An analysis of the potential effects of the Project must include several future possibilities, including:

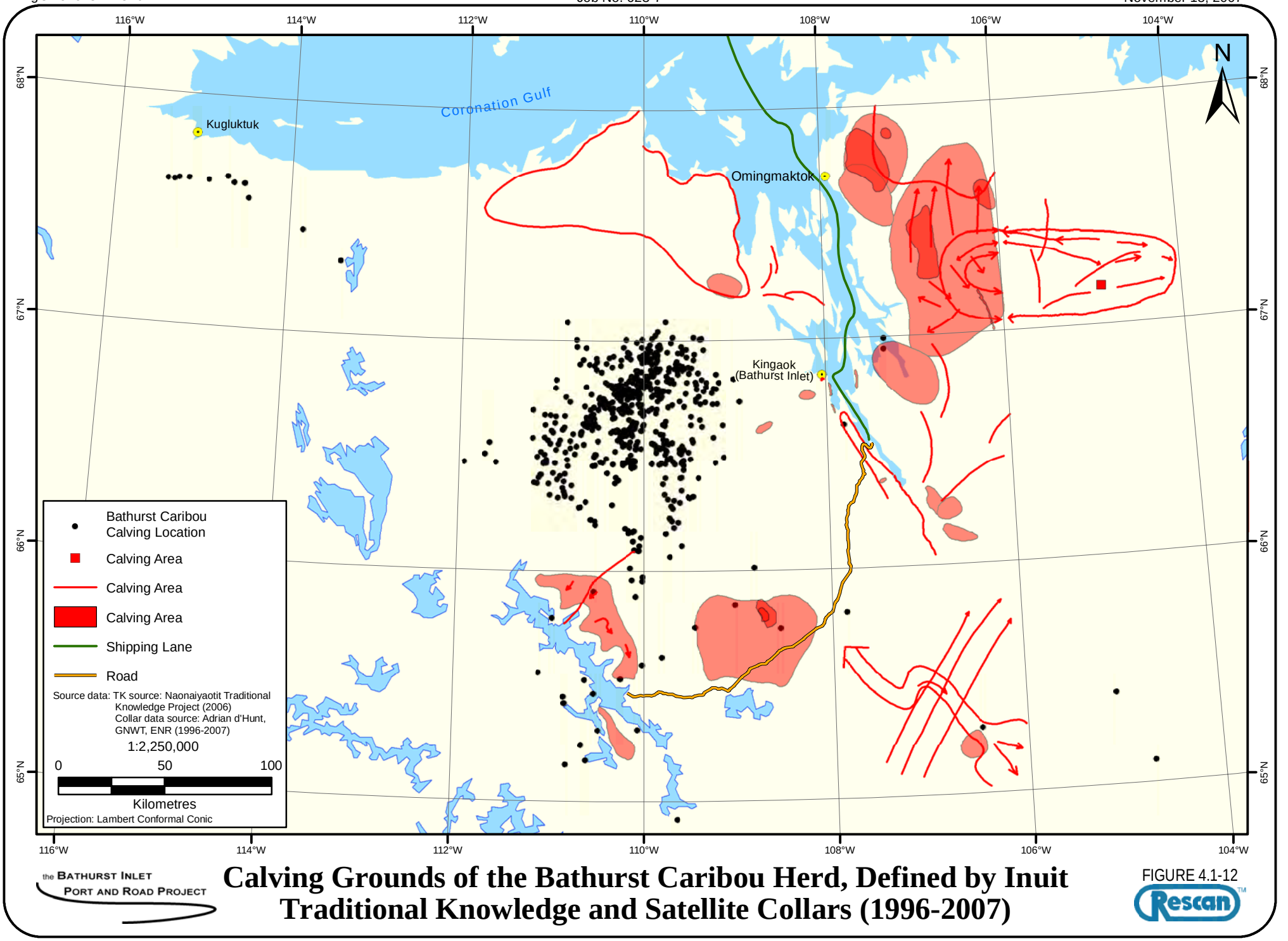
1. the calving grounds remain in the current location;
2. the calving grounds expand or shift to Contwoyto and Nose Lakes; or
3. the calving grounds shift to the east side of Bathurst Inlet.

The Ahiak calving grounds are concentrated away from the RSA. Shifts in these calving grounds are less likely to lead to interactions with the Project and are not considered further in this assessment.

4.1.3 Potential Effects – Bathurst Herd and Ahiak Herd

4.1.3.1 Terrestrial Habitat Loss

Construction of the road, port facility, and Contwoyto Camp will remove suitable caribou habitat within the RSA. Habitat loss and resulting reduction in food availability can affect wildlife when significant areas of habitat are removed. Typically, however, habitat loss is secondary to the effects of wildlife avoidance (indirect habitat loss) and disruption of movement, particularly for caribou (Wolfe *et al.*, 2000; Sections 4.1.3.2 and 4.1.3.3).



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Calving Grounds of the Bathurst Caribou Herd, Defined by Inuit Traditional Knowledge and Satellite Collars (1996-2007)

FIGURE 4.1-12

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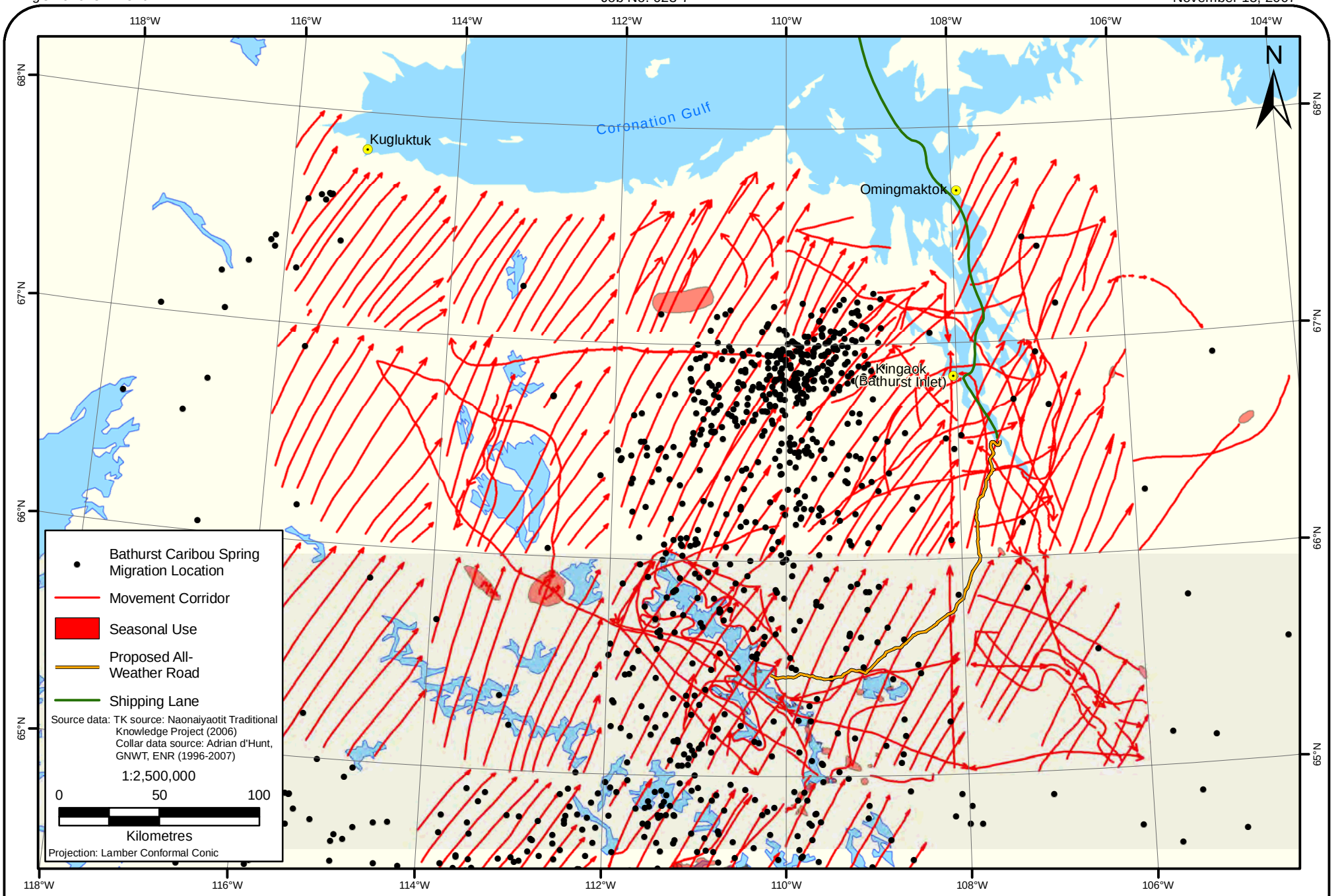

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Bathurst Caribou Spring Migration Routes as Defined by Inuit Traditional Knowledge and Satellite Collars (1996-2007)

FIGURE 4.1-13

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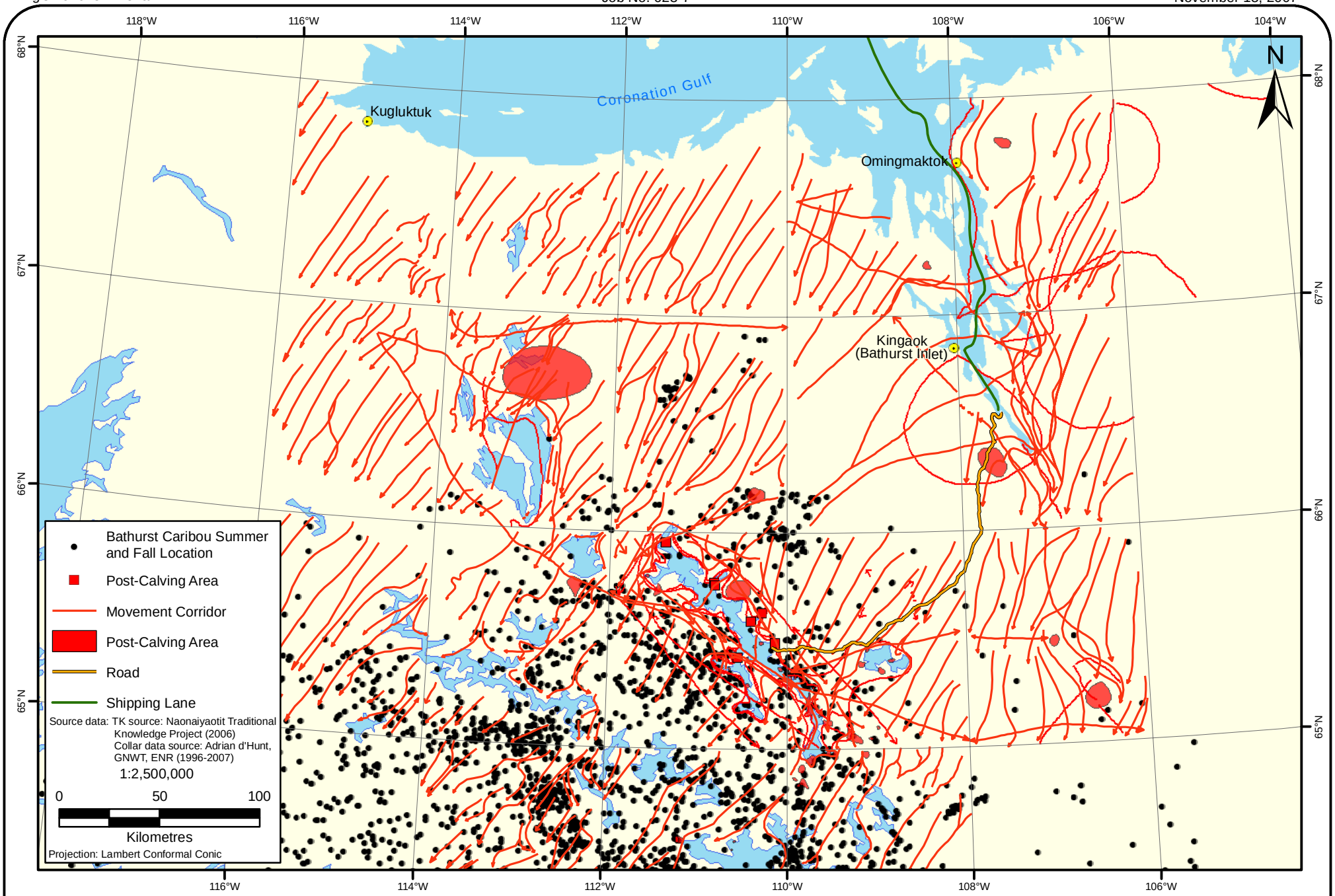

Bathurst Caribou Fall Migration Routes as Defined by Inuit Traditional Knowledge and Satellite Collars (1996-2007)

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FIGURE 4.1-14

Rescan™

Habitat types were identified in the Project area using ecosystem mapping (Appendix D-1 of the DEIS) and were rated against habitat requirements for the Bathurst and Ahiak herds using Habitat Suitability Ratings (Appendix D-8 of the DEIS).

The areas and percentages of habitat types that will be lost or modified due to the Project for caribou are listed in Table 4.1-2. "Area Lost" refers to the area of habitat directly lost due to the road, Contwoyto Camp and the facilities at the Bathurst Inlet Port site. "Area Modified" refers to the combined area that will be lost and heavily and lightly degraded. "Heavily Degraded" refers to a 5 m wide zone immediately outside the Area Lost. "Lightly Degraded" refers to a 95 m wide zone immediately outside the Heavily Degraded area (the area affected by dust) (Appendix D-1 of the DEIS).

Bathurst Caribou

Habitat suitability ratings were done for the calving, post-calving and summer periods for the Bathurst herd. Although Bathurst caribou migrate through the RSA in the spring and fall, the utility of mapping habitat suitability during migration is limited since animals are in transit and are not choosing habitat solely by food availability.

Habitat Suitability Ratings for the Bathurst herd identified 1,133,408 ha of suitable calving habitat and 1,025,293 ha of suitable post-calving/summer habitat within the RSA. Suitable habitat is defined as habitat receiving a moderate or high habitat rating (Appendix D-8 of the DEIS). Project development will result in the direct loss of 366 ha of suitable calving habitat, representing 0.03 % of the available habitat in the RSA, and 378 ha (0.04 %) of suitable post-calving/summer habitat. A total of 4,823 ha (0.4 %) of suitable calving habitat and 4,889 ha (0.5 %) of suitable post-calving/summer habitat will be modified by the Project (Table 4.1-2).

Table 4.1-2
Areas of Suitable Habitat in the RSA and Areas Modified

Herd	Season	Habitat in the RSA	Habitat Lost	Percent RSA Lost	Habitat Modified	Percent RSA Modified
Bathurst						
	Winter[1]	N/A	---	---	---	---
	Spring Migration[2]	N/A	---	---	---	---
	Calving	1,133,408 ha	366 ha	0.03 %	4,823 ha	0.4 %
	Post-Calving/Summer	1,025,293 ha	378 ha	0.04 %	4,889 ha	0.4 %
	Fall Migration[2]	N/A	---	---	---	---
Ahiak						
	Winter	938,382 ha	325 ha	0.03 %	3,992 ha	0.4%
	Spring Migration[2]	N/A	---	---	---	---
	Calving	1,133,408 ha	366 ha	0.03 %	4,823 ha	0.4 %
	Post -Calving/Summer	1,025,293 ha	378 ha	0.04 %	4,889 ha	0.4 %
	Fall Migration[2]	N/A	---	---	---	---

[1] Bathurst caribou are not generally found within the RSA during this period of the year.
[2] Habitat suitability ratings were not done for caribou during the spring and fall migrations because caribou are choosing travel routes, rather than foraging.

The potential long-term impact of habitat loss on the Bathurst herd will depend on:

- the periods of the year when caribou are using the RSA (4.1.2);
- the current population status (4.1.2);
- the current distribution of caribou in the RSA (4.1.2.5); and
- long-term shifts in the locations of the calving and post-calving areas (4.1.2.6).

Bathurst caribou use habitat in the RSA during five periods of the year: spring migration, calving, post-calving, summer and fall migration. Satellite collar data, aerial surveys, and habitat rating of the calving grounds suggest that there is a small amount of overlap between the Bathurst calving grounds and the RSA and that construction of the road, camp and port will result in little habitat loss for calving. The distribution of caribou during the post-calving and summer periods, however, directly overlaps a large area of the RSA, which increases the importance of habitat loss for animals during these periods.

The Bathurst herd has undergone long-term shifts in the location of its calving ground. In recent years, cows have calved north of Contwoyto Lake, between the Hood and Burnside Rivers (Figure 4.1-2; Sutherland and Gunn, 1996; Gunn and D'Hont, 2002; Gunn *et al.*, 2002). Cows return to the same general area to calve in successive years. However, the calving ground shifts over longer time frames. The calving ground has gradually shifted from the western side of Bathurst Inlet (in the 1950s) to the eastern side (1960s to mid-1980s) and in recent years it has shifted back to the western side (Sutherland and Gunn, 1996; Thorpe *et al.*, 2001; Gunn and D'Hont, 2002; Appendix F-5 of the DEIS). The current population status and this long-term shift in calving grounds increase the uncertainty of the potential impact of the Project on habitat loss for this herd.

If the herd increases in size and uses a larger calving ground, or shifts the location of the calving ground to overlap the RSA, then the potential impact of the Project on habitat for these caribou will likely be greater than the current evaluation. If the calving ground moves back to the eastern side of Bathurst Inlet, then the potential impact of the Project from habitat loss for Bathurst caribou will likely be reduced.

Ahiak Caribou

Very little information exists on the ecology of the Ahiak caribou herd. Ahiak and Bathurst caribou occupy similar terrain; therefore, habitat use by these two herds was assumed to be similar and common Habitat Suitability Ratings were determined for both herds (Table 4.1-2). In addition to the calving and post-calving/summer seasons, habitat suitability for the Ahiak herd was rated for the winter period. Preferred winter habitats of Ahiak caribou were assumed to include lichen veneer, heath tundra, eskers and avens communities, following known preferences of Bathurst caribou.

Overall, 938,382 ha of suitable winter habitat were identified within the RSA (Table 4.1-2) (Appendix D-8 of the DEIS). Suitable habitat is defined as habitat receiving a moderate or high rating. Of the suitable habitat identified in the study area for Ahiak caribou, Project development will result in the direct loss of 325 ha (0.03 % of available habitat in RSA) of suitable winter

habitat. Of the suitable winter habitat, 3992 ha will be modified, which represents 0.4 % of available habitat in the RSA (Table 4.1-2).

4.1.3.2 Disturbance to Feeding and/or Breeding

Project activities along the road, at the port facility and Contwoyto Camp may alter the behaviour, health, or distribution of caribou in the RSA. Animals may spend more time being vigilant or less time feeding in response to noise or visual disturbances. Animals may also experience high metabolic stress levels, a common response of caribou exposed to blasting or traffic noise (Bradshaw *et al.*, 1997). Finally, caribou may avoid areas surrounding Project infrastructure leading to indirect habitat loss. This section evaluates the potential effects of Project-related disturbances on caribou behaviour, stress and displacement and ultimately the effects of the Project on potential indirect habitat loss for caribou.

Habitat loss for caribou depends on the types of disturbances, and the distribution of caribou at various periods of the year relative to Project components. This section describes background on avoidance of Project infrastructure by caribou and evaluates the potential effects of disturbances to caribou feeding.

In each of these future scenarios, the amount of overlap between the calving ground and the RSA is different and is therefore evaluated separately.

Avoidance of Project Infrastructure by Caribou

Disturbances from visual and auditory stimuli can cause caribou to alter their regular behavioural patterns. Such disturbances can alter caribou behaviour, food update, energy output, and ultimately affect either survival or reproductive output (*e.g.*, more startle responses and therefore less time spent feeding). For instance, studies in Alaska (Prudhoe Oil Field) reported that female caribou exposed to development-related disturbances (*e.g.*, roads, construction noise) during calving, early post-calving and summer periods experienced higher energy expenditures, leading to reduced calf survival (Cameron *et al.*, 1992; Nellemann and Cameron, 1996b).

Caribou will avoid areas with visual and auditory disturbances. This avoidance results in indirect habitat loss and may displace cows and calves into suboptimal locations with lower amounts or qualities of forage or which may have increased predation risks. Industrial developments are known to influence caribou behaviour (Bradshaw *et al.*, 1997; Dyer *et al.*, 2002). In some situations, mine and mine-related activities can inhibit normal caribou behaviours such as feeding and resting (Nellemann and Cameron, 1996b; Dyer *et al.*, 2002) and reduce local densities of calving caribou following construction (Cameron *et al.*, 1992; Nellemann and Cameron, 1998b; Wolfe *et al.*, 2000; Johnson *et al.*, 2005). However, numerous caribou have been observed in close proximity to industrial developments in the NWT, such as the EKATI Diamond Mine (BHP Billiton, 2007).

Research and Inuit Traditional Knowledge consistently indicate that calving females and cow-calf groups are more prone to disturbance and likely to avoid industrial developments and roads compared to mixed adult groups (Nellemann and Cameron, 1996b; Dyer *et al.*, 2002; Nellemann *et al.*, 2003; Cameron *et al.*, 2005). Evaluating the effects of caribou avoidance will depend on

the types of developments that caribou avoid and the distance, and hence the area, to which this influence extends.

In the oil-field near Prudhoe Bay, Alaska, the majority of caribou avoided gravel roads during the calving season (with very low traffic levels; Cameron *et al.*, 1992). Dyer *et al*. (2002) found the distance of avoidance by woodland caribou around industrial roads and wells was higher during periods of increased traffic. Similarly, Nellemann and Cameron (1996b) found that maternal females were displaced from 4 to 10 km from roads and oil production facilities. However, caribou have been documented crossing roads and using roads as movement corridors at the EKATI Diamond Mine in the NWT (BHP Billiton, 2007).

Studies report that caribou will avoid developments and roads to a varying degree, but the factors which determine these distances are not well understood. Lawhead (1988) reported that caribou avoided areas within three to five kilometres of roads during calving and movements were deflected or delayed near developments. For the Bathurst herd, Johnson *et al*., (2005) reported that calving caribou in the central Canadian Arctic avoided major developments and associated infrastructure and that this avoidance behaviour extended to 33 km. Therefore, the entire RSA might be considered as potentially displacing caribou during the calving and post-calving periods and this effect will vary among herds.

Evaluating the Effects of Caribou Avoidance

The potential effects of caribou avoidance of the port facility, Contwoyto Camp and the road will be evaluated separately. Caribou avoidance of major developments has been reported to range from 3 to 33 km depending on the type of facility and season (see background section). Caribou avoidance during movement and the potential for the road to act as a barrier to migration are discussed in Section 4.1.3.3.

The port facility is expected to produce relatively moderate levels of visual and auditory disturbances due to the level of activity, lighting and infrastructure present. Under current conditions, the inferred seasonal home ranges of caribou overlap the port facility site during the calving and post-calving periods for the Bathurst caribou and during the calving and summer periods for Ahiak caribou. The peninsula on which the port is located is also identified as a caribou water crossing location. Hence, the likelihood and degree of avoidance by caribou is expected to be high and at the moderate to high end of the observed scale of caribou response during these periods. This potential effect will occur during both construction and operations phase until closure.

Under current conditions, the inferred seasonal home ranges of caribou overlaps the Contwoyto camp site during the Bathurst calving period and during the summer period for Ahiak caribou; however, during spring migration post-calving, summer and fall migration periods for the Bathurst herd, caribou are relatively common in the area of the Contwoyto camp. Hence, the likelihood and degree of avoidance are expected to be low and at the low end of the observed scale of caribou response during these periods. Contwoyto Camp is a small, 20 person camp which will produce relatively low levels of visual and auditory disturbance. This effect will occur during construction and for the lifetime of the camp until closure.

The road covers the largest area of the RSA and the potential effects of the road are greater than those of the port or camp, having the highest potential to impact caribou behaviour and cause indirect habitat loss. Caribou are known to avoid active gravel roads, even at very low traffic densities (Dau and Cameron, 1986; Lawhead, 1988). Avoidance appears to be negligible on roads without traffic and climb steeply with the amount of traffic (Dyer *et al.*, 2002).

The effects of the road are evaluated for the three future scenarios (detailed in section 4.1.2.6):

1. the calving grounds remain in the current location;
2. the calving ground expands or shifts to Contwoyto and Nose Lakes; or
3. the calving ground shifts to the east side of Bathurst Inlet.

Under current conditions (Scenario 1), inferred caribou seasonal home range overlaps with the RSA during the calving, post-calving and summer periods for the Bathurst herd and during the summer and winter periods for the Ahiak herd. Caribou are expected to avoid the road during periods when active hauling is occurring (1 January to 30 April) and to a much lesser degree outside the active hauling season (1 May to 31 Dec) when a very low volume of traffic for inspection and road maintenance is expected.

If the Bathurst herd calving ground shifts or expands to Contwoyto and Nose Lakes (Scenario 2), the calving ground would overlap the RSA and may result in higher levels of indirect habitat loss at this important period for caribou. If vehicles were prohibited from driving on the road during this period, this effect would likely be mitigated, but represents a much higher probability of adverse effects than the current scenario.

If the Bathurst herd calving ground shifted to the east side of Bathurst inlet (Scenario 3), the degree of overlap between the calving ground and the RSA would be reduced or eliminated. Hence, the potential effects of the Project on this herd's calving ground would also be reduced or eliminated.

4.1.3.3 Disruption to Movement

Linear developments such as roads, pipelines and rail lines can fragment wildlife habitat across many taxa and caribou have been shown to avoid roads and pipelines in Alaska and Arctic Canada (Wolfe *et al.*, 2000). Roads are often described as a "semi-permeable barrier" to caribou movement (Dyer *et al.*, 2002), with permeability depending on the amount and frequency of traffic. This section evaluates the effects of the road, port facility and Contwoyto Camp as barriers to caribou movements and migration. The evaluation considers:

1. background on caribou avoidance of similar developments;
2. water and ice crossings for caribou in the RSA; and
3. evaluation of three possible future scenarios for movement patterns of caribou in the RSA.

Indirect habitat loss due to avoidance of linear developments is addressed in Section 4.1.3.2.

Background

Most barren-ground caribou migrate yearly from their southern wintering grounds to northern calving grounds, the locations of which may shift depending on a complex combination of predator abundance, vegetation dynamics and social interactions among caribou (Russel *et al.*, 2002). In addition, caribou move from dense concentrations covering a smaller area during calving to lower concentrations covering larger areas during post-calving and summer. The road, port, Contwoyto Camp and associated infrastructure may lay perpendicular to the migration and movement routes of the Bathurst herd (and to a lesser degree, the Ahiak herd), and as such present potential inhibitors to migration and other movements of caribou.

The characteristics of roads or other linear features known to deflect movement of caribou include high traffic levels (Murphy, 1988; Rescan, 2007a) and a height of >1.2 m above ground level (Hanson, 1981; Curatolo and Murphy, 1986; Eide *et al.*, 1986; Murphy and Curatolo, 1987). The proposed road will have variable traffic levels (highest during winter) with no adjacent linear feature; its proposed height above the tundra varies from 1.05 to 2.05 m.

Johnson *et al*. (2005) found that caribou in the central Canadian Arctic avoided major development sites (operating mines, communities, winter road camps) during spring migration. Although migrating caribou are known to move relatively quickly through the regions of the EKATI and Diavik diamond mine developments, which include a 29 km all-weather road (Gunn *et al.*, 2001), the frequency of caribou crossing this road is known to depend on traffic volume and on height of the snow bank at the edge of the road (Rescan, 2007a). Similarly, Dyer *et al*. (2002) found that, while caribou could cross roads, they did so less often than would be expected by chance and that the frequency of crossing depended on traffic volume.

