CUMBERLAND
RESOURCES LTD.

MEADOWBANK GOLD PROJECT

BASELINE TERRESTRIAL ECOSYSTEM REPORT

JANUARY 2005

TABLE OF CONTENTS

DESCRIPTION OF SUPPORTING DOCUMENTATION

EIA DOCUMENTATION ORGANIZATION CHART

PROJECT LOCATION MAP

PROPOSED SITE LAYOUT

SECTION 1 • EXECUTIVE SUMMARY 1-1

SECTION 2 • INTRODUCTION 2-1

2.1 Background 2-1
2.2 Objectives 2-1
2.3 Setting 2-2
2.3.1 Biophysical Environment 2-2
2.3.2 Human Environment 2-3
2.4 Baseline Study Areas 2-4
2.5 References 2-4

SECTION 3 • VEGETATION 3-1

3.1 Introduction 3-1
3.1.1 Background 3-1
3.1.2 Goals & Objectives 3-1
3.2 Methods 3-1
3.2.1 Local Study Area 3-1
3.2.2 Regional Study Area & Winter Road Corridor 3-4
3.3 Results & Existing Conditions 3-13
3.3.1 Overview 3-13
3.3.2 Local Study Area 3-13
3.3.3 Regional Study Area 3-17
3.3.4 Winter Road Corridor 3-19
3.4 References 3-21

SECTION 4 • TERRAIN & SOILS 4-1

4.1 Introduction 4-1
4.2 Methods 4-1
4.3 Existing Conditions 4-1
4.3.1 Overview 4-1
4.3.2 Terrain 4-1

4.3.3 Soils 4-2
4.3.4 Terrain & Soils Characteristics of ELC Units 4-7
4.4 References 4-11

SECTION 5 • WILDLIFE 5-1

5.1 Introduction..5-1
5.1.1 Background 5-1
5.1.2 Objectives 5-1
5.2 Methods...5-1
5.2.1 Literature Review 5-1
5.2.2 Field Surveys 5-1
5.2.3 Habitat Suitability 5-7
5.3 Results & Existing Conditions..5-9
5.3.1 Overview 5-9
5.3.2 Local Study Area..5-14
5.3.3 Wildlife Log Book 5-21
5.3.4 Regional Study Area 5-24
5.3.5 Habitat Considerations & Suitability...5-24
5.3.6 Terrestrial Mammals 5-28
5.3.7 Birds...5-49
5.4 References 5-70

LIST OF TABLES

2.1 Summary of Mean Monthly Climate Data for Meadowbank Gold Property 2-3
3.1 Details of Spectral Band Characteristics of Landsat 7 3-5
3.2 Values Used for the Parameters in the Unsupervised ELC Classification 3-6
3.3 ELC Units Identified for the RSA/Winter Road Corridor & their Equivalent ELC Units as Defined for the LSA 3-8
3.4 DSD Ground Cover Types & the Equivalent ELC Units...3-10
3.5 Level One Accuracy Assessment of the RSA/Winter Road Corridor ELC Classification.....3-11
3.6 Level Two Accuracy Assessment of the RSA/Winter Road Corridor ELC Classification.....3-11
3.7 Preliminary Results of Phenology Studies 3-16
3.8 Area Summary of ELC Units in the LSA...3-17
3.9 Area Summary of ELC Units in the RSA 3-19
3.10 Area Summary of ELC Units Along the Winter Road Corridor..3-19
4.1 Summary of Terrain & Soils Characteristics of ELC Units 4-8
5.1 Baseline Survey Sessions in Meadowbank Study Areas, 1999, 2002-2003 5-2
5.2 Summary of the Vegetation, Soils & Terrain & Potential Wildlife Use of the ELC Units Identified in the Meadowbank Study Areas..5-10
5.3 Recorded Observations of Wildlife Species & Sign at 11 Observation Points within the LSA..5-18
5.4 Habitat Characterization of the Area (ha) in Bird Survey Plots into the ELC Classes for Meadowbank LSA 5-19
5.5 Number of Pairs of Breeding Birds Recorded on Plots within the Meadowbank LSA, June 2003. A question mark indicates that breeding may not be occurring................5-20
5.6 Seasonal Occurrence of Frequently Reported Wildlife in the Camp Wildlife Logbook 5-21
5.7 Birds Recorded on Checklist Surveys within the Meadowbank LSA, June 2003 5-22

5.8 Number of Sightings Recorded in Wildlife Log Book, by Year & Species, at Meadowbank Camp, 1996-1999 & 2002-2003 5-23
5.9 Summary of Habitat Suitability Rankings for Mammalian Key Wildlife Resources in the Meadowbank Area 5-26
5.10 Spring Arrival & Fall Departure Dates for Waterfowl Recorded in the Warden Grove Area, Thelon River, 1977-1978 (Norment, 1985) 5-50
5.11 Waterfowl Breeding Chronology 5-51
5.12 Spring Arrival & Fall Departure Dates for Raptors Recorded in the Warden Grove Area, Thelon River, 1977-1978 (Norment, 1985) 5-56
5.13 Raptor Breeding Chronology 5-56
5.14 Breeding Chronology of Rock & Willow Ptarmigan in the Yukon & at Chesterfield Inlet 5-61
5.15 Spring Arrival & Fall Departure Dates for Passerines Recorded in the Warden Grove Area, Thelon River & at Chesterfield Inlet 5-65
5.16 Passerine Breeding Chronology 5-65

LIST OF FIGURES

2.1 Site Access & Marine Activity 2-2
2.2 Baseline Study Areas 2-5
3.1 Baseline Vegetation Plots within the LSA 3-2
3.2 Ecological Land Classification within the LSA Boundary 3-18
3.3 Ecological Land Classification for the RSA & Winter Road Corridor 3-20
5.1 Aerial Survey Transects in the LSA, Fall 2002 & Winter 2003 5-3
5.2 Ground Survey Transects & Observation Stations in the LSA, Summer 2002, Fall 2002 & Winter 2003. 5-4
5.3 Breeding Bird Survey Plots in the LSA, June 2003 5-6
5.4 Aerial Survey Transects in the RSA, 1999 & 2002-2003 5-8
5.5 Seasonal Frequency Distribution of Mammals & Birds Observed on 2002-2003 Aerial Surveys in the LSA 5-14
5.6 Seasonal Frequency Distribution of Mammals Observed on 2002-2003 Ground Surveys in the LSA. 5-15
5.7 Seasonal Pellet Density for Mammals Recorded on 5 m Radius Plots within the LSA in 2002-2003. 5-15
5.8 Seasonal Frequency Distribution of Waterfowl & Shorebirds Observed on 2002-2003 Ground Surveys in the LSA. 5-16
5.9 Seasonal Frequency Distribution of Passerines Observed on 2002-2003 Ground Surveys in the LSA. 5-17
5.10 Seasonal Frequency Distribution of Ptarmigan & Raptors Observed on 2002-2003 Ground Surveys in the LSA. 5-17
5.11 Relative Seasonal Abundance of Mammals Observed on 1999, 2002-2003 Aerial Surveys in the RSA 5-25
5.12 Relative Seasonal Abundance of Waterfowl, Raptor & Ptarmigan Observed on 1999, 2002-2003 Aerial Surveys in the RSA 5-25
5.13 Habitat Distribution of Mammal Observations in the RSA & LSA During Fall 2002 Aerial Surveys 5-27
5.14 Habitat Distribution of Waterfowl Observations in the RSA & LSA During Fall 2002 Aerial Surveys 5-27
5.15 Habitat Distribution of Raptor & Ptarmigan Observations in the RSA & LSA during Fall 2002 Aerial Surveys 5-28
5.16 Location of Caribou Calving Grounds Relative to the Proposed Development 5-29

5.17 Late Summer Range of Beverly Qamanirjuaq Caribou (Generalized) in Relation to the Proposed Development 5-30
5.18 Location of Radio-Collared Lorrillard Caribou in Fall & Winter Relative to the Proposed Development 5-32
5.19 Location of Radio-Collared Wager Bay Caribou in Fall & Winter Relative to the Proposed Development 5-33
5.20 Location of a Radio-Collared Boothia Peninsula Caribou in November Relative to the Proposed Development 5-34

LIST OF APPENDICES

A.1 Minutes of Meeting with the Baker Lake Hunters' & Trappers' Organization, 19 September 2002

A.2 Project Area Plant Communities & Associations

A.3 List of Vascular Plant Species Identified in the LSA During Baseline Vegetation Surveys in August 1999 & 2002

A.4 List of Vascular Plant Species Likely to Occur in the LSA, but Not Collected during the 1999 & 2002 Baseline Vegetation Surveys

A.5 List of Non-vascular Plant Species Identified in the LSA During Baseline Vegetation Surveys in August 1999 & 2002

A.6 Mammal Species Known or Expected to Occur in the Meadowbank Study Areas

A.7 Bird Species Known or Expected to Occur in the Meadowbank Study Areas

A.8 Breeding Bird Survey Data Forms

A.9 Incidental Wildlife Observations from the Meadowbank Camp Logbook, 1996-2003

A.10 Caribou Observations Recorded during Aerial Surveys in the LSA in Fall 2002 & Winter/Fall 2003

A.11 Seasonal Number & Distribution of Caribou Recorded during Aerial Surveys in the RSA & Winter Road Corridor

A.12 Seasonal Number & Distribution of Muskoxen Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.13 Seasonal Number & Distribution of Wolves Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.14 Seasonal Number & Distribution of Geese & Swans Recorded during Aerial Surveys in the RSA & Winter Road Corridor: Baseline Aerial Surveys, 1999-2003

A.15 Seasonal Number & Distribution of Raptors Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.16 Seasonal Number & Distribution of Ptarmigan Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.17 Seasonal Number & Distribution of Grizzly Bears Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.18 Seasonal Number & Distribution of Dens & Burrows Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.19 Seasonal Number & Distribution of Ducks Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003

A.20 Waterbird Observations recorded during Aerial Surveys in the LSA in June 2003

DESCRIPTION OF SUPPORTING DOCUMENTATION

Cumberland Resources Ltd. (Cumberland) is proposing to develop a mine on the Meadowbank property. The property is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake on Inuit-owned surface lands. Cumberland has been actively exploring the Meadowbank area since 1995. Engineering, environmental baseline studies, and community consultations have paralleled these exploration programs and have been integrated to form the basis of current project design.

The Meadowbank project is subject to the environmental review and related licensing and permitting processes established by Part 5 of the Nunavut Land Claims Agreement. To complete an environmental impact assessment (EIA) for the Meadowbank Gold project, Cumberland followed the steps listed below:

1. Determined the VECs (air quality, noise, water quality, surface water quantity and distribution, permafrost, fish populations, fish habitat, ungulates, predatory mammals, small mammals, raptors, waterbirds, and other breeding birds) and VSECs (employment, training and business opportunities; traditional ways of life; individual and community wellness; infrastructure and social services; and sites of heritage significance) based on discussions with stakeholders, public meetings, traditional knowledge, and the experience of other mines in the north.

2. Conducted baseline studies for each VEC and compared / contrasted the results with the information gained through traditional knowledge studies (see Column 1 on the following page for a list of baseline reports).

3. Used the baseline and traditional knowledge studies to determine the key potential project interactions and impacts for each VEC (see Column 2 for a list of EIA reports).

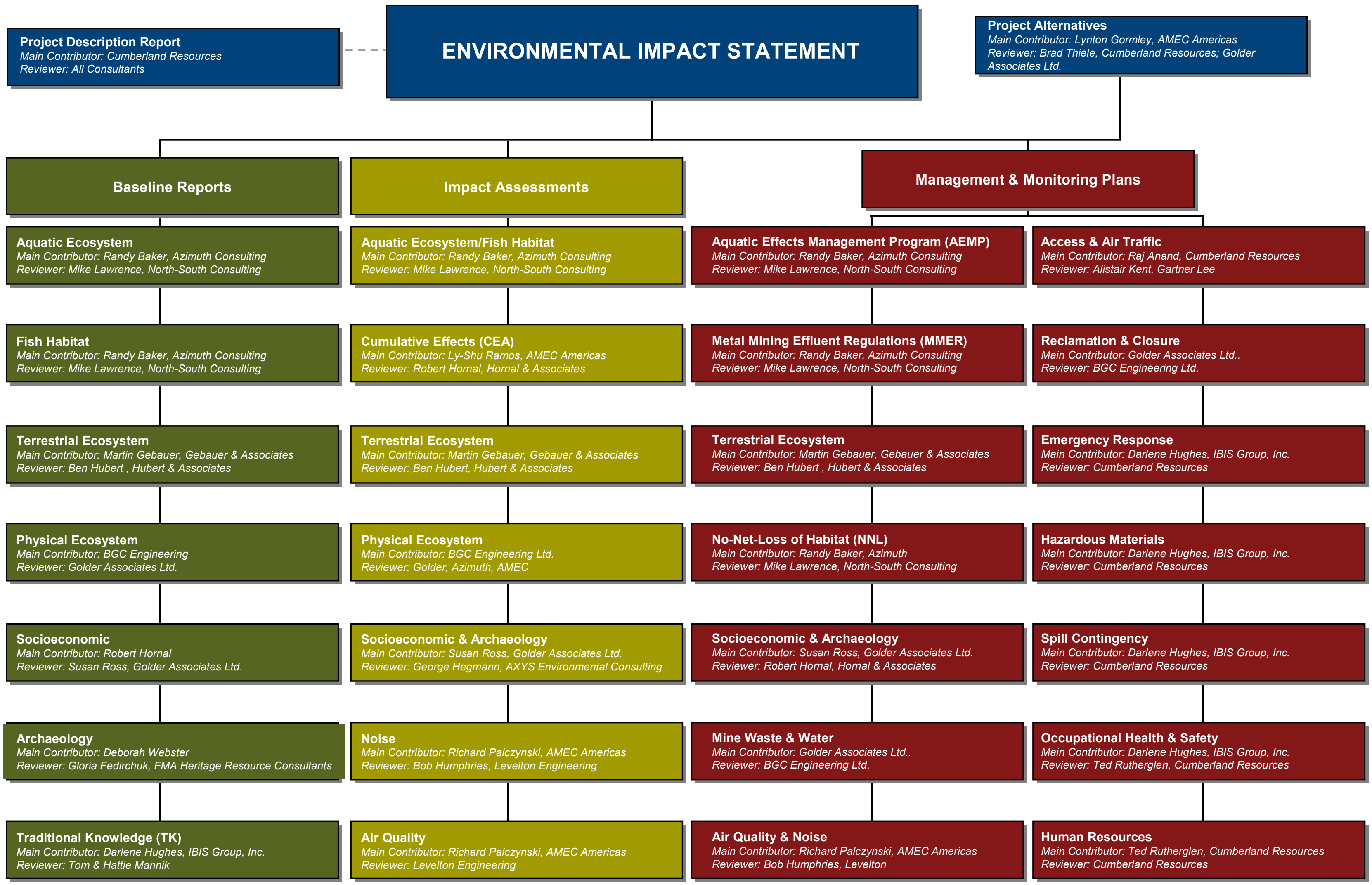
4. Developed preliminary mitigation strategies for key potential interactions and proposed contingency plans to mitigate unforeseen impacts by applying the precautionary principle (see Column 3 for a list of management plans).