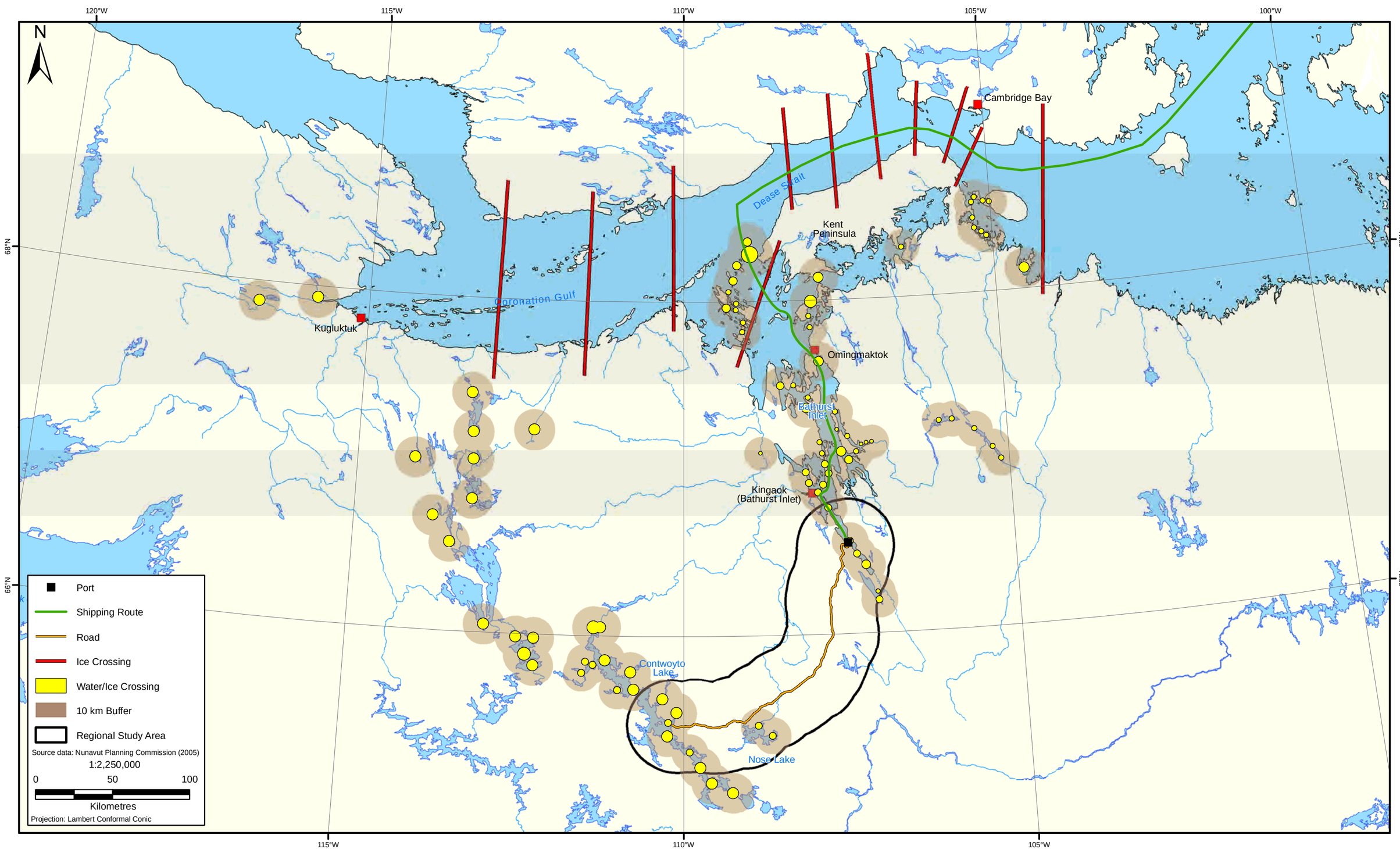
Designated Caribou Water and Ice Crossings

The draft WKRLUP (NPC, 2005) uses Inuit Traditional Knowledge to identify water and ice crossings for caribou in the Kitikmeot Region. Several designated crossings occur in the RSA on Contwoyto Lake, Nose Lake and Bathurst Inlet (Figures 4.1-15, 4.1-16, 4.1-17). Caribou are particularly susceptible to disturbance at designated crossings (NPC, 2005).

The WKRLUP (NPC, 2005) identifies mitigation measures for minimizing the potential effects of developments on caribou crossings. Between May 15 and September 1, camps may not be constructed, fuel may not be cached and blasting may not be conducted within 10 km of designated crossings. The WKRLUP (NPC, 2005) also states that between May 15 and July 15, work and activities may not take place and if operations have commenced then all operations must be suspended immediately if calving or post calving caribou are present in or near the area of work or activity. These recommendations will apply to the Project. These measures will likely reduce the potential effects of the Project on caribou at designated crossings.

The potential effect of the road as an inhibitor to caribou movement will likely depend on:

- the road structure (including snow banks);
- traffic levels on the road; and
- the timing of caribou migration and use of the RSA.

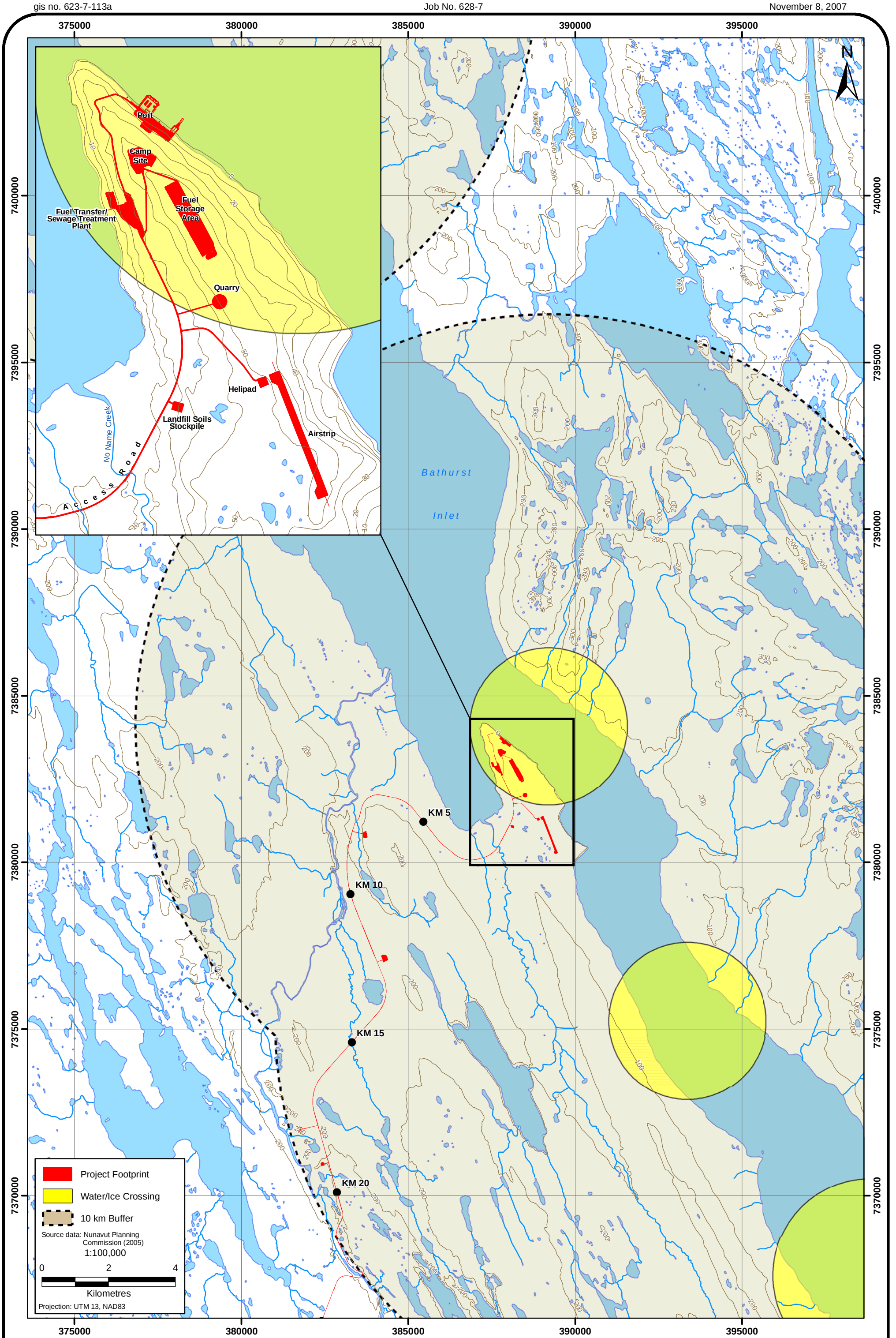


the BATHURST INLET PORT AND ROAD PROJECT

FIGURE 4.1-15

Designated Caribou Crossings with 10 km Buffer

Rescan™



the Bathurst Inlet Port and Road Project

FIGURE 4.1-16

Caribou Crossings at the Port Site

Rescan™

530000 535000 540000 545000 550000 555000 560000 565000

7270000

7265000

7260000

7255000

N

Contwoyto Camp

KM 210

KM 205

KM 200

KM 195

KM 190

KM 185

Contwoyto Lake

Project Footprint

Water/Ice Crossing

10 km Buffer

Source data: Nunavut Planning Commission (2005)

Note: Areas jutting out from the road in the Local Study Area are quarry sites

1:100,000

0 2 4

Kilometres

Projection: UTM 12, NAD83

the BATHURST INLET PORT AND ROAD PROJECT

FIGURE 4.1-17

Caribou Crossings Near Contwoyto Camp

Rescan™

This assessment is consistent with community consultation with elders, who stated that the road would not likely disrupt movement patterns of caribou if it was not used during periods of migration (Appendix F-1 of the DEIS).

The road structure (including snow banks) can present a visual barrier and prevent crossing by caribou. The Wildlife Mitigation and Management Plan (Section 5) proposes crossing ramps at identified caribou migratory routes and management of the snow banks along the road.

Eskers are often used by migrating caribou. Eskers provide easy passage and increased wind reduces insect harassment in summer. In some cases, the road will cross eskers and other established caribou movement corridors. In these cases, traffic crossing eskers may inhibit caribou from crossing the road (Appendix F-1 of the DEIS).

Traffic levels on the road will be high between January 1 to April 30, during which traffic volumes will be high enough (>60 vehicles/day) to act as a 'semi-permeable' barrier to movement of caribou (Dyer *et al.*, 2002), which is expected to result in a detectable change in movement. For the remainder of the year, traffic volumes are expected to be low and will be restricted to road inspection and maintenance vehicles from mid-July to early September.

Seasonal use of the road for hauling is expected to occur between January 1 and April 30. This period corresponds to the winter period and the spring migration period for both Bathurst and Ahiak caribou. During the winter period, the Bathurst caribou are on their wintering grounds to the south of the RSA.

Bathurst caribou interactions with the RSA are evaluated for three possible future scenarios:

1. The calving grounds remain in the current location:

With the calving ground in the current location, Bathurst caribou travel through the RSA during the spring migration (April 15 to June 5), which overlaps with the winter hauling season between April 15 and April 30 (Figure 4.1-11). During this overlap, caribou density in the RSA is low and caribou are typically to the south of the RSA. The sensitive period for migrating Bathurst caribou is the post-calving migration from the calving grounds (north of the RSA), south-east across the road, to the summer grounds in and to the south-east of the RSA. During this post-calving period, traffic on the road is expected to be low, confined to inspections and road maintenance, but no hauling of materials.

2. The calving grounds expand or shift to Contwoyto and Nose Lakes:

If the calving grounds expand or shift to Contwoyto and Nose Lakes, caribou movement through the RSA would likely be similar to the current conditions, with caribou crossing the road during spring migration and the post calving period.

3. The calving grounds shift to the east side of Bathurst Inlet:

If the calving grounds move to the east of Bathurst Inlet from their current location, caribou would be expected to be in the RSA and crossing the road during spring migration. The number of caribou crossing the road during the post-calving season may be reduced since caribou would

be moving parallel to the road from the calving ground to the summer areas, rather than across the road. Hence, this scenario may represent a reduced potential effect for the Bathurst herd.

Ahiak caribou are present in low numbers on the northern extent of their wintering range during the winter hauling season. The spring migration for Ahiak caribou also overlaps with the winter hauling season between April 15 and 30. The Ahiak caribou do not cross the road en masse at any season as the Bathurst caribou do during the post-calving season. The presence of Ahiak caribou at low density within the RSA throughout the winter haul season is offset by the fact that a primary migration path of this herd does not cross the road at any time of year. Hence, the effects of the road as an inhibitor to migration on Ahiak caribou are rated as lower than those on the Bathurst herd.

4.1.3.4 Features Acting as an Attractant

Features of the Project that may act as attractants to caribou, which could subsequently lead to increased human-caribou interactions and caribou mortality from vehicle collisions include:

- the road acting as a movement corridor and providing insect relief;
- road edges (due to early regeneration forage); and
- gravel pits and quarries as sources of revegetation.

The following section provides background on the road and quarries as caribou attractants and rates their potential effect on the Bathurst and Ahiak caribou during the summer period.

The Road as a Movement Corridor

Caribou travel along structures that facilitate ease of movement through their environment, especially during migration. In the central Arctic, such structures include eskers, frozen lakes, ridges and high points where snow is relatively shallow (Appendix F-5 of the DEIS; Thorpe *et al.*, 2001; Johnson *et al.*, 2005). Roads may be used as movement corridors by caribou because they provide easy terrain for travel relative to the surrounding tundra (Banfield, 1974; Stuart-Smith and James, 1996; Forman and Alexander, 1998). Banfield (1974) noted that migrating caribou from the Porcupine herd travelled along roads, particularly if the roads ran along migration routes.

The proposed road may act as a movement corridor for caribou in the RSA, increasing the probability of caribou-vehicle collisions. Use of the road for travel may be an issue for 12 months of the year, since caribou from at least one of the Bathurst or Ahiak herds will be present year round. If the road does serve as a migration corridor, highest use of the road by caribou would be expected during the spring and fall migrations (April 15 to June 4 and September 1 to October 31) when large numbers of caribou migrate through the RSA. At this time, traffic on the road will consist of maintenance vehicle only and interactions between caribou and vehicles will be minimal.

Escape Habitat from Insect Harassment

During the post-calving and summer seasons, caribou minimize exposure to insects by selecting cool, windy habitats such as eskers (Murphy and Curatolo, 1987; Russel *et al.*, 1993; Thorpe *et*

al., 2001; Gunn *et al.*, 2002; Appendix F-5 of the DEIS). Studies within Prudhoe Bay oil fields of Alaska suggest that barren-ground caribou also use roads to escape insect harassment (Pollard *et al.*, 1996; Noel *et al.*, 1998). If caribou seek escape from insects along the proposed road, they could be adversely affected by vehicular traffic during construction and summer maintenance periods. However, traffic on the road is expected to be very low during the summer maintenance period.

Foraging Habitat

In boreal ecosystems, early-regeneration of roadside vegetation can act as an attractant to wildlife and increase the number of vehicle collisions with caribou (Forman and Alexander, 1998). Plant communities in the Arctic are less likely to provide attractive early successional forage due to the short growing season and slow revegetation rates. Hence, caribou are not expected to be attracted to forage along the road verge. At the EKATI Diamond Mine, caribou were never observed foraging on the road verge and were just as likely to feed in the first 50 m from the road as in the 50 to 200 m range (BHP Billiton, 2007). Furthermore, dust from the road may reduce the availability and quality of roadside forage which would further reduce the attractiveness of this area for caribou (Wolfe *et al.*, 2000). Winter dust in habitats adjacent to the road will be reduced by the freshet; summer dust will be very low due to very low traffic

Gravel pits and quarries may contain disturbed soil that would support early-regeneration plant communities. Some pits and quarries will be progressively decommissioned during the operational phase of the Project while others will be decommissioned with Project closure. Decommissioning will include some revegetation of sloped soil areas where possible. Regenerating vegetation may be an attractant to caribou during the summer when road traffic is very low.

4.1.3.5 Mortality

The port, camp, and road may cause increased mortality to caribou either directly or indirectly. Caribou may be injured when crossing roads (direct mortality) or may experience indirect mortality as a result of predation and hunting. The following section describes and evaluates the potential for elevated direct and indirect mortality on caribou at the port facility, camp and on and near the road.

Direct Mortality

Caribou may be injured while crossing roads or navigating other features associated with development projects, resulting in greater mortality rates. The injuries will have individual-level effects. Kendrick *et al*., (2005) documented observations by Łutsël K'é elders, suggesting that caribou might have sustained injuries while negotiating road berms and waste rock dumps (50 m high) after being disturbed by mining activities in the area. However, during seven years of incidental observations (2000 to 2006), only one caribou with a broken hind leg was reported in the Long Lake Containment Facility of the EKATI mine, although the cause of the broken leg was unknown (BHP Billiton, 2007).

Indirect Mortality

Bergerud *et al*., (1984) reviewed the demography, movement and behaviour patterns of eight caribou herds exposed to industrial activities or transportation corridors and concluded that

declines in abundance were most strongly related to increases in mortality rates due to hunting or predation by wolves. Roads are thought to provide increased access to hunters and wolves to caribou ranges (Bergerud *et al.*, 1984). Caribou mortalities attributed to wolf predation tend to be closer to Project infrastructure than the average locations of caribou, indicating that caribou that are close to linear corridors are at a higher risk of predation (James and Stuart-Smith, 2000). Wolves follow the movements of and prey on the Bathurst caribou herd (Gunn, 1984; Walton *et al.*, 2001; Frame, 2005; Gunn *et al.*, 2005b). Predation can influence calf survival and lead to herd-level declines in abundance (Gunn, 1984; Gunn *et al.*, 2005b). Therefore, potential exists for the presence of the road to lead to declines in abundance in caribou if the road increases encounter rates between caribou and predators. In addition, if camps attract predators such as grizzly bears and wolves, the prevalence of these carnivores, and risk of predation, may increase near the Project footprint. The magnitude of this effect will be mediated by territoriality between wolves and the number of caribou that each wolf will consume. This effect is not expected to increase the herd-level mortality of caribou significantly, but may lead to a re-distribution of where and when caribou are removed.

Construction of the road may facilitate an increase in access and hunting pressure on caribou. However, socio-economic studies report that an increase in immigration and hunting pressure is unlikely (Appendix F-2 of the DEIS).

4.1.3.6 Reduction in Reproductive Productivity

The combined effects of potential disturbance, potential disruption to movement, and potential stress may result in an energy cost to caribou sufficient to cause a reduction in reproduction. Bathurst caribou are found in the RSA mainly during the low traffic road maintenance period (1 May to 31 Dec). However, caribou are known to avoid active gravel roads, even at very low traffic densities (Dau and Cameron, 1986; Lawhead, 1988). Ahiak caribou, which are present at low densities in the RSA during winter, may be disturbed by high volume haul traffic. Caribou require access to relatively high quality forage and must conserve energy during this time in order to survive the winter and reproduce the following year.

During development of roads and production related facilities in the oil fields of Alaska, avoidance behaviour by caribou resulted in a loss of access and use of preferred calving habitats (Nellemann and Cameron, 1996b). This displacement subsequently led to reduced body condition and lower parturition rates; 64.3% in the areas affected by petroleum-based infrastructure, versus 82.5% in control areas (Cameron *et al.*, 2005). Therefore, predicting the effect of a development on reproductive productivity requires knowledge of habitat lost or avoided due to the Project and suitability of surrounding habitat that caribou might be displaced into. In particular, the calving and post-calving seasons are critical for productivity of caribou and an analysis of habitat availability should focus on these periods.

During calving and post-calving periods, caribou in the central Canadian Arctic are known to forage primarily on lichen, which composes >60% of the diet of Bathurst caribou (Griffith *et al.*, 2001). During these periods, caribou prefer the lichen veneer, riparian shrub, and birch seep habitats (Griffith *et al.*, 2001; Johnson *et al.*, 2005). The relative value of the RSA as foraging

habitat for calving caribou can be evaluated, therefore, by comparing the availability of these preferred habitat types to the availability of these habitats beyond the RSA.

Vegetation was classified for the RSA in the Vegetation Assessment (Appendix D-1 of the DEIS) and was compared to habitat found in the area outside the RSA, classified by Matthews et *al.* (2001) (Table 4.1-3). The RSA contains proportionally more heath tundra and bedrock than the surrounding landscape. These two habitats have moderate and low value for caribou during the calving and post-calving periods. As such, the Project will not likely displace caribou into calving and post-calving habitat of lower-value than they currently use.

Table 4.1-3
Availability of Habitat Types in the RSA Relative to the Availability of These Habitat Types on Surrounding Landscape

	Value to Caribou[1]			Availability of Habitat on Landscape[2]				
Habitat	**Calving**	**Post-calving**	**RSA (%)**	**Mean (%)**	**SD**	**n**	**Z[5]**	**p[6]**
Heath Tundra	M	M	38	28.0	6.0	6	1.65	0.050
Water[3]	M	M	22	24.9	6.6	6	-0.44	0.669
Boulders	L	M	13	5.6	7.5	6	0.99	0.161
Bedrock	L	L	12	1.9	1.0	6	9.82	<0.001
Boulder-Heath Tundra	M	M	11	13.4	7.2	6	-0.33	0.631
Sedge	M	H	3	6.4	3.9	6	-0.87	0.808
Lichen Veneer	H	L	0.4	2.4	1.7	6	-1.16	0.877
Riparian Shrub	H	H	0.4	0.5	0.6	6	-0.21	0.584
Esker	L	H	0.2	1.0	1.0	6	-0.81	0.790
Birch Seep	H	H	0.03	1.4	1.2	6	-1.14	0.873
Un-vegetated	L	Nil	0.03	3.2	7.0	6	-0.46	0.676
Other[4]			0	9.8	2.4	6		

[1] From habitat suitability model (Appendix D-8 of the DEIS).
[2] Availability of habitat was calculated as the mean proportion of each habitat type classified from Landsat images that encompass the RSA (Scenes 44-15, 45-15, 46-14, 44-14, 46-13, and 43-13; from Matthews *et al.*, 2001).
[3] Includes shallow water and deep water, from Matthews *et al.*,(2001).
[4] Includes tussock/hummock, spruce forest, peat bog, ice and snow, gravel, mixed forest, old burn, young burn, and unclassified, from Matthews *et al.*, (2001).
[5] A Z-test assumes you have the true population mean and variances. There are only 6 (n) of the landscape units from the Griffith report that overlap with the RSA, and all these were included. The Z-test then allows you to answer, given the mean and variance, what is the proportion of the landscape that has values larger than the ones observed in the RSA
[6] p indicates the probability level – the test has reported a significant result when p>0.05 (alpha).

4.1.4 Potential Effects – Dolphin and Union Herd and Peary Herd

Two caribou herds are found along the shipping route; the Dolphin and Union Herd and the Peary herd. These herds cross sea ice as they migrate between wintering and calving/summer areas. The following sections evaluate the potential effects of the Project on these herds, including:

- indirect mortality due to increased human population near Bathurst Inlet hunting on Dolphin and Union caribou;
- the effect of shipping on the movements of Dolphin and Union caribou; and

- the effect of shipping on the movements of Peary caribou.

Human populations are not expected to increase due to the Project along the shipping route north of Cambridge Bay in the Peary caribou range due to very low human settlement or projected increases in settlement. Hence, increased hunting pressure is not evaluated for the Peary caribou.

4.1.4.1 Indirect Mortality

Construction of the road may facilitate hunting pressure on caribou. However, socio-economic studies report that an increase in immigration and hunting pressure is unlikely (Appendix F-2 of the DEIS).

4.1.4.2 Disruption to Movement

Dolphin and Union Herd

If shipping activity breaks ice in Dease Strait or the Queen Maud Gulf during the migration period, Dolphin and Union caribou migration may be blocked or animals may fall through recently broken or thin/unstable ice. Analysis of satellite collar data from Dolphin and Union caribou indicate that spring migration occurs from April 21 to July 9, while fall migration occurs from October 21 to December 3 (Mathieu Dumond, Government of Nunavut, *unpublished data*). COSEWIC states that shipping and ice breaking make Dolphin and Union caribou "vulnerable to die-offs similar to those that have affected Peary caribou" (COSEWIC, 2004). The draft WKRLUP also expresses concern for caribou at ice crossings between Victoria Island and the mainland and stipulates that shipping "may not take place outside the normal open water season between July 1 and October 15" (NPC, 2005).

Shipping activities for the Project are planned to occur only during the open water season with no ice breaker support in Dease Strait or the Queen Maud Gulf to extend the normal shipping season. Changes in sea ice coverage through climate change may alter the migratory dates of these caribou by altering the quality, coverage and timing of thaw and freeze up (COSEWIC, 2004). The primary concerns related to shipping in Arctic waters are accidents and malfunctions resulting in pollution. This effect is addressed in Appendix E-6 of the DEIS.

Peary Caribou

Peary caribou from the Prince of Wales-Somerset and Boothia Peninsula groups cross the shipping route through Peel Sound and Franklin Strait during movement between calving areas on Prince of Wales Island and wintering areas on Somerset Island and the Boothia Peninsula (COSEWIC, 2004; Miller *et al.*, 2005). Inuit groups and biologists have expressed concern over the effects of shipping and ice breaking on the inter-island movements of Peary caribou (Miller and Gunn, 1978, 1980; COSEWIC, 2004). During spring migration, the majority of Peary caribou cross Peel Sound and Franklin Strait from May through June over ice (COSEWIC, 2004; Miller *et al.*, 2005). However, data are not available for the period when caribou cross Peel Sound and Franklin Strait during fall migration. Traffic from the proposed shipping route was mentioned as a specific concern by Inuit hunters at meetings of the Kitikmeot Hunters and Trappers Association (COSEWIC, 2004). Peel Sound and Franklin Strait remains over 50% ice-covered for most of the year, only breaking up from mid-August to mid-October in some years

(Figures 4.1-18 and 4.1-19). Examination of expected shipping seasons for a ten year period in the Peel Sound area, indicated only three years showed an open water shipping season of more than three weeks and four years showed a likelihood of no open water shipping season, except for pockets of less than one week scattered through the summer (Dickins, 2004; Chapter 3, Appendix E-10 of DEIS). Climate warming may change the timing of freeze-up and break-up of sea ice, potentially disrupting Peary caribou inter-island movements (COSEWIC, 2004). If ice-breaking occurs in Peel Sound and Franklin Strait, even using of ice-tolerant ships, Peary caribou migration may be disrupted by open water, partially frozen tracks left in the ice by ships, and animals are at risk of drowning as they cross freshly frozen or unstable ice (COSEWIC, 2004).

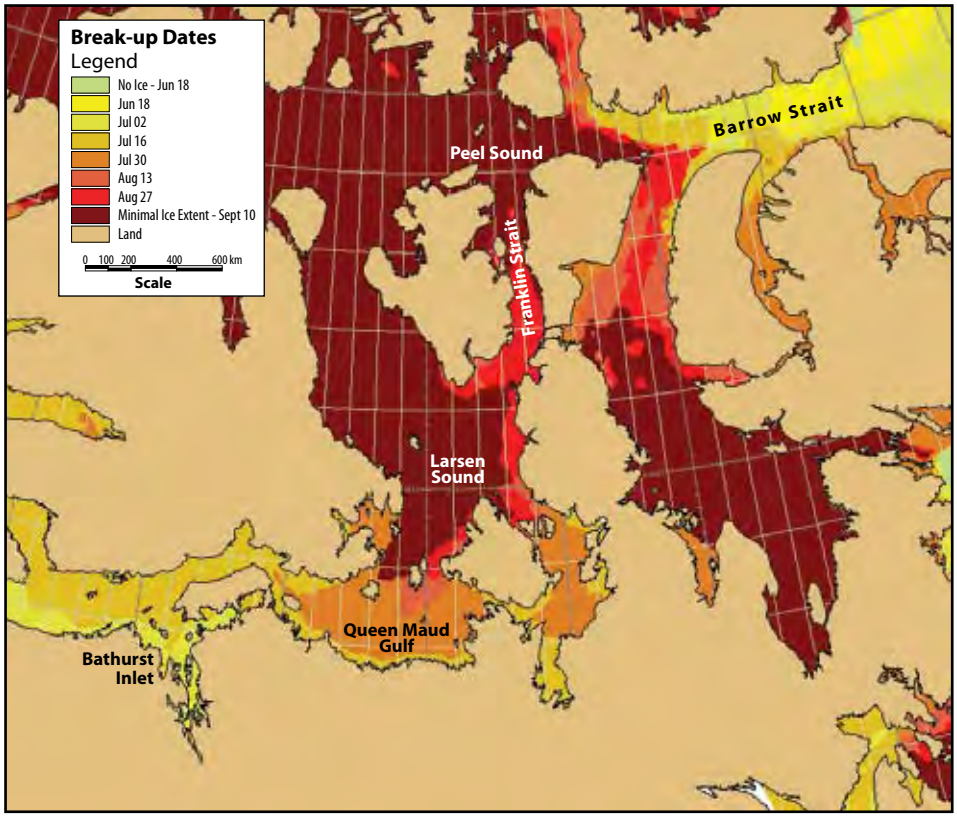
4.1.5 Caribou Conclusion

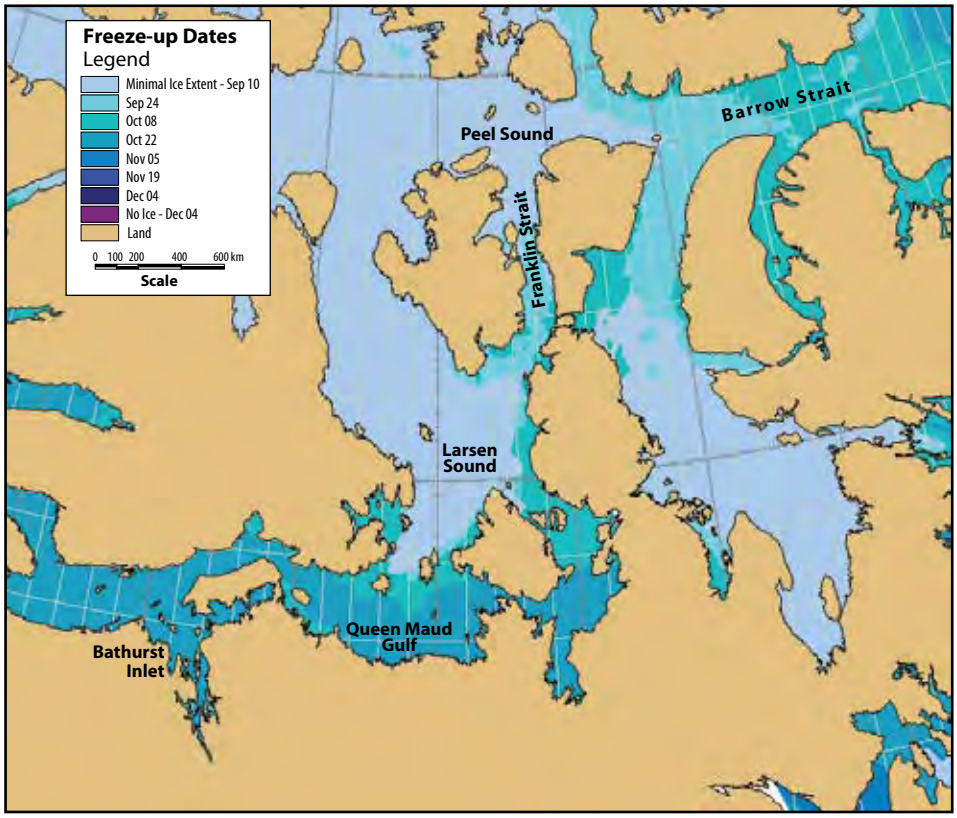
Given the Project Description, potential effects of development projects on caribou elsewhere, and existing studies of caribou in the area, the following effects have been identified as low or moderate in significance for caribou (with mitigation):

- direct and indirect habitat loss on Bathurst caribou;
- disruption of movement of Bathurst and Ahiak herds during early spring migration, specifically between April 15 to April 30 and disruption of movement for the Bathurst herd during the post-calving season;
- disruption of movement of Ahiak herd during winter are expected due to road traffic volumes at that time;
- displacement of caribou during calving and post-calving periods, particularly of the Bathurst herd during post-calving, due to the location of the road within in the known extent of post-calving grounds for the Bathurst herd;
- a potential for increased mortality through wildlife-vehicle collisions, increased predation and increased hunting;
- shipping and its effects on sea ice and hence migration of Dolphin and Union caribou and Peary caribou across ice bridges, particularly in the fall; and
- overall potential for synergistic effects leading to a reduction in caribou reproductive success.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for Bathurst caribou, Ahiak caribou and Dolphin and Union caribou are predicted to be ***Low***, and the combined significance of residual effects for Peary caribou is predicted to be ***Moderate***. Details of how individual effects of the project are predicted for caribou are outlined in Table 4-1 and Table 4.1-4.