5. Developed long-term monitoring programs to identify residual effects and areas in which mitigation measures are non-compliant and require further refinement. These mitigation and monitoring procedures will be integrated into all stages of project development and will assist in identifying how natural changes in the environment can be distinguished from project-related impacts (monitoring plans are also included in Column 3).

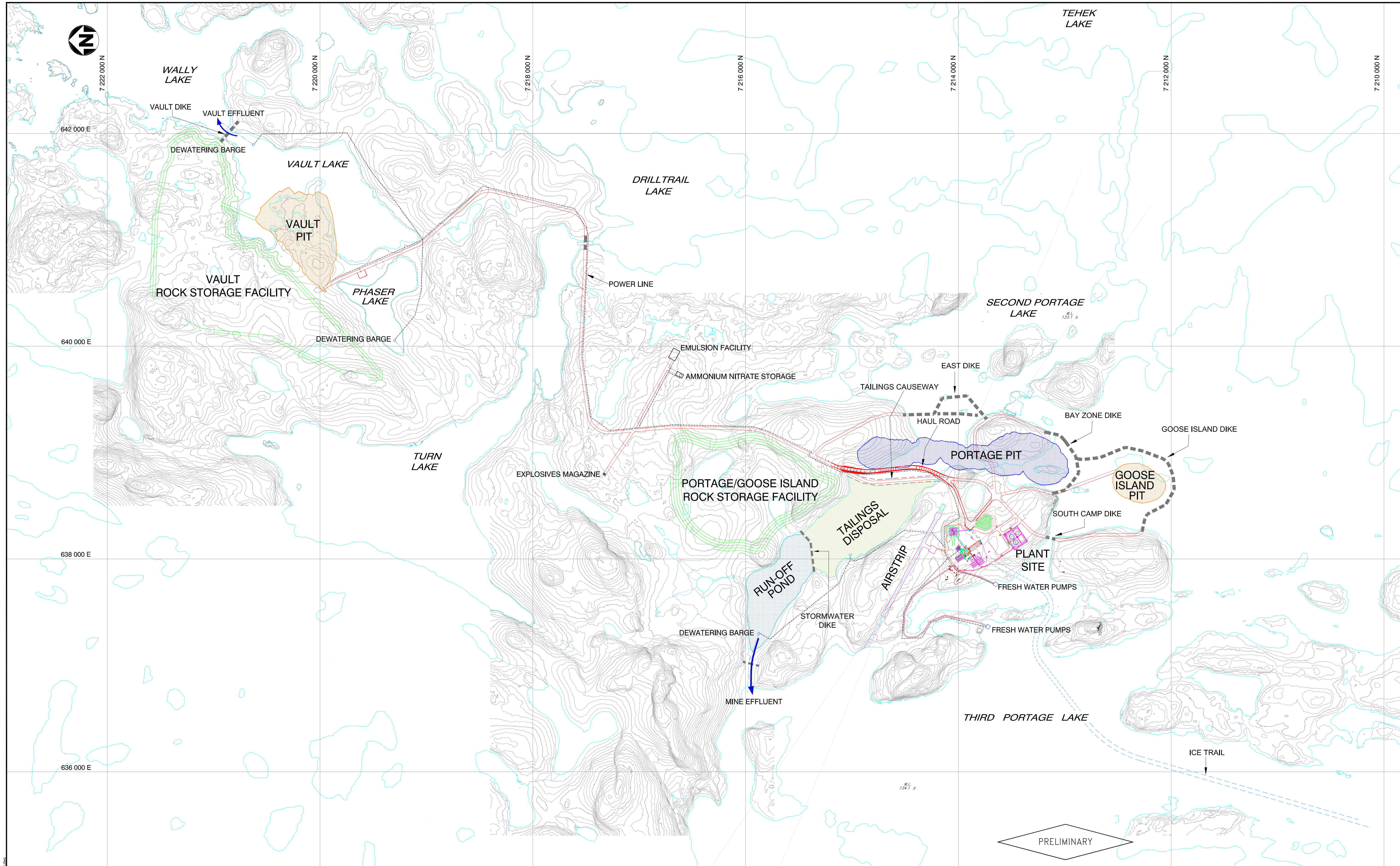
6. Produce and submit an EIS report to NIRB.

As shown on the following page, this report is part of the documentation series that has been produced during this six-stage EIA process.

EIA DOCUMENTATION ORGANIZATION CHART



PROJECT LOCATION MAP



0 250 500 750 1000 1250 1500 1750 2000m

Datum: UTM NAD83 Zone 14

Proposed Mine Site Layout

CUMBERLAND
RESOURCES LTD.
Meadowbank Gold Project

SOURCE: AMEC drawing 100-c000c.dwg

SECTION 1 • EXECUTIVE SUMMARY

This document has been prepared in support of the proposal of Cumberland Resources Ltd. (Cumberland) to develop the Meadowbank Gold property, located approximately 75 km north of Baker Lake, Kivalliq Region, Nunavut. The objective of this report is to provide baseline information on soils and terrain, vegetation, and terrestrial wildlife in and around the Meadowbank Gold property.

Two study areas, a Regional Study Area (RSA) and a Local Study Area (LSA) were established for the purposes of conducting baseline surveys of the proposed project area. The RSA is 100 x 100 km (10,000 km^2), and is centered on the field camp (also the site of the future plant site). The LSA is 91 km^2, and includes two sites: a 5 km radius area centered on the field camp and a 2 km radius area centered on the Vault gold deposit, located adjacent to the northeast border of the first site. A third study area includes a 5 km wide survey corridor centered on the proposed winter road between the Meadowbank camp and Baker Lake. The majority (62%) of the winter road corridor is within the RSA.

Baseline surveys were conducted for the terrestrial components described in this report as follows:

- Vegetation
  - LSA surveys in August 1999 and 2002
  - phenology studies in summer 2003.
- Wildlife
  - aerial LSA surveys in fall 2002, and winter and fall 2003
  - ground LSA surveys in spring 1999, summer and fall 2002, and winter 2003
  - aerial RSA surveys in spring 1999, summer and fall 2002, and winter 2003
  - aerial survey of the winter road corridor in winter 2003
  - breeding and migratory bird survey in the LSA in summer 2003
  - incidental observations recorded in the Meadowbank Camp wildlife log from 1996 to 1999 and 2002 to 2003.

Descriptions of baseline terrain and soils conditions in the LSA and RSA were obtained from a literature review, and from results of vegetation baseline surveys and surficial materials studies that were conducted in the LSA. The most common vegetated Ecological Land Classification (ELC) units in the Meadowbank area were Heath Tundra community and Lichen-Rock community associations. The heath tundra community unit is dominated by bog blueberry (*Vaccinium uliginosum*), lingonberry (*Vaccinium vitis-idaea*), white arctic heather (*Cassiope tetragona*), Labrador tea (*Ledum palustre*), bearberry (*Arctostaphylos alpina*), and crowberry (*Empetrum nigrum*), and is typically found on morainal deposits on gently sloping uplands with low to medium moisture and nutrient regimes. The lichen-rock community unit is found on gentle slopes with low moisture and nutrient regimes, and thin or absent soils associated with boulder fields or bedrock outcrops. Water was another very common ELC unit in the area and two of the wetter ELC units, sedge community and birch seep community, were also relatively common. Eskers and their typical ridge top ELC units (e.g., avens community) were uncommon.

During the baseline wildlife surveys, 47 terrestrial wildlife species (11 mammals, 36 birds) were recorded in the Meadowbank area. Barren-ground caribou (*Rangifer tarandus groenlandicus*) was the most common mammal species recorded. Caribou are present in good numbers during the fall, winter, and spring, but are very sparsely distributed in summer, suggesting that the RSA is not used as a major calving ground. Caribou wintering in the RSA appear to originate from a number of the different herds in the region. Other common mammal species recorded in the Meadowbank area included muskox (*Ovibos moschatus*), arctic hare (*Lepus arcticus*), arctic ground squirrel (*Spermophilus parryi*), arctic fox (*Alopex lagopus*), and wolf (*Canis lupus*).

Bird species observed in greater numbers than any other species during the surveys were snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*), Lapland longspur (*Calcarius lapponicus*), and horned lark (*Eremophila alpestris*). Other commonly observed breeding bird species were American pipit (*Anthus rubescens*), snow bunting (*Plectrophenax nivalis*), savannah sparrow (*Passerculus sandwichensis*), semipalmated sandpiper (*Calidris pusilla*), sandhill crane (*Grus canadensis*), and rock ptarmigan (*Lagopus mutus*). Snow bunting (*Plectrophenax nivalis*), sandhill crane (*Grus canadensis*), Canada goose, and snow goose were most common during the migratory period. Raptors, including all three species of jaegers, were recorded occasionally during baseline surveys.

A literature review was conducted for each of 29 wildlife species selected based on their abundance and conservation concern in the Meadowbank area:

- Ungulates: barren-ground caribou, muskox
- Carnivores: grizzly bear (*Ursus arctos*), wolf, wolverine (*Gulo gulo*)
- Furbearers: arctic fox, ermine (*Mustela erminea*)
- Small mammals: arctic hare, arctic ground squirrel, collared lemming (*Dicrostonyx groenlandicus*), northern red-backed vole (*Clethrionomys rutilis*)
- Waterfowl: greater white-fronted goose (*Anser albifrons*), snow goose, Ross' goose (*Chen rossii*), Canada goose, long-tailed duck (*Clangula hyemalis*)
- Raptors: rough-legged hawk (Buteo lagopus), gyrfalcon (Falco rusticolus), snowy owl (Nyctea scandiaca), peregrine falcon (Falco peregrinus tundrius)
- Ptarmigan: rock ptarmigan, willow ptarmigan (Lagopus lagopus)
- Shorebirds: semipalmated sandpiper, American golden-plover (Pluvialis dominica)
- Passerines: horned lark, American pipit, white-crowned sparrow (*Zonotrichia leucophrys*), Lapland longspur, snow bunting.

SECTION 2 • INTRODUCTION

2.1 BACKGROUND

This document has been prepared in support of the proposal of Cumberland Resources Ltd. to develop the Meadowbank Gold property. The property is located approximately 75 km north of Baker Lake in the Kivalliq Region (formerly District of Keewatin), Nunavut.

On-site infrastructure will include a process plant, power plant, maintenance facilities, tank farm, accommodation for approximately 250 people, water treatment plant, sewage treatment plant, tailings impoundment area, and airstrip. There will be permanent on-site access roads, and a 7 km stretch of two-lane haul road connecting the Vault deposit to the main mining facilities.

The proposed mine site will be accessible only by air in the spring, summer, and fall, and in winter via a proposed 92 km long winter haul route from the Hamlet of Baker Lake. The winter road may be in use up to four months per year depending on weather conditions.

Mine-related barge and shipping access to the Hamlet of Baker Lake will be via Chesterfield Inlet (Figure 2.1). Standard shipping routes along the west coast of Hudson Bay and across the northern region of the Bay will be used.

2.2 OBJECTIVES

The objective of this report is to provide baseline information on three components (i.e., vegetation, soils and terrain, and wildlife) of the terrestrial ecosystem in and around the Meadowbank Gold property and along the proposed winter haul road. These components were addressed as follows:

- Vegetation
  - summary of baseline vegetation surveys to date
  - development of an ELC
- Soils and Terrain
  - review and summary of soils and terrain types and processes
  - description of the soils and terrain characteristics of the ELC units
- Terrestrial Wildlife
  - summary of baseline wildlife surveys to date
  - review and summary of information available on species conservation status, distribution, abundance, general biology, and habitat use
  - summary of habitat suitability in the area based on ELC units

Figure 2.1: Site Access & Marine Activity

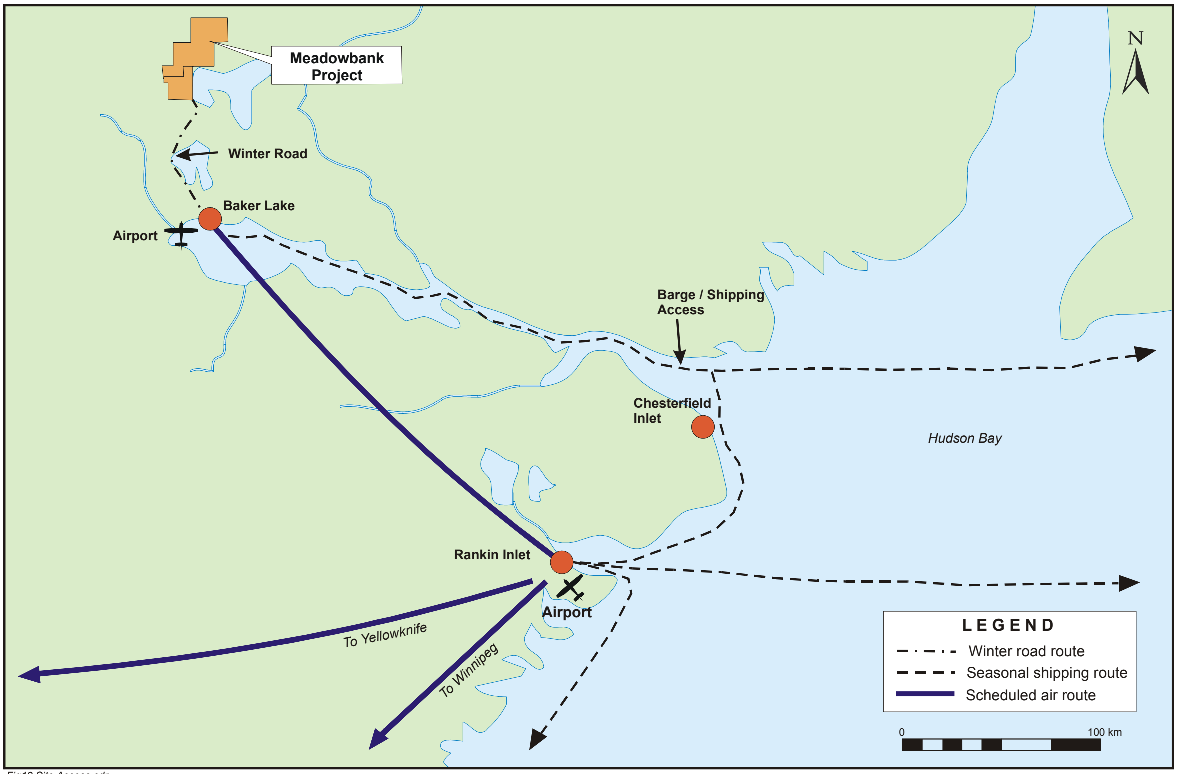


Fig13 Site Access.cdr

2.3 SETTING

2.3.1 Biophysical Environment

2.3.1.1 Terrestrial

The Meadowbank Gold property is situated in an area characterized by low, rolling hills that are covered predominantly in heath tundra interspersed with lichen-dominated bedrock outcroppings and boulder fields. Lakes and ponds are numerous, and are typically clear and nutrient-poor. The largest lake in the area is Tehek Lake, located immediately east of the proposed mine development. The Meadowbank area is on the drainage divide between streams flowing to the Arctic Ocean via Chantry Inlet, and those flowing to Hudson Bay via Chesterfield Inlet. There are no major river corridors in the Meadowbank area. Elevation ranges from approximately 130 m at lakeshores up to 200 m on ridge crests. The area in the immediate vicinity of the proposed mine development has low relief (10 to 12 m).