Despite these predicted potential effects, the population-level consequences of developments such as the Project are unclear. Arctic caribou herds have shown large decadal fluctuations in abundance and separating the effects of development from other sources of variation (climate, food abundance and predation) may be difficult. Therefore, the size and health of the herds in the areas surrounding the Project should continue to be monitored. Natural variation can be accounted for using nested statistical designs in analyzing caribou data, allowing for better detection of Project-related effects.





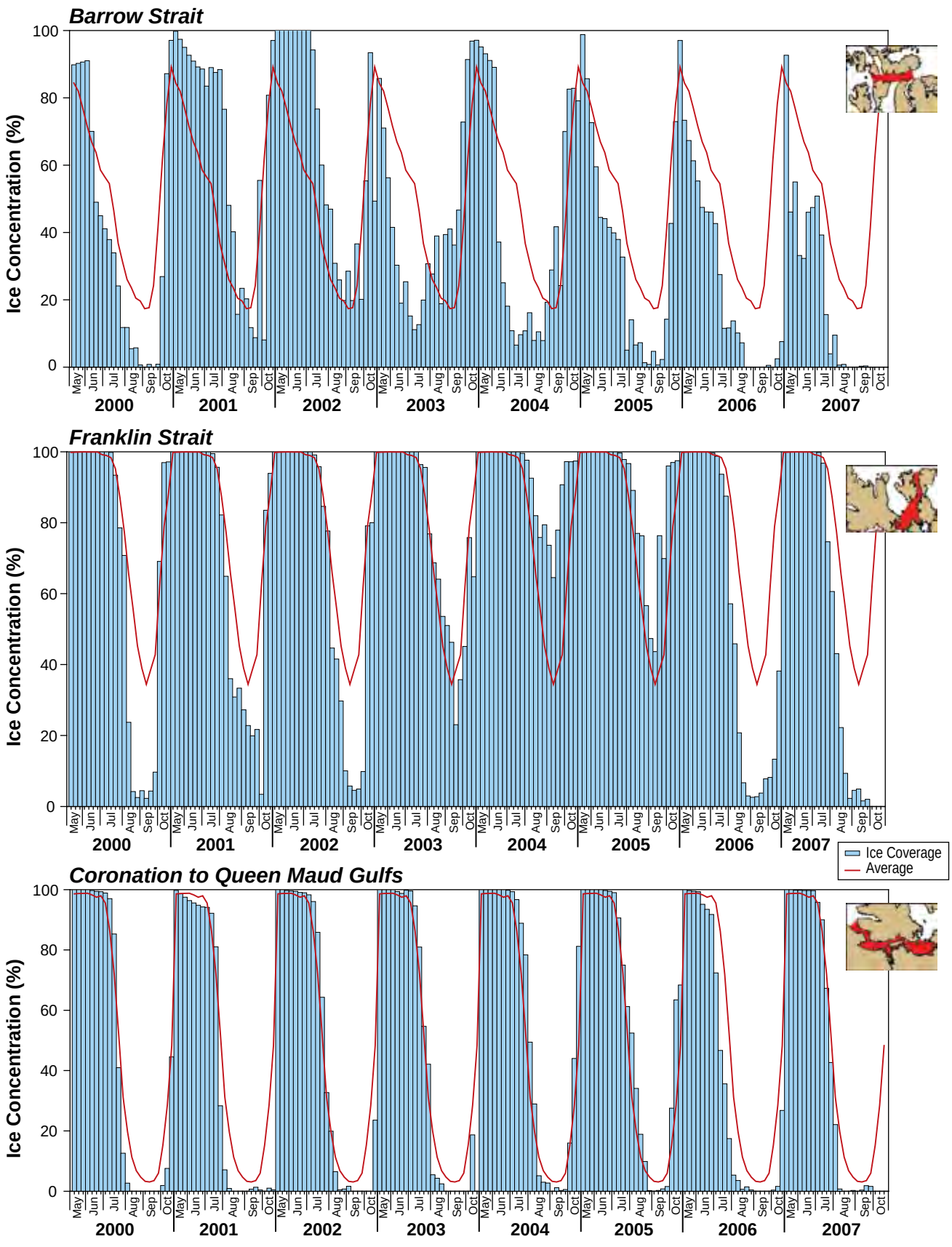
Source: Environment Canada (2007)

the BATHURST INLET PORT AND ROAD PROJECT

Average Ice Break-up and Freeze-up Dates, 1971 to 2000

FIGURE 4.1-18

Rescan™



Note: Red line indicates 1971 to 2000 average
Source: Environment Canada (2007)

the BATHURST INLET PORT AND ROAD PROJECT

Historical Weekly Ice Coverage, 2000 to 2007

FIGURE 4.1-19

Rescan™

Table 4.1-4
Residual Effects Rating for Caribou

VEC	Habitat Loss	Disturbance	Disruption to Movement	Features Acting as Attractants	Direct Mortality	Indirect Mortality	Reduction in Reproductive Productivity
Bathurst	Low	Low	Low	Negligible		Negligible	Low
Ahiak		Low	Low	Negligible		Negligible	Low
Dolphin and Union	--	--	Low	--	--	Negligible	--
Peary	--	--	Moderate	--	--	--	--

4.2 Muskox

Muskox have been identified as a Valued Ecosystem Component due to their cultural significance to Inuit people, their importance in Arctic food webs, and their sensitivity to disturbance. Muskox are particularly sensitive to disturbance during the late winter/calving season (April 1 to June 15) (Gunn and Case, 1984). Although the abundance of muskox in the West Kitikmeot region of Nunavut has increased over the past three decades (Fournier and Gunn, 1998), populations on mainland Nunavut have experienced recent declines and calf production has been low (Dumond, 2006). These animals are recovering from near-extinction in the late 19th and early 20th centuries (Fournier and Gunn, 1998; Campbell and Setterington, 2001).

Muskox have been observed throughout the RSA where they occur at low densities throughout the year (Appendices D-7 and D-9 of the DEIS). The following sections assess the potential impacts of the Project on muskox in the RSA, including:

- habitat loss;
- disturbance to feeding and breeding;
- disruption to movement;
- increased mortality (direct and indirect); and
- reduction in muskox productivity due to a combination of the previous effects.

Detailed information on the distribution, seasonal habitats, population trends and observations of muskox in the RSA are available in Section 2.

4.2.1 Spatial Boundary

The spatial boundary of the effects assessment for muskox covers the RSA, which extends 30 km from the road, port and camp. For some effects, such as disturbance and behavioural changes, effects of the Project may be limited to the RSA. Other effects, such as reduction in productivity and the potential for hunting along the road, are evaluated against the long-term stability of the MX/14 muskox population as a whole.

4.2.2 Potential Effects

4.2.2.1 Terrestrial Habitat Loss

Construction of the road, port facility and Contwoyto Camp will result in the direct removal of muskox habitat within the RSA. Habitat types in these areas were identified using ecosystem mapping (Appendix D-1 of the DEIS) and rated against habitat requirements for muskox using habitat suitability ratings (Appendix D-8 of the DEIS).

Habitat Suitability Ratings were done for sensitive periods for muskox; late winter/calving (April 1 to June 15) and rutting/autumn (August 15 to September 15). In late winter/calving, muskox must replenish fat reserves that become low or depleted during the winter (Reynolds *et al.*, 2002). In addition, calving occurs during this time and cows require high quality forage for pregnancy and lactation (Gunn and Sutherland, 1997; Reynolds *et al.*, 2002). During rutting/autumn, muskox require high quality forage in order to breed successfully and fatten-up for the coming winter (White *et al.*, 1989; Adamczewsk *et al.*, 1998; Reynolds *et al.*, 2002). Habitat suitability rating for muskox identified 1,309,515 ha of suitable late winter/calving habitat (87% of the RSA) and 1,135,736 ha of suitable rutting/autumn habitat (75% of the RSA) within the RSA. Project development will result in the direct loss of 387 ha (0.03 %) of late winter/calving habitat and 382 ha (0.03 %) of rutting/autumn habitat.

In addition to direct habitat loss, indirect loss of habitat can occur through the degradation of areas surrounding the Project footprint, such as due to dust accumulation and reduced foraging quality. Muskox habitat in the RSA will be degraded around the Project footprint; 235 ha (0.02%) will be heavily degraded, while 4,377 ha (0.4%) will be lightly degraded in late winter/calving. Two-hundred and thirty-two hectares (0.02%) will be heavily degraded and 4,331 ha (0.4%) will be lightly degraded in rutting/autumn.

4.2.2.2 Disturbance to Feeding and Breeding

Disturbances, including visual and auditory stimuli, can cause muskox to alter their regular behaviour patterns, resulting in lost feeding time, stress, reduced reproductive potential, or avoidance of disturbed areas (McLaren and Green, 1985). For example, muskox herds often run from people on foot, snowmobiles or other vehicles (Gray, 1973; Russell, 1975). Very young calves can be left behind when muskox herds stampede (Gunn and Adamczewski, 2003). Sensitive periods occur during late winter/calving (April 1 to June 15) and rutting/autumn (August 15 to September 15) when animals are calving and developing fat reserves critical for reproduction and survival. However, late winter/calving is potentially the most sensitive period for muskox because animals are in their poorest condition at the end of winter and have high energetic demands during calving. Muskox are also likely to avoid areas with visual and auditory disturbances resulting in indirect habitat loss. However, some muskox can become tolerant of noise and related industrial activity as was shown by a herd that spent the summer months in close proximity of Lupin mine.

The Central Mainland muskox population is found throughout mainland West Kitikmeot at low densities (Gunn, 1990; Dumond, 2007). The highest densities for this population occur outside the RSA, in the northwestern portion of mainland West Kitikmeot (Dumond, 2007). An

estimated 1,732 muskox inhabit this 17,071 km^2 area and the proportion of calves relative to total muskox is estimated at 6.5% (Dumond, 2007). An estimated 374 muskox inhabit a 20,302 km^2 area that overlaps the RSA and the proportion of calves relative to total muskox is estimated at 6.1%. Although the population estimate for the RSA is lower than that for the northwestern portion of mainland West Kitikmeot, the proportion of calves in the population is comparable; therefore, the RSA is a relatively productive area for muskox. This increases the importance of potential disruption to feeding and breeding due to the Project for these animals.

Muskox were close to extinction in the late 19th and early 20th centuries due to overhunting (Fournier and Gunn, 1998; Campbell and Setterington, 2001). While muskox numbers have generally increased over the last three decades (Fournier and Gunn, 1998; Campbell and Setterington, 2001), muskox in the RSA have experienced recent population declines and calf production is low (Dumond, 2007). Muskox in the RSA may be at risk from disturbances and habitat loss due to developments, which may exacerbate the already low population and calf numbers. The current decline in muskox numbers increases the importance of potential disruption to feeding and breeding due to the Project for muskox.

Road

The proposed road covers the largest area of the RSA and the potential effects of the road are greater than those of the port or camp for causing potential indirect habitat loss. Muskox are likely to avoid active roads, even at low traffic densities. For example, McLaren and Green (1985) observed muskox reacting to the start-up of a snowmobile engine over 1 km away and to the acceleration of a vehicle. Muskox are found in the vicinity of the proposed road year-round and are expected to avoid the road during hauling periods (January 1 to April 30) and to a lesser degree outside the hauling season (May 1 to December 31) when very low traffic levels for road maintenance are expected. Furthermore, explosions and boulder crushing at quarries are expected to generate significant disturbance to muskox, especially during construction.

Port Facility

The port facility is expected to produce relatively high levels of visual and auditory disturbances due to the level of activity, lighting and infrastructure present. Muskox are found in the vicinity of the port facility year-round.

Contwoyto Camp

Contwoyto Camp is a small 20 person camp which will produce relatively low levels of visual and auditory disturbance. Muskox are found in the vicinity of Contwoyto Camp year-round.

4.2.2.3 Disruption to Movement

Muskox have relatively small home ranges and migrate short distances between calving, rutting and wintering areas (Reynolds, 1998). In the winter, home range sizes of muskox are 27 to 70 km^2 and 223 km^2 in summer (Reynolds, 1998). Muskox have high fidelity to their home ranges and major shifts in distribution are rare (Reynolds *et al.*, 2002). When dispersing, mixed-sex groups of muskox move into areas already colonized by males.

The road, port facility and Contwoyto Camp, may disrupt movement of muskox by bisecting home ranges or impeding dispersal. Linear developments such as roads have been shown to fragment wildlife habitat across many taxa and are typically the greatest potential negative effect of a project on wildlife (Jalkotzy *et al.*, 1997).

Road

Features of roads that deflect ungulate movements in Alaska and Arctic Canada have high traffic levels (Murphy, 1988; Rescan, 2007a), adjacent linear features (*e.g.*, road with parallel pipeline or powerline) (Murphy and Curatolo, 1987), a height of > 1.2 m above ground level (Hanson, 1981; Curatolo and Murphy, 1986; Eide *et al.*, 1986; Murphy and Curatolo, 1987; Lawhead, 1988) or a snow bank height of > 0.5 m (Rescan, 2007a).

The proposed road has variable traffic levels, no adjacent linear feature and its height will vary from 1.05 to 2.05 m. Traffic levels on the road will be highest from January 1 to April 30 during the operations phase of the Project. During this time, traffic volumes will potentially be high enough (> 60 vehicles/day) to act as a 'semi-permeable' barrier to muskox movement. For the remainder of the year and during the construction phase, traffic volumes are expected to be very low and restricted to road maintenance vehicles and road construction equipment, respectively.

The proposed road may disrupt movements of muskox between feeding areas within home ranges during the sensitive periods of late winter/calving (April 1 to June 15) and rutting/autumn (August 15 to September 15). The period of high traffic volume on the proposed road overlaps the muskox calving period in April. If animals are prevented from accessing high quality foraging areas during this energy-demanding period, calf production could be negatively impacted and the muskox population in the RSA could be affected. In addition, high traffic volumes on the proposed road overlap the winter season for muskox from January 1 to March 31 during the operations phase. Animals are food-limited during the winter and require access to optimal feeding areas (Jingfors, 1980).

Port Facility and Contwoyto Camp

The proposed port facility and Contwoyto Camp may act as barriers to seasonal movements or dispersal of muskox. However, these Project components are concentrated in specific locations and do not cross large continuous portions of tundra as does the proposed road.

4.2.2.4 Mortality

The proposed road, port facility and Contwoyto Camp may cause increased mortality to muskox either directly or indirectly. Muskox may be injured when crossing roads due to collisions with vehicles (direct mortality) or they may experience higher predation if predators are attracted to the Project infrastructure for denning or as travel routes for hunting (indirect mortality).

Direct Mortality

The primary source of direct mortality for muskox is through collisions with vehicles on the road. Muskox are residents of the RSA year-round and may come into contact with the road during the heavy traffic period from 1 January to 30 April.

Indirect Mortality

The potential sources of indirect mortality for muskox due to the Project are increased predation from wolves and grizzly bears and a possibility of increased hunting. Ungulate mortalities attributed to wolf predation tend to be closer to linear corridors than the average location of ungulates, indicating that ungulates that are close to linear corridors are at a higher risk of predation (James and Stuart-Smith, 2000). Unless the total number of predators increase in the RSA, this effect will likely result in a re-distribution of the locations where muskox are most at risk of predation in the RSA and will not likely result in population-level consequences for this species.

4.2.2.5 Reduction in Reproductive Productivity

The muskox population in the RSA is currently declining and reproductive rates are low (Dumond, 2007); therefore, effects due to the Project that reduce reproductive productivity could be particularly detrimental to these animals. Most Project effects have the potential to reduce muskox productivity and synergistic interactions between these effects may exacerbate these effects. Disturbances from visual and auditory stimuli will potentially have the greatest impact on muskox productivity, resulting in indirect habitat loss, increased stress behaviours or reduced feeding time, particularly during sensitive periods (late winter/calving from April 1 to June 15, and rutting/autumn from August 15 to September 15).

4.2.3 Muskox Conclusion

Given the Project Description, potential effects of development projects on muskox elsewhere, and existing studies of muskox in the area, the evaluation of residual effects identified as ***Negligible*** or ***Low*** for muskox are as follows:

- habitat loss from construction of the road, port facility and Contwoyto Camp, rated ***Low***;
- disturbance of feeding and breeding behaviours from Project construction and operations, rated ***Low***;
- disruption of movement, rated ***Negligible***;
- increased mortality (direct and indirect), rated ***Negligible***; and
- reduced productivity due to synergistic effects of the Project, rated ***Low***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for muskox is predicted to be ***Low***. Details of how individual effects of the project are predicted for muskox are outlined in Table 4-1.

4.3 Grizzly Bear

Grizzly bears were selected as a Valued Ecosystem Component in this assessment because of their cultural significance to the Inuit, their territorial and federal conservation status, their low ecological resiliency, and the potential for human-bear interactions. Scientific research has found that grizzly bears have low ecological resiliency (capacity to absorb disturbance or stress and recover to a similar state before the stress was imposed), are sensitive to human activity, and are

frequently displaced by industrial developments (McLellan, 1990; Weaver *et al.*, 1996; Ross, 2002).

This document assesses the potential impacts of the Project on grizzly bears in the RSA. In particular, this assessment evaluates the following potential effects:

- habitat loss;
- disturbance to feeding, breeding and denning;
- disruption to movement;
- features acting as attractants;
- mortality (indirect); and
- reduction in grizzly bear reproductive productivity due to a combination of the previous effects.

Detailed information on the distribution, seasonal habitat use, population trends and grizzly bear observations in the RSA are available in the Wildlife Environmental Setting (Section 2.5.1).

4.3.1 Spatial Boundary

The spatial boundary for the grizzly bear effects assessment is the RSA, a 30 km buffer around the port, camp and road, due to the large home ranges (2,000 km^2 to 7,000 km^2) of this species.

4.3.2 Potential Effects

4.3.2.1 Terrestrial Habitat Loss

Direct habitat loss will occur due to construction of the road and Contwoyto camp (379 ha combined) and the port facility (38 ha). When significant areas of habitat are removed, which subsequently leads to a reduction in food availability, wildlife populations can be affected. Typically, however, habitat loss is secondary to the effects of disruption of movement and wildlife avoidance (Wolfe *et al.*, 2000).

Habitat types in the Project areas were identified using Ecosystem Mapping (Appendix D-1 of the DEIS) and rated against habitat requirements for grizzly bears using Wildlife Suitability Rating (Appendix D-8 of the DEIS) within the RSA. Suitable habitat is defined as habitat receiving a moderate or high habitat rating.

Grizzly bear habitat use varies during the year and was rated for each season, yielding 803,294 ha of spring habitat, 1,129,718 ha of summer habitat, 803,294 ha of fall habitat and 938,832 ha of winter (hibernation) habitat in the RSA. The Project will occupy 417 ha, of which 381 ha (0.05%) of spring habitat, 372 ha (0.03%) of summer habitat, 380 ha (0.05%) of fall habitat, 322 ha (0.03%) of winter habitat will be directly lost (Table 4.3-1).

In addition to direct habitat loss, indirect loss of habitat can occur through the degradation of areas surrounding the Project footprint, due to dust accumulation and reduced foraging quality.

Indirect habitat loss results in the degradation of 0.39 % to 0.57 % of suitable grizzly bear habitat in the RSA (Table 4.3-1).

The amount of suitable grizzly bear habitat that will be lost as a result of Project development represents a small portion of the total amount of suitable habitat available in the study area. The carrying capacity of the habitat for grizzly bear at the landscape level is therefore unlikely to be affected either during construction, operations or upon reclamation after closure.

Table 4.3-1
Suitable Grizzly Bear Habitat in the RSA, Habitat Lost and Degraded

Season	Habitat in the RSA	Habitat Lost	Percent RSA Lost	Habitat Degraded	Percent RSA Degraded
Spring	803,294 ha	381 ha	0.05%	4,493 ha	0.56%
Summer	1,129,718 ha	372 ha	0.03%	4,465 ha	0.39%
Fall	803,294 ha	380 ha	0.05%	4,477 ha	0.57%
Winter	938,832 ha	322 ha	0.03%	3,629 ha	0.39%

4.3.2.2 Disturbance to Feeding, Breeding and Denning

Project activities along the road, port facility and Contwoyto Camp may alter the behaviour, health, or distribution of grizzly bears in the RSA. Noise from construction operations, such as blasting, truck traffic and aerial support, are likely sources of anthropogenic disturbance to grizzly bears. Animals may spend more time being vigilant or less time feeding in response to auditory or visual disturbances. In response, animals may experience high metabolic stress levels (AMEC Americas Limited, 2005). Finally, grizzly bears may avoid areas surrounding Project infrastructure leading to potential indirect habitat loss. This section evaluates the potential effects of potential Project-related disturbances on grizzly bear feeding, denning and breeding success.

Contwoyto Camp is a small, 20 person camp which will produce relatively low levels of visual and auditory disturbance. The port facility is expected to produce relatively high levels of visual and auditory disturbances due to the level of activity, lighting, and infrastructure present. The magnitude of potential disturbance to grizzly bears is likely moderate. However, both these facilities cover a very small portion of the RSA and are thus unlikely to cause significant disturbance to grizzly bears. The road covers the largest area of the RSA and the potential effects of the road are larger than those of the port or camp. Thus, the potential effects of disturbances are mainly discussed for the road, but effects due to the port and camp are mentioned as needed.

Feeding

Auditory and visual disturbances caused by construction and operations, such as blasting, may stress grizzly bears in the vicinity of the activities and lead to reduction in foraging time (AMEC Americas Limited, 2005). Johnson *et al.* (2005) estimated that major development projects and

their associated infrastructure had a negative effect on habitat use by grizzly bears up to a distance of 23 km from the sites.

Denning and Breeding

Disturbance to denning grizzly bears may result in increased movement of bears away from dens which leads to elevated energy expenditure (Reynolds *et al.*, 1986), den abandonment (Reynolds *et al.*, 1976), possible loss of cubs (Schoen *et al.*, 1987) and displacement from denning habitats (Craighead Jr. and Craighead, 1972). Females in particular are vulnerable to the effects of disturbance at their den sites (Linnell *et al.*, 2000). Reduced reproductive success of pregnant females has been documented as a result of den disturbance and den abandonment has been linked to a greater probability of death for dependent offspring (Linnell *et al.*, 2000; Ross, 2002).

Research has shown that hibernating bears are unlikely to be disturbed by anything but extreme noise events (Amstrup, 1993; Linnell *et al.*, 2000). Even the noise resulting from blasting may have a limited effect on hibernating grizzly bears, as the dens are usually acoustically isolated when covered with snow (Linnell *et al.*, 2000). Yet a threshold distance likely exists, although this has never been determined for barren-ground grizzly bears. Blasting and other major disturbances in the immediate vicinity of a den are highly likely to disturb a bear, if not kill it.

The construction and operation of the Project could influence the selection of grizzly denning areas over time. For example, Linnell *et al.* (2000) and Petram *et al.*, (2004) indicated that, although grizzly bears may tolerate human activity and noise during denning if the disturbance is >1 km from the den site, they will tend to avoid human activity areas when selecting den sites.

4.3.2.3 Disruption to Movement

Grizzly bears maintain large home ranges that include separate seasonal habitats. Travel routes within and between habitats are variable and in most cases not easily identifiable across the landscape. There have been numerous studies that investigate the effects of development, specifically roads, on the movements of grizzly bears that can be used to make predictions (Archibald *et al.*, 1987; McLellan and Shackleton, 1988, 1989; Mace *et al.*, 1996; Benn and Herrero, 2002; Wielgus *et al.*, 2002; Johnson *et al.*, 2005; Waller and Servheen, 2005).

Port

The development of the port on Bathurst Inlet is unlikely to result in the isolation of grizzly bear habitats. The port is located on a peninsula, and while the presence of physical structures such as a fuel tank farm and sediment ponds, may result in bears avoiding the area, the port facility is unlikely to impede the movement of bears between and within habitats.

Road

The road may act as an inhibitor of grizzly bear movements. Studies report that bears can avoid roads by 500 m and that the degree of avoidance is related to vehicle traffic (Mace *et al.*, 1996; Benn and Herrero, 2002; Wielgus *et al.*, 2002; Waller and Servheen, 2005). Females are particularly sensitive and avoid crossing large roads in some parts of their range (Ross, 2002; Waller and Servheen, 2005). Other studies show that bears will cross roads when needed, particularly low traffic roads (Gibeau and Herrero, 1998). Since the road will have limited

traffic volumes between May and September when grizzly bears are active, it is unlikely to act as an inhibitor of grizzly bear movements.

Contwoyto Camp

Contwoyto Camp will occupy 1.5 ha of suitable bear habitat, which is negligible in comparison to the overall home range of grizzly bears. Although physical structures may influence movements of bears, their effect is expected to be minimal at the landscape scale.

4.3.2.4 Features Acting as an Attractant

Features of the Project that may act as attractants to grizzly bears, which could subsequently lead to increased human-bear interactions and grizzly bear mortality include:

- camp sites;
- the road acting as a movement corridor; and
- road verges (edges) due to the presence of road-killed carrion or discarded waste.

Contwoyto Camp, Port Camp and Construction Camps

Both scientific observation (Herrero, 1985) and the NTKP (Appendix F-5 of the DEIS) indicate that grizzly bears can be attracted to human settlements in search of food. Benn and Herrero (2002) studied grizzly bear mortality in Banff and Yoho National Parks in BC and found that the destruction of problem bears accounted for over 70% of bear mortality, more so than traffic-related deaths and increased hunting impacts. Bears are particularly attracted to landfills, as well as aromatic waste material such as oils and aerosols. This attraction to project sites increases the potential for wildlife-human interaction and therefore an increased potential for grizzly bears to become nuisance animals.