Glaciation has shaped the terrain of the Meadowbank area. The surficial geology is characterized by extensive deposits of glacial till, and eskers are present, although uncommon. Permafrost is another significant feature. The majority of the area (>90%) near the proposed mine development is likely underlain by continuous permafrost with the only breaks (i.e., taliks) occurring under water bodies that are too deep to freeze entirely.

Summers are short (June to September), with temperatures ranging from -5°C to 25°C. Most of the annual precipitation falls as rain during this period. Winters are long (October to May), with temperatures ranging from 5°C to -40°C. Light to moderate snowfall is accompanied by variable winds up to 70 km/h. Snow may occur in any month of the year. Table 2.1 provides overview of the temperature for the Meadowbank area.

Table 2.1: Summary of Mean Monthly Climate Data for Meadowbank Gold Property

	Air Temperature				
	Extreme Day		Average		
Month	**Max (°C)**	**Min (°C)**	**Max (°C)**	**Min (°C)**	**Mean (°C)**
January	-4.9	-43.0	-28.9	-35.6	-32.3
February	-9.1	-43.4	-26.9	-34.4	-30.8
March	-3.1	-40.1	-21.0	-29.1	-24.9
April	2.1	-35.4	-12.5	-22.1	-17.1
May	8.0	-22.3	-2.5	-9.4	-5.7
June	22.7	-12.9	8.1	0.2	4.1
July	26.9	1.3	17.0	7.6	12.4
August	27.4	-0.4	13.4	6.6	9.9
September	20.5	-7.9	6.1	1.4	3.6
October	5.3	-24.1	-4.9	-10.4	-7.5
November	-1.3	-32.3	-14.3	-20.9	-17.5
December	-6.3	-39.6	-22.6	-29.0	-25.9

2.3.2 Human Environment

The hamlet of Baker Lake is the nearest community to the proposed mining development. It is located on the northwest shore of Baker Lake near the mouth of the Thelon River. The population in 2001 was approximately 1,500 (Statistics Canada, 2002). Baker Lake is Nunavut's only inland, non-marine Inuit community. Traditionally, the Inuit of the Baker Lake area were almost entirely dependent on caribou for subsistence, and moved with them from season to season. It was not until the 1950s that the community along the shores of Baker Lake was permanently established.

Hunting and trapping activity in the Meadowbank area is limited (ISL, 1978), primarily because of its distance from Baker Lake, and because of the relatively low abundance of target species; however, important traditional caribou hunting areas do occur throughout the region according to the Baker Lake Hunters' and Trappers' Organization (HTO) (Appendix A.1).

Until relatively recently, subsistence hunting was the only human activity regularly carried out in the Kivalliq Region. The first mine in Kivalliq was opened at Rankin Inlet in the 1950s. Uranium exploration began in the 1970s in the Baker Lake area (eventually known as the Kiggavik Uranium project), but no mine was ever developed. Also in the 1970s, Polar Gas proposed a pipeline through the area, but again no development occurred. One of the routes evaluated for the Polar Gas project ran just west of the site of Cumberland's proposed mining facilities (ISL, 1978).

Currently, there are seven active mining projects in the Kivalliq Region, in addition to Cumberland's Meadowbank Gold property (MOG et al, 2002). The closest to the Meadowbank area is the Kazan project, located 70 km south of Baker Lake (MOG et al, 2002). Past producing mines in Kivalliq included the North Rankin Nickel mine at Rankin Inlet (closed in the early 1960s), located approximately 320 km southeast of Meadowbank, and the Cullaton Lake/Shear Lake operation, located more than 350 km south of Meadowbank (MOG et al, 2002).

Both Baker Lake and the smaller community of Chesterfield Inlet are near the shipping activities associated with the proposed mine development. There are established commercial shipping and coastal barging routes in this part of Hudson Bay, originating from Churchill, Manitoba (Muir and Pirie, 2000).

2.4 BASELINE STUDY AREAS

A Regional Study Area (RSA) and a Local Study Area (LSA) (Figure 2.2) were established in spring 1999 for the purposes of conducting baseline wildlife surveys of the proposed project area. The RSA is 100 x 100 km (10,000 km^2), and centered on the field camp, which is also the location of the proposed plant site. Originally, the LSA was defined by a 5 km radius area centered on the field camp, but was extended in 2002 to include the Vault gold deposit. The second section of the LSA is adjacent to and northeast of the first section, and is defined by a 2 km radius area centered on the Vault deposit. A smaller LSA was chosen for the Vault area because of the more localized mine activities (i.e., only Vault pit and waste dump). The two sections of the LSA encompass an approximately 94 km^2 area. A third study area has been defined in this report to facilitate analysis of baseline information related to the proposed winter road from Baker Lake to the mine development site. The winter road study area is delineated by a 5 km wide survey corridor centered on the proposed road. The majority (62%) of the winter road corridor is within the RSA.

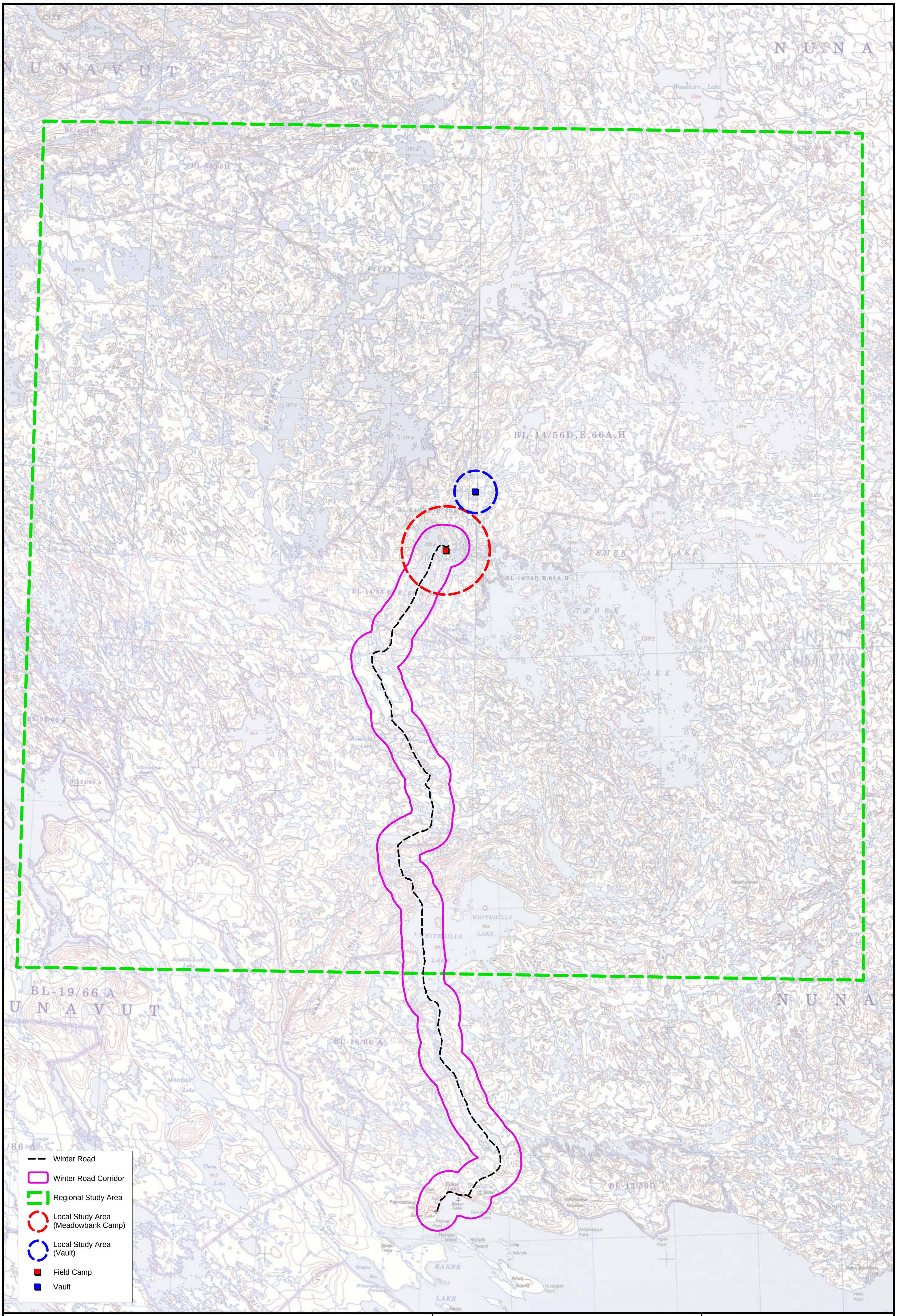
2.5 REFERENCES

Interdisciplinary Systems Ltd. (ISL), 1978. Effects of exploration and development in the Baker Lake Area, Volume 2 – Map Supplement. Prepared for: Department of Indian Affairs and Northern Development, Ottawa, ON.

Minerals, Oil & Gas Division (MOG), Nunavut Mineral Resources Section, Lands and Resources Department, and Canada-Nunavut Geoscience Office, 2002. Nunavut Mining, Mineral Exploration and Geoscience: Mining and Exploration Overview 2002.

Muir, M.A. and D. Pirie, 2000. Regulation of marine transportation and implications for ocean management in Hudson Bay. Prepared for Department of Fisheries and Oceans, Winnipeg.

Statistics Canada, 2002. 2001 Community profiles. http://www12.statcan.ca



Baseline Study Areas for the Meadowbank Gold Project

Area of Detail

NORTH

4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE		SCALE	
25 September, 2003		1:430,000	
DRAWN	CHECKED	FIGURE NO.	REV
PM	CB	2.2	3
REVIEWED	PROJECT		VOL.
CB	KA9007		-

SECTION 3 • VEGETATION

3.1 INTRODUCTION

3.1.1 Background

The focus of this section is the development of Ecological Land Classification (ELC) maps for the LSA, RSA, and winter road corridor. The ELC process delineates unique and distinguishable habitat types (e.g., Lichen-Rock, Sedge) on the landscape using a combination of field studies, air photo interpretation, and satellite imagery. The ELC units are the basis for the description of terrain and soil characteristics, and for the description of habitat suitability for the key wildlife resources. Baseline vegetation studies in 1999 and 2002 provided the framework for the ELC in the Meadowbank area (see Appendix A.2 for description of vegetation communities). In addition, a land classification initiative being undertaken by the Nunavut Department of Sustainable Development (DSD) provided inputs to the ELC for the regional study area and winter road corridor.

3.1.2 Goals & Objectives

The primary goal for undertaking ELC was to quantify the availability of various habitat types within the regional and local study areas. Development of a habitat suitability rating scheme for various wildlife species (i.e., Valued Ecosystem Components [VECs]) and calculation of the amount of habitat affected by mine development allows for a more accurate assessment of the potential impacts of the mine on both a local and regional level. Determination of the cumulative impacts of the project can also be assessed more readily.