Road and Quarries

Closed roads or roads with little traffic are frequently used as travel routes by large carnivores (unpublished reports referenced in Jalkotzy *et al.* (1997)). In addition, carnivores are attracted to roads by vehicle-killed wildlife and waste discarded during construction and operations. Both issues serve to increase the risk of bear-vehicle interactions.

4.3.2.5 Mortality

The port, camp and road may cause increased mortality to grizzly bears either directly or indirectly. Grizzly bears may be injured when crossing roads (direct mortality) or may experience higher mortality due to increased hunting in the region (indirect mortality).

Direct Mortality

Benn and Herrero (2002) studied grizzly bear mortality and found that a major source of mortality occurs near (within 200 m) of roads, with vehicle-bear interactions accounting for 19% of all deaths. Thus, direct mortality due to collisions with vehicles along the road was identified as a potential effect for grizzly bears. However, the grizzly bear population in the region is small and limited traffic is expected on the road during the active bear season.

Indirect Mortality

In southeastern Alaska, where grizzly bears are legally hunted, there was a direct positive correlation between bear kills by hunters and cumulative kilometers of constructed roads (Titus and Beier, 1991). However, socio-economic studies in the BIPAR RSA and vicinity report that hunting is not expected to increase in the region (Appendix F-2 of the DEIS).

4.3.2.6 Reduction in Grizzly Bear Productivity

The potential for a reduction in reproductive productivity of grizzly bears, and the significance of the reduction, would depend on a number of factors, including the degree of disturbance, as well as the number, sex and age-class of individuals of each species killed as a result of direct mortality and the influence of these factors on the demographics of the local population. These effects may synergistically reduce grizzly bear productivity.

4.3.3 Grizzly Bear Conclusion

Given the Project Description, potential effects of development projects on grizzly bear elsewhere, and existing studies of grizzly bear in the area, the evaluation of residual effects identified as ***Negligible*** or ***Low*** for grizzly bear are as follows:

- terrestrial habitat loss, rated ***Negligible***;
- disturbance to feeding, breeding and denning, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- features acting as attractants, rated ***Low***;
- mortality (direct and indirect), rated ***Negligible***; and
- reduction in grizzly bear reproductive productivity due to a combination of the previous effects, rated ***Low***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for grizzly bear is predicted to be ***Low***. Details of how individual effects of the project are predicted for grizzly bear are outlined in Table 4-1.

4.4 Wolverine

Wolverines were chosen as a VEC because of their cultural significance to the Inuit, their territorial and federal conservation status, economic value as an important fur-bearing species and their role as indicator species. Due to their low population densities and low reproductive rates and dependence on large, connected and intact ecosystems, wolverines are possibly the most sensitive terrestrial wildlife indicator of ecological integrity (COSEWIC, 2003).

This section assesses the potential impacts of the Project on wolverines in the RSA. The following potential effects are evaluated:

- terrestrial habitat loss;

- disturbance to feeding, breeding and denning;
- disruption to movement;
- Project facilities acting as attractants;
- mortality due to wildlife-vehicle collisions and increased hunting pressure in the RSA; and
- reduction in productivity due to the previous effects.

Detailed information on the distribution, seasonal habitat use, population trends and wolverine observations in the RSA are available in the Wildlife Environmental Setting (Section 2.5.2).

4.4.1 Spatial Boundary

Studies conducted near the Project area in the Kitkmeot region estimated that the home range of male wolverines average 400 km^2, and that females range over significantly smaller areas (126 km^2). These same studies also found that juveniles range over larger areas than mature animals (Lee, 1997; Mulders, 2000). Therefore, the caribou RSA was selected as the environmental assessment area for wolverines.

4.4.2 Potential Effects

4.4.2.1 Terrestrial Habitat Loss

Due to a wolverine's large home range, low population density and low reproductive rate, they require vast areas of habitat to sustain viable populations (COSEWIC, 2003). Direct habitat loss will occur from construction of the road, port facility, and Contwoyto Camp. When significant areas of habitat are removed, which subsequently leads to a reduction in food availability, wildlife populations can be affected. Habitat loss can also have an indirect effect on wildlife by causing degradation in habitat surrounding the impact zones.

Habitat types in the Project areas were identified using Ecosystem Mapping (Appendix D-1 of the DEIS) and rated against habitat requirements for wolverines using Habitat Suitability Rating in the RSA (Appendix D-8 of the DEIS).

Of the 417 ha of wildlife habitat directly lost during this Project, 389 ha will be suitable wolverine denning habitat and growing/pup rearing habitat. Of the suitable habitat identified within the RSA, approximately 0.03% of denning habitat and growing/pup rearing habitat will be lost.

Of the 245 ha of land that will be heavily degraded and 45,764 ha what will be lightly degraded within the Project footprint, the following amounts of suitable wolf habitat in the RSA will be altered: 235 ha (heavily degraded) and 4,394 ha (lightly degraded) for both the denning habitat and growing/pup rearing habitat. Of the suitable habitat in the RSA, these areas (heavily and lightly degraded) represent approximately 0.3% of denning and growing/pup rearing habitats. The total area that will be modified (lost and degraded) within the RSA is 5,019 ha (0.4%) for both wolverine habitats.

4.4.2.2 Disturbance to Feeding, Breeding and Denning

The behaviour, distribution and population of wolverines in the RSA may be affected by disturbance from Project activities, including noise from construction operations and trucks. Wolverines are known to avoid areas of human activity and hide during aircraft overflights (AXYS Environmental Consulting Ltd. and Penner and Associates Ltd., 1998), resulting in animals spending more time being vigilant or less time feeding or increased metabolic stress levels. Wolverines may also avoid areas surrounding Project infrastructure leading to indirect habitat loss.

Feeding

Wolverine feeding behaviour may be affected in areas with relatively high human activity and/or vehicular traffic, such as near the road and around work sites. Wolverines have been found to avoid areas of high human activities, which reduce the amount of suitable foraging habitat.

It is important to note that ungulates are an important food source for wolverines and any disturbance to the behaviours and movements of caribou and muskox may result in negative effects on wolverines. Any disturbance that has a negative effect on prey populations will have a negative effect on the associated predator population.

Denning and Breeding

Although little is known about wolverine breeding habits, research has shown that den sites used for pup rearing, resting and storing food are crucial to wolverine survival. Disturbance during the late winter denning period may result in females and their litters relocating or abandoning dens (Magoun and Copeland, 1998; Heinemeyer *et al.*, 2001). Disturbances during the construction and operation phases of this Project may influence the selection of wolverine denning areas over time. A wolverine den was located in the study area during baseline studies in 2001 to 2002.

4.4.2.3 Disruption to Movement

Wolverines have large home ranges and are known to travel long distances across varying terrain. Movement between habitats and their ability to follow prey is critical for maintaining populations in the Arctic environment.

Port

The proposed marine port at Bathurst Inlet will occupy approximately 88 ha of suitable wolverine habitat. Although the existence of physical structures such as a truck stop and sewage treatment plant may affect movements of individual wolverines, large areas of continuous habitat will remain.

Road

Wolverines prefer large, untouched areas, yet their home ranges have been found to overlap active traplines, busy logging roads and the edges of communities (COSEWIC, 2003). Nonetheless, transportation corridors are a significant source of wolverine mortality and roads may act as semi-permeable barriers to movements and dispersal. In British Columbia, wolverines avoided areas within 100 m of the Trans Canada Highway and preferred areas more

than 1,100 m away (Austin, 1998). This same study found that wolverines chose narrow crossings less than 100 m wide, which suggests that the proposed road route will not significantly restrict movements, since the road will be 17.2 m across at its widest point. The effects of the road on wolverine movements are likely to be related mainly to the presence of vehicles and humans, not the presence of the road itself. The heavy traffic expected during the winter season will likely disrupt wolverine movements.

Contwoyto Camp

Contwoyto Camp will occupy a very small area of suitable wolverine habitat, which is very small in comparison to the overall home range of this species. The presence of physical structures may influence movement behaviour of wolverines.

4.4.2.4 Features Acting as an Attractant

Features of the Project that may act as attractants to wolverines, which could subsequently lead to increased human-wolverine interactions and wolverine mortality include:

- camp sites (due to the presence of inaccessible wastes);
- road verges (edges) that may hold road killed carrion; and
- the road acting as a movement corridor.

Contwoyto Camp, Port Camp, and Construction Camps

Wolverines are curious and have been found to investigate and rob food from campsites, food caches and empty cabins (COSEWIC, 2003). As with grizzly bears, construction camps and the permanent camps at the port and Contwoyto Lake may act as attractants to wolverines looking for food. This attraction to Project sites increases the potential for wildlife-human interaction and therefore an increased potential for individuals to become nuisance animals.

Road

Wolverines, being scavengers, are likely to be attracted to the road by road killed wildlife or prey using the road as movement corridors (*e.g.*, caribou). Also, wolverines are known to use snowmobile and ski paths as travel routes, so the road may be used by wolverines as an energy efficient means of travel (unpublished reports referenced in Jalkotzy *et al.* (1997)). These attractions will increase the risk of mortality as a result of vehicle strikes or increased predation from both mammalian (*e.g.*, grizzly bears and wolves) and avian predators (*e.g.*, Golden eagles).

4.4.2.5 Mortality

The Project may cause increased mortality to wolverines, either directly or indirectly. Wolverines may be injured when crossing roads (direct mortality) or experience higher mortality due to increased hunting pressure in the region (indirect mortality).

Direct Mortality

Direct mortality of wolverine due to the Project may result from den destruction during construction and vehicle collisions on the road. Unweaned juveniles in dens could potentially be killed during construction of the road and operation facilities, particularly during periods of active

denning in late winter. However, only one den was located within 500 m of the Project footprint (LSA) during baseline surveys in 2001/2002 and mitigation plans include avoidance of active dens during construction.

Roads and other transportation corridors are significant sources of mortality to wolverines (COSEWIC, 2003). Given that the road passes through suitable wolverine habitat and the high volume of winter traffic expected on the road, it is likely that wolverines will come into contact with vehicles.

Indirect Mortality

Construction of the road may increase hunting pressure on wolverines. However, socio-economic studies report that an increase in immigration and hunting pressure is unlikely (Appendix F-2 of the DEIS).

4.4.2.6 Reduction in Wildlife Productivity

Wolverines have low population densities and reproductive rates, making them susceptible to disturbances. The loss of only a few individuals could have significant consequences for the entire population in the RSA. Changes to dispersal and feeding behaviours may increase stress, decrease physical condition and thus decrease reproductive success of wolverines.

4.4.3 Wolverine Conclusion

Given the Project Description, potential effects of development projects on wolverines elsewhere, and existing studies of wolverines in the area, the evaluation of residual effects identified as ***Negligible*** or ***Low*** for wolverine are as follows:

- terrestrial habitat loss, rated ***Negligible***;
- disturbance to feeding, breeding and denning, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- Project facilities acting as attractants, rated ***Low***;
- direct mortality due to wildlife-vehicle collisions, rated ***Low***;
- indirect mortality due to increased hunting, rated ***Negligible***; and
- reduction in productivity due to the previous effects, rated ***Low***, although the confidence of this assessment is low.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for wolverine is predicted to be ***Low***. Details of how individual effects of the project are predicted for wolverines are outlined in Table 4-1.

4.5 Wolf

Wolves are found throughout Nunavut and the species was selected as a VEC in this assessment because of its cultural role for the Inuit, its economic value as a fur-bearer, its importance for

maintaining wolverine populations as wolverines feed on carrion killed by wolves and its role as an indicator of ecosystem health because it is the main predator of caribou and muskox. Wolf distribution patterns, densities, territorial boundaries and dispersal movements are all influenced by prey abundance and distribution and by interactions between packs.

This document assesses the potential impacts of the Project on wolves in the RSA, including:

- habitat loss;
- disturbance to feeding, breeding and denning;
- disruption to movement;
- Project facilities acting as attractants;
- mortality due to wildlife-vehicle collisions and increased hunting pressure in the RSA; and
- reduction in productivity due to the previous effects.

Detailed information on the distribution, seasonal habitat use, population trends and wolf observations in the RSA are presented in the Wildlife Environmental Setting (Section 2.5.3).

4.5.1 Spatial Boundary

A study in the central Canadian Arctic estimated annual range sizes of approximately 63,000 km^2 for males and 45,000 km^2 for females (Walton *et al.*, 2001). The same study also indicated that winter ranges were larger than summer ranges. Due to the large range sizes of wolves in the Canadian Arctic, the RSA was selected for the environmental assessment area.

4.5.2 Potential Effects

4.5.2.1 Terrestrial Habitat Loss

Direct habitat loss will occur from construction of the road, port and Contwoyto Camp. When significant areas of habitat are removed, which subsequently leads to a reduction in food availability, wildlife populations can be affected. Typically, however, habitat loss is secondary to the effects of disruption of movement and wildlife avoidance (Walton *et al.*, 2001).

Habitat types in the Project area were identified using Ecosystem Mapping (Appendix D-1 of the DEIS) and Habitat Suitability Ratings were done in the RSA (Appendix D-8 of the DEIS) for the spring/denning and summer/pup rearing season. During the winter season, habitat requirement for wolves is primarily based on the distribution of caribou (Section 4.1). In the denning and pup-rearing season, wolves remain close to the den site; therefore, suitable habitat for wolves was only mapped in the LSA for this season. The LSA extends 500m on either side of the road, camp, and port facilities and encompasses approximately 1,500,000 ha.

During the denning and pup rearing period, a total of 2,328 ha of suitable habitat is available in the LSA, primarily in esker complexes. Of the 417 ha of wildlife habitat directly lost in this Project, 15 ha is suitable wolf denning habitat (0.6% of suitable habitat available in the LSA) and the remaining habitat has a low or nil habitat rating. Of the suitable habitat available to wolves

in the LSA, 6 ha will be heavily degraded and 80 ha will be lightly degraded. Thus, approximately 86 ha may be indirectly lost representing 3.7% of the suitable habitat in the LSA.

4.5.2.2 Disturbance to Feeding, Breeding and Denning

There are several sources of potential disturbance to wolves from this Project, including auditory disturbances from blasting during construction and visual disturbances from lights at operation facilities and vehicles travelling in darkness.

Feeding

Auditory and visual disturbances caused by construction and operations, such as blasting, may cause stress for wolves in the vicinity of these activities and lead to reduction in hunting. Noise from traffic on the road may lead to avoidance of important hunting areas, thus limiting the habitat effectiveness of these areas over time. However, most wolves follow the caribou herds for much of the year and wolf numbers will be very low in the LSA during the winter haul season.

Since wolves prey primarily on caribou, any disturbances that affect their primary food source will have a carry-over effect to wolves. Potential effects to caribou are discussed in Section 4.1.

Breeding and Denning

Research has found that some wolves seem to be tolerant of human activity near dens (Thiel *et al.*, 1998; Frame, 2005) whereas other research shows that wolves move pups to secondary den sites in response to disturbance (Chapman, 1977; Ballard *et al.*, 1997). Wolves are most susceptible to disturbance during the denning period because movements are localized around den sites. Developments that disturb or displace denning wolves may have serious consequences for reproductive productivity of wolves (Walton *et al.*, 2001). Given that the majority of pup mortalities occur within the first 6 months of life (Harrington and Mech, 1982), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den will affect reproductive success of the pack.

Breeding success in wolves is strongly related to prey availability (Fuller, 1989; Frame, 2005), and in the central Arctic prey availability is a function of caribou migration patterns (Frame, 2005). Scarce prey will also influence reproductive success, so again, the state of the barren-ground caribou are vital to the success of the wolf population. Developments that alter the distribution or timing of caribou migration may have profound effects on breeding success of wolves (Walton *et al.*, 2001).

4.5.2.3 Disruption to Movement

Wolves have large home ranges, from 43,000 to 65,000 km^2, which vary between seasons. For seven months of the year, wolf movement patterns follow those of their primary prey, the caribou.

Port

Although the presence of physical structures at the port site may alter movement patterns of individual wolves, it is unlikely to have a significant effect because there are still large areas of habitat available for wolves to move freely.

Road

The proposed road between Bathurst Inlet and Contwoyto Lake will cross suitable wolf habitat but is unlikely to be a significant deterrent to wolf movement. Research has found that wolves do not have an aversion to roads and readily travel on roadways if traffic levels are low (Gehring, 1995). Wolves have been found to learn to avoid roads with high traffic volumes but readily cross secondary roads (Thurber *et al.*, 1994; Frair, 1999). Several studies have reported that wolves likely do not persist where road density exceeds approximately 0.6 km/km^2 (Thiel, 1985; Jensen *et al.*, 1986; Mech *et al.*, 1988). Additionally, wolves follow caribou outside the RSA in the winter, during the period of high activity on the road.

Contwoyto Camp

The permanent camp at Contwoyto Lake will occupy a small portion of suitable wolf habitat and is unlikely to influence wolf movement behaviour.

4.5.2.4 Features Acting as an Attractant

Features of the Project that may act as attractants to wolves, which could subsequently lead to increased human-wolf interactions and wolf mortality include:

- camp sites (due to the presence of wastes and other potential food items);
- road verges (due to the presence of road-killed carrion and prey); and
- the road acting as a movement corridor.

Contwoyto Camp and Other Temporary Camps

Camps may attract wolves due to scents or when searching for food (McNay, 2002). Wolves generally avoid areas of human activity (Thurber *et al.*, 1994), but may become food-conditioned and be considered problem animals (McNay, 2002).

Road

Wolves may be attracted to road kill along road verges or may follow prey (*e.g.*, caribou) that has been attracted to the road. Additionally, wolves may use the road as a movement corridor. These attractions may increase the risk of mortality as a result of vehicle strikes during periods of very heavy traffic.

4.5.2.5 Mortality

Human-caused mortality is a primary cause of death in many wolf populations across North America (Frame, 2005). Wolves may be injured when crossing roads (direct mortality) or may experience higher mortality due to increased hunting pressure in the region (indirect mortality).

Direct Mortality

The potential source of direct mortality identified for wolves in association with the Project development and operations are vehicle collisions along the road. Collisions with vehicles are a major source of wolf mortality (Frame, 2005). Wolves can learn to avoid high-traffic routes, but they do not necessarily avoid all roads (Gehring, 1995). Wolves may be attracted to roads by

road kill, by prey that has been attracted to the road verges to feed on vegetation or road kill. Although some road mortality is expected, Mech (1989) concluded that relatively small areas of high road densities can sustain wolves so long as suitable roadless areas are nearby.

Indirect Mortality

Construction of the road may increase hunting pressure on wolverines. However, socio-economic studies report that an increase in immigration and hunting pressure is unlikely (Appendix F-2 of the DEIS).

4.5.2.6 Reduction in Reproductive Productivity

Reproductive success in wolves is strongly related to prey availability (Fuller, 1989; Frame, 2005) and prey availability in the central Arctic is a function of caribou migration patterns (Frame, 2005). Scarce prey will also influence reproductive success, so again, the state of the barren-ground caribou are vital to the success of wolves. Developments that alter the distribution or timing of caribou migration may have profound effects on reproductive productivity of wolves (Walton *et al.*, 2001).

Given that the majority of pup mortality occurs within the first six months of life (Harrington and Mech, 1982), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den will affect reproductive success of the pack.

Overall, the magnitude of the synergistic effects of potential impacts from Project development will likely have a minimal effect on wolf reproductive productivity. If, however, caribou numbers or distributions are significantly altered, the magnitude of this effect would increase.

4.5.3 Wolf Conclusion

Given the Project Description, potential effects of development projects on wolf elsewhere, and existing studies of wolves in the area, the evaluation of residual effects identified as ***Negligible*** for wolf are as follows:

- terrestrial habitat loss, rated ***Negligible***;
- disturbance to feeding, breeding and denning, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- Project facilities acting as attractants, rated ***Negligible***;
- mortality due to wildlife-vehicle collisions and increased hunting pressure in the RSA, rated ***Negligible***; and
- reduction in productivity due to the previous effects, rated ***Negligible***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for wolf is predicted to be ***Negligible***. Details of how individual effects of the project are predicted for wolf are outlined in Table 4-1.

4.6 Migratory Songbirds and Shorebirds

Particular emphasis was placed on assessing the effects of the Project on migrating songbirds and shorebirds, the group protected under the *Migratory Birds Convention Act* most likely to be impacted by the development, as determined through baseline studies. In addition, migratory songbirds and shorebirds were chosen as VECs because of their cultural importance to the Inuit and their conservation status. Several species observed in the RSA are listed as sensitive in Nunavut and the Eskimo Curlew is listed as endangered by COSEWIC. Birds are also indicators of biodiversity and environmental health and their relatively high numbers in the region enables statistical detection of changes in populations or communities in relation to development.

This document assesses the potential impacts of the Project on migratory birds. In particular, this assessment evaluates the following potential effects:

- habitat loss;
- disturbance to feeding, breeding and nesting;
- disruption to movement;
- the port and camp sites acting as attractants, specifically visual attraction by lights;
- the road as an attractant which may increase road-related mortality;
- direct mortality during construction operations; and
- a reduction in wildlife productivity.

Detailed information on the distribution, seasonal habitat use, population trends and migratory bird observations in the RSA are available in the Wildlife Environmental Setting (Section 2.7.1).

4.6.1 Spatial Boundary

Migratory birds have large annual ranges, often travelling thousands of kilometres in a few months. Although migratory birds undergo large seasonal migrations, birds are confined to localized breeding ranges once on their breeding grounds. Thus, the spatial boundary of the effects assessment for migratory songbirds and shorebirds covers the LSA which extends for 500 m around the road, port, and camp. Within the LSA, there is area that will be lost (area directly under project infrastructure). In addition, area is expected to be heavily degraded and lightly degraded, and these areas measure 5 m and 100 m out from the centerline of the ROW, respectively.

Migratory birds are present in the study area during the summer. They arrive in early June and fly south in early September. Therefore, this assessment will address effects applicable from June 1 to September 15.

4.6.2 Potential Effects

4.6.2.1 Terrestrial Habitat Loss

Habitat requirements for migratory birds are diverse. During baseline studies, three main migratory bird communities were detected using cluster analysis and delineated by three main

habitat types: heath tundra and boulder habitats, riparian shrub and birch seep habitats, and sedge wetlands (Appendix D-10 of the DEIS). Habitat suitability ratings were therefore done for these three communities for the spring/nesting and summer/fledging seasons (Appendix D-8 of the DEIS).

Habitat ratings for migratory birds were rated as either associated or not associated with a given habitat community. Within the LSA, the heath tundra community represents 19,446 ha (73.6%), the riparian shrub community 490 ha (1.9%) and the sedge community 2,195 ha (8.3%). The area (ha) and proportion of associated and non-associated habitat within the LSA and RSA are reported in Table 4.4-1.

Table 4.4-1
Area (Ha) and Proportion of Associated and Non-associated Habitat within the LSA and RSA

Heath Tundra Community (1) – Spring/Nesting and Summer/Fledging				
Suitability Rating	**Area in LSA**	**% LSA**	**Area in RSA**	**% RSA**
Community 1 Habitat	19,446	73.6	738,771	48.9
Non-Community 1 Habitat	6,992	26.4	762,914	51.0
Riparian Shrub Community (2) – Spring/Nesting and Summer/Fledging				
Suitability Rating	**Area in LSA**	**% LSA**	**Area in RSA**	**% RSA**
Community 2 Habitat	490	1.9	338,424	22
Non-Community 2 Habitat	25,948	98.1	1,163,261	77.6
Sedge Community (3) – Spring/Nesting and Summer/Fledging				
Suitability Rating	**Area in LSA**	**% LSA**	**Area in RSA**	**% RSA**
Community 3 Habitat	2,195	8.3	50,195	3
Non-Community 3 Habitat	24, 243	91.7	1451490	97

In addition to habitat directly lost, surrounding areas will be modified as well. Within the LSA, 1.0% of the heath tundra community will be heavily degraded and 18.7% will be lightly degraded. For the riparian shrub community, 4 ha (0.7%) will be heavily degraded and 74 ha (15.1%) will be lightly degraded. Lastly, 20 ha of sedge community habitat will be heavily degraded, representing 0.9 % of the available sedge habitat in the LSA. A total of 381 ha or 17.4% will be lightly degraded.

Although the amount of habitat directly lost within the LSA is relatively high, the effects of habitat loss will be localized and abundant areas of suitable habitat will still remain. Some loss of the nesting territories and nesting habitat of individual birds will occur, but the habitat loss is not expected to affect the population-level carrying capacity of the landscape for songbirds and shorebirds.

4.6.2.2 Disturbance to Feeding, Breeding and Nesting

The population-level effects of road noise on migratory birds have been documented by numerous studies (Clark and Karr, 1979; Van Der Zande and Vos, 1984; Foppen and Reijnen, 1994; Reijnen

and Foppen, 1994; Reijnen, 1995; Reijnen *et al.*, 1995; Reijnen *et al.*, 1996). These effects include a lower density of territorial males, reduced total annual output of males and reduced overall population size, possibly due to interference with breeding and territorial calls, particularly those of young males (Reijnen and Foppen, 1994). Effects have been observed to extend as far as 1.8 km from a busy highway and as much as 600 m from a rural road (Reijnen *et al.*, 1996). However, these studies involved roads with extremely high traffic densities (5,000 to 50,000 vehicles per day) and such volumes are not expected on the road during the summer, when songbirds and shorebirds will be present. Also, the amount of disturbed area is small relative to the size of the available habitat.

Feeding

Bird feeding behaviour may be affected in areas with relatively high human and/or vehicular traffic, such as on or near the road and around work sites. When the presence or disturbance is constant, birds may become habituated over time, reducing the frequency and duration of disturbance events. In addition, disturbances will only extend over a very small area of suitable foraging habitat for birds and there will still be vast areas for birds to occupy. The effects of disturbance are likely to be of greater concern for breeding rather than for feeding with regard to migratory birds in the study area. Disturbance of feeding, if it occurred, would be a secondary effect.

Nesting and Breeding

Research has found that traffic noise was the most important factor affecting breeding density of birds, more so than direct mortality and pollution (Reijnen *et al.*, 1995; Forman and Deblinger, 2000). Nesting and incubation may be disrupted in specific areas with frequent vehicular and aircraft activity or near construction operations generating loud noises, especially explosions. Disturbance events initiated in the middle of the breeding season may result in nest abandonment, and over several years, disturbance is likely to result in a shift in nest site selection to avoid areas exposed to disturbance (Reijnen *et al.*, 1995). The effects of disturbances can extend over 1.5 km (Reijnen *et al.*, 1996), but overall, the amount of disturbed habitat is very small relative to the available habitat in the RSA and the effects of auditory and sensory disturbances will be limited to the vicinity of Project facilities.

4.6.2.3 Disruption to Movement

Project infrastructure is unlikely to impede migratory songbird and shorebird movements. Birds may, however, avoid the road due to disturbance from traffic of lights. Birds migrate in the spring and fall when there are several hours of darkness in the Arctic (Section 4.6.2.4).

4.6.2.4 Features Acting as an Attractant

Features of the Project that may act as attractants to songbirds and shorebirds, which could subsequently lead to increased bird mortality include:

- lights from Project facilities; and
- road verges as feeding and breeding habitat.

The following sections provide information on lighting and the road as bird attractants and rates their potential effect migratory songbirds and shorebirds.

Lighting

Lighting attracts migratory birds, often leading to avian collisions and deaths (Kerlinger, 2000; Manville II, 2000; Erickson *et al.*, 2005). Constant artificial lighting at night may disorient and entrap birds accustomed to navigating in a dark environment (Ogden, 1996) and interfere with migration routes (Squires and Hanson, 1918; Wiese *et al.*, 2001; Longcore and Rich, 2004).

The port site is the major source of light from the Project. Migratory birds would arrive near the port site in spring when there are approximately 20 hours of direct sunlight (as measured on May 15, 2007; AAD, 2007). Full twilight would occur in June and continue until the middle of July. During fall migration there are approximately 10 hours of direct sunlight (as measured on Aug 31, 2007; AAD, 2007). However, the amount of light produced by the camp and port sites is small, and daylight hours during migratory periods in the Arctic are, on average, long.

Road

Migratory birds may be attracted to roads and roadsides for a variety of reasons including available territories, open habitat for ground-dwelling and nesting birds, foraging opportunities from roadkill, and high densities of insects and small mammals (Mumme *et al.*, 2000; Harden, 2002). Attraction to roads will increase the probability of road strikes and subsequent mortality. However, the footprint of the road is relatively small compared to the available habitat in the region and traffic volumes are expected to be low during the summer months when migratory birds are present.

4.6.2.5 Mortality

Direct Mortality

Potential sources of direct mortality identified for songbirds and shorebirds in association with Project development are habitat disturbance during construction (potentially destroying nests, eggs, or young) and vehicle collisions along the road during summer maintenance operations.

Mortality of adults and eggs or young in nests could result when construction is conducted during the breeding period. Migratory birds are protected under the federal *Migratory Birds Convention Act* and the *Nunavut Wildlife Act*. Thus, all efforts must be made to avoid nest destruction during Project development and operation.

Birds are attracted to roads and roadsides for a variety of reasons: available territories, open habitat for ground-dwelling and nesting birds and high densities of insects and small mammals (Mumme *et al.*, 2000; Harden, 2002). In the Canadian Rockies, small birds comprise 20 to 65% of small vertebrate roadkills (Clevenger *et al.*, 2003). The potential therefore exists for bird mortalities along the road and effects are expected to peak during the breeding/fledging (summer) and dispersal (autumn) seasons. Birds in the Arctic tundra are especially vulnerable to collisions with vehicles because they tend to fly at low altitudes above the ground, as there is minimal to no vegetation with any vertical structure. So, instead of birds flying from treetop to

treetop, most songbirds in the tundra fly just above ground level, making them susceptible to vehicle strikes. Low traffic speeds and traffic levels are expected along the road during the summer months when birds are present in the LSA.

4.6.2.6 Reduction in Reproductive Productivity

Vegetation clearance and noise disturbance to nesting birds during the breeding season could affect the reproductive success of migratory birds during the construction and operation phases of the Project. Reduced breeding success could result from nest abandonment and/or a short term flushing response in response to maintenance vehicles passing-by which exposes eggs and hatchlings to predators, producing a very localized but moderate-magnitude impact over the short term. Birds returning to breeding sites from prior years may be unsuccessful due to stress of disturbances but this effect will likely be reversible when birds relocate to new breeding sites in the vast landscape available to them.

4.6.3 Songbird and Shorebird Conclusion

Given the Project Description, potential effects of development projects on migratory birds elsewhere, and existing studies of migratory birds in the area, the evaluation of residual effects identified as ***Negligible*** for migratory birds are as follows:

- habitat loss, rated ***Negligible***;
- disturbance to feeding, breeding and nesting, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- the port and camp sites acting as attractants, specifically visual attraction by lights, rated ***Negligible***;
- the road as an attractant which may increase road-related mortality, rated ***Negligible***;
- direct mortality during construction operations, rated ***Negligible***; and
- a reduction in wildlife productivity, rated ***Negligible***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for migratory birds is predicted to be ***Negligible***. Details of how individual effects of the project are predicted for migratory birds are outlined in Table 4-1.

4.7 Peregrine Falcon and Short-Eared Owl

The tundra peregrine falcon (*Falco peregrinus tundrius*) and short-eared owl (*Asio flammeus*) were chosen as representative VECs for cliff-nesting and ground-nesting raptors, respectively, because of their federal and territorial conservation status, their cultural importance to the Inuit, their role as indicators of environmental quality and their sensitivity to disturbances, especially during breeding.

This document assesses the potential effects of the Project on the populations of peregrine falcons and short-eared owls, including:

- direct terrestrial habitat loss;
- disturbances to feeding, breeding and nesting;
- disruption to movement;
- features acting as attractants;
- direct mortality from collisions with vehicles and infrastructure; and
- reduction in reproductive productivity.

Detailed information on the distribution, seasonal habitats, and observations of raptors in the RSA are available in the Environmental Setting (Sections 2.7.3 and 2.7.4).

4.7.1 Spatial Boundary

The LSA was selected as the environmental assessment area for raptors since movements are restricted to the area around nesting territories during the summer months when peregrine falcons and short-eared owls are present in the region.

4.7.2 Potential Effects

4.7.2.1 Terrestrial Habitat Loss

Peregrine Falcon

In the central Arctic, tundra peregrine falcons nest predominately on south facing cliffs and outcrops near water. The area within 1.6 km of known cliff nest sites of all cliff-nesting raptor species was classified as high-quality habitat for these birds (Appendix D-8 of the DEIS).

The effect of habitat loss will likely have a potential impact on peregrine falcon. The proposed road route between km 0 and 40 may remove some high quality raptor habitat, and with its current alignment, will pass within 1.6 km of over 40 known raptor nests (Figure 9.2-1 in Appendix D-8 of the DEIS). However, the area available to peregrine falcon is large and research has shown that construction and blasting have no severe adverse effects on peregrine falcon behaviour, reproductive productivity and occupancy of nesting territories (Holthuijzen, 1990).

Short-eared Owl

Short-eared owls spend the winter in open grasslands, prairies, fields, salt marshes, and estuaries outside of the study area and migrate to alpine and Arctic tundra for the summer and breeding seasons. Therefore, habitat suitability for short-eared owls was assessed for the spring/nesting and summer/fledgling seasons. The majority of habitat within the LSA was assessed as usable: 24,497 ha (92.7 % of LSA) versus only 1,941 ha (7.3 % of LSA) of unsuitable short-eared owl habitat.

Of the 417 ha that will be lost directly lost as a result of Project development, 372 ha would be usable short-eared owl habitat for both the spring/nesting and summer/brood rearing seasons. This area represents 1.5% of the LSA and 0.03% of the RSA. In addition to direct habitat loss, some areas will be modified by the Project resulting in indirect habitat loss. Approximately

227 ha of suitable short-eared owl habitat will be heavily degraded and 4243 ha will be lightly degraded. These areas represent 0.9% and 17.3%, respectively, of the suitable habitat available to owls in the LSA.

Habitat loss as a result of development can negatively affect some raptor species (B.C. MWLAP, 2005), whereas other raptors can co-exist in human-modified landscapes, particularly where ecologically important features such as nest sites are retained (citations in Berry *et al.*, 1998). While individuals may be temporarily displaced during construction, the potential for long-term effects resulting from the loss of habitat is expected to be very low for the raptor species inhabiting the Project area. The Project footprint is small, and many of the species that will potentially lose some nesting habitat have a demonstrated ability to co-exist with development, and all species are expected to continue to occur in the area following Project development.

4.7.2.2 Disturbance to Feeding, Breeding and Nesting

Project activities may change the behaviour of raptors via indirect effects related to sensory and auditory disturbance. Disturbance, such as noises from construction and vehicles, can result in increased stress levels and energy expenditure, disruption of feeding and/or breeding behaviour. Research has shown that peregrine falcons are able to nest successfully within a few hundred meters of areas with blasting, construction, quarrying, aircraft activity and mining operations (Pruett-Jones *et al.*, 1980; Haugh, 1982; White and Thurow, 1985; White *et al.*, 1988). However, the draft WKRLUP indicates that disruption to peregrine falcon breeding sites and breeding areas may reduce reproductive success and may be a factor in the local decline of falcon populations in the Arctic (NPC, 2005).

4.7.2.3 Disruption to Movement

Although raptors may come into contact with vehicles, the road is expected to have no effect on peregrine falcon and short-eared owl movements due to their high mobility and the minimal use of the road during summer months, when raptors are present in the LSA.

4.7.2.4 Features Acting as an Attractant

Birds of prey are attracted to roadways with high densities of small mammals and roadkill (Mumme *et al.*, 2000). In addition to carrion, roadsides are important hunting grounds for diurnal and nocturnal raptors, such as the peregrine falcon and short-eared owl. Attraction of raptors to roadsides exposes individuals to the risk of collisions with vehicles.

4.7.2.5 Mortality

Direct Mortality

The potential sources of direct mortality identified for peregrine falcons and short-eared owls in association with Project development are destruction of ground-nesting owl nests (*i.e.*, snowy and short eared owls), subsequently killing any eggs or young in the nest, and vehicle collisions along the road, which is covered in Section 4.7.2.4, Features Acting as an Attractant.

4.7.2.6 Reduction in Reproductive Productivity

Habitat loss, disturbance from Project construction and operations and direct mortality all have the potential to reduce raptor reproductive success, especially if they act synergistically. Along with the direct loss of individuals from the breeding pool, increased stress levels in raptors will likely lead to lower fitness and eventually affect their reproductive output (Richardson and Miller, 1997).

4.7.3 Raptor Conclusion

Given the Project description, potential effects of development projects on raptors elsewhere, and existing studies of raptors in the area, the evaluation of residual effects identified as ***Negligible*** for raptors are as follows:

- direct terrestrial habitat loss, rated ***Negligible***;
- disturbances to feeding, breeding and nesting, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- features acting as attractants, rated ***Negligible***;
- direct mortality from collisions with vehicles and infrastructure, rated ***Negligible***; and
- reduction in reproductive productivity, rated ***Negligible***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for raptors is predicted to be ***Negligible***. Details of how individual effects of the project are predicted for raptors are outlined in Table 4-1.

4.8 Long-Tailed Duck

Through public scoping, government recommendations and scientific literature, waterfowl were selected as VECs for this assessment because of their cultural significance and role as important food sources for Inuit people. Fourteen waterfowl species were observed within the RSA (Appendix D-10 of the DEIS) of which long-tailed ducks (*Clangula hyemalis*) have been chosen as a representative waterfowl VEC.

This document assesses the potential impacts of the Project on long-tailed ducks, including:

- habitat loss;
- disturbance to feeding, breeding and nesting;
- disruption to movement;
- the port and camp sites acting as attractants, specifically visual attraction by lights;
- direct mortality during construction operations; and
- reduction in wildlife productivity.

Detailed information on the distribution, seasonal habitat use, population trends and waterfowl observations in the RSA are available in the Wildlife Environmental Setting (Section 2.7.4).

4.8.1 Spatial Boundary

Although waterfowl have large annual home ranges and move large distances between seasons, their activities within the study area will be concentrated around their breeding/nesting grounds. The area surrounding long-tailed duck nesting and feeding grounds is generally spatially discrete; therefore, the LSA will be used in the effects assessment.

All waterfowl species inhabiting the areas surrounding the Project are migratory and are thus present in the study area from May to September. Therefore, effects on long-tailed ducks from May 1 to September 15 will be discussed.

4.8.2 Potential Effects

4.8.2.1 Terrestrial Habitat Loss

Direct habitat loss of wetland will occur from construction of the road, port and Contwoyto Camp (Appendix D-8 of the DEIS). Removal of terrestrial habitat can reduce nesting habitat and food availability and adversely affect waterfowl.

Habitat types in the Project areas were identified using Ecosystem Mapping (Appendix D-1 of the DEIS) and rated against habitat requirements for long-tailed ducks using Wildlife Suitability Rating for the spring/nesting and summer/fledging seasons combined (Appendix D-8 of the DEIS). Large portions of the LSA are wetlands (*e.g.*, sedge communities) and waterbodies that are associated with heath tundra. Some of these wetlands, especially smaller waterbodies edged with emergent vegetation, are particularly suitable for long-tailed ducks. Within the LSA, 4,711 ha represent suitable habitat for long-tailed ducks, which is 17.8% of the LSA. Of this available suitable habitat, 34 ha or 0.7% will be directly lost due to the Project, primarily riparian habitat, sedge communities and water bodies. Indirect habitat loss will also occur through the degradation of areas surrounding the Project footprint. In total, 24 ha of suitable habitat will be heavily degraded and 514 ha will be lightly degraded. These areas represent 0.5% and 10.9% of the suitable habitat in the LSA, respectively.

Habitat lost from this Project will primarily affect breeding habitat for long-tailed ducks and high quality habitat around the port site. In addition, geese and wading birds will be affected by habitat loss as they breed, nest and rear their broods almost entirely in tundra (Zöckler and Lysenko, 2000). However, the areas lost as a direct result of this Project represent a small amount of the overall summer breeding habitat available to long-tailed ducks. In addition, the road alignment will avoid waterbodies (habitat highly suitable for waterfowl brood rearing).

4.8.2.2 Disturbance to Feeding, Breeding and Nesting

Auditory and sensory disturbances from a variety of sources have the potential to alter feeding, breeding and nesting behaviours in waterfowl. Noise from traffic has been shown to be the most critical factor in causing reduced bird densities close to roads (Reijnen, 1995). Negative responses to aircraft and industrial noises have also been documented for waterfowl (Conomy *et*

al., 1998a; Conomy *et al.*, 1998b). The greatest source of disturbance to long-tailed ducks is expected to be the port site at Bathurst Inlet.

Disturbance of feeding sites for long-tailed ducks may occur around wetlands and other waterbodies in close proximity to the road route and port site. The greatest potential for disturbance of breeding long-tailed ducks is along Bathurst Inlet at the port site where noise disturbance may alter nesting and breeding behaviour of waterfowl. However, activity at the port site will be low during the nesting period in spring.

Responses to aircraft and industrial noise have been reported for waterfowl, although the effects are difficult to generalize: some waterfowl may habituate to aircraft noise (*e.g.*, black ducks *Anas rubripes*), whereas others may become sensitive (*e.g.*, wood ducks *Aix sponsa*) (Conomy *et al.*, 1998a; Conomy *et al.*, 1998b). Because aircraft noise properties differ with aircraft type, birds may also respond differently to different aircraft. For example, geese appear to be more sensitive to rotary-winged than fixed-winged aircraft (Ward *et al.*, 1999).

4.8.2.3 Disruption to Movement

For the Project, the road and camp sites will likely have minimal effects on long-tailed duck movements, but the port will be located in highly suitable waterfowl habitat and may cause some disruption to movement behaviour. However, Project facilities will occupy a small footprint relative to available waterfowl habitat. A greater effect is expected in relation to disturbances from these sites on long-tailed duck behaviour which are addressed in the sections on Disturbance to Feeding, Breeding and Nesting and Features Acting as Attractants.

4.8.2.4 Features Acting as an Attractant

Features of the Project that may act as attractants to long-tailed ducks, which could subsequently lead to increased mortality include:

- lights emanating from Project facilities (described in Section 4.6.2.4); and
- standing bodies of water, such as sediment ponds.

Standing Water

Generally waterfowl such as ducks and gulls, may be attracted to standing water and garbage areas (*e.g.*, sediment ponds, garbage piles). Numerous studies have documented waterfowl use of artificial bodies of water, such as sewage ponds, sediment ponds and waterbodies associated with mining (Read, 1999 and citations therein). Poisoning of waterfowl that use waterbodies containing toxic materials has been reported and incidents with more than 100 deaths have occurred (Ryan and Shanks, 1996; Read, 1999). There will be two runoff sediment ponds for the entire Project.

4.8.2.5 Mortality

The port, camp, and road may cause increased direct or indirect mortality to long-tailed ducks, including being injured during collisions with aircrafts or vehicles (direct mortality).

Direct Mortality

Long-tailed ducks face direct mortality threats from collisions with aircrafts, particularly in the vicinity of the airstrip at the port site where ducks have been observed on the inlet. However, the probability of this hazard to long-tailed ducks is deemed to be very low. Summer vehicle traffic along the road also poses a collision threat to long-tailed ducks but such incidents are expected to be infrequent, involving few individual birds and low traffic densities, and therefore of minor effect on local populations.

Indirect Mortality

Project construction and operation may result in indirect impacts to long-tailed ducks. Fugitive dust deposition associated with construction and road use could affect plant health and bird forage. Settled dust on roadside vegetation may contain high concentrations of metals and, along with other contaminants in arctic environments, may lead to bioaccumulation in wildlife (Braune *et al.*, 1999). Dust deposition may also result in early snowmelt and changes in the timing of plant emergence and flowering, resulting in reduced forage quality for birds. However, this effect is negligible when compared to the available habitat in the LSA.

4.8.2.6 Reduction in Wildlife Productivity

Suitable long-tailed duck breeding habitat lies in close proximity to the road and the port at Bathurst Inlet. Reproductive success of long-tailed duck may therefore be affected by disturbances resulting from construction and operations activities near these locations.

4.8.3 Long-tailed Duck Conclusion

Given the Project Description, potential effects of development projects on waterfowl elsewhere, and existing studies of waterfowl in the area, the evaluation of residual effects identified as ***Negligible*** for waterfowl are as follows:

- habitat loss, rated ***Negligible***;
- disturbance to feeding, breeding and nesting, rated ***Negligible***;
- disruption to movement, rated ***Negligible***;
- lights as an attractant the port and camp sites, rated ***Negligible***;
- direct mortality during construction operations, rated ***Negligible***; and
- a reduction in wildlife productivity, rated ***Negligible***.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Management Plan (Section 5), the combined significance of residual effects for waterfowl is predicted to be ***Negligible***. Details of how individual effects of the project are predicted for waterfowl are outlined in Table 4-1.

Table 4-1
Summary of Effects Assessment for Terrestrial Wildlife

Description of Potential Effect					Mitigation and Enhancement[1]	Evaluation of Residual Effect									
Description	Project Phase (Timing)	Project Component	Direction	Nature	(Design Changes, Management, Monitoring, Compensation, Enhancement)	Description of Residual Effect (after mitigation) [2]	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological Context (Resilience)	Influence on Resource Capacity	Probability of Occurrence	Significance	Confidence Limit
Bathurst Caribou																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	0.03% of suitable calving ground and 0.04% of suitable post-calving/summer habitat will be lost within the RSA.	Low	Local	Far Future	One Time	Long Term	Neutral	Low	High	**Low**	Intermediate
Disturbance to Feeding and Breeding	Construction and operations	Port Site and Camp	Adverse	Direct	Limited vehicle traffic during caribou sensitive periods, traffic convoys to limit disturbance, no public access to the road, all vehicles,	Caribou will likely avoid disturbed areas.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
	Construction and operations	Road	Adverse	Direct	generators, and other noisy equipment will be regularly maintained to reduce noise, no blasting if caribou are present, and studies will		Low	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
Disruption of Movement	Construction and operations	Road	Adverse	Direct	Minimize height of road where possible, place ramps at key crossing points, and minimize material size of ramps.	Caribou will likely avoid the road or travel along the road instead of crossing. Post-calving movements may be disrupted or delayed.	Low	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
Features Acting as Attractants	Operations	Road	Adverse	Indirect	Lowering speed limits and posting signs in caribou sensitive areas, escape ramps in quarries and implementing an employee education plan.	Increased vehicle and human interactions resulting in higher probability of vehicle-related mortality.	Low	Regional	Medium	Sporadic	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Direct Mortality	Construction and operations	Road, port site and camp	Adverse	Direct	Caribou crossings at important corridors, minimize size of ramp material, proper camp maintenance and clean-up.	Caribou may injure themselves crossing the road.	Negligible	Regional	Medium	Sporadic	Long Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
Indirect Mortality	All	Road	Adverse	Indirect	Restricting road access to project vehicles and no hunting by project employees.	Possible increases in immigration and hunting in the region may negatively affect caribou populations.	Low	Regional	Far Future	Regular	Long Term	Neutral	Moderate	Moderate	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	All	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Medium	Continuous	Long Term	Neutral	Moderate	Moderate	**Low**	Intermediate
Ahiak Caribou																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	0.03% of suitable winter habitat, 0.03% of suitable calving ground, and 0.04% of suitable post-calving/summer habitat will be lost within the RSA.	Negligible	Local	Far Future	One Time	Long Term	Neutral	Low	High	**Negligible**	Intermediate
Disturbance to Feeding and Breeding	Construction and operations	Port Site and Camp	Adverse	Direct	Limited vehicle traffic during caribou sensitive periods, traffic convoys to limit disturbance when possible, no public access to the road, all	Caribou will likely avoid disturbed areas.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
	Construction and operations	Road	Adverse	Direct	vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, no blasting if caribou are present, and		Low	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
Disruption of Movement	Construction and operations	Road	Adverse	Direct	Minimize height of road where possible, place ramps at key crossing points and minimize size of ramp materials.	Caribou will likely avoid the road or travel along the road instead of crosisng. Post-calving movements may be disrupted or delayed.	Low	Regional	Medium	Continuous	Long Term	Neutral	Low	High	**Low**	Intermediate
Features Acting as Attractants	Operations	Road	Adverse	Indirect	Lowering speed limits and posting signs in caribou sensitive areas, escape ramps in quarries and implementing an employee education plan.	Increased vehicle and human interactions resulting in higher probability of vehicle-related mortality.	Low	Regional	Medium	Sporadic	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Direct Mortality	Construction and operations	Road, port site and camp	Adverse	Direct	Caribou crossings at important corridors, minimize size of ramp material, proper camp maintenance and clean-up.	Caribou may injure themselves crossing the road.	Negligible	Regional	Medium	Sporadic	Long Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
Indirect Mortality	All	Road	Adverse	Indirect	Restricting road access to project vehicles and no hunting by project employees.	Possible increases in immigration and hunting in the region may negatively affect caribou populations.	Low	Regional	Far Future	Regular	Long Term	Neutral	Moderate	Moderate	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	All	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Medium	Continuous	Long Term	Neutral	Moderate	Moderate	**Low**	Intermediate
Dolphin and Union Caribou																
Disruption of Movement	Operations	Shipping route	Adverse	Indirect	Conduct further studies on caribou to identify fall migration across ice (Franklin Strait, Peel Strait) and avoid disruption of caribou movement due to the potential of ice breaking along the shipping route.	Shipping may alter the timing of spring ice break-up or full freeze up which could alter or adversly affect caribou migration.	Low	Regional	Far Future	Regular	Long Term	Neutral	Low	High	**Low**	Intermediate
Indirect Mortality	Operations	Shipping route	Adverse	Indirect	No hunting policy for project employees.	Possible increases in immigration and hunting in the region may negatively affect caribou populations.	Low	Regional	Far Future	Regular	Long Term	Neutral	Low	Moderate	**Negligible**	Intermediate
Peary Caribou																
Disruption of Movement	Operations	Shipping Route	Adverse	Indirect	Conduct further studies on Peary caribou to identify fall migration across ice (Franklin Strait, Peel Strait) and avoid disruption of caribou movement due to the potential of ice breaking along the shipping route.	Shipping may alter the timing of spring ice break-up or full freeze up which could alter or adversly affect caribou migration.	Moderate	Regional	Far Future	Regular	Irreversible	Low	Low	Moderate	**Moderate**	Intermediate
Muskox																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	0.03% of suitable late winter/calving habitat and 0.03% of suitable rutting/autumn habitat will be lost within the RSA.	Low	Local	Far Future	One Time	Long Term	Low	Nil	High	**Low**	Intermediate
Disturbance to Feeding and Breeding	Construction and Operations	Road, port site and camp	Adverse	Indirect	Avoid blasting if muskox are nearby, all vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, and a wildlife monitoring prgram will be implemented.	Disturbances cause animals to spend more time being vigilant and less time feeding. Also results in increased metabolic stress levels.	Low	Landscape	Medium	Continuous	Short Term	Low	Low	Moderate	**Low**	Intermediate
Disruption of Movement	Construction and Operations	Port site and camp	Adverse	Direct	None	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Landscape	Medium	Continuous	Long Term	Low	Low	Moderate	**Negligible**	Intermediate
	Construction and Operations	Road	Adverse	Direct	Minimizing the height of the road and snow banks where possible.		Negligible	Landscape	Medium	Regular	Long Term	Low	Low	Moderate	**Negligible**	Intermediate
Direct Mortality	Operations	Road	Adverse	Direct	Limit public access to area, lowering speed limits and posting signs at sensitive crossing areas.	Vehicle collisions along the road and possible injuries from contact with human infrastructure.	Negligible	Local	Medium	Regular	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Indirect Mortality	All	Road	Adverse	Indirect	Restricting road access to project vehicles, and a no hunting policy for project employees.	Possible increased immigration and hunting in the region may negatively impact muskox populations.	Low	Regional	Far Future	Sporadic	Long Term	Low	Moderate	Moderate	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Low	Low	Moderate	**Low**	Intermediate

[1] **Mitigation and enhancement are further expanded upon in Chapter 5, Mitigation and Management** [2] **If there no residual effect after mitigation there is no need for further evaluation.**

(continued)

Table 4-1
Summary of Effects Assessment for Terrestrial Wildlife (continued)

Description of Potential Effect					Mitigation and Enhancement	Evaluation of Residual Effect									
Description	**Project Phase (Timing)**	**Project Component**	**Direction**	**Nature**	**(Design Changes, Management, Monitoring, Compensation, Enhancement)**	**Description of Residual Effect (after mitigation) [1]**	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological Context (Resilience)**	**Influence on Resource Capacity**	**Probability of Occurrence**	**Significance**	**Confidence Limit**
Grizzly Bear																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	Between 0.03% and 0.05% of suitable bear habitat will be lost within the RSA.	Negligible	Local	Far Future	One Time	Long Term	Low	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Denning	Construction and operations	Port site and camp	Adverse	Direct	Avoid construction and blasting near grizzly bear dens, all vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, and implementation of a wildlife monitoring program.	Habitat avoidance leading to lowered foraging area and denning habitat.	Negligible	Landscape	Medium	Continuous	Short Term	Low	Nil	High	**Negligible**	High
	Construction and operations	Road	Adverse	Direct			Negligible	Landscape	Medium	Continuous	Long Term	Low	Nil	High	**Negligible**	High
Disruption of Movement	Construction and operations	Port site and camp	Adverse	Direct	Avoidance of grizzly bear dens during construction and minimal road traffic between May and September when bears are active.	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Low	Nil	Low	**Negligible**	High
	Construction and operations	Road	Adverse	Direct			Negligible	Regional	Medium	Continuous	Short Term	Low	Nil	Moderate	**Negligible**	High
Features Acting as Attractants	Operations	Port site and camp	Adverse	Direct	Proper waste storage and incineration, guidelines for dealing with problem bears, fencing to exclude grizzly bears from project infastructure, and employee eduation regarding bears.	Lower incidence of human-bear conflicts.	Low	Local	Medium	Regular	Short Term	Neutral	Nil	High	**Low**	High
	Operations	Road	Adverse	Direct	Prompt removal of carcasses on road and employee eduation regarding bears.	Lower incidence of vehicle-bear collisions.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	High	**Negligible**	High
Direct Mortality	Construction and operations	Road	Adverse	Direct	Limit public access to area, lowering speed limits in sensitive bear areas and prompt removal of carcasses.	Due to some activity on the road between May and October when bears are active, there is still the possibility of bear-vehicle collisions.	Negligible	Local	Medium	Sporadic	Short Term	Low	Nil	Moderate	**Negligible**	High
Indirect Mortality	All	Road	Adverse	Indirect	Limit public access to area, and a no-hunting policy for employees.	Possible increased hunting pressure in the region may lead to higher mortality rates.	Negligible	Regional	Far Future	Sporadic	Short Term	Low	Nil	Low	**Negligible**	High
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Low	Low	Moderate	**Low**	High
Wolverine																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	0.03% of suitablie denning habitat and 0.03% of suitable growing/pup rearing habitat will be lost within the RSA.	Negligible	Local	Far Future	One Time	Long Term	Low	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Denning	Construction and Operations	Port site and camp	Adverse	Indirect	Avoid wolverine dens during construction and blasting, restricting access of public vehicles, all vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, and implementation of a wildlife monitoring program.	Disturbances cause animals to spend more time being vigilant and less time feeding. Also results in increased metabolic stress levels and habitat avoidance (indirect habitat loss).	Negligible	Landscape	Medium	Continuous	Long Term	Low	Low	Moderate	**Negligible**	Intermediate
	Operations	Road	Adverse	Direct			Low	Landscape	Medium	Continuous	Long Term	Low	Low	Moderate	**Negligible**	Intermediate
Disruption of Movement	Operations	Port site and camp	Adverse	Direct	None. Facilities occupy small footprints relative to habitat available for movements.	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Low	Nil	Moderate	**Negligible**	Intermediate
		Road	Adverse	Direct	Avoidance of wolverine dens and minimizing traffic during wolverine sensitive times.		Low	Regional	Medium	Continuous	Long Term	Low	Nil	Moderate	**Negligible**	Intermediate
Features Acting as Attractants	Operations	Road, port site and camp	Adverse	Direct	Proper waste storage and incineration, removal of carcasses on road, fencing to exclude wolverines from project infastructure, and employee eduation programs.	Wolverine-human interactions, potential for problem animals.	Low	Local	Medium	Sporadic	Short Term	Neutral	Nil	Moderate	**Low**	Intermediate
Direct Mortality	Construction and Operations	Road	Adverse	Direct	Lowering speed limits in sensitive wolverine areas, prompt removal of carcasses and avoidance of wolverine dens during project construction.	Collisions with vehicles will be lower but still likely to occur.	Low	Local	Medium	Sporadic	Short Term	Low	Nil	Moderate	**Low**	Intermediate
Indirect Mortality	All	Road	Adverse	Indirect	Limit public access to area and a no-hunting policy for employees.	Possible increased hunting pressure in the region may lead to higher mortality rates.	Low	Regional	Far Future	Sporadic	Short Term	Low	Nil	Low	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Low	Low	Moderate	**Low**	Intermediate
Wolf																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	0.6% of suitable wolf habitat lost in the LSA.	Negligible	Local	Far Future	One Time	Long Term	Neutral	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Denning	Construction and Operations	Road, port site and camp	Adverse	Direct	Avoid construction and blasting near wolf dens, restricting access of public vehicles, all vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, and implementation of a wildlife monitoring program.	Disturbances cause animals to spend more time being vigilant and less time feeding. Also results in increased metabolic stress levels and habitat avoidance (indirect habitat loss).	Negligible	Landscape	Medium	Continuous	Long Term	Neutral	Nil	High	**Negligible**	High
Disruption of Movement	Operations	Road	Adverse	Direct	Avoidance of wolf dens, minimizing traffic volumes between May and September.	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
	Operations	Port site and camp	Adverse	Direct	None. Facilities occupy small footprints relative to available habitat for movements.		Negligible	Regional	Medium	Continuous	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Features Acting as Attractants	Construction and Operations	Port site and camp	Adverse	Direct	Proper waste storage and incineration, fencing to exclude wolves from project infastructure, and implementation of an employee wildlife eduation program.	Human-wolf interaction and potential problem animals.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
	Operations	Road	Adverse	Direct	Removal of carcasses on road and implementation of an employee wildlife eduation program.	Use of the road and immediate area, increasing probability of collisions with vehicles.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Direct Mortality	Construction and Operations	Road	Adverse	Direct	Limiting traffic volumes in summer and restricting access of public vehicles.	Wolves may still come into contact with vehicles which may result in mortality.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	Intermediate
Indirect Mortality	All	Road	Adverse	Indirect	Limit public access to the project area and implement a no-hunting policy for project employees.	Possible increases in hunting pressure, both legal and illegal, may negatively affect wolf populations.	Negligible	Regional	Far Future	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	Intermediate
Reduction in Wildlife Productivity	Construction and Operations	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Negligible	Regional	Far Future	Continuous	Long Term	Low	Nil	Low	**Negligible**	Intermediate

[1] Mitigation and enhancement are further expanded upon in Chapter 5, Mitigation and Management [2] If there no residual effect after mitigation there is no need for further evaluation.