3.2 METHODS

3.2.1 Local Study Area

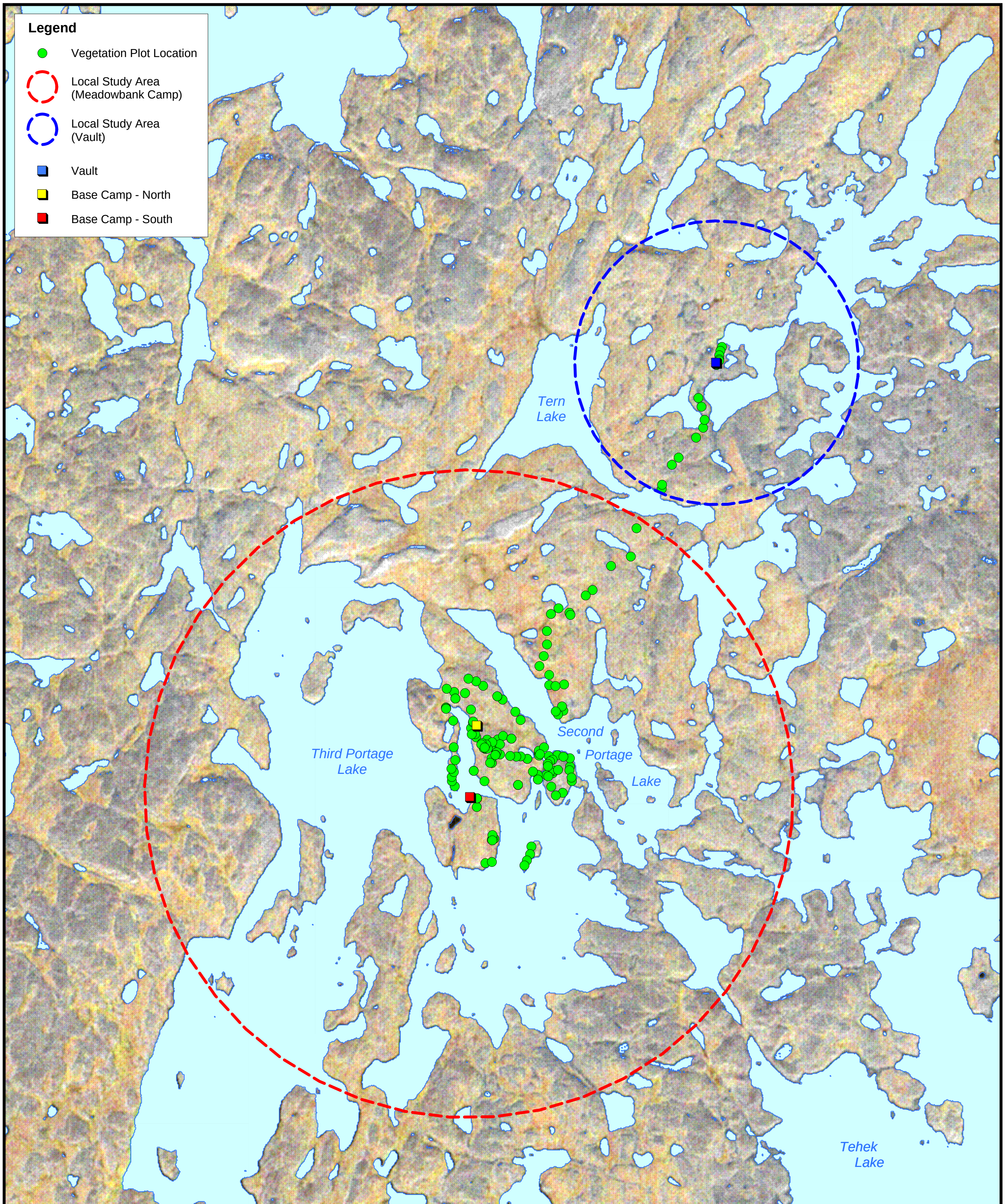
3.2.1.1 Field Surveys

Baseline vegetation studies were conducted in August 1999 and 2002 in the LSA (Appendix A.2). A total of 156 vegetation plots, 5 x 5 m in size, were evaluated within the LSA (Figure 3.1). Plots were selected visually from the ground, and located within a single plant association where possible. Species and the percent cover by species were recorded at each plot. Plants were identified either in the field, or at camp with the aid of field guides relevant to the area. Specimens of all willows, grasses, sedges, cottongrasses, and rushes were collected for later identification by specialists.

Additionally, an aerial reconnaissance survey was done in 1999 to look for community types not represented within the ground survey area.

3.2.1.2 Phenology Studies

Phenology is the study of the development of individual plants throughout the growing season, from dormancy through flowering, seed development, and release back to dormancy.



Baseline vegetation plots within the local study area

NORTH

600 0 600 1200 1800

Scale in metres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY: KAVIK-AXYS Inc.			
DATE	22 May, 2003	SCALE	1:85,000
DRAWN PM	CHECKED CB	FIGURE NO. 3.1	REV 1
REVIEWED CB	PROJECT KA073		VOL -

In 2002, six phenology plots were established near North Camp in the following communities: sedge, heath tundra, birch seep, lichen rock, snowbank, and avens. Species tracked within these communities included, bearberry, alpine arnica, dwarf birch, *Carex* sedges, white arctic heather, mountain avens, crowberry, cottongrass, Labrador tea, least willow, willow sp., prickly saxifrage, star chickweed, bog blueberry and crowberry (see Appendix A.3 for scientific names). Plots were marked with white plastic conduit tubing wrapped with orange flagging tape.

Phenology observations were made on a weekly basis from late May to early September. Data that were recorded included, snow-free date, first greening of sedges/cottongrasses, first leaf activity in dicots, floral activity, fruit formation, and seed release and dispersal

3.2.1.3 Ecological Land Classification

Eight plant communities, two subgroups (disturbed sites and esker complexes), and fifteen plant associations have been identified in the LSA (Appendix A.2). These categories were the basis of the ELC units, and the entire LSA was mapped on a 2002 series of 1:10,000 colour air photos flown specifically by Cumberland for the project. The inked linework was digitized in ArcInfo, and the area of each ELC unit was calculated. The mapped ELC units are summarized below. The soil and terrain characteristics of these units are described later in Table 4.1.

- *Water* – any open water was delineated, but not differentiated as to depth or any other characteristics.

- *Sedge Community* **–** typically located in depressions, drainage basins, or at the margins of shallow water bodies, and is characterized by species such as sedges and cottongrasses. Although four sedge community associations (i.e., emergent, non-tussock, tussock, and tussocks being invaded by heaths) are present, these could not be distinguished and mapped at the 1:10,000 scale.

- *Moss Community* **–** a moss-dominated area that is typically located in seepage areas at the base of slopes, and at the margins of lakes, ponds or streams. Because this unit is too small to be distinguished at the 1:10,000 scale, only known locations of this unit are indicated on the LSA ELC map. Although two different moss community associations (i.e., mossy lakeshore and mossy cliff base) are known, they could not be distinguished and mapped at the 1:10,000 scale.

- *Birch Seep Community* **–** located in seepage areas at the base of slopes or at the edges of sedge associations and is dominated by dwarf birch.

- *Riparian Shrub Community – Birch Association* **–** occurs in the drainages between lakes, typically on boulder substrate, and is associated with more defined drainages than that of the birch seep community. Dwarf birch is the dominant species, often forming an unbroken canopy.

- *Heath Tundra Community* **–** the climax community on the uplands in the Meadowbank area, and is the most common unit in the LSA. Five Heath Tundra Community associations have been identified within the LSA: hummock (found at the edge or at the head of drainage basins); upland; heath tundra with boulders (found in fields of glacial erratic boulders or bedrock outcrops;), heath tundra with frost scars (found in drier areas or where frost boils elevate the soil); and lichen-heath tundra (found in well-drained ridge tops or over sand and fine gravel on gentle slopes); however, these could not be distinguished and mapped at the 1:10,000 scale.

- *Snowbank Community* **–** develops at sites where the wind deposits deep snow drifts over consecutive winters (e.g., leeward slopes), and where snow persists the longest in the summer. In the Meadowbank area, these units often occur on east, southeast, or south-facing slopes.

- *Avens Community* **–** similar to the Heath Tundra community, but occurs in drier areas, usually on ridge tops, and is dominated by mountain avens.

- *Lichen-Rock Community* **–** characteristics (e.g., lichen species composition) vary according to wind exposure, moisture availability, and the chemical composition of the rock substrate. Two associations in this community have been described: Lichen-Rock community – Boulder (foliose and fruticose lichens associated with felsenmeer or boulder field substrates; and Lichen-Rock community – bedrock (crustose lichens associated with exposed bedrock outcrops). Both are mapped in the LSA.

- *Ridge Crest Community* – is typically associated with eskers. Vegetation cover is often non-contiguous as the environment is dry and unstable. Two associations were mapped in the LSA: Ridge Crest community – Sand; and Ridge Crest community – cobble. The ridge crest community – cobble association is similar to the lichen-rock community – boulder association.

- *Disturbed Sites* – includes those sites in the LSA that have been disturbed by human activities. Disturbed sites that were mapped include the two field camps located in the southern section of the LSA and an exploration site just east of these camps.

3.2.2 Regional Study Area & Winter Road Corridor

3.2.2.1 Satellite Imagery

Digital satellite imagery (Landsat 7) was obtained through Meridian Mapping Ltd. of Nanaimo, BC. The imagery was used to develop an ELC classification for both the RSA and the winter road corridor. The image analysis software used to develop the ELC was ER Mapper. The geo-referenced imagery was received in ER Mapper format projected to Universal Transverse Mercator (UTM), Zone 15, NAD83 datum.

Four satellite scenes from various dates were obtained, and two were used in the classification. The scenes cover an area approximately 185 x 170 km in size, and have a pixel resolution of 30 m. Scene numbers 36-14 and 36-15 were taken on 3 September 2000, and encompass both the RSA and the winter access road corridor. A subset of these two scenes was selected to reduce the amount of data being analyzed.

Landsat 7 imagery has eight data bands that capture different ranges of the electromagnetic spectrum. In addition, each image contains three pixel resolutions. Each band can be used to detect different features in the imagery. Table 3.1 details the spectral characteristics of each of the bands.

Table 3.1: Details of Spectral Band Characteristics of Landsat 7

Band	**Spectral Range (microns)**	**Nominal Spectral Location**	**Pixel Resolution (meters)**
1	0.450 to 0.515	Visible - Blue	30
2	0.525 to 0.605	Visible - Green	30
3	0.630 to 0.690	Visible - Red	30
4	0.750 to 0.900	Near infrared	30
5	1.550 to 1.750	Mid-infrared	30
6	10.400 to 12.50	Thermal infrared	60
7	2.090 to 2.350	Mid-Infrared	30
Panchromatic	0.520 to 0.900	Visible to near infrared	15

3.2.2.2 Image Classification

Classification Background

Image classification is a statistical process that groups pixels into similar categories based on spectral signatures (i.e., colours). There are two methods of image classification: supervised and unsupervised. Classifications can use either method, or a combination of the two to create a thematic data layer based on imagery.

Supervised classifications are performed when an analyst ‘trains’ the software or ‘tells’ the software what the spectral signatures are for each class that has been defined in the classification scheme. To obtain a high level of accuracy from a supervised classification, it is important to have a good working knowledge of the area and its vegetation. A significant amount of appropriate field data or groundtruthing data is therefore necessary to ensure an accurate classification.

Unsupervised classification is a process, in which the software groups spectral signatures into unique clusters of data, based on parameters specified by the analyst. The analyst then groups the spectral classes into a defined classification scheme. This method does not require any ‘training sites’ to classify the spectral signatures, thereby overcoming the problem of insufficient coverage and availability of groundtruthing data. The groundtruthing data that are available is useful in the later stage in which the spectral classes are grouped into a defined classification scheme.

Once the imagery has been classified using either method, a filter is run over the classification to smooth the results and to remove speckle. This provides a more realistic representation of the imagery and establishes the minimum polygon size. There are some classes in the classification scheme that have characteristics that do not allow them to be classified using the described techniques (e.g., eskers). These classes are easily identified on the imagery, and are manually added to the classification using a masking technique.

Classification Details

Based on the type and availability of groundtruthing data for this project, an unsupervised classification was performed on scenes 36-14 and 36-15, using bands 2, 3, 4, 5, and 7. The specific algorithm that ER Mapper uses for unsupervised classification is called an ISOCLASS algorithm. This algorithm is a clustering analysis process that groups the data based on spectral signatures, then goes through a number of iterations of splitting and merging classes, based on the class means, until it meets a number of parameters specified by the analyst. The parameters needed for the classification include the following (Earth Resource Mapping Pty Ltd., 1998):

- *Maximum iterations* – the maximum number of times the program will go over the imagery grouping the signatures into unique classes.
- *Desired percent unchanged* – the percentage of cells that have not changed classes between iterations.
- *Maximum number of classes* – the maximum number of unique spectral classes created in the classification.
- *Minimum members in a class (%)* – classes with less than the minimum percentage of members are deleted and reassigned to an alternative class.
- *Maximum standard deviation* – if the standard deviation of a class is above this value, then the class is split into two.
- *Split separation value* – this can take the place of the maximum standard deviation, and defines the range around the old class mean that is acceptable for a particular class. Values outside this range will be split and assigned to another class.
- *Minimum distance between class means* – specifies the distribution of the spectral classes.

The values assigned for the parameters used in the ELC classification are listed in Table 3.2.

Table 3.2: Values Used for the Parameters in the Unsupervised ELC Classification

Parameter	Value
Maximum iterations	9999
Desired percent unchanged	96.0 or 97.0
Maximum number of classes	255
Minimum members is a class (%)	0.01
Maximum standard deviation	4.5
Split separation value	0.0
Minimum distance between class means	3.2

The unsupervised classification produced between 67 and 124 spectral classes for the two image scenes. Using the ELC units developed for the LSA (Section 3.2.1.3) and the imagery, the spectral classes for the RSA are grouped into the following classes:

- Deep Water
- Shallow Water
- Sedge Community
- Birch Seep Community
- Riparian Shrub Community
- Heath Tundra Community
- Heath Tundra / Lichen-Rock Association
- Lichen-Rock Community – Boulder Association
- Lichen-Rock Community – Bedrock Association
- Eskers
- Sand/Gravel
- Disturbed Sites
- Unclassified.

Once the spectral classes have been grouped into the classification scheme, the data is passed through a median filter. Median filters remove the speckle effect or noise created in the classification, and amalgamate small areas. The filtering process is performed to smooth the classification so that it more closely represents the complexity of the vegetation communities of the area.

3.2.2.3 Ecological Land Classification Scheme

The classification scheme developed for this project closely follows the LSA vegetation community types identified during investigations conducted within the LSA in 1999 and 2002 (Appendix A.2), and the classification scheme developed for the West Kitikmeot/Slave Study Area (Matthews, 2001). There are 13 ELC units that have been identified for this project. Detailed descriptions of the vegetation characteristics of these units are found in Section 3 and Appendix A.2. The classes represent unique vegetation associations and site physiography that are found in the RSA and winter road corridor. The relationship between the ELC units for the RSA and the LSA are shown in Table 3.3.