(continued)

Table 4-1
Summary of Effects Assessment for Terrestrial Wildlife (completed)

Description of Potential Effect					Mitigation and Enhancement	Evaluation of Residual Effect									
Description	**Project Phase (Timing)**	**Project Component**	**Direction**	**Nature**	**(Design Changes, Management, Monitoring, Compensation, Enhancement)[1]**	**Description of Residual Effect (after mitigation) [2]**	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological Context (Resilience)**	**Influence on Resource Capacity**	**Probability of Occurrence**	**Significance**	**Confidence Limit**
Migratory Song and Shore Birds																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	Within the LSA, 73% of heath tundra, 2% of riparian shrub, and 8% of sedge communities will be lost.	Negligible	Local	Far Future	One Time	Long Term	High	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Nesting	Construction and Operations	Road, port site and camp	Adverse	Direct	Avoidance of active bird nests during project construction, lowering of speed limits along the road (< 80 km/h), and aerial flight restrictions should be implemented.	Disturbances cause animals to spend more time being vigilant and less time feeding. Also results in increased metabolic stress levels and habitat avoidance (indirect habitat loss).	Negligible	Local	Medium	Regular	Short Term	Neutral	Nil	Moderate	**Negligible**	High
Disruption of Movement	Construction and Operations	Road, port site and camp	Adverse	Direct	Minimal road traffic between May and September, when birds are present in the area, and lowering of speed limits along the road (< 80 km/h).	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Nil	Low	**Negligible**	High
Features Acting as Attractants	Operations	Port Site and Camp	Adverse	Direct	At the port facility and camp, all lighting will be directed into the facility to limit stray light as a visual disturbance.	Lights can cause birds to become disoriented and collide with each other or a structure, resulting in direct mortality and interfering with migration routes.	Low	Local	Medium	Continuous	Short Term	Neutral	Nil	Low	**Negligible**	Intermediate
	Operations	Road	Adverse	Direct	Vehicle traffic will be restricted to projecl vehicles only.	Possible collisions with vehicles.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Direct Mortality	Construction and Operations	Road	Adverse	Direct	Avoidance of active bird nests during project construction and blasting.	Destruction of nests and eggs or young in nest.	Negligible	Local	Medium	Sporadic	Short Term	Low	Nil	Low	**Negligible**	High
	Operations	Road	Adverse	Direct	Minimal road traffic between May and September, when birds are present in the area, and lowering of speed limits along the road (< 80 km/h).	Potential for collisions with vehicles.	Negligible	Local	Medium	Regular	Short Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Peregrine Falcon																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	Possible removal of suitable cliff habitat and displacement from occupied areas.	Negligible	Local	Far Future	One Time	Long Term	Neutral	Low	High	**Negligible**	High
Disturbance to Feeding, Breeding and Nesting	Construction and Operations	Road, port site and camp	Adverse	Direct	All vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, all lighting at the port and camp will be directed into the facilities to limit stray light as a visual disturbance, and aerial flight restrictions should be implemented.	Disturbances cause animals to spend more time being vigilant and less time feeding. Also results in increased metabolic stress levels and habitat avoidance (indirect habitat loss).	Negligible	Local	Medium	Continuous	Long Term	Low	Nil	Moderate	**Negligible**	Intermediate
Disruption of Movement	Construction and Operations	Road	Adverse	Direct	Minimal traffic volumes during the time periods when peregrine falcons are present in the study area (summer).	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Features Acting as Attractants	Operations	Road	Adverse	Direct	Removal of roadkill and minimal use of the road during period when peregrine falcons are present in the RSA.	Use of areas near road will increase the probability of collisions with vehicles.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Direct Mortality	Operations	Road	Adverse	Direct	Minimal traffic volumes during the time periods when peregrine falcons are present in the study area.	Collisions with vehicles resulting in mortality.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Low	Nil	Low	**Negligible**	Intermediate
Short-Eared Owl																
Terrestrial Habitat Loss	Construction	Road, port site and camp	Adverse	Direct	None	1.5% of suitable owl habitat will be lost within the LSA.	Negligible	Local	Far Future	One Time	Long Term	Neutral	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Nesting	Construction and Operations	Road, port site and camp	Adverse	Direct	All vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, all lighting at the port and camp will be directed into the facilities to limit stray light as a visual disturbance, and aerial flight restrictions should be implemented.	Increased stress levels and energy expenditure, leading to disruption of feeding, breeding and nesting behviours.	Negligible	Local	Medium	Continuous	Long Term	Low	Nil	Moderate	**Negligible**	Intermediate
Disruption of Movement	Construction and Operations	Road	Adverse	Direct	Minimal traffic volumes during the time periods when owls are present in the study area (summer).	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Regional	Medium	Continuous	Long Term	Neutral	Nil	Low	**Negligible**	Intermediate
Features Acting as Attractants	Operations	Road	Adverse	Direct	Removal of roadkill as quickly as possible and minimal use of the road when owls are present in the RSA.	Use of areas near road will increase the probability of collisions with vehicles.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Direct Mortality	Operations	Road	Adverse	Direct	Minimal traffic volumes during the summer when owls are present in the study area.	Collisions with vehicles resulting in mortality.	Negligible	Local	Medium	Sporadic	Short Term	Neutral	Nil	Low	**Negligible**	High
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Direct	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Negligible	Regional	Far Future	Continuous	Long Term	Low	Nil	Low	**Negligible**	Intermediate
Long-Tailed Duck																
Terrestrial Habitat Loss	Construction	Port site	Adverse	Direct	None	Overall, 0.7% of suitable duck habitat will be lost within the LSA.	Negligible	Local	Far Future	One Time	Irreversible	Neutral	Nil	High	**Negligible**	High
	Construction	Road and camp	Adverse	Direct			Negligible	Local	Far Future	One Time	Irreversible	Neutral	Nil	High	**Negligible**	High
Disturbance to Feeding, Breeding and Nesting	Construction and Operations	Port site	Adverse	Indirect	All vehicles, generators, and other noisy equipment will be regularly maintained to reduce noise, all lighting at the port and camp will be directed into the facilities to limit stray light as a visual disturbance, and aerial flight restrictions should be implemented.	Construction and operation activities may disturb ducks.	Negligible	Local	Medium	Continuous	Short Term	Neutral	Nil	High	**Negligible**	High
Disruption of Movement	Construction and Operations	Port site	Adverse	Indirect	None	Disruption of movement patterns leading to changes in habitat use and connections between populations.	Negligible	Local	Medium	Regular	Short Term	Neutral	Nil	Low	**Negligible**	High
Features Acting as Attractants	Operations	Port site and camp	Adverse	Direct	At the port facility and camp, all lighting will be directed into the facility to limit stray light as a visual disturbance, water quality of standing water in project areas will be monitored, and wildlife exclusion measures such as rock berms, fencing and/or netting around sediment ponds and other open-waterbodies containing contaminated water or hazardous liquids.	Lights and sewage treatment ponds must be used for operational and safety reasons, thus adverse residual effects (collisions, mortality due to consumption of toxins) are still likely.	Low	Local	Medium	Sporadic	Short Term	Neutral	Nil	Moderate	**Negligible**	High
Direct Mortality	Construction and operations	Road	Adverse	Direct	Minimal road traffic during the summer months when waterfowl are present in the area (June to September).	Possible collisions with vehicles.	Negligible	Local	Medium	Sporadic	Long Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
	Construction and operations	Port site and camp	Adverse	Direct	None	Collisions with aircraft and other vehicles.	Negligible	Local	Medium	Sporadic	Long Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
Indirect Mortality	Construction and operations	Road	Adverse	Indirect	None	Dust deposition along the road reduces the quality of forage.	Negligible	Local	Medium	Regular	Short Term	Neutral	Nil	Moderate	**Negligible**	Intermediate
Reduction in Wildlife Productivity	All	Road, port site and camp	Adverse	Indirect	Mitigation and management plans established for other effects will contribute to reducing the magnitude of this effect.	Reduction in reproductive success due to synergistic interactions of all potential effects.	Low	Regional	Far Future	Continuous	Long Term	Low	Nil	Moderate	**Low-Negligible**	Intermediate

[1] **Mitigation and enhancement are further expanded upon in Chapter 5, Mitigation and Management**

[2] **If there no residual effect after mitigation there is no need for further evaluation.**

5. MITIGATION AND MANAGEMENT PLANS

5. Mitigation and Management Plan

5.1 Introduction

5.1.1 Overview and Objectives

In 2004, potential wildlife issues resulting from the proposal were raised by NIRB and the public. The effects assessment for wildlife (Chapter 4) was designed to address those concerns and their potential impact on the nine wildlife species or groups identified as VECs within the study area. Wildlife species or groups that have been designated as VECs include:

- barren-ground caribou;
- muskox;
- grizzly bear;
- wolf;
- wolverine;
- migratory birds;
- cliff-nesting raptors;
- ground-nesting raptors; and
- waterfowl.

This Draft Wildlife Mitigation and Management Plan (WMMP) will focus on developing mitigation and management directions which will reduce the impact of the Project on identified wildlife and wildlife issues (outlined in Chapter 3, Table 3.2-3). The WMMP is intended to direct the actions of the proponent in maintaining wildlife habitats and populations in areas influenced by Project development, while taking into account operational requirements and the safety of Project employees.

Unless otherwise indicated, measures described in the WMMP apply to all Project components for the life of the Project. This plan is designed to be adaptive, effective, and achievable in both the short and long term and includes measurable objectives that will be evaluated in the Monitoring Plan (Chapter 6).

This plan is recommended to the proponent as a means to achieve the objectives stated above.

5.1.2 Adaptive Management Approach

Wildlife management for the Project will be undertaken using an adaptive management approach. The mitigation and management procedures discussed here have been formulated to consider potential effects of Project development on wildlife, as well as reflecting current best management practices. Management strategies will need to be reviewed periodically due to the changing nature of the Project over time, and adapted based on the effectiveness of initial management practices. This review process will be guided by the Wildlife Monitoring Program (Chapter 6) and by further research findings and best management guidelines from collaborating

organizations or regulators as they become available. An adaptive management approach will allow the proponent to respond to concerns as they arise throughout the life of the Project.

5.1.3 Roles and Responsibilities

Mitigation and management directives within the WMMP will apply to all employees, contractors, visitors and all persons generally present and or associated with the Project, including users of the road, port site and camps. Education, training, and awareness programs (Section 5.7) for these persons will be undertaken to ensure understanding and compliance with the WMMP which will be the responsibility of the Project management.

5.1.4 Draft Wildlife Mitigation and Management Plan

The WMMP is offered as a recommendation which can be adjusted and refined during the environmental assessment process leading to the Final Environmental Impact Statement (FEIS) and Project Certificate. Mitigation and management directives to address potential effects of the road, port and camps on wildlife are described in the following sections and include:

- avoidance of wildlife sensitive areas and periods;
- maintenance of habitat continuity;
- minimizing sensory disturbance;
- road access restrictions;
- right of way for wildlife;
- prohibition for feeding, littering, and hunting wildlife;
- road traffic management measures reduce and if possible prevent collisions with wildlife and road kill generally;
- carrion control;
- effective response to the presence of problem wildlife;
- reducing effects on wildlife productivity;
- putrescible waste storage and incineration;
- manage standing and contaminated water including deterrents;
- dust reduction;
- wildlife observation and incident reporting; and
- employee and contractor awareness and training.

The potential Project effects and mitigation and management directions proposed within this WMMP has been divided into six subject-specific areas including:

- General Wildlife Management;
- Caribou Management;
- Road Right-of-Way;

- Waste and Other Attractants;
- Problem Wildlife Prevention and Response; and
- Wildlife Education and Awareness

The intent of the WMMP is to address all potential effects of the Project on wildlife VECs summarized in Table 5.1-1 below. The WMMP is not exclusive and may be amended pending further literature reviews, scientific findings and management needs.

Table 5.1-1
Scope and coverage of BIPR draft Wildlife Management Plan

Effect	General Wildlife	Caribou	Road Right-of-Way	Waste and Other Attractant	Problem Wildlife Prevention and Response	Employee Wildlife Education and Awareness
Habitat Loss	X	X	X			
Disturbance of Movements	X	X	X			
Disturbance of feeding, nesting and breeding	X	X	X	X		X
Attractants	X	X	X	X	X	X
Mortality (direct)	X	X	X	X	X	X
Mortality (indirect)	X	X	X	X	X	X
Reduction in Productivity*	X	X	X	X	X	

***Measures to mitigate for reduction in reproductive productivity are a compilation of all management direction in the management plans, with the intended outcome of these measures, if followed, to avoid and minimize adverse effects on wildlife productivity.**

5.2 General Wildlife Management

5.2.1 Project-specific Issues

The General Wildlife Management section is an umbrella that includes mitigation measures that address potential effects of the Project on wildlife that apply to all Project activities. Assessment of Project activities identified the following potential wildlife effects and concerns:

- habitat loss;
- disruption of movements;
- disturbance of feeding, nesting, denning or breeding activities and habitats;
- features acting as an attractant; and

- mortality (direct and indirect).

5.2.2 Goals and Objectives

The goal of the General Wildlife Management provisions is to minimize wildlife disturbance and mitigate for effects associated with the Project. Specific objectives of the General Wildlife Management are to:

- maintain the functional integrity of the landscape to support healthy and sustainable wildlife populations;
- maintain the functional integrity of wildlife sensitive areas that may be encroached upon by the Project footprint or activities;
- prevent harassment and hunting of wildlife by all persons in the area associated with the Project;
- prevent the use of the road for illegal hunting and harvesting;
- prevent habituation of wildlife to humans;
- avoid direct and indirect mortality of wildlife due to Project activities; and
- collaborate with governments and other stakeholders in protecting sustainable wildlife habitat and wildlife populations in the Kitikmeot Region of Nunavut.

5.2.3 Mitigation and Management

5.2.3.1 Compliance with Relevant Wildlife Legislation

Species at Risk Act

The *Species at Risk Act* (SARA), Section 79 (2) states that during an assessment of effects, the adverse effects of the project on listed wildlife species and its critical habitat must be indentified, that measures are taken to avoid or lessen those effects and that the effects need to be monitored. This section applies to all species listed on Schedule 1 of SARA. However, as a matter of best practice, those species on other Schedules of SARA and under consideration for listing in SARA, including those designated as at risk by the Committee on the Status of Endangered Wildlife (COSEWIC), should also be considered during an environmental assessment in a similar manner. Species at Risk that are designated as 'special concern' by COSEWIC and being considered for Schedule 1 of SARA include peregrine falcon (currently Schedule 3), short-eared owl (currently Schedule 3), grizzly bear (special concern, COSEWIC), wolverine (special concern, COSEWIC) and polar bear (special concern, COSEWIC). Species potentially occurring in the Project area and their conservation status are listed in Tables 2.3-1 to 2.3-9 (Chapter 2).

Mitigation measures to lessen Project effects on species at risk include:

- comply with the *Species at Risk Act* (SARA) during Project construction and operations. General Prohibitions and Measures to Protect Listed Wildlife Species can be found at the SARA website (http://www.sararegistry.gc.ca/the_act/HTML/Part9_e.cfm). For instance, under General Prohibitions in sections 32 and 33, SARA makes it an offence to:

- kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened;
- possess, collect, buy, sell or trade an individual of a listed species that is extirpated, endangered or threatened, or its part or derivative; and
- damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction; and
- avoid contact with or disturbance to any Species at Risk.

Also it is expected that observers record all the locations, dates, numbers of animals, and frequency of observations of Species at Risk and actions taken to avoid contact or disturbance to the species.

Migratory Bird Convention Act and Migratory Birds Regulations

Under the Migratory Birds Convention Act, 1994, section 12 (1), the Governor in Council may make any regulations that the Governor in Council considers necessary to carry out the purposes and provisions of this Act and the Convention, including regulations for prohibiting the killing, capturing, injuring, taking or disturbing of migratory birds or the damaging, destroying, removing or disturbing of nests (http://laws.justice.gc.ca/en/showtdm/cs/M-7.01/en). Under the Migratory Birds Regulations, enabled by Migratory Birds Convention Act, section 6 no person shall disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird (http://laws.justice.gc.ca/en/showtdm/cr/C.R.C.-c.1035) except under authority of a permit therefor.

Mitigation measures to lessen Project effects on migratory birds include:

- comply with the *Migratory Bird Convention Act* and *Migratory Birds Regulations* during Project construction and operations; and
- avoid harassment or destruction of nests or eggs of migratory birds and raptors.

Nunavut Wildlife Act

Mitigation measures to lessen Project effects on wildlife include:

- comply with the *Nunavut Wildlife Act* during Project construction and operations. Territorial legislation can be found at the Nunavut Government website (http://www.justice.gov.nu.ca/english/index.html) and Prohibitions and Measures to protect wildlife and wildlife habitat under the Nunavut Wildlife Act can be found at (http://action.attavik.ca/home/justice-gn/attach-en_sourcelaw/e2003snc262.pdf). For instance, the *Act* identifies habitat protection (section 65), prohibits activities in critical habitats (section 66), protects of bird eggs and nests (section 72), prohibits significant disturbance to a substantial number of wildlife (section 73), prohibits breaking into, destruction or damage to any abode of a bear, fox, beaver, muskrat, weasel, wolf or wolverine (section 73), and prohibits harassment of wild animals (section 74). Critical habitat means the habitat that is necessary for the survival or recovery of a listed species (section 2).

5.2.3.2 Aerial Flight Restriction

Pilots flying helicopters and fixed wing aircraft used for Project activities will adhere to wildlife-recommended guidelines designed to:

- avoid low-level aircraft overflights of concentrations of wildlife and high-use wildlife habitat;
- develop pre-determined flight paths to provide horizontal as well as vertical buffer distances between flight paths and sensitive habitats;
- reduce disturbance to nesting birds (during sensitive periods, Table 5.2-1) by maintaining an aircraft flight altitude of at least 610 m above ground level (a.g.l.) during horizontal (point to point) flights;
- reduce disturbance to resting, feeding, or moulting birds by maintaining a vertical distance of 1,000 m a.g.l. and a minimum horizontal distance of 1,500 m from any observed concentration (flocks/groups) of birds;
- reduce disturbance to wildlife (*i.e.*, small and large mammals) by maintaining an aircraft flight altitude of > 300 m a.g.l. outside the bird breeding season and 610 m a.g.l. during bird breeding season; and
- avoid wildlife harassment and disturbance at all times.

5.2.3.3 No Feeding of Wildlife Policy

Wildlife may be attracted to areas of Project development or human use by natural curiosity or habitat preference. Management directives for human-wildlife interactions shall:

- implement a no feeding and intentional attraction of wildlife policy;
- disseminate the policy to all Project and contractor employees during orientation; and
- enforce this policy by supervisors and regulatory authorities.

5.2.3.4 No Littering Policy

Management directives for this policy are to:

- implement a no littering policy at the start of construction which will continue throughout the life of the Project;
- disseminate the policy to all Project and contractor employees during orientation;
- enforce this policy by supervisors and regulatory authorities; and
- provide appropriate containment for secure waste storage and incineration (see also Section 5.5 below).

5.2.3.5 No Hunting Policy

A no hunting policy will be in effect throughout the life of the Project. Management directives for this policy shall include:

- prohibit hunting and trapping by all Project and contractor employees;
- prohibit vehicle-based hunting or hunting from the road, and within a buffer area along the road (*i.e.*, human safety);
- report any poaching or evidence of illegal hunting/trapping to government authorities;
- prohibit all Project and contractor employees from carrying personal firearms;
- enforce this policy by supervisors and regulatory authorities; and
- develop an effective whistleblower policy with the means to implement it.

5.3 Road Right-of-Way Management

5.3.1 Project-specific Issues

Assessment of the Project activities related to the haul road identified the following potential effects and concerns (Section 3.2.1 and Table 3.2-3):

- habitat loss;
- disruption of movements;
- disturbance of feeding, nesting, denning or breeding habitats;
- features acting as attractants (*e.g.*, road-side revegetation as forage source);
- mortality (direct and indirect); and
- reduction in wildlife productivity.

5.3.2 Goals and Objectives

The goal for Road Right-of-Way Management is to minimize or reduce potential effects of road construction and traffic on wildlife. This plan will focus on the road during construction and operation phases. Objectives include:

- avoid direct and indirect wildlife mortality due to Project activities;
- maintain the permeability of the landscape by enabling wildlife free passage across the road;
- prevent unauthorized use of the road;
- limit habitat loss or degradation to the Project footprint; and
- gather knowledge on the use of the road by wildlife.

5.3.3 Mitigation and Management

5.3.3.1 Avoidance of Wildlife Sensitive Areas

Mitigation measures to minimize disturbance in wildlife sensitive areas are to:

- identify locations of dens and raptor nests prior to construction.

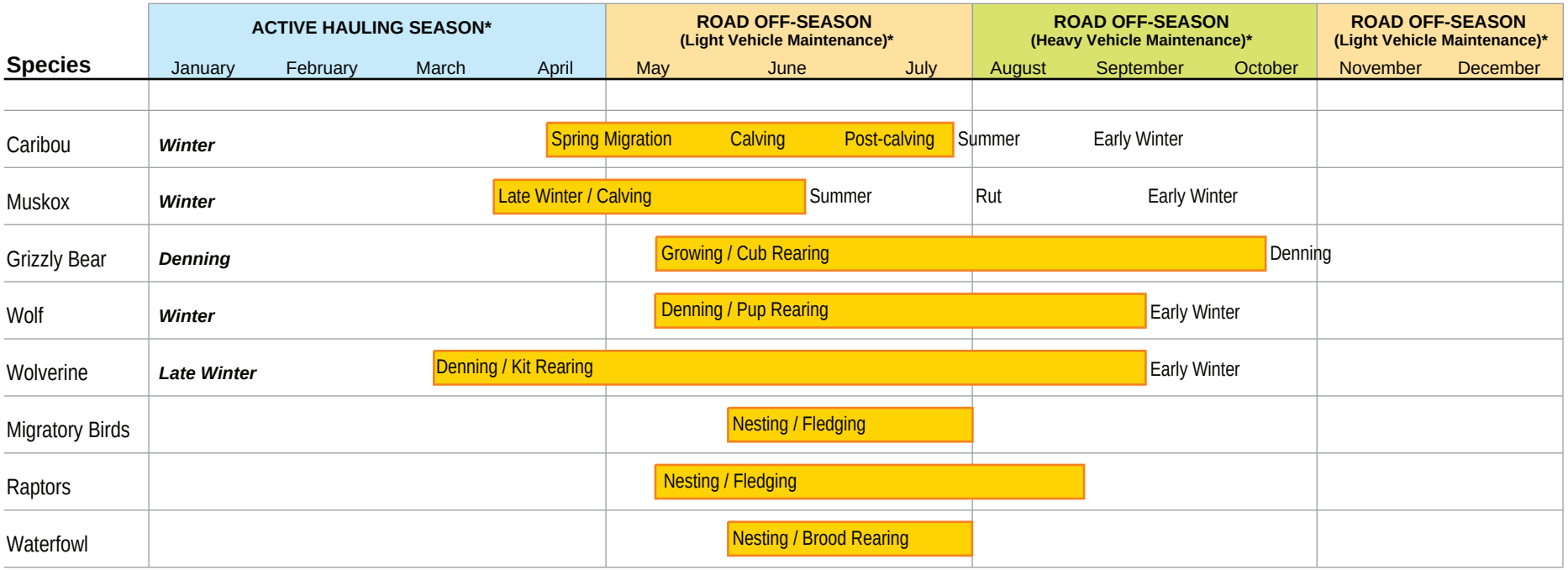
- avoid Project construction and operations within critical distances of identified wolf, wolverine, and grizzly bear dens and raptor nests (Figures 4.2-1, 5.2-1, 6.2-1, 9.2-1 in Appendix D-8, Habitat Suitability Ratings baseline report).
- confirm wildlife are not present in identified dens or nests (*e.g.*, wildlife sighting or sign) in the vicinity of construction or maintenance sites before activities commence. If wildlife or sign of active use is observed, Project activities should be halted or minimized to avoid disturbance to wildlife, until wildlife has passed by, or until denning or nesting is completed (*i.e.*, young have left the vicinity).
- identify spatial shifts in sensitive areas (*e.g.*, new grizzly bear dens, raptor nests to address above mitigation measures) through field survey by a qualified wildlife biologist and incidental wildlife reporting data.
- avoid use of eskers as sources of quarry material if possible.
- avoid construction of road crossing structures (*e.g.*, ramp) near waterways to minimize impacts to aquatic habitats.
- restrict vehicles to road and quarry footprints during construction and operations to avoid unnecessary disturbance to tundra.
- use Conformity Requirement 3.5 (Respecting Denning Areas and Migration Routes on Eskers) of the draft WKRLUP (NPC, 2005) as a guiding principle for Project construction and operations, such that:
  - works and activities do not disturb grizzly bear, fox, wolf or wolverine dens or caribou migration routes located in or on eskers.

5.3.3.2 Avoidance of Wildlife Sensitive Periods

Mitigation measures to minimize disturbance of wildlife during road construction and operation include:

- if possible schedule Project construction and operations activities to avoid disturbance of wildlife during sensitive periods (Table 5.3-1, Figure 5.3-1);

  avoid blasting near active wildlife dens during sensitive periods. For instance, if blasting is to occur near a known grizzly bear den, blasting activities should be either a) scheduled to occur between May 15 and October 1, when bears and cubs have left the den, rather than in early spring or late fall when denning habitat is critical to survival and disturbance may increase den abandonment and mortality or b) road building material may be hauled from another quarry location;
- use temporary road closures during sensitive periods when large numbers of wildlife are in the vicinity of the road or when movements of wildlife (*i.e.*, calving spring and post-calving migration) are crossing the road;
- schedule road maintenance activities to begin mid-July, monitor prior-to and during activities to detect large caribou movements and to avoid disruption of post-calving movement to summer range south of Contwoyto Lake;



Legend

Sensitive Period**

NOTE: Timing of Sensitive Periods may shift due to climate change and/or project activities, therefore, wildlife monitoring will be undertaken to note any change in these dates.

** Dates provided in the Project Description (Appendix A-2 of the DEIS)*

*** Dates reflect literature review of wildlife in the project area, consultation with Inuit and local biologists, government regulations and baseline studies.*

the BATHURST INLET PORT AND ROAD PROJECT

Sensitive Periods Coinciding with Timing of Road Seasons

FIGURE 5.3-1

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- avoid disturbance (*e.g.*, blasting) to nesting and breeding migratory birds and raptors. Sensitive periods (Table 5.3-1) are approximate, and if active nests (*i.e.*, nests containing eggs or young) are encountered outside of these dates, all Project activities should halt until nesting is completed (i.e., young have left the vicinity of the nest); and
- apply adaptive management to current mitigation measures when new knowledge, monitoring results and relevant research becomes available.

Table 5.3-1
Wildlife Sensitive Periods Applicable to the Project

VEC	Activity	Sensitive Period[1]
Caribou	Spring migration[2]	April 15 to June 4
	Calving[3]	June 5 to June 15
	Post calving[4]	June 16 to July 20
Muskox	Late winter/Calving	April 1 to June 15
Grizzly Bear	Growing/Cub rearing	May 16 to October 15
Wolverine	Denning/Kit rearing	March 15 to September 15
Wolves	Denning/Pup rearing	May 15 to September 15
Migratory Birds	Nesting/fledging	June 1 to July 31
Raptors	Nesting/fledging	May 5 to September 1
Waterfowl	Nesting/fledging	June 1 to September 1

[1]Sensitive period that interacts with the Project. For complete life history stages, see Chapter 2.
[2]During the spring migration, the majority of Peary caribou cross Peel Sound and Franklin Strait from May through June over ice. No timing data are available for fall migration.
[3]Calving: Bathurst June 5 to June 15; Ahiak: June 5 to June 20.
[4]Post calving: Bathurst June 16 to July 20; Ahiak: June 21 to July 25.

5.3.3.3 Road Access and Traffic Management

The potential for this road to be used by others in the future is a concern. Management and restrictions on access, traffic volume, and frequency will be required. Measures to reduce impacts to wildlife due to the road include:

- monitor and dispatch traffic from camps located at the Bathurst Inlet port and Contwoyto Lake;
- limit road access for operations of haul trucks from January to April, light vehicle for inspection and maintenance during wildlife sensitive periods (May to mid-July), heavy vehicle required for maintenance (mid-July to October), and light vehicle for inspection and maintenance (November to December) (Figure 5.3-1);
- close the road to the public and restrict use of the road, port site and camps to persons and vehicles required for operations and maintenance;
- prohibit private vehicles (including snowmobiles and all-terrain vehicles) on-site;
- manage traffic flow in space and time to accommodate migrating wildlife crossing the road (*e.g.*, scheduled convoys);

- enforce speed limits of 60 km/hr (loaded) and 80 km/hr (unloaded);
- use temporary, lowered speed restrictions (with signage) in particularly sensitive areas or if large numbers of wildlife are in the vicinity of the road or are attempting to cross the road;
- use temporary road closures during sensitive periods when large numbers of wildlife are in the vicinity of the road or when movements of wildlife (*i.e.*, caribou migration) are attempting to cross the road;
- avoid foot traffic;
- provide access to Inuit for cultural and traditional uses, subject to an agreement between the proponent and local Inuit; and
- have Project staff that will monitor traffic on the road.

5.3.3.4 Wildlife Right of Way

There is potential for vehicles to encounter wildlife during road construction. Measures to reduce impacts to wildlife within the road Right-of-Way include:

- give wildlife the right-of-way on all roads at all times (including within camp and port site);
- report any encounter with wildlife (including observations or interactions) along the access road; and
- develop appropriate mitigation strategies for areas of high risk.

5.3.3.5 Road-related Wildlife Mortalities

Despite measures taken to avoid wildlife, accidental vehicle-wildlife collisions are possible. Mitigation measures for managing road-related wildlife mortalities include:

- install signage to alert drivers of speed limits, identified wildlife movement corridors, wildlife crossings (*i.e.*, caribou), and road crossing structures (*e.g.*, ramps and esker crossings);
- remove road kill and naturally occurring wildlife kills located near roads or, if more appropriate do not remove natural kills and mark the area with temporary signage indicating scavengers may be present in the area. Signage will be removed promptly when carcass is no longer an attractant; and
- report all road-killed or injured wildlife to appropriate project staff immediately upon occurrence and establish a reporting system to allow Project or contractor employees to raise concerns anonymously, if needed.

5.3.3.6 Wildlife Incident and Accident Reporting

Mitigation measures to reduce the incidence of wildlife-vehicle interactions include:

- a reporting protocol and log for all wildlife-vehicle interactions and wildlife-road structure interactions (*e.g.*, caribou resting on road turn-outs). Reporting system should allow employees to raise concerns anonymously or report observed non-compliance;
- records for location, species, date, and type of wildlife-vehicle interactions will be kept by the Project and will be reviewed annually;
- a standard response plan for Project-related wildlife incidents and accidents to ensure the safety of Project employees and wildlife;
- review the management plan and adapt as necessary to reduce the incidence of wildlife-vehicle interactions; and
- disseminate information on reporting procedures for wildlife observations and incidents/accidents to all Project or contractor employees through the Employee Wildlife Education and Compliance measures (Section 5.7).

5.3.3.7 Dust Reduction and Control

Fugitive dust is a concern on the tundra. Mitigation measures to manage dust production from road traffic include:

- comply with road access and traffic restrictions; and
- avoid chemical dust suppressants. Some chemical dust suppressants may be an attractant to wildlife (*e.g.*, salt-based), resulting in an increase in vehicle-wildlife interactions. Thus if dust suppressants are necessary, those that will not be wildlife attractants should be considered and prior consultation with wildlife biologist is required.

5.4 Caribou Management

5.4.1 Project-specific Issues

Assessment of Project activities identified the following potential effects and concerns (Section 4.5.3, Table 5.1-1) for the Bathurst, Ahiak, Dolphin and Union and Peary caribou:

- direct and indirect habitat loss on Bathurst caribou;
- disruption of movement of Bathurst and Ahiak herds during early spring migration, specifically between April 15 to April 30 and disruption of movement for the Bathurst herd during the post-calving season;
- disruption of movement of Ahiak herd during winter are expected due to road traffic volumes at that time;
- displacement of caribou during calving and post-calving periods, particularly of the Bathurst herd during post-calving, due to the location of the road within the known extent of post-calving grounds for the Bathurst herd;
- a potential for increased mortality through wildlife-vehicle collisions, increased predation and increased hunting;

- shipping and its effects on sea ice and hence migration of Dolphin and Union caribou and Peary caribou across ice bridges, particularly in the fall; and
- overall potential for synergistic effects leading to a reduction in caribou reproductive success.

5.4.2 Goals and Objectives

The goal of Caribou Management is to minimize caribou disturbance and mitigate effects of developments associated with the Project on caribou. This plan focuses on the haul road during construction and operation phases, port, camps, and shipping route. Objectives of the Caribou Management are:

- maintain the functional integrity of the landscape to support healthy and sustainable caribou populations;
- maintain the functional integrity of sensitive caribou areas including calving grounds, post-calving grounds, and migration corridors in the Project area;
- maintain healthy caribou and healthy and sustainable caribou numbers; and
- collaborate with governments and other stakeholders in protecting sustainable wildlife habitat and wildlife populations in the Kitikmeot Region of Nunavut.

5.4.3 Mitigation and Management

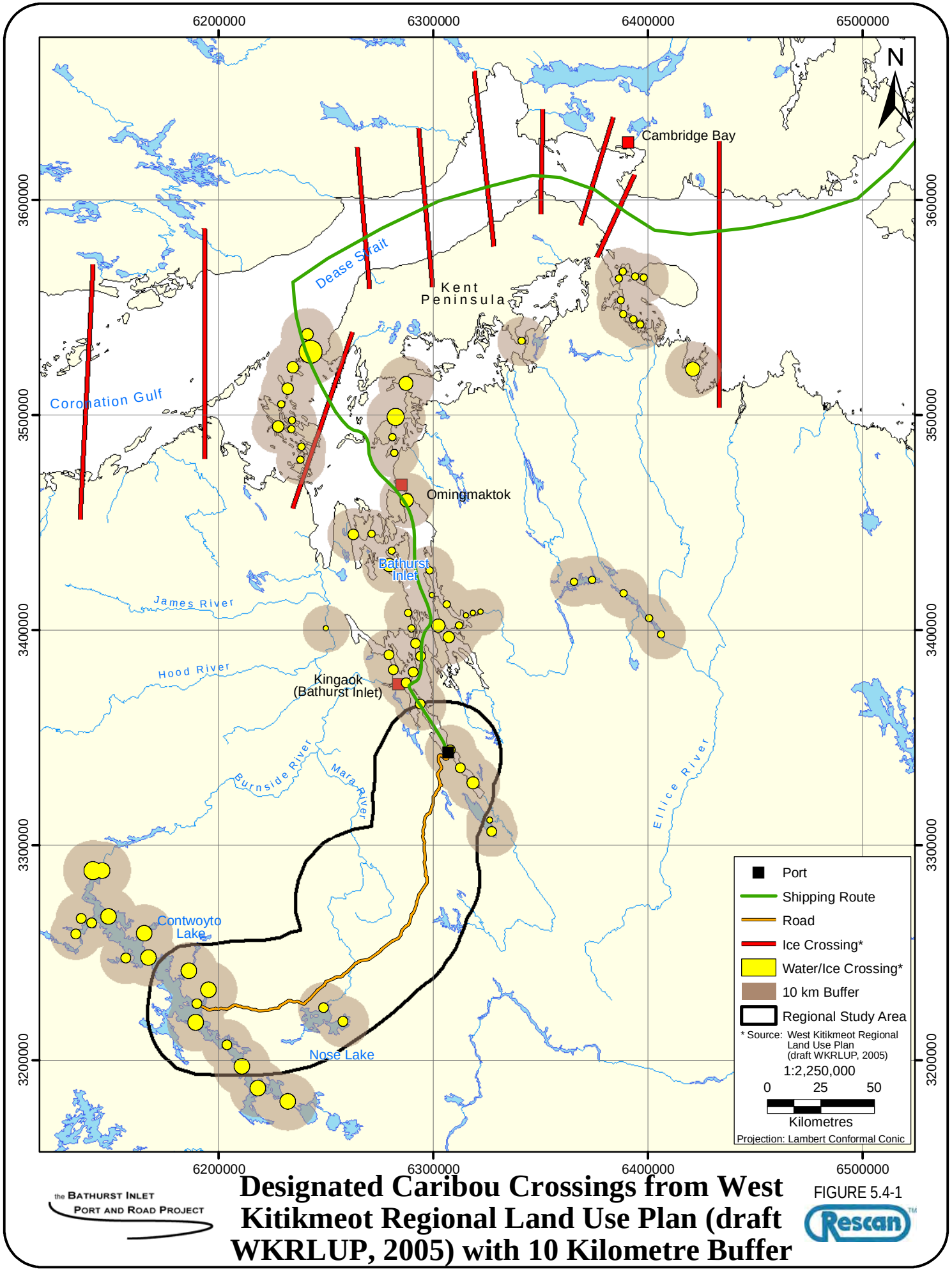
5.4.3.1 Avoidance of Sensitive Areas

Mitigation measures to minimize disturbance of caribou sensitive areas include:

- use the Interim Caribou Protection Measures of the draft WKRLUP (NPC, 2005) as guiding principles for Project construction and operations, such that land-based works and activities must not impede caribou access to open or ice-covered fresh water or marine crossings shown in Figure 5.4-1, as updated from time to time.
- conduct as part of a multi-stakeholder approach, further studies on Peary caribou to identify fall migration across ice (Franklin Strait, Peel Strait) and avoid disruption of caribou movement due to the potential of ice breaking along the shipping route;
- monitor caribou abundance, distribution and movement relative to the road to assess year-to-year variation and adapt management plans to observed seasonal caribou relative abundance and distribution; and
- apply adaptive management to current mitigation measures when new knowledge, monitoring results (as above), and research becomes available.

5.4.3.2 Avoidance of Sensitive Periods

Mitigation measures to minimize disturbance of caribou during sensitive periods include:



the Bathurst Inlet Port and Road Project

Designated Caribou Crossings from West Kitikmeot Regional Land Use Plan (draft WKRLUP, 2005) with 10 Kilometre Buffer

FIGURE 5.4-1

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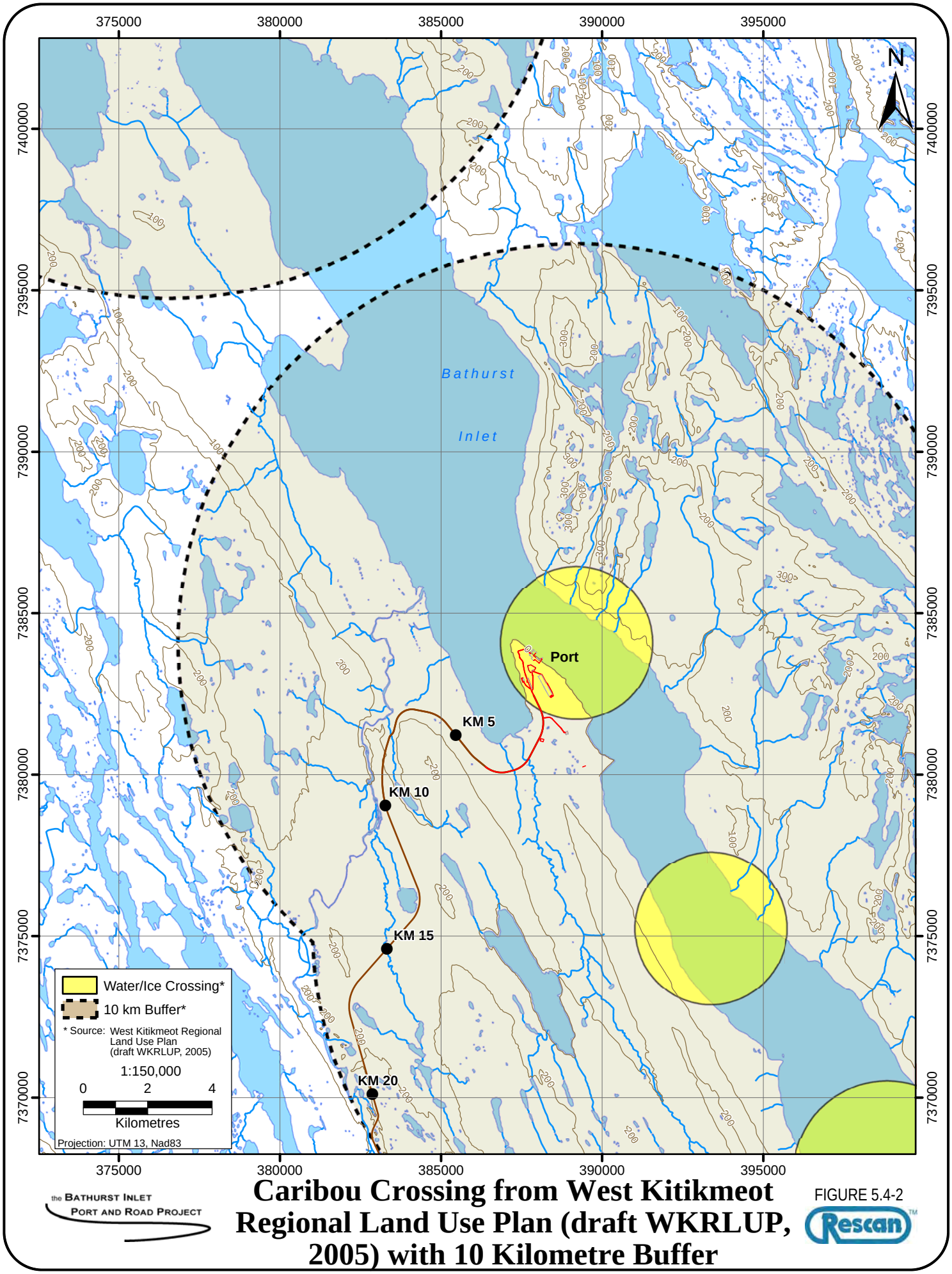
- confirm large numbers of caribou are not present in the vicinity of operations before activities commence. If large numbers of caribou are present, Project activities may cause significant disturbance and should be halted until large numbers of caribou are no longer present.
- use temporary road closures during sensitive periods (Table 5.4-1) when large numbers of caribou are in the vicinity or attempting to cross the road (*i.e.*, calving spring and post-calving migration).
- subject to specific approvals from land use authorities, apply the Interim Caribou Protection Measures of the draft WKRLUP (NPC, 2005) as guiding principles for Project construction and operations, which state under Conformity Requirement 3.1 (Interim Protection of Caribou), that:

1. Between May 15 and July 15, works and activities may not take place and, if operations have commenced, all operations must be suspended immediately if calving or post-calving caribou are present in or near the area of work or activity.
2. During caribou migration: a) migration must not be blocked or substantially diverted and b) activities that may interfere with migration, such as airborne geophysics surveys or movement of equipment, must cease until the migrating caribou have passed.
3. Between May 15 and September 1: a) camps may not be constructed, fuel may not be cached, and blasting may not be conducted within 10 km of any designated crossing as shown in Figures 5.4-1, 5.4-2, and 5.4-3, as updated from time to time, and b) diamond drilling operations may not be conducted within 5 km of any designated crossing .
   - use the Interim Caribou Protection Measures of the draft WKRLUP (NPC, 2005) as guiding principles for Project construction and operations, which state under Conformity Requirement 6.2 (Avoiding Ice-breaking by Ships for the Protection of Caribou and Travelers), that:
     - Shipping may not take place: a) outside the normal open water season between July 1 and October 15, or b) during the normal ice-forming period between October 15 and October 30 unless the shipping does not break ice.
4. apply adaptive management to current mitigation measures when new knowledge, monitoring results, and research becomes available.



the Bathurst Inlet Port and Road Project

Caribou Crossing from West Kitikmeot Regional Land Use Plan (draft WKRLUP, 2005) with 10 Kilometre Buffer

FIGURE 5.4-2

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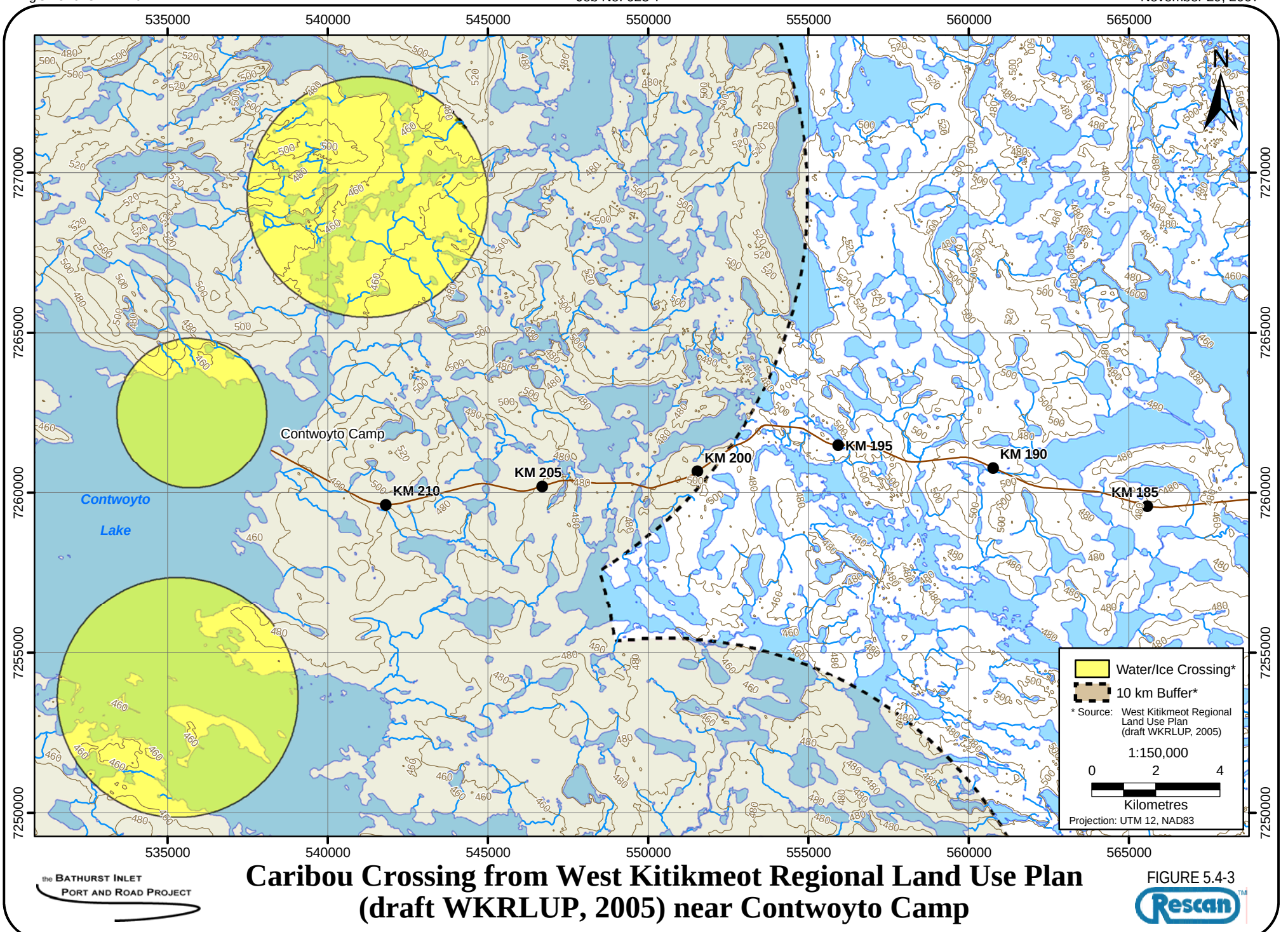

Caribou Crossing from West Kitikmeot Regional Land Use Plan (draft WKRLUP, 2005) near Contwoyto Camp

the Bathurst Inlet Port and Road Project

FIGURE 5.4-3

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Table 5.4-1
Caribou Sensitive Periods Applicable to the Project

Caribou Herd	Activity	Sensitive Period[1]
Bathurst	Spring Migration	April 15 to June 4
	Calving	June 5 to June 15
	Post Calving	June 16 to July 20
Ahiak	Spring Migration	April 15 to June 4
	Calving	June 5 to June 20
	Post Calving	June 21 to July 25
Dolphin and Union	Spring Migration	April 21 to July 9
	Fall Migration	October 21 to December 3
Peary[2]	Spring Migration	May 1 to July 1
	Fall Migration	unknown

[1]Sensitive period that interacts with the Project. For complete life history stages, see Chapter 2.
[2]Limited data available for Peary caribou ice migrations. During the spring migration, the majority of Peary caribou cross Peel Sound and Franklin Strait from May through June over ice. No timing data are available for fall migration.

5.4.3.3 Maintenance of habitat continuity

Mitigation measures to limit caribou disturbance, reduce avoidance of the Project area, and lessen the road as a "semi-permeable" barrier to movement include:

- avoid road construction to the extent possible near eskers and other movement corridors for caribou;
- limit the height of the road, such that the height should not exceed 1.2 m where possible. If road height does exceed 1.2 m, road crossing structures (*e.g*., gravel ramps) should be constructed at intervals along the road to minimize the elevated road as a visual barrier and to facilitate caribou movement across the elevated road structure;
- construct (where eskers must be crossed by the road) caribou crossing ramps perpendicular to, and on either side of the road at the apex of the esker to maintain a movement corridor and to facilitate driver sight lines for animals using the esker as a travel corridor (Section 5.4.3.5);
- identify caribou movement corridors and potential road crossing locations for placement of caribou crossing ramps. Specifically, these areas include major caribou movement corridors between Contwoyto Lake and Nose Lake (between kilometre 140 and 211) and within the first 40 km of the road from Bathurst Inlet. In general, if no caribou crossing points are identified in a particular road section, then ramps will be placed regularly along the road. Lakes, topography or infrastructure may funnel caribou to specific areas along the road and these areas should be identified as prime sites for placement of road-crossing structures (Smith and Cameron, 1985). Sites could also be chosen by reconnaissance flights to identify congregations of caribou tracks, use of local information or Inuit knowledge and meta-analysis of existing data;

- construct sloping crossing ramps with a 5:1 ratio at identified crossing sites; ramps should be constructed on either side of the road to direct and facilitate caribou movement across road;
- ensure that ramp placement, design, width, length, and slope be evaluated by a wildlife biologist prior to construction as design details can influence the effectiveness of crossing structures (Cronin *et al.*, 1994). Ramps will be constructed using smaller material size (*i.e.*, fine to coarse material, not large boulders) to facilitate caribou movement and to ensure caribou are not injured when using ramps. Caribou crossing ramps constructed in oilfields in Alaska were a minimum of 30.48m (100 feet) wide with 10% slope (Cronin *et al.*, 1994);
- construct additional ramps during later stages of the Project as required to provide ramps at crossings observed along other sections of the road (*i.e.*, adaptive management);
- avoid construction of ramps in close proximity to areas of concentrated or frequent anthropogenic activity (*i.e.*, quarry or borrow pits);
- erect road signage at all crossing ramps;
- avoid parking vehicles or equipment on ramps. Ramp effectiveness as caribou crossings was reduced when occupied by parked vehicles (Cronin *et al.*, 1994); and
- ensure snowbanks and snowdrifts at the road edge and at ramp-road interfaces do not exceed 75 cm in height.

Mitigation measures to avoid disrupting caribou migration across the shipping route include:

- identify timing of caribou movement across ice during migration (as part of a multi-stakeholder research project involving deployment of satellite collars on Peary caribou) prior to potential ice-breaking activities; and
- if possible, have shipping in the Dolphin and Union Strait, Queen Maud Gulf, Franklin Strait and Peel Strait occur during ice-free periods.

5.4.3.4 Minimize Direct and Indirect Mortality

Mitigation measures to minimize mortality are to:

- require all drivers on the road undergo a caribou and wildlife training program to prevent caribou-vehicle collisions;
- implement a monitoring program to report caribou crossing locations and identify these areas by appropriate road signage;
- implement a caribou reporting program that updates drivers on current large caribou herd locations; and
- ensure quarry reclamation allow for caribou access and egress, to avoid formation of predator or mortality traps.

5.4.3.5 Minimize Sensory Disturbance

Caribou are sensitive to sensory disturbance (Cronin *et al.*, 1994; Bradshaw *et al.*, 1997; Bradshaw *et al.*, 1998). Mitigation measures to limit sensory disturbance include:

- maintain all equipment to reduce noise;
- blasting along the road be conducted when caribou are not present;
- shut down equipment and keep personnel quiet if caribou approach work site. Activities may resume after caribou pass and have moved away. (Removal of equipment and personnel may actually create more disturbance);
- subject to specific approvals from land use authorities, use the Interim Caribou Protection Measures of the draft WKRLUP (NPC, 2005) as guiding principles for Project construction and operations, which state as Measure 2 and 3 of Conformity Requirement 3.1 (Interim Protection of Caribou), that:
  - During caribou migration: a) migration must not be blocked or substantially diverted and b) activities that may interfere with migration, such as airborne geophysics surveys or movement of equipment, must cease until the migrating caribou have passed; and
  - Between May 15 and September 1: a) camps may not be constructed, fuel may not be cached, and blasting may not be conducted within 10 km of any designated crossing as shown in Figures 5.4-1, 5.4-2, and 5.4-3, as updated from time to time, and b) diamond drilling operations may not be conducted within 5 km of any designated crossing.

5.4.3.6 Reduce Effects on Caribou Productivity

The potential effects of the Project, as identified in the effects assessment (Section 4.1.3) interrelate and their combined effects may affect caribou productivity (*i.e.*, caribou health, caribou numbers and recruitment). Direct measures to mitigate for potential reduction in caribou productivity are not outlined in this document. It is intended that the management and mitigation measures outlined above, in the General Wildlife Management (Section 5.2) and Road Right-of-Way Management (section 5.3), if followed, will alleviate pressures on the health and productivity of caribou herds that interact with the Project.

5.5 Waste and Wildlife Attractant Management

5.5.1 Project-specific Issues

Features or substances that interest or may be resources to wildlife are considered to be wildlife attractants. Within the Project area, the following may be potential wildlife attractants: standing waters, putrescible waste, putrescible waste storage facilities, buildings and lights. The main sources of waste and other potential wildlife attractants will be at the port site at Bathurst Inlet and the camp at Contwoyto Lake. Assessment of the Project activities identified the following potential effects and concerns (Section 3.2.1, Table 3.2-3) for wildlife due to Project-specific attractants:

- potential for wildlife to be attracted to Project sites by the presence of waste and waste management facilities;
- potential for wildlife to ingest or use poor-quality water sources as habitat, and thereby become exposed to metals and/or other contaminants;
- the road as an attractant (scavenging road-killed carrion, road-side revegetation as forage source) which may increase risk of vehicle-wildlife interactions and road-related mortality (direct mortality); and
- artificial light at port and camps as an attractant to migratory birds, which may result in bird disorientation and increase risk of direct mortality (*i.e.*, collisions and disruption of migration).

5.5.2 Goals and Objectives

The goal of the Waste and Wildlife Attractant Management is to minimize the potential for human-wildlife interactions through control of wastes and potential wildlife attractants in the Project area. The objectives of Waste and Wildlife Attractant Management are to:

- ensure Project infrastructure and activities minimize effects of potential attractants on wildlife;
- reduce and manage putrescible wastes to minimize wildlife attraction to Project facilities; and
- minimize standing water and restrict access to contaminated water.

5.5.3 Mitigation and Management

5.5.3.1 Overview

Mitigation measures to minimize and eliminate Project-specific attractants to wildlife and their effects on wildlife are described in the following sections and include:

- management of standing and contaminated water;
- waste storage and incineration;
- carrion control;
- wildlife exclusion; and
- minimizing sensory attraction.