Table 3.3: ELC Units Identified for the RSA/Winter Road Corridor & their Equivalent ELC Units as Defined for the LSA

RSA and Winter Road Corridor ELC Units	Equivalent ELC Units as Defined for LSA
Deep Water	Water
Shallow Water	Water
Sedge Community	Sedge Community
Birch Seep Community	Birch Seep Community
Riparian Shrub Community	Riparian Shrub Community – Birch Association
Heath Tundra Community	Heath Tundra Community
Heath Tundra/Lichen Rock Association	Transition Zone between the Heath Tundra Community and the Lichen-Rock Community
Lichen-Rock Community – Boulder Association	Lichen-Rock Community – Boulder Association
Lichen-Rock Community – Bedrock Association	Lichen-Rock Community – Bedrock Association
Eskers	Ridge Crest Community – Sand Association or Ridge Crest Community – Cobble Association
Sand/Gravel	Not present in LSA
Disturbed Sites	Disturbed Sites
Unclassified	Not present in LSA

The ELC units for the RSA/winter road corridor are defined as follows:

- *Deep Water* – Characterized by water with depths greater than or equal to 2 m. This class is easily interpreted due to the spectral energy being absorbed by the water with very little reflectance.

- *Shallow Water* – Water with a depth of approximately 2 m or less. Due to the depth of the water, the bottom of the waterbody reflects the spectral energy. Shallow water is very closely related to the wetland community classes (sedge community and riparian shrub community) because of the high water content, therefore, the separation of these classes can be highly confused.

- *Sedge Community* – Sedge communities generally occur in poorly drained areas and around water features. The vegetation composition and the high water content characteristics provide a unique spectral signature that is easily recognizable from other vegetation classes; however, this ELC unit can be highly confused with shallow water.

- *Birch Seep Community* – The Birch Seep community is associated with a moderate to high moisture regime found at the toe of gentle slopes (0-6%), and on the edge of sedge communities.

- *Riparian Shrub Community* – The Riparian Shrub community is closely associated with water and boulder features. The high water content absorbs the spectral energy, and the boulder features have unique texture characteristics.

- *Heath Tundra Community* – Heath Tundra occurs on a number of different types of landforms, and is therefore affected by the climatic characteristics of each landform (e.g., wind exposure, snow cover, moisture regimes, and soil development).

- *Heath Tundra/Lichen-Rock Association* – The Heath Tundra/Lichen Rock association is a transitional class between heath tundra and lichen rock communities. The spectral signatures of this class closely resemble, and can be highly confused with, both parent communities.

- *Lichen-Rock Community – Boulder Association* – Exposed boulders have a very high reflectance value in imagery, and are very easy to identify. The variable size and shape of boulders add texture to the imagery that allows it to be distinguished from the bedrock association. Lichen is the main plant community associated with boulders.

- *Lichen-Rock Community – Bedrock Association* – Bedrock outcrops have a very high reflectance value in imagery, similar to boulders. The outcrops are generally in a linear orientation and make up a small proportion of the total classified area. Lichen is the main plant community associated with bedrock.

- *Eskers* – Eskers may support a variety of different plant communities, and can be overlain by number of different ELC classes. They are also a very small proportion of the area relative to the other classes. As a result, this class was identified manually in the imagery and added into the classification.

- *Sand/Gravel* – There are small areas of sand or gravel (e.g., beaches) found within the regional study area. This class represents a relatively small proportion of the total classified area.

- *Disturbed Sites* – There is very little disturbed land in the area being classified. The class includes any urban area (Baker Lake) or camp settlements large enough to be detected in the imagery. Due to the characteristics of this class, it cannot be automatically classified; therefore, these areas were added manually. This class represents a very small proportion of the total classified area.

- *Unclassified* – A very small percentage of cells within the imagery do not fall within a defined class. These cells have been grouped as unclassified.

3.2.2.4 Accuracy Assessment

Description

Adequate groundtruthing data are required to conduct an accuracy assessment on a classification. The field data must provide a representative sample of all the classes in the classification scheme, and need to be spatially located within polygons of appropriate size for a regional scale classification.

The groundtruthing data available for this project came from two sources:

- baseline vegetation data collected at 156 plots within a portion of the LSA, centered on the existing camp location

- Landsat verification data collected at 157 sites in the Tehek Lake area by Department of Sustainable Development (M. Campbell, pers. comm., 2003). Forty-five of these DSD sites fall within the RSA and winter road corridor, and were used in the accuracy assessment of the ELC that was developed for these study areas. At each site, information was recorded on landform, surficial expression, substrate, moisture regime, canopy cover type, ground cover type, and plant species. Ground cover type is a comparable category to ELC unit and was used for the accuracy assessment.

The baseline vegetation data collected at Meadowbank were intended to facilitate the identification of plant communities within the LSA, and are of limited use in groundtruthing the regional classification. The plots are clustered and represent only a very small portion of the RSA. In addition, some of the regional ELC units are not represented in these data.

Six of the 45 DSD sites that fall within the extent of the classified imagery, did not have a ground cover type assigned, and have been excluded from the accuracy assessment. The DSD ground cover types are slightly different from the ELC units used for this project, which makes a detailed comparison of the two datasets challenging. The DSD ground cover types and the equivalent ELC units are listed in Table 3.4.

Table 3.4: DSD Ground Cover Types & the Equivalent ELC Units

DSD Ground Cover Type	Equivalent RSA/Winter Road Corridor ELC Unit
Wet Sedge Meadow	Sedge Community
Wet Sedge Meadow	Birch Seep Community
Wet Sedge Meadow	Riparian Shrub Community
Lichen-Heath Upland	Heath Tundra Community
Low Shrub Tundra	Heath Tundra Community
Hummock Graminoid Tundra	Heath Tundra Community
Boulder Field	Lichen-Rock Community – Boulder Association
Rock Outcrop	Lichen-Rock Community – Bedrock Association
Gravel and/or Sandridge	Sand/Gravel

There are five ELC units that are not represented among the DSD ground cover types. These are deep water, shallow water, heath tundra/lichen-rock association, disturbed sites, and eskers; consequently, these ELC units were not assessed for accuracy.

The accuracy assessment is achieved by determining on which ELC unit a given DSD site falls. This information is summarized in a confusion matrix. A confusion matrix has the ELC units along one axis and the DSD ground cover types along the other axis. The number of points that fall within each of the matrix cells was then evaluated and two levels of assessment were performed: the first level used the 24 DSD sites that had a definite ground cover type class assigned. This level of assessment ensures that the sites used correspond directly to an equivalent ELC unit; thus, there is no interpretation involved. The second level incorporated all 39 DSD sites. DSD sites that have more than one ground cover type assigned were included, thus, they can be correct for more than one ELC unit. The results of the first and second level accuracy assessments are shown in Tables 3.5 and 3.6, respectively.

Table 3.5: Level One Accuracy Assessment of the RSA/Winter Road Corridor ELC Classification

RSA/Winter Road Corridor ELC Units	Ground Cover Types from DSD sites					
	Wet Sedge Meadow	**Lichen-Heath Upland**	**Low Shrub Tundra**	**Boulder Field**	**Rock Outcrop**	**ELC Unit Total**
Sedge Community	1					1
Birch Seep Community						
Riparian Shrub Community						
Heath Tundra Community		5	2			7
Lichen-Rock Community - Boulder Association		1		10		11
Lichen-Rock Community - Bedrock Association		3			1	4
Sand/Gravel				1		1
Ground Cover Type Total	1	9	2	11	1	24

Note: Shaded areas indicate equivalencies between ground cover type and ELC unit (see Table 3.4).

Table 3.6: Level Two Accuracy Assessment of the RSA/Winter Road Corridor ELC Classification

RSA/Winter Road Corridor ELC Units	Ground Cover Types from DSD sites							
	Wet Sedge Meadow	**Lichen-Heath Upland**	**Low Shrub Tundra**	**Hummock Graminoid Tundra**	**Boulder Field**	**Rock Outcrop**	**Gravel and/or Sandridge**	**ELC Unit Total**
Sedge Community	1							1
Birch Seep Community	3	1						4
Riparian Shrub Community	1							1
Heath Tundra Community		6	4					10
Lichen-Rock Community - Boulder Association		1		1	16			18
Lichen-Rock Community - Bedrock Association		3				1		4
Sand/Gravel					1			1
Ground Cover Type Total	5	11	4	1	17	1	0	39

Note: Shaded areas indicate equivalencies between ground cover type and ELC unit (see Table 3.4).

The confusion matrix summarizes the relationship between ground cover type and ELC unit designation in the cases where DSD sites fall within ELC unit polygons. The confusion matrix is interpreted according to the following example from Table 3.6:

- There are 18 DSD sites that fall within lichen-rock community – boulder association ELC unit polygons.
- 16 of these sites are the ground cover type boulder field, the equivalent class to the lichen-rock community – boulder association; therefore, this ELC unit designation is considered correct.
- One site is the ground cover type lichen-heath upland, therefore, the ELC unit designation is considered incorrect.
- Another site is the ground cover type hummock graminoid tundra, therefore, the ELC unit designation is again considered incorrect.
- The lichen-rock community – boulder association ELC unit was correctly identified in 16 of 18 cases where a DSD site fell within a polygon.

Accuracy Assessment Limitations

The limitations of the accuracy assessment are as follows:

- The number of DSD sites available is insufficient for a complete accuracy assessment.
- The DSD sites are not equally distributed among the ELC units. For example, some ELC units have 17 DSD sites while other ELC units have only one DSD site.
- There are five ELC units that do not have equivalent ground cover types. These ELC units could not be assessed for accuracy.
- The ELC units and ground cover types are not completely equivalent, which can introduce error into the assessment. For example, the ground cover type wet sedge meadow can represent three different ELC units (sedge community, birch seep community, and riparian shrub community).
- Fifteen DSD sites were given more than one ground cover type designation (i.e., composite sites). For example, a data sheet might identify the ground cover type as lichen-heath upland, but include comments that indicate boulder field is also present. This introduces interpretation error when conducting the accuracy assessment because the site could be correct for more than one ELC unit.

The overall accuracy of the ELC developed for the RSA/winter road corridor cannot be determined because of these limitations; however, the assessment as presented does give an indication of the accuracy for certain ELC units, although this information should be used with caution.

3.3 RESULTS & EXISTING CONDITIONS

3.3.1 Overview

Botanical investigations in the Kivalliq Region were not undertaken in any detail until the 1960s. Significant knowledge on the regional vegetation has been acquired in association with studies on the Beverly and Qamanirjuaq caribou herds (Miller, 1976); in the Wager Bay area (Cody et al, 1989); and as part of impact assessments for proposed developments in the Baker Lake area, Rankin Inlet, and the Central Arctic (Burt, 1997); however, the distribution and ecology of non-vascular plants remains relatively unknown in the region.

Studies of vegetation and of plant ecology have been conducted in a few areas near the proposed mine development (e.g., Larsen's surveys at Pelly Lake and Snow Bunting Lake [Larsen, 1972]), but the Meadowbank area itself had not been surveyed until 1999, 2002, and 2003.

3.3.2 Local Study Area

3.3.2.1 Plant Species

Vegetation surveys at Meadowbank identified 111 vascular plant species (including hybrids and intergrades) from 25 families in the LSA during the 1999 and 2002 baseline surveys (Appendix A.3). An additional 63 vascular plant species are likely to occur in the vicinity of the proposed mine development, but were not observed during field surveys (Appendix A.4). In addition, 53 non-vascular plants, primarily lichens, were identified during the same surveys (Appendix A.5); however, many of the non-vascular plants collected during those surveys remain unidentified.

3.3.2.2 Plant Communities & Associations

Description of plant communities and associations are based on the following: observable features in each grouping; species composition, in conjunction with terrain features; or ecological conditions in the immediate vicinity. Terrain features are the basis for, and control the development of, plant communities. At the same time, the plant communities overlay terrain features, and it is possible to have several types in the same geographic area. For example, boulders bear a complex lichen flora, yet the boulders themselves may be completely surrounded by heath tundra. Alternatively, heath tundra mats may be perched on boulders and surrounded by a boulder field. Each category is simply a human effort to label, to categorize, and to define situations that occur as a continuum in the natural world.

The term “community” has been used to refer to the larger, more distinct categories (e.g., sedge). The term association has been used to refer to subgroups of the communities (e.g., non-tussock sedge association). A detailed description of vegetation communities, including various associations, is provided in Appendix A.2. A brief summary is provided below.

Sedge Community – The dominant species in this ELC unit are sedges (see Appendix.A.3 for scientific names of all plant species described in this report) and cottongrasses. These units are located in depressions or drainage basins, or at the margins of shallow water bodies. Small willows are also often found in this unit.

Four associations within the Sedge community have been identified:

- emergent
- non-tussock
- tussock
- tussocks being invaded by heaths.

Moss Community – Mosses (primarily *Sphagnum* sp.) dominate this unit, but a variety of vascular plants are also present (e.g., heaths, sedges and grasses). These units are located in seepage areas at the base of slopes, and at the margins of lakes, ponds or streams. Two moss community associations (i.e., mossy lakeshore and mossy cliff base) were identified during vegetation surveys.

Birch Seep Community – Dwarf birch is the characteristic species in this ELC unit, which is located in seepage areas at the base of slopes or at the edges of sedge associations. Plant species growing under the birches vary depending on the amount of seepage, but may include heaths, such as lingonberry, bog blueberry, and white arctic heather, and sometimes bearberry and crowberry; sedges and grasses; and occasionally large-flowered wintergreen. Lichens are usually sparse. A number of willow species also occur in this unit. There may be little or no understorey or ground cover where the canopy is dense.

Riparian Shrub Community – Birch Association – This ELC unit occurs in the drainages between lakes, typically on boulder substrate, and is associated with more defined drainages than that of the birch seep community. Dwarf birch is the dominant species, often forming an unbroken canopy. Ground cover is generally sparse except where tundra mats bridge the boulders. Some vegetation may be rooted in perched material on the boulders. Willows can occur, but are small. A willow association may develop in the center of birch associations where there is considerable water flow (e.g., stream valleys); however, this ELC unit has not been confirmed in the LSA to date.

Heath Tundra Community – This ELC unit is the climax community on the uplands in the Meadowbank area, and is the most common unit in the LSA. Heath tundra communities are dominated by bog blueberry, lingonberry, white arctic heather, Labrador tea, bearberry, and crowberry. Five Heath Tundra Community associations have been identified within the LSA (i.e., hummock [found at the edge or at the head of drainage basins], upland, heath tundra with boulders [found in fields of glacial erratic boulders or bedrock outcrops], heath tundra with frost scars [found in drier areas or where frost boils elevate the soil], and lichen-heath tundra [found in well-drained ridge tops or over sand and fine gravel on gentle slopes].