In addition to the above, mitigation and management directives outlined in the General Wildlife Management provisions (Section 5.2) should be applied during all Project activities (*e.g.*, no littering policy, no feeding wildlife policy).

It is assumed that multiple wildlife species in the Project area will benefit from the proposed mitigation and management strategies. These directives are not exclusive and may be altered to reflect local and scientific knowledge, experience, and management needs.

It is intended that all mitigation and management directives related to Waste and Wildlife Attractant Management apply to all employees and other persons associated with the Project including users of the road, port site and camps. Education and training programs (Section 5.7) to ensure understanding and compliance with Waste and Wildlife Attractant Management provisions will be undertaken and will be the responsibility of the Project management.

5.5.3.2 Standing and Contaminated Water Management

Wildlife, especially waterfowl will be attracted to standing water within areas of Project activity. Mitigation measures to reduce the potential for wildlife being exposed to contaminated water include:

- monitor the quality of standing water in Project areas, as outlined in the Surface Water Management Plan (Appendix C-2 of the DEIS); and
- use wildlife exclusion measures such as rock berms, fencing and/or netting around ponds or other open-water bodies containing contaminated water or hazardous liquids.

5.5.3.3 Waste Storage and Incineration

Various wildlife attractants that will be produced during the construction and operation of the Project include kitchen, petroleum and sewage wastes. Although many wildlife species may be attracted to waste producing and storage areas, certain wildlife, such as grizzly bears, are likely to pose more of a problem than others. Therefore, waste management will focus on grizzly bears as the species of primary consideration, with the idea that safeguarding for bears should also be effective for wolverine, wolves, and other scavengers.

As outlined in Section 7.3 of the Project Description (Appendix D-2 of the DEIS), all combustible waste will be incinerated on a regular basis so as not to attract scavengers and non-combustible waste will be disposed of either at a solid inert waste site or be shipped out. Mitigation measures to further reduce the potential for human-wildlife interaction due to wildlife attraction to human use areas include:

- incinerate all kitchen wastes within a timely manner;
- store recyclable wastes and chemicals in wildlife-proof facilities;
- store all attractants and wastes (garbage, food waste) at the port site, Contwoyto Lake camp and construction sites along the road in bear-proof storage containers. Bear-proof containers must be tightly secured at all times. Standard criteria for waste containers to be considered effective at preventing bears from accessing wastes are outlined in an existing Rescan Bear Management Plan (Rescan, 2007b);
- conduct regular road and camp cleanups to ensure that no hazardous substances, wires, or loose materials are present to endanger wildlife and ensure proper storage and disposal of hazardous wastes.
- remove waste from collection sites regularly, incinerate in an approved industrial-strength incinerator or store in wildlife-proof fenced areas and wildlife-proof buildings until incineration and dispose at an approved disposal site as soon as possible.

- use landfills only for disposal of non-wildlife attracting waste; and
- prevent wildlife from entering landfills, incinerators and sewage treatment facilities using appropriate wildlife exclusion techniques (*e.g.*, fencing).

5.5.3.4 Carrion Control

Wildlife scavengers (*e.g.*, grizzly bears, wolverines) in the Project area will be attracted to animal carcasses. Mitigation measures to address any carcasses in areas of human use include:

- remove road-kill from road and dispose of using approved methods (*i.e.*, incineration) as quickly as possible to avoid attracting carrion feeders to the road side;
- remove naturally occurring wildlife kills located near roads or, if more appropriate, mark the area with temporary signage indicating scavengers may be present in the area. Signage will be removed when carcass is no longer an attractant; and
- enforce temporary closures of areas where wildlife carcasses cannot be removed until the carcass has been consumed and scavengers have left the area.

5.5.3.5 Wildlife Exclusion

Where it is not possible for Project activities to avoid a wildlife sensitive area or timing period, or where an activity itself is likely to attract wildlife, reasonable measures will be taken to prevent wildlife from coming into contact with humans and human activities. Mitigation measures include:

- design and maintain buildings to exclude wildlife wherever possible (*e.g.*, construct vents to prevent small mammals and birds entering);
- build berms at high walls of quarries to deflect wildlife movement and prevent falls or injury;
- conduct monitoring to ensure wildlife are not accessing areas of human use (*e.g.*, monitor buildings for presence of wildlife); and
- monitor and record wildlife use of all Project-related areas (*e.g.*, birds nesting in quarry pits, caribou travelling along the road).

5.5.3.6 Minimize Sensory Disturbance

Lights are an attractant to many species of wildlife, especially birds. Lighting at the port and camp sites will be designed to minimize potential impact to wildlife while ensuring safe operating conditions. Mitigation measures to reduce sensory disturbance to wildlife include:

- use directed lighting rather than broad lighting whenever possible;
- direct all lighting at the port facility and camp into the facility toward the ground and do not direct horizontally out into the surrounding environment to limit stray light as a visual disturbance; and

- avoid use of solid and pulsating red lights, which seem to be more attractive to birds at night during inclement weather conditions than are white strobe lights (Erickson *et al.*, 2002).

5.6 Problem Wildlife Management

5.6.1 Project-specific Issues

Although mitigation measures can greatly reduce the probability of negative wildlife interactions, animals may still be attracted to a Project site. Ascribing "problem" status to an animal should only occur after all other appropriate management actions have been exhausted (*e.g.*, wildlife exclusion, attractant removed), or if the animal poses imminent danger to human safety. A problem animal is any animal judged by an objective assessment of its behaviour to be a threat to human safety or liable to cause considerable property damage.

Problem animals can be divided into two categories: habituated animals, and food-conditioned animals. Habituated animals have lost their natural fear of humans, and so may not display avoidance behaviour around humans or in human-use areas such as camps or along roads. Such behaviours are frequently observed in National Parks where bears will continue eating along the side of a road, seemingly oblivious to tourists flocking to observe them. Habituated animals provide an elevated level of risk to both themselves and humans because of the increased amount of time they spend in close proximity to humans. Habituated animals are more likely to become food conditioned, which occurs when an animal that has received a significant reward of non-natural foods (such as garbage or camp food) persistently seeks out those foods.

Cases may occur when bears and other wildlife become problems, either by consistently destroying property or threatening human safety. The Problem Wildlife Management provisions addresses potential effects of the Project on features acting as an attractant, mortality (direct and indirect) and decreased productivity (Table 5.1-1).

5.6.2 Goals and Objectives

The goal of the Problem Wildlife Management is to minimize wildlife-human interaction, ensure safety of Project employees and prevent avoidable wildlife mortalities. Objectives of the Problem Wildlife Management include:

- provide a response plan for dealing with adverse human-wildlife interactions;
- prevent habituation of wildlife to Project facilities and people; and
- avoid destruction of wildlife, unless absolutely necessary.

5.6.3 Management and Mitigation

5.6.3.1 Protocol for Human-wildlife Interactions

Mitigation and management measures to address problem wildlife interacting with the Project are outlined in the Protocol for Human-Wildlife Interaction. The Protocol is written to address problem

bears, however it can be modified to address other problem wildlife, if necessary (Table 5.6-2). Details of these management responses to human-wildlife interactions are as follows:

1. monitoring: report and record wildlife sightings and signs;
2. post warning: provide accurate and current information of all potentially dangerous wildlife in the area;
3. area closure: restrict human access to areas where the potential for negative human-wildlife interactions is likely;
4. adverse conditioning (AVCD): apply AVCD activities to problem wildlife such that the animal associates negative consequences with undesirable behaviours in order to prevent or reverse habituation;
5. translocation: capture and relocate problem animals away from specific attractant and areas of concentrated human activity to minimize probability of repeat occurrences and interactions; or
6. destruction: undertake (with authorization from appropriate wildlife management authority) only when an animal is determined to pose an unacceptable hazard to human safety.

Table 5.6-2
Protocol to Determine Appropriate Management Responses to Human-Animal Interactions

Type of Human-Animal Interaction	Management Response					
	Monitor	Post Warning	Area Closure	AVCD	Trans-locate	Destroy
1. Animal sighting or sign reported	X	X				
2. Animal showing normal feeding behaviour and avoids people	X	X				
3. Animal reacting defensively following surprise or provoked encounter (defensive aggression)	X	X	X			
4. Animal tolerates people but ignores them and their facilities (no threat present)	X	X	X	X		
5. Animal shows repeated interest in people and/or human facilities, which will likely result in food-conditioning or close approaches (habituated)	X	X	X	X		
6. Animal receives minimal or low-level reinforcement to unnatural food sources (mildly food-conditioned)	X	X	X	X	X	
7. Animal is heavily habituated to people and has repeatedly obtained unnatural foods (food-conditioned)	X	X	X	X	X	
8. Animal has previously been relocated and is unlikely to change its behaviour		X	X	X		X
9. Animal displays aggressive offensive or predatory behaviour and is an imminent threat to human safety.		X	X			X

Mitigation measures to manage for problem wildlife in the Project area include:

- disseminate protocol for Human-Wildlife Interactions to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers;
- identify appropriate personnel (*i.e.*, environmental monitor, wildlife biologist) to monitor and evaluate human-wildlife conflicts carefully using the protocol for Human-Wildlife Interactions to determine whether animal should be considered a problem animal and appropriate course of action;
- leave wildlife that avoid humans and show normal feeding behaviour alone;
- avoid destruction of wildlife unless no other recourse is possible. Bears or other wild animals that cause injury to humans as a result of natural defensive or protective behaviour (*e.g.*, protecting its young during a startling encounter) should not be destroyed or translocated; and
- inform employees of the disciplinary consequences (as determined by the Project management) of disregarding measures taken to manage problem wildlife (*e.g.*, area closures).

5.7 Employee Wildlife Education

5.7.1 Project-specific Issues

Employee Wildlife Education addresses potential effects of the Project on wildlife including: habitat loss, disturbance to feeding, nesting, denning or breeding habitats; features acting as an attractant and mortality, both directly and indirectly (Table 5.1-2).

Employees and contractors will be educated on basic local wildlife ecology (specifically identified VECs), Project-related concerns for wildlife and biodiversity. All Project personnel will be encouraged to promote stewardship activities. Employees and contractors will also be expected to comply with the direction provided in the overall General Wildlife Management and other subject-specific management provisions.

5.7.2 Goals and Objectives

The goal of Employee Wildlife Education is to create employee and contractor awareness for the potential effects of Project facilities and Project operations on wildlife, minimize disturbance and disruption to wildlife, and ensure safety of all employees. The objectives of Employee Wildlife Education include:

- provide an accessible and comprehensible wildlife awareness program;
- ensure awareness and understanding for the recommended mitigation measures and procedures outlined throughout this document; and
- promote compliance with mitigation measures through education and enforcement.

5.7.3 Mitigation and Management

5.7.3.1 Employee Wildlife Education Program

All contractors and employees working on the Project will participate in the Employee Wildlife Education program in conjunction with Project orientation. Mandatory annual refresher courses will ensure ongoing employee awareness of wildlife concerns and mitigation procedures for the Project. This program will be supported by standard operating procedures, reporting forms, information sheets and awareness posters and signage. The education program will include, but not be limited to:

- access road restrictions and operating protocols (*e.g.*, wildlife right-of-way, speed limits, check-ins, road-wildlife reporting programs);
- awareness of wildlife-sensitive locations (*e.g.*, movement corridors, breeding areas) and wildlife-sensitive periods;
- local wildlife species of concern and threats to native biodiversity;
- waste and wildlife attractant management;
- no feeding of wildlife policy;
- no harassment of wildlife;
- no-hunting policies;
- bear-aware training;
- wildlife incidental observation reporting;
- wildlife incident/accident reporting and response procedures;
- anonymous reporting system for employees to voice concerns and inform management of non-compliance; and
- compliance requirements and disciplinary action that will be enforced by Project management.

5.8 Evaluating Mitigation and Management

5.8.1 Future Monitoring

To meet the objectives of the WMMP, evaluation of the effectiveness of mitigation measures to minimize wildlife disturbance must be conducted. Evaluation of the mitigation measures will be addressed in the Wildlife Management and Monitoring Plan (Chapter 6) with the intent to monitor effectiveness and adaptively manage measures.

Direct measures to mitigate for potential reductions in wildlife reproductive productivity have not been outlined in the WMMP. It is intended that the mitigation measures outlined, if followed, will alleviate pressures on the health and productivity of wildlife that interact with the Project.

6. MONITORING AND EVALUATION

6. Monitoring and Evaluation

6.1 Introduction

6.1.1 Overview

A wildlife monitoring program is proposed to evaluate the effectiveness of mitigation and management efforts outlined in the Wildlife Mitigation and Management Plan (Chapter 5) in reducing the impact of the Project on identified wildlife and wildlife issues. The proposed wildlife monitoring program is presented as a draft framework for 1) wildlife-specific monitoring studies and 2) facility-specific monitoring studies:

1. Wildlife monitoring of focal species (*i.e.*, caribou, grizzly bear and wolverine) is proposed in a multi-stakeholder initiative with a focus on wildlife abundance, movement and distribution relative to the Project activities and facilities. Implementation of the wildlife monitoring program should involve the integration of tasks, where possible, to achieve increased efficiency and cost effectiveness. A wildlife monitoring program of this nature can only be implemented with the cooperation and financial contribution of multiple stakeholders in the region and so is advanced here as a model for discussion.
2. Facility-specific (*e.g.*, road traffic measures, problem wildlife, waste management) monitoring studies will focus on effectiveness of mitigation measures to minimize disturbance and effects of the Project on wildlife.

A draft framework for the proposed wildlife monitoring program will be outlined in the following sections, with the caveat that a formal and detailed environmental monitoring program should be developed prior to initiation of works associated with the proposed Project. The framework identifies each monitoring study, methodology to be used, spatial extent, frequency and duration of monitoring, monitoring objective (quantify impact or assess mitigation), parameters measured and performance indicators. Elements of the formal wildlife monitoring program may include a comprehensive outline of existing baseline studies, gap analysis, monitoring methodology, field study design, performance indicators, statistical analyses, reporting, responsibilities, triggers for adaptive management, and potential adaptive management and mitigation responses.

6.1.2 Goals and Objectives

The goal of the wildlife monitoring program is to assess interaction between the Project and wildlife populations in order to modify operations if it is found that the Project is having a measurable negative effect on specific wildlife populations in the region. The overall objectives of the wildlife monitoring program include: assess the interactions and related effects of the Project (road, camps, port) on the wildlife VECs identified in the effects assessment (Chapter 4);

- evaluate impact predictions in the effects assessment (Chapter 4);
- measure the effectiveness of the impact mitigation;
- identify opportunities for adaptive management;

- continuously reduce uncertainty of Project effects on wildlife; and
- collaborate with other industry parties, government and Inuit peoples in the event that long term wildlife monitoring programs are initiated in the Kitikmeot region of Nunavut.

6.1.3 Approach

The formal Wildlife Monitoring Program that emerges from the Final EIS review by NIRB should be developed by a working group that includes representatives from:

- the Proponent;
- the Government of Nunavut;
- the Kitikmeot Inuit Association or designate; and
- the Canadian Wildlife Service.

The working group would be responsible for:

1. developing the initial Wildlife Monitoring Program;
2. reviewing the Wildlife Monitoring Program findings; and
3. suggesting changes to the Wildlife Monitoring Program.

6.1.4 Spatial and Temporal Boundaries

The RSA encompasses the road, Contwoyto Camp, port, and a 30-km buffer on either side of the proposed road, covering an area of 1,476 km^2. The LSA encompasses the road, Contwoyto Camp, port, and a 500 m buffer (either side of the proposed road), covering 26,438 ha. The shipping route includes Bathurst Inlet, Dease Strait, Queen Maud Gulf, Victoria Strait, Franklin Strait, Peel Sound, Franklin Strait and Barrow Strait.

The life of the Project is defined for the EIS as 22.5 years (July 2009 to 2032) and includes construction (2.5 years), operations (19 years), and decommissioning (1 year).

6.1.5 Reporting

The results of the wildlife monitoring program will be compiled in an annual report that will be distributed to regulatory agencies and neighbouring Kitikmeot communities. The annual wildlife monitoring report will include:

1. results of the monitoring studies;
2. analysis of the results with comparisons to findings from earlier years (*i.e.*, baseline and annual monitoring); and
3. recommendations (if any) for changes to wildlife monitoring and management practices.

6.1.6 Responsibilities

Monitoring studies proposed under the wildlife monitoring program are put forth in this document as conceptual and are considered models for discussion (Tables 6.2-1 and 6.2-2). The

Wildlife Monitoring studies (Table 6.2-1) are considerable in scope and cost and therefore can only be effectively implemented with the cooperation and sustained financial contribution of multiple stakeholders. Undertaking facility-specific monitoring studies (Table 6.2-2) will be the responsibility of the proponent.

6.1.7 Adaptive Management

The Wildlife Monitoring Program will allow the Wildlife Mitigation and Management Plan to be continually refined (*i.e.*, adaptive management) to foster management strategies that continue to minimize wildlife effects in the context of ongoing environmental change.

Changes to the Wildlife Mitigation and Management Plan and Wildlife Monitoring Program will occur following recommendations from the Working Group, guided by findings of the monitoring studies, best management guidelines from organizations as they become available and wildlife concerns or issues that emerge in the course of Project development, operation and closure.

6.2 Wildlife Monitoring Program

6.2.1 Overview

Monitoring studies are offered as recommendations and will be refined during the environmental assessment process leading to the Final Environmental Impact Statement (FEIS) and Project Certificate. The proposed wildlife monitoring program is presented as a draft framework for 1) wildlife-specific monitoring studies and 2) facility-specific monitoring studies and will address construction and operation phases of the Project to evaluate effectiveness of:

- maintenance of habitat continuity for caribou;
- distribution and movement of caribou and carnivores relative to the road;
- road traffic management measures to reduce road-related wildlife mortality;
- putrescible waste storage and incineration to reduce wildlife attractant potential;
- response to the presence of problem wildlife;
- reporting process for incidental wildlife observations, human-wildlife interaction and accidents; and
- employee education and training.

6.2.2 Wildlife Monitoring Studies

A framework of potential elements for wildlife monitoring studies is presented for discussion with other stakeholders in the region and is outlined in Table 6.2-1.

6.2.3 Facility-specific Monitoring Studies

A framework describing possible elements for facility-specific monitoring studies that would be implemented by the proponent is outlined in Table 6.2-2.

Table 6.2-1
Framework for Wildlife Monitoring Studies[1] as a Multi-Stakeholder Initiative

Monitoring Study	Method	Spatial Extent	Project Phase	Frequency	Duration	Description	Study Objective	Parameters Measured/Performance Indicator to Be Monitored
Caribou abundance, distribution and movement relative to Road, Camps and Port Methods proposed:								
1) Aerial Survey	FIELD-BASED Aerial Survey-transects	RSA	Construction & Operation	5 surveys/year: spring migration, calving, post-calving, summer, fall migration	First 5 years: Annually (during construction and first 3 years of operation phase) Every 3 years following for the life of project, including survey post-decommissioning of road	Document and assess relative abundance, distribution and movement in relation to project infrastructure Provides "snap-shot in time" data	Quantify Impact Assess Mitigation	Population measures and distribution relative to existing collar data Numbers of caribou, group composition (males, females, calves), recruitment rates. Distribution of caribou groups (e.g., nursery versus non-nursery), distance from road, spatial and temporal distribution on landscape Detection of changes in spatial and temporal migration patterns Locations of predator kill sites relative to infrastructure
2) Satellite Collars	OFFICE-BASED Satellite Collars	RSA (with potential for providing data within the greater region)	Construction & Operation	Monitoring of satellite collar as data becomes available	Life of project	Document and assess distribution and movement of caribou relative to project infrastructure and the greater area Provides continuos data over extended period of time	Quantify Impact Assess Mitigation	Detection of changes in spatial and temporal migration patterns, calving and post calving grounds Identification of avoidance behaviour, deflection and movement delay of caribou by infrastructure
Road Permeability to Caribou	FIELD-BASED Snow Track Survey (ground-based along road)	Road	Construction & Operation	Biweekly (4 times April through May)	First 5 years: Annually (during construction and first 3 years of operation phase) Every 3 years following for the life of project, including survey post-decommissioning of road	Document and assess attempts and willingness of caribou to cross road, use of man-made crossing structures, and identify caribou crossing sites	Assess Mitigation	Identification of movement corridors and road crossing sites, differentiating between high, moderate and low use areas Caribou use, effectiveness and design of road crossing structures (*e.g* ., ramps) Deflection and movement delay of caribou by road
Caribou Ice Migration (Peary caribou)	OFFICE-BASED Satellite Collars	Shipping Route	Construction & Operation	Deployment in first 2 years of project (construction) in Peary herd prior to potential ice-breaking activities	Life of project	Document timing and movement corridors for Peary caribou ice migration (spatially and temporally) due to potentail for ice-breaking in shipping route	Quantify Impact Assess Mitigation	Identification of spring and fall ice migrations for Peary Caribou,and detection of changes in movement corridors and timing Detection of changes in spatial and temporal migration patterns, calving and post calving grounds Population parameters including adult female survival and calf mortality of collared animals
Mammalian Indicator Species Surveys - grizzly bear, wolverine Methods proposed:								
1) Aerial Survey	FIELD-BASED Aerial Survey-transects	RSA	Construction & Operation	Concurrent to caribou aerial surveys	First 5 years: Annually (during construction and first 3 years of operation phase) Every 3 years following for the life of project, including survey post-decommissioning of road	Surveys will be tailored to species sensitive periods and areas Provides "snap-shot in time" data	Quantify impact Assess mitigation	Carnivore abundance and distribution relative to data from existing carnivore monitoring programs Identification of potential causes of disturbance (*i.e.* , mechanisms)
2) DNA Hair Snag Survey	FIELD-BASED DNA (Hair snag on posts)	RSA	Construction & Operation	To be determined in consultation with Government of Nunavut large carnivore biologists Proposed: Biweekly during Haul Season, Bimonthly during Off Season	First 5 years: Annually (during construction and first 3 years of operation phase)	Surveys will be tailored to species sensitive periods and areas Provides data over extended period of time Collection of hair samples from carnivores using gridded post system to monitor changes in abundance and distribution relative to the road (extension of existing government large carnivore project). Microsatellite DNA analysis: hair samples will be provided to the government carnivore research programs	Quantify impact Assess mitigation	Carnivore distribution relative to data from existing carnivore monitoring programs Identification of potential causes of disturbance or wildlife attraction (*i.e.* , mechanisms) Number of hair samples collected and provided to government

[1] monitoring studies are presented as models for discussion and can only be effectively implemented with the cooperation and financial contribution of multiple stakeholders in the region

Table 6.2-2
Facility-specific Monitoring Studies for the Proposed Wildlife Monitoring Program

Monitoring Study	Method	Spatial Extent	Project Phase	Frequency	Duration	Description	Study Objective	Parameters Measured/ Performance Indicator to be Monitored
Wildlife Detection and Habitat Use relative to road Methods: 1) Den Survey	FIELD-BASED Aerial Survey Ground- based Survey	LSA	Construction	Aerial: concurrent to raptor surveys Ground: Bi-annual: fall and spring	First 2 years: overlapping with construction phase	Revisit identified den sites (from baseline work and traditional knowledge); search for new dens	Quantify impact Assess mitigation	Number of dens, status (active, inactive), species, location, date, measurements, number of offspring (if known) Indicator of distribution of carnivores Data used directly to apply mitigation measures identified in Chapter 5 (e.g., avoid blasting near sensitive habitat, section 5.3.3)
2) Raptor Nest Survey	Aerial Survey	LSA	Construction	Biannually: June (nesting period): 1 flight day August (fledgling period): 1 flight day	First 2 years: overlapping with construction phase	Continuation of baseline study for comparison pre- and during construction. Detection of peregrine falcon to monitor changes in habitat use and reproductive success	Quantify impact Assess mitigation	Document presence of nests in June, then assess reproductive success in August during construction Number of nests, status (active, inactive), species, number of raptors observed, location, date, number of offspring (if known), fledge date (if known)
Road Access and Maintenance Monitoring	OFFICE BASED Data compilation and analysis FIELD-BASED Driving survey	Road	Construction & Operation	Continuous	Life of project	Document and analyze road maintenance activities,log traffic use of road, field-check snowbank heights, clearance of caribou crossing ramps of snow and vehicles. Field-survey (driving road) can identify wildlife crossing areas or movement corridors, use of crossing ramps.	Assess Mitigation	Number of vehicles using road daily, user-identified Number of unauthorized vehicles documented annually Frequency of snow ploughing, blowing and gravelling Frequency and location of crossing ramps cleared of snowbanks Vehicle use of caribou crossing ramps Wildlife use of crossing ramps and identification of wildlife movement corridors Frequency and amount of dust control measures used Number of road closures due to wildlife presence, posted signs, and posters Number, location, slope of caribou ramps
Road-related and Human-caused Wildlife Mortality	OFFICE BASED Data compilation and analysis	road, LSA	Construction & Operation	Daily monitoring & recording Analysis: twice during Haul Season (Feb and April) to allow for prompt adaptive management	Life of Project	Document and analyse road-wildlife, vehicle-wildlife interactions, occurrences of carrion and wildlife attraction to the road, and road-related wildlife mortalities.	Quantify impact Assess mitigation	Identification of high-risk wildlife conflict areas and periods along road Identification of factors causing collision Identification of species at high risk of collision, location, dates and times Number and species of wildlife road-related mortalities,and wildlife-vehicle interactions reported Number of carrion reported, incidents followed up on, wildlife carcass removed from road and disposal method Cause of animal death (vehicle, predator kill, other) Wildlife/scavenger presence, species, number of animals, age and sex, location, date and time of observation, behaviour of wildlife (e.g., feeding, aggressive behaviours, etc.) and condition of wildlife observed (if applicable) (e.g., emaciated, wounded, healthy, etc.) Analyze hunter harvest records (locations of kills relative to road), if data is available from Hunter Harvest records of the NWT/Nunavut government and Inuit Hunter Harvest knowledge (location, harvest numbers)
Human-Wildlife Incident and Problem Wildlife Reporting	OFFICE BASED Data compilation and analysis	LSA Camps Port	Construction & Operation	Ongoing Analysis: annually	Life of Project	Document and analyse incidental wildlife-human interactions, problem wildlife incidents and accidents	Quantify Impact Assess Mitigation	Number, species, and location of incidental wildlife observations Assessment of completeness of data records Number of wildlife incidents/accidents reported Location, species, descriptions of human-animal interaction, use of Protocol for Human-Wildlife Interactions, outcome identified Number of animals adverse conditioned, translocated, destroyed
Incidental Wildlife Reporting	OFFICE-BASED Data compilation and analysis	LSA	Construction & Operation	Annually	Life of project	Document and analyse reporting data (source: road dispatch and drivers) Data includes incidental wildlife sightings in vicinity of road,camps, port and LSA (e.g., caribou, muskox, carnivores, small mammals, birds, raptors)	Assess Mitigation	Number of incidental wildlife sightings Location, species, time, date, number, group composition (e.g., nursery, non-nursery) Identification of locations of caribou crossing the road Frequency of wildlife approaching road, number of animals approaching, crossing or interacting with the road Number of occurrences of wildlife (e.g., birds), species, location, date and time of observation, behaviour of wildlife in vicinity of lighted facilities Number of dens/nests affected (moved, destroyed, abandoned) by construction activities Assessment of completeness of data records
Waste Disposal	Observation	LSA Waste-disposal facilities (waste bins, incinerators and landfill)	Construction & Operation	monitoring as required Annual reporting	Life of project	Ensure proper disposal of waste and minimize attraction of wildlife to waste disposal and storage facilities	Quantify impact Assess mitigation	Survey frequency and monitoring intensity Misdirected waste including location, date and time of observation and type and amount of waste observed Identify problem areas and problem substances Determine the frequency of waste misdirection Assess waste as wildlife attractants Number of occurrences of wildlife sightings or sign (*i.e* ., chew marks on waste, wildlife-mediated waste dispersion, wildlife scat or tracks, *etc.*). Wildlife presence, species, number of animals, age and sex, location, date and time of observation, behaviour of wildlife (*e.g.* , feeding.), condition of wildlife (*e.g* ., limping, wounded) and any damage of property resulting from wildlife attraction to waste.
Employee Education and Safety Course Monitoring	OFFICE BASED Data compilation and analysis	N/A	Construction & Operation	Start of employment, Annually	Life of Project	Review implementation of education and training program Review project-related concerns for wildlife and biodiversity Promote and encourage stewardship activities	Assess mitigation	Number of employees who have taken the course Number of site-wide presentations Number of displayed educational posters and signs Employee adherence to each of the management plans (e.g., maintaining posted driving speeds, disposing of wastes properly)

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An explanation of the acronyms used throughout this reference list can be found in the *Acronyms and Abbreviations* section.

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