Snowbank Community – This ELC unit develops at sites where the wind deposits deep snow drifts over consecutive winters (e.g., leeward slopes), and where snow persists the longest in the summer. In the Meadowbank area, these units often occur on east, southeast, or south-facing slopes, and typically support three indicator species: least willow, Labrador tea, and white arctic heather. In steeper areas with very large drifts, mountain heather, few-flowered anemone, mustards (*Draba* spp), mountain sorrel, pygmy buttercup, and occasionally, arctic alpine fleabane occur.

Avens Community – This ELC unit is similar to the heath tundra community, but occurs in drier areas, usually on ridge tops, and is dominated by mountain avens. Grasses and xeric sedges are a major component of this unit. Other species include heaths (e.g., lingonberry, bog blueberry, bearberry, Labrador tea, and Lapland rosebay, and a variety of other flowering species (e.g., prickly saxifrage and snow cinquefoil). Thrift was only found in this unit in the Meadowbank area. Dwarf birch and willows may also occur in small numbers.

Lichen-Rock Community – Lichens dominate this ELC unit. The unit's characteristics (e.g., lichen species composition) vary according to wind exposure, moisture availability, and the chemical composition of the rock substrate. Two associations have been described (i.e., lichen-rock community – boulder association [foliose and fruticose lichens associated with felsenmeer or boulder field substrates], and lichen-rock community – bedrock association [crustose lichens associated with exposed bedrock outcrops].

Ridge Crest Community – This ELC unit is typically associated with eskers. Vegetation cover is often non-contiguous as the environment is dry and unstable. Two associations were mapped in the LSA (i.e., ridge crest community – sand association and ridge crest community – cobble association). The vegetation in this unit occurs in dense mats, which may include bog blueberry, lingonberry, crowberry, black bearberry, or prickly saxifrage. Moss campion, snow cinquefoil, grasses (e.g., purple reedgrass), and xeric woodrushes (e.g., confused woodrush) may also be present. Lichens are sparse in this unit. The ridge crest community - cobble association is similar to the lichen-rock community – boulder association.

Disturbed Sites – This ELC unit groups those sites in the LSA that have been disturbed as the result of human activities. The only disturbed sites that were mapped are the two field camps located in the southern section of the LSA and an exploration site just east of these camps.

3.3.2.3 Rare Plants & Plant Communities

No rare vascular plants or plant communities were found in the Meadowbank LSA. Although it is possible that some rare non-vascular species (e.g., lichens) may be present, very little is known of non-vascular plant distribution in the Arctic and most species are difficult to identify.

Seven vascular plant species of restricted range are known or expected to occur in the area, but none are considered to be rare or of special concern. These species include greyleaf willow, Bell's crazyweed, mountain heather, diapensia, alpine pussytoes, marsh marigold, and Rocky Mountain cinquefoil. The former five species were all recorded at Meadowbank.

One species of willow, Tyrrell's Willow (*Salix tyrellii*), was formerly listed on the COSEWIC list, but as a result of work on the WMC International Ltd. Meliadine Gold project, it has now been delisted, as it is far more common than originally thought (P. Burt, pers. comm., 2003). It was recorded commonly throughout the Meadowbank study area.

3.3.2.4 Phenology Studies

Phenology studies at Meadowbank ran from late May through 11 September 2003. Data are part of ongoing monitoring studies at Meadowbank. Results of the first year of monitoring are provided in Table 3.7.

Table 3.7: Preliminary Results of Phenology Studies

Month	May			June						July				July						August					Sept		
Time period ->	25-31	1 to 7	8 to 14	15 to 21		22 to 28		Jun 29-Jul 5		6 to 12		13 to 19		20 to 26		27-Aug. 2		3 to 9		10 to16	17 to 23		24 to 30		31-Sept 6	7 to 13	
Checked on ->	27	5	10	17		24		4		9		14		22		29		7		none	21		29		none	11	
Plot #1 Sedge																											
Carex	D	G1	G1	G1		G1		G2		G3	G3	G4	G4	G5	G5	G6	G5	G8	G8		G8	G8	G8	G8		G8	G8
Cottongrass	G3	G3	G3	G3		G3	F1	G2	G3	G4	G4	G4	G4	G5	G5	G6	G5	G8	G8		G8	G8	G8	G8		G8	G8
Mountain avens	D	D	L1	L1		L2		L2	F1	L3	F2	L3	F5	L3	F5	L4	F6	L6	F10		L6	F10	L7	F10		L8	D
Labrador tea	D	D	D	D		L2		L3	F1	L3	F2	L3	F2	L3	F2	L4	F6	L4	F9		L4	F9	L5	F10		L4	F10
Blueberry	D	D	D	D		D		L1	F1	L2	F2	L3	F3	L3	F4	L4	F6	L5	F7		L5	F8	L5	F8		L8	F10
Arctic heather	D	L1	L1	D		L3		L1	F1	L3	F2	L3	F5	L4	F6	L4	F6	L4	F6		?	?	L5	F9		L6	F10
Plot #2 Birch Seep																											
Dwarf birch								L2	F1	L2	F1	L3	F2	L3	F6	L3	F6	L3	F6		L4	F6	L5	F10		L8	D
Labrador tea								L2	F1	L3	F1	L3	F1	L4	F6	L4	F6	L4	F6		L4	F9	L4	F10		L4	F10
Blueberry								L1		L3	F1	L3	F2	L3	F6	L4	F6	L5	F6		L4	F8	L5	F8		L7	D
Lingonberry								L1	F1	L3	F1	L3	F1	L4	F5	L4	F6	L5	F7		L4	F7	L4	F7		L5	F8
Arctic heather								L2	F1	L3	F2	L3	F3	L4	F5	L4	F6	L4	F6		L4	F9	L5	F9		L5	F9
Crowberry								L2	F1	L3	F1	L3	?	L4	F6	L4	F6	L4	F6		L4	F8	L4	F8		L5	F8
Plot #3 Snowbank																											
Least willow						L1	F1	L3	F2	L3	F2	L3	F3	L3	F6	L3	F6	L3	F10		L3	F10	L4	F10		L8	F10
Prickly saxifrage						D		L3	F2	L3	F1	L3	F2	L3	F3	L3	F6	L3	F6		L4	F9	L4	F10		L8	D
Labrador tea						L1		L2	F1	L3	F1	L3	F2	L4	F6	L4	F6	L4	F6		L4	F9	L5	F10		L5	F10
Alpine arnica						D		L2	F1	L3	F3	L3	F2	L3	F5	L3	F5	L3	F6		L4	F6	L4	F10		L5	D
Blueberry						D		L2	F1	L3	F2	L3	F3	L4	F5	L4	F6	L4	F6		L5	F8	L5	F8		L8	F10
Star chickweed						D		L3	F2	L3	F2	?	?	L3	F3	L3	F5	L3	F6		L3	F6	L3	F10		L6	D
Plot #4 Heath Tundra																											
Carex sedges	D	D	D	D		G1		G2		G3		G3		?	?	?	?	G6	G8		G8	G8	?	?		?	?
Blueberry	D	D	D	D		D		L2	F1	L3	F2	L3	F3	L4	F5	L4	F6	L4	F7		L4	F8	L5	F8		L6	F10
Lingonberry	D	D	L1	L1		L3	D	L3	F2	L3	F1	L3	F2	L3	F5	L4	F6	L4	F7		L4	F7	L4	F7		L5	F8
Bearberry	D	D	D	L1		L1	D	L2	F1	L3	F1	L3	F1	L3	F6	L4	F6	L4	F7		L5	F8	L5	F8		L6	D
Dwarf birch	D	D	D	D		D		L3	F2	L3	F2	L3	F3	L3	F6	L3	F6	L3	F6		L4	F6	L5	F10		L8	D
Labrador tea	D	L1	L1	L1		L1	D	L3	F2	L3	F2	L3	F3	L4	F6	L4	F6	L4	F6		L4	F9	L4	F10		L4	F10
Arctic heather	D	L1	L1	L1		L1	D	L2	F2	L3	F3	L3	F5	L4	F6	L4	F6	L4	F6		L4	F9	L4	F10		L5	F10
Plot #5 Lichen-Rock																											
Labrador tea				D		L1	D	L2	F2	L2	F1	L3	F2	L4	F5	L4	F6	L4	F6		L4	F9	L5	F10		L5	F10
Arctic heather				D		D		L2	F1	L3	F3	L3	F3	L4	F6	L4	F6	L4	F6		L4	F9	L5	F9		L5	F10
Lingonberry				D		D		L2	F1	L3	F1	L3	F1	L3	F4	L4	F6	L5	F7		L5	F7	L5	F7		L5	F8
Blueberry				D		D		L2	F1	L3	F1	L3	F2	L4	F5	L4	F6	L5	F6		L5	F8	L5	F8		L6	F10
Crowberry				D		D		L2	F1	L2	F1	L3	F6	L4	F6	L4	F6	L4	F6		L5	F8	L5	F8		L5	F8
Plot #6 Avens Community																											
Carex sedges	D	D	D	D		G2		G2		G3	G3	G3	G3														
Mountain avens	D	D	L1	L3	F1	L3	F1	L3	F2	L3	F3	L3	F5	G5	G5	G6	G5	G6	G8		G8	G8	G8	G8		D	G8
Willow	D	L1	L1	L1	F1	L1	F1	L2	F1	L3	F2	L3	F5	L4	F6	L4	F6	L4	F10		L4	F10	L5	F10		L6	D
Blueberry	D	D	D	D		D		L1	F1	L3	F2	L3	F3	L3	F10	L3	F6	L3	F6		L3	F9	L3	F10		L8	F10
Arctic heather	D	D	L1	L3	F1	L3	F1	L2	F1	L3	F3	?	?	L3	F1	L4	F6	L3	?		L5	F8	L5	?		L6	D

COLOUR CODES

The following are the colour codes used in delineating phases of vegetative life cycle and bloom.
Charts are attached, following the bloom by plant association and species within an association.

- Dormancy
- Spring greenup
- Foliage full
- Flower buds visible
- First flowers
- Full bloom
- Fall colour, flowers fading, berries developing
- Seeds dispersing/berries ripe
- Dormancy
- Snow cover

GRASS, LEAF, & FLOWER CODES:

Grass/Sedge Codes:

D = Dormant; winter state
G1 = New leaves appear at base
G2 = Flower stalk just visible, no flowers yet
G3 = Stalk elongated, flower structure visible
G4 = Full bloom, stamens present, pollen being shed
G5 = Seeds forming
G6 = Leaves turning brown
G8 = Seeds being released

Leaf Codes:

D = Dormant; winter state
L1 = Leaf buds swelling
L2 =Leaves starting to unfurl
L3 = Fully leafed out
L4 =First leaves changing colour
L5 = Fall colour in most leaves
L6 = Leaves withering or winter colour
L7 = Leaf fall starting (less than 10%)
L8 = Main leaf fall/leaves withering

Flower Codes:

D = Dormant; winter state
F1 = Flower structures barely visible
F2 = First open flowers (less than 10% of flowers open)
F3 = Full bloom; pollen on anthers
F4 = Pollination occurring, pollen on stigmas
F5 = 1st petals (< than 10%) fading/falling
F6 = Fruits/seeds developing
F7 = Berries starting to ripen (<10% are ripe)
F8 = Berries fully ripe
F9 = Seed capsules mature (dry)
F10 = Seeds being released

Look at individual plants, determine the average condition of each species, and record codes under correct column below.

3.3.2.5 Area Summary & Distribution of ELC Units

The ELC units developed for this baseline report were based on the eight plant communities, two subgroups (disturbed sites and esker complexes), and 15 associations described earlier (also see Appendix A.2). Thirteen ELC units (including water) were identified and mapped in the LSA.

An area summary of the ELC units found in the LSA is presented in Table 3.8. Water is the most common mapped unit in the LSA, but the most common vegetated unit is the heath tundra community. The southern section of the LSA consists mainly of heath tundra with patches of the birch seep community and the lichen-rock associations. In the northern section of the LSA, lichen-rock community – boulder association is the most abundant ELC unit, with patches of heath tundra and birch seep. Figure 3.2 shows the distribution of each ELC in the LSA.

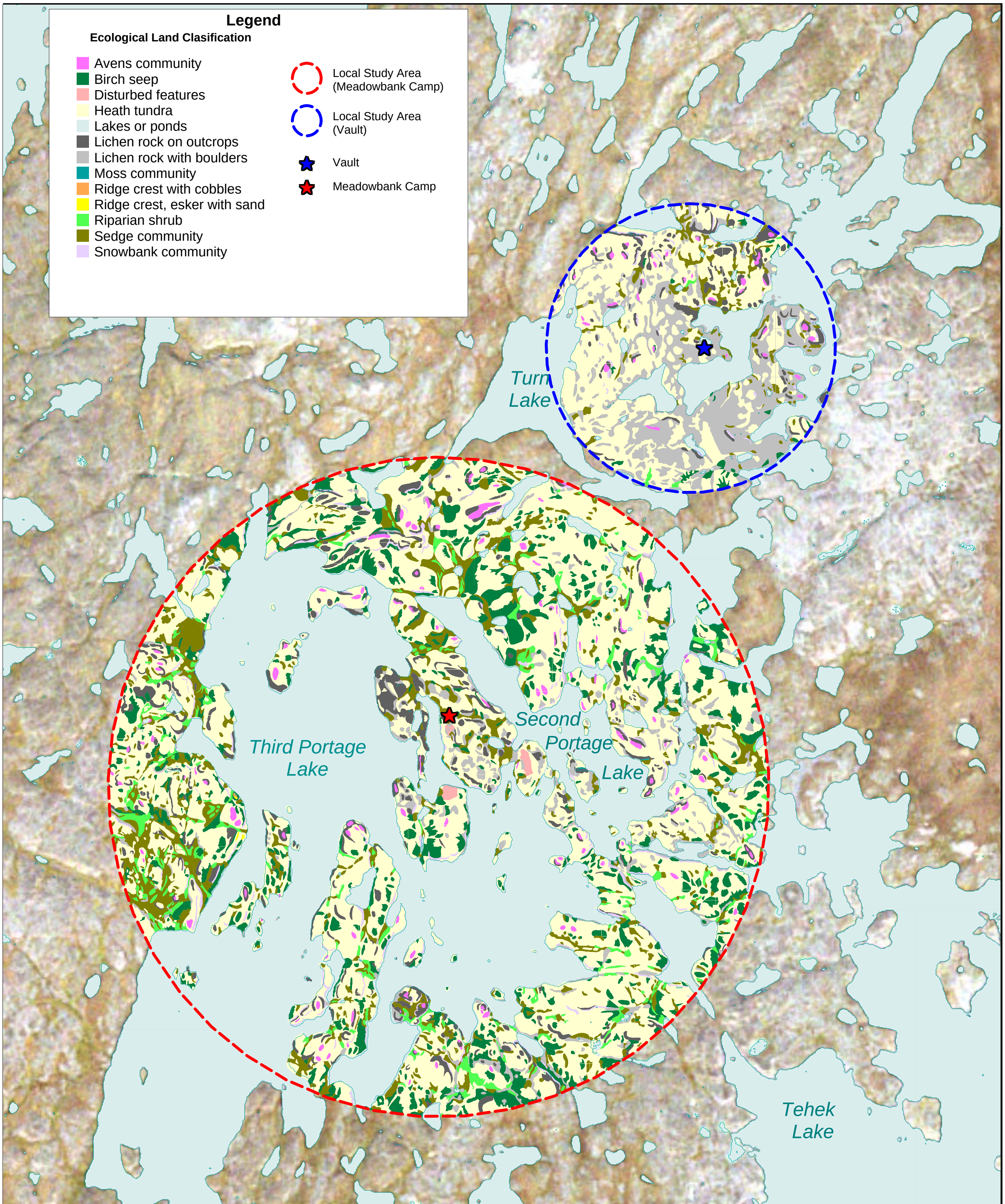
Table 3.8: Area Summary of ELC Units in the LSA

Ecological Land Classification Unit	Area (ha)	Proportion of entire LSA (%)
Water	3,733	40
Sedge Community	585	6
Moss Community	1	<1
Birch Seep Community	622	7
Riparian Shrub Community – Birch Association	168	2
Heath Tundra Community	3,160	34
Snowbank Community	95	1
Avens Community	72	<1
Lichen-Rock Community – Boulder Association	601	6
Lichen-Rock Community – Bedrock Association	337	4
Ridge Crest Community – Sand Association	1	<1
Ridge Crest Community – Cobble Association	<1	<1
Disturbed Sites	10	<1
Total	**9,395**	**100**

3.3.3 Regional Study Area

Thirteen ELC units (including 'unclassified') were identified and mapped for the RSA. Area summaries of the ELC units found in the RSA are presented in Table 3.9.

The two most common ELC units in the RSA are heath tundra community and lichen-rock community – boulder association. The heath tundra community is most prevalent in the southwest of the RSA, while the lichen-rock community – boulder association is mainly found in the northeast area of the RSA. Throughout the RSA, the two classes of water (shallow and deep water) are the next most common ELC.



Ecological Land Classification within the LSA Boundary

Area of Detail

NORTH

600 0 600 1200 1800

Scale in metres

SCALE 1:85,000

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

Figure 3.2

Acknowledgements: Original drawing by AXYS Environmental Consulting Ltd.

Table 3.9: Area Summary of ELC Units in the RSA

Ecological Land Classification Unit	Area (ha)	Proportion of Entire RSA (%)
Deep Water	180,420	18
Shallow Water	60,715	6
Sedge Community	29,485	3
Birch Seep Community	56,925	5
Riparian Shrub Community	6,845	1
Heath Tundra Community	268,344	26
Heath Tundra/Lichen Rock Association	14,102	1
Lichen-Rock Community - Boulder Association	262,674	26
Lichen-Rock Community - Bedrock Association	137,760	14
Eskers	588	<1
Sand/Gravel	1,444	<1
Disturbed Sites	4	<1
Unclassified	673	<1
TOTAL	**1,019,979**	**100**

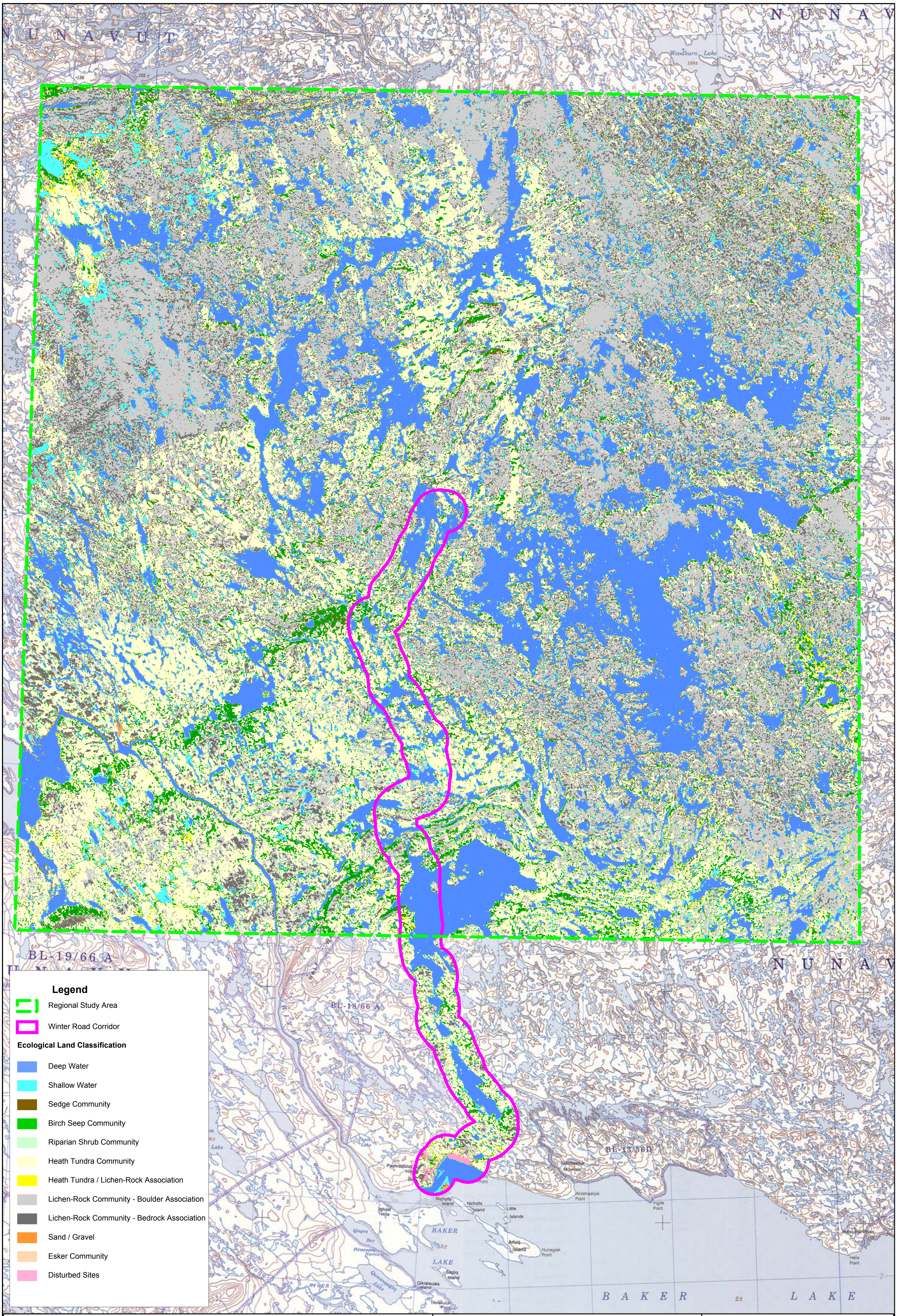
3.3.4 Winter Road Corridor

Thirteen ELC units (including 'unclassified') were also identified and mapped for the winter road corridor. Area summaries of the ELC units found in the winter road corridor are presented in Table 3.10.

Table 3.10: Area Summary of ELC Units Along the Winter Road Corridor

ELC Unit	Area (ha)	Proportion of Entire Winter Road Corridor (%)
Deep Water	14,845	29
Shallow Water	2,524	5
Sedge Community	944	2
Birch Seep Community	4,701	9
Riparian Shrub Community	766	1
Heath Tundra Community	16,934	33
Heath Tundra/Lichen Rock Association	888	2
Lichen-Rock Community - Boulder Association	5,085	10
Lichen-Rock Community - Bedrock Association	3,372	7
Eskers	0	0
Sand/Gravel	279	1
Disturbed Sites	369	1
Unclassified	24	<1
TOTAL	**50,731**	**100**

The most common ELC unit along the winter road corridor is heath tundra. This community is found throughout the winter road corridor, and together with the two water classes (shallow and deep water), makes up 67% of the total study area. Figure 3.3 shows the distribution of the ELC unit in the winter road corridor and RSA.



Ecological Land Classification for the RSA and Winter Road Corridor

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY: KAVIK-AXYS Inc.			
DATE: 22 May 2003		SCALE: 1:430,000	
DRAWN: JS	CHECKED	FIGURE NO.	REV: 1
REVIEWED	PROJECT: KA073	3.3	VOL: -

3.4 REFERENCES

Burt, P.M., 1997. Diavik Diamond project. Vegetation baseline studies: Plant associations and habitat types and plant species list. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT.

Cody, W.J., G.W. Scotter and S.C. Zoltai, 1989. Vascular plant flora of the Wager Bay Region, District of Keewatin, Northwest Territories. Canadian Field-Naturalist 103:551-559.

Earth Resource Mapping Pty Ltd., 1998. ER Mapper 6.0 User Guide. Earth Resource Mapping, San Diego, CA.

Larsen, J.A., 1972. The vegetation of Northern Keewatin. Canadian Field-Naturalist 86:45-72.

Matthews, S., 2001. West Kitikmeot/Slave study area land cover classification report. Draft manuscript. 34 pp.

Miller, D.R., 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 3: Taiga winter range relationships and diet. Canadian Wildlife Service Report Series Number 36. Ottawa, ON.

SECTION 4 • TERRAIN & SOILS

4.1 INTRODUCTION

This section presents the methodology used to develop baseline information on terrain and soils, and provides a description of the baseline terrain and soil conditions. The main soil development factors and periglacial processes at work in the area of the proposed development are also discussed. Finally, the terrain and soils characteristics of the ELC units developed for the three study areas are described.

4.2 METHODS

Published literature was reviewed to provide a description of the baseline terrain and soils conditions in the LSA and RSA. Available literature relevant to terrain and soils included several small scale (1:100,000 to 1:1,000,000) maps of surficial geology, soils, and topography (Canada-Nunavut Geoscience Office, 2002; AAFC, 1996; Natural Resources Canada NTS Sheets 66H, 56E, 66A and 56D; ESWG, 1995). Information was also available through studies initiated by Cumberland that investigated the vegetation present in the LSA and characterized surficial materials. Potential soil subgroups were extrapolated from the terrain, surficial material, and vegetation characteristics for the identified ELC units in the LSA and RSA. Soil classification was based on the Canadian System of Soil Classification (SCWG, 1998).

4.3 EXISTING CONDITIONS

4.3.1 Overview

The Meadowbank area is within the Wager Bay Plateau Ecoregion, which is characterized by broad sloping uplands, plains, and valleys formed by the underlying rocks of the Canadian Shield (ESWG, 1995). Glacial features such as ribbed and ground moraine, boulder fields, and eskers are present within the project area. Periglacial landforms are a key feature on the landscape, and thus, demonstrate the significant influence of climate and permafrost in the area.

4.3.2 Terrain

4.3.2.1 Permafrost

The proposed development is within the continuous permafrost zone. Permafrost is defined as ground that remains at or below 0°C for at least two years (Permafrost Subcommittee, 1988). Permafrost does not necessarily contain ice; rather, its definition is based solely on temperature criteria of the mineral or organic parent material. Permafrost in this area is considered stable and has temperatures colder than -5°C (Trenhaile, 1990). The permafrost generally has low ice content, estimated at between 0% and 10% (ESWG, 1995). Depth of the permafrost in the Meadowbank area is estimated to be between 400 and 500 m based on thermistor data from the Meadowbank area.

4.3.2.2 Topography

The project area is undulating, with slopes rarely exceeding 10%, and has numerous lakes interspersed throughout the landscape (AAFC, 1996). The area contains relatively few defined drainage channels, but rather, has areas of lower elevation between lakes, which form surface water connections. These drainage channels are often ephemeral, containing flow only during the spring thaw. Channels are frequently lined with boulders and contain little fluvial material. Elevation ranges from 133 masl to approximately 200 masl in the development area. Relief is commonly between 10 and 12 m near the main development area, but can range up to 60 m throughout the local area.

4.3.2.3 Surficial Geology

The RSA contains large areas of water in a complex pattern of large and small lakes. The dominant surficial material in the RSA is morainal, although limited areas of alluvial, lacustrine, glaciofluvial, and colluvial materials, as well as bedrock, boulder fields, and organic accumulations are also present.

4.3.3 Soils

4.3.3.1 Soil Development

General Description

Soil development is dependent on climate, vegetation, topography, parent material, and time (Jenny, 1941). The regional soils reflect the dominant soil development conditions within the project study areas. The Cumberland project is located in an area of long, cold winters, and short, cool summers. Mean annual precipitation ranges from 200 to 300 mm (ESWG, 1996). Additionally, the proposed development is in the continuous permafrost zone, and soils are therefore primarily Cryosolic and are influenced by periglacial processes.

One of the principal influences on soil development within the LSA and RSA is climate. Ambient air and soil temperatures are low, and precipitation is not abundant. Cold temperatures and low soil moisture are extremely restrictive on soil development processes. Low soil temperatures can slow or prevent soil chemical, physical, or biological reactions from occurring. Water is fundamental to many processes because it has the ability to dissolve and move soil constituents. Conversely, fluctuations between freeze and thaw conditions are instrumental to many periglacial processes that are fundamental to many terrain and soils characteristics in the LSA and RSA.

Soils in the LSA and RSA are generally nutrient poor due to the slow rates of weathering and decomposition. Abundant nutrients are not available through release from parent materials by way of weathering or by being liberated through the decomposition of organic matter. Northern environments possess conditions that promote the accumulation of organic material rather than decomposition. Microbial decomposition of organic matter is prohibited or slowed when exposed to low soil temperatures and oxygen levels. Organic material within the active layer of arctic and subarctic soils has been determined to be several thousand years old, which emphasizes the slow rate of decomposition in northern environments (Zoltai et al, 1978). Organic matter accumulations in the study area are generally not deep, and are therefore associated with Histic Turbic Cryosols or Histic Static Cryosols, rather than Organic Cryosols.

The presence of permafrost tends to create a layer directly above the permafrost table that shows signs of long-term water saturation. Melting at the top of the permafrost table results in waterlogging above the impermeable ice layer. Poorly drained conditions can extend throughout the active layer in level or depressional areas where the soil water does not drain horizontally. Poor drainage may also occur in coarse textured soils over permafrost, although drainage is usually rapid in areas that are not affected by permafrost.

The absence of relief can also create areas of poor drainage because runoff is slow or absent. Topography is generally undulating in the LSA and RSA, with slopes less than 10%, although discrete areas of relief are present. Excess moisture limits the transfer of soil constituents within the profile. Saturation with water also prevents adequate aeration for microbial activities that are necessary for soil development. Profiles subjected to water saturation are associated with the development of Gleysolic Static Cryosols and Gleysolic Turbic Cryosols, depending on whether cryoturbation is present.

Periglacial Processes

Periglacial refers to processes or landforms related to cold climates, and is frequently associated with freeze and thaw cycles (Williams and Smith, 1989). The primary periglacial processes or landforms that occur in the LSA and RSA and affect terrain and soils are cryoturbation, patterned ground, solifluction, and felsenmeer.

Cryoturbation

Soils within the LSA and RSA are strongly affected by cryoturbation. Cryoturbation is frost action that causes churning, heaving, and considerable structural modification of the soil and subsoil (Gregorich et al, 2001). The soil profile becomes churned up, resulting in mixed, broken, displaced, and disrupted horizons (SCWG, 1998). Cryoturbation can take the form of sorted and non-sorted circles, polygons, stripes, and earth hummocks (SCWG, 1998). It is generally believed that displacement of material in the soil profile is caused by pressures generated during annual freezing of the active layer (Zoltai et al, 1978).

Cryoturbation commonly causes organic-mineral or peaty horizons (the Ah or Om/Oh horizons) to move from a position near the surface to one lower in the profile, just above the permafrost table (SCWG, 1998; Zoltai et al, 1978). Cryoturbation is not an organized process, and portions of horizons are often displaced, resulting in an extremely complex soil profile. This is in opposition to the relatively horizontal orientation and ordered age sequence of soils that are not affected by cryoturbation. Fine-grained soils with low temperatures, high moisture levels, frequent freeze-thaw cycles, and permafrost within the upper 1 m promote cryoturbation (Zoltai et al, 1978; Bockheim and Tarnocai, 1998).

Patterned Ground

Cryoturbation can also cause mechanical sorting by particle size (Tarnocai et al, 1993; SCWG, 1998). Mechanical sorting results in patterned ground where larger particles (stones and cobbles) are brought to the surface because they are subject to greater frost heave forces than small particles

(Williams and Smith, 1989). This can create distinctive patterns of microrelief such as polygons, nets, circles, and hummocks.

Non-sorted circles (frost boils) are a common type of patterned ground in the LSA. This type of feature demonstrates a more-or-less circular, vegetation-free patch surrounded by vegetated ground that tends to form an elevated rim above the inner circle. Non-sorted circles are a product of cryoturbation, and dominantly contain medium-grained material (fine sand to silt) in the inner circle, while coarser material and some stones may be present on the rim. These features may form by the extrusion of liquefied mud to the surface; liquefied soil material is extruded to the surface as a viscous mass (Shilts, 1978). Liquefaction can occur from shock stress (i.e., vibration), or changes in moisture content, pore pressure buildup, and stress history (from several sources). In the LSA, these features generally demonstrate hardened surfaces, forming a circle of bare ground.

Solifluction

Solifluction lobes are the manifestation of the presence of a saturated soil over the impermeable permafrost table. In the spring, the saturated surface soil flows downslope at a slow rate, creating lobes of soil (Williams and Smith, 1989). The soil moves as a viscous liquid down slopes of as little as 2° or 3°, and may carry rocks of considerable size in suspension (Gregorich et al, 2001).

Felsenmeer

Felsenmeer is common within the study areas, and occurs due to frost action on exposed rock. The pressure exerted from the expansion of water upon freezing acts on the rock, resulting in shattered rock at the base of cliffs or other steep slopes, and on fairly level surfaces (Trenhaile, 1990).

4.3.3.2 Soil Classification

The proposed mine development is located within the continuous permafrost zone; hence, the soils present within the LSA and RSA are predominantly classified within the Cryosolic order. Cryosolic soils are formed in either mineral or organic materials that have permafrost either within one metre of the surface or within two metres if the active layer of the soil profile has been strongly cryoturbated. Cryosols have a mean annual temperature of less than or equal to 0°C.

The active layer of Cryosolic soils is frequently saturated with water, especially near the frozen layers or permafrost table. Colours associated with gleyzation are, therefore, common in mineral soils, even those that occur on well-drained portions of the landscape. The most common surface soil texture in the LSA is sandy loam, and profiles generally have an increased coarse fragment content with depth.

Two great groups of the Cryosolic order are commonly found within the study areas: Turbic Cryosols and Static Cryosols (ESWG, 1996). The defining characteristics of these great groups and their subgroups are described in the following sections.

Turbic Cryosol

Mineral soils with marked cryoturbation are classified as Turbic Cryosols. They are often found in conjunction with permafrost features such as patterned ground. To be classified as a Turbic Cryosol, the permafrost layer must be found within two metres of the mineral surface. The LSA and RSA contain dominantly Brunisolic Turbic Cryosols and Orthic Turbic Cryosols (AAFC, 1996).

These soils can be found in any area where the mean annual soil temperature is less than or equal to 0°C; however, they are most commonly found in finer-textured mineral parent materials such as glacial till and glaciolacustrine.

Orthic Turbic Cryosol (O.TC)

Soils are classified as Orthic Turbic Cryosols (O.TC) if their B horizon is less than 10 cm thick and is frozen (Bmy), and the profile is strongly cryoturbated. Permafrost must be encountered within two metres of the surface, and there may be gleying in the horizon immediately above the permafrost. The surface material may be organic in nature, but must be less than 15 cm thick.

Soils are classified as Orthic Eutric Turbic Cryosols (OE.TC) if their B horizon has a pH greater than 5.5 (high degree of base saturation), and as Orthic Dystric Turbic Cryosols (OD.TC) if their B horizon has an acidic pH less than 5.5 (low degree of base saturation).

Brunisolic Turbic Cryosol (BR.TC)

Soils are classified as Brunisolic Turbic Cryosols (BR.TC) if they contain an unfrozen B horizon (Bm) at least 10 cm thick. This B horizon must be continuous over the imperfectly- to well-drained part of the pedon, and must be relatively unaffected by cryoturbation. All other horizons (other than the B horizon described above) should be strongly cryoturbated. The surface material may be organic in nature, but must be less than 15 cm thick.

Soils are classified as Brunisolic Eutric Turbic Cryosols (BRE.TC) if their B horizon has a pH greater than 5.5 (high degree of base saturation), and as Brunisolic Dystric Turbic Cryosols (BRD.TC) if their B horizon has an acidic pH less than 5.5 (low degree of base saturation).

Gleysolic Turbic Cryosol (GL.TC)

Gleysolic Turbic Cryosols (GL.TC) develop in poorly drained areas under reducing conditions. Either the B or C horizon must be both gleyed and strongly cryoturbated. These soils show evidence of gleying or mottling to the mineral surface. The surface material may be organic in nature, but must be less than 40 cm thick. These soils are most commonly found in lower landscape positions where surface water collects, or in areas of localized groundwater discharge.

Regosolic Turbic Cryosol (R.TC)

Regosolic Turbic Cryosols (R.TC) are characterized by the absence of a B horizon but with evidence of cryoturbation. They are poorly developed soils and usually have little incorporated organic matter. These soils are commonly found in higher landscape positions such as slope crests where surface water dominantly runs laterally across the ground surface instead of vertically through the profile.

Static Cryosol

Static Cryosols have permafrost within one metre of the surface, but show little or no evidence of cryoturbation. They generally develop on coarse-textured mineral parent material or thin soils over bedrock. They may also form in a wide textural range of recently deposited or disturbed sediments where evidence of cryoturbation is still largely absent. They may contain surface organic horizons less than 40 cm thick.

These soils can be found in any areas where the mean annual soil temperature is less than or equal to 0°C; however, they are most commonly found in coarse textured mineral parent materials such as glaciofluvial, fluvial, aeolian, and some glacial till materials.

Orthic Static Cryosol (O.SC)

Soils are classified as Orthic Static Cryosols (O.SC) if they contain a B horizon less than 10 cm thick. The surface material may be organic in nature, but must be less than 15 cm thick.

Soils are classified as Orthic Eutric Static Cryosols (OE.SC) if their B horizon has a pH greater than 5.5 (high degree of base saturation), and as Orthic Dystric Static Cryosols (OD.SC) if their B horizon has an acidic pH less than 5.5 (low degree of base saturation).

Brunisolic Static Cryosol (BR.SC)

Soils are classified as Brunisolic Static Cryosols (BR.SC) if they contain an unfrozen B horizon (Bm) at least 10 cm thick. The surface material may be organic in nature, but must be less than 15 cm thick.

Soils are classified as Brunisolic Eutric Static Cryosols (BRE.SC) if their B horizon has a pH greater than 5.5 (high degree of base saturation), and as Brunisolic Dystric Static Cryosols (BRD.SC) if their B horizon has an acidic pH less than 5.5 (low degree of base saturation).

Gleysolic Static Cryosol (GL.SC)

Gleysolic Static Cryosols (GL.SC) develop in poorly drained areas under reducing conditions. These soils contain a B horizon or C horizon (or both) that is gleyed. Soils show evidence of gleying or mottling to the mineral surface. The surface material may be organic in nature, but must be less than 40 cm thick.

These soils are generally located in low landscape positions where surface water can accumulate and cause saturated, reducing conditions. They may also occur where groundwater discharges to the surface (or near surface).

Histic Static Cryosol (H.SC)

Soils are classified as Histic Static Cryosols (H.SC) if they contain a thick organic (peaty) horizon 15 to 40 cm thick in the upper one metre of the soil profile. Soils where the combined thickness of surface and subsurface organic layers exceeds 15 cm are also considered Histic Static Cryosols. These soils must contain a B horizon that is continuous across the pedon. These soils are most commonly found in lower landscape positions that are conducive to the accumulation of organic matter.

Soils are classified as Histic Eutric Static Cryosols (HE.SC) if their B horizon has a pH greater than 5.5 (high degree of base saturation), and as Histic Dystric Static Cryosols (HD.SC) if their B horizon has an acidic pH less than 5.5 (low degree of base saturation).

Regosolic Static Cryosol (R.SC)

Regosolic Static Cryosols (R.SC) are characterized by the absence of a B horizon. These soils are poorly developed, and usually occur on recently deposited material. Regosolic Static Cryosols may contain a thin peaty organic surface horizon less than 15 cm thick.

These soils are most commonly found in higher landscape positions such as slope crests where surface water dominantly runs laterally across the ground surface instead of vertically through the profile.

Histic Regosolic Static Cryosol (HR.SC)

Histic Regosolic Static Cryosol (HR.SC) soils are characterized by a thick (15 to 40 cm) organic surface horizon and the absence of a B horizon. These soils are most commonly found in lower landscape positions that are conducive to the accumulation of organic matter.

4.3.4 Terrain & Soils Characteristics of ELC Units

The terrain and soils characteristics for all the ELC units (except water) identified for the LSA and RSA/winter road corridor (Sections 3.2.1.3 and 3.2.2.3) are described in the following section, and are summarized in Table 4.1.

4.3.4.1 Sedge Community

This ELC unit occurs in depressions, drainage basins, and along lakeshores. These areas are all associated with nearly level topography (0-2% slope) and poor drainage. Rock content at the surface is low, and organic material generally covers 85% of the surface, with the remainder composed of water. There is frequently a peat layer at the surface with a thickness of 15 to 20 cm, underlain by

Table 4.1: Summary of Terrain & Soils Characteristics of ELC Units

Ecological Land Classification Unit	Terrain Type	Terrain Characteristics	Potential Soil Subgroups[1]
Deep Water Shallow Water Water	N/A		
Sedge Community	Shallow organic over lacustrine, fluvial, or morainal materials	Depressions, drainage basins, shorelines. Poorly drained, saturated soils with peaty surface layer. High moisture and nutrient regime.	GL.SC, HR.SC, H.SC
Moss Community	Lacustrine, morainal	Nearly level shoreline or toe slope areas. High moisture regime, medium to high nutrient regime. Saturated soils, cryoturbation may be present.	GL.SC, GL.TC
Birch Seep Community	Morainal	Toe of gentle slope with groundwater outflow. Medium to high moisture regime, medium nutrient regime. Cryoturbation may be present.	R.TC, O.TC, R.SC, O.SC, BR.TC, BR.SC
Riparian Shrub Community Riparian Shrub Community – Birch Association	Fluvial, boulder fields	Gently sloping drainage areas with high boulder content or transitory ponds. High moisture regime, medium nutrient regime. Thin or absent soil.	R.SC, R.TC
Heath Tundra Community	Morainal	Gently sloping upland areas. Low to medium moisture and nutrient regime. Cryoturbation occurs (mainly frost boils).	O.TC, BR.TC
Snowbank Community	Bedrock, colluvial, glaciofluvial	Leeward sides of hills, outcrops, eskers. Gently- to moderately-sloping on east, southeast, or south-facing slopes. Thin soils with a high moisture regime in spring, low nutrient regime.	R.SC, O.SC
Avens Community	Bedrock, lithic morainal (<10 cm deep over bedrock)	Dry ridge tops with a low moisture and nutrient regime. Rocky sites with thin soils. Cryoturbation occurs (mainly frost boils).	R.TC, O.TC
Heath Tundra – Lichen-Rock Community	Transitional unit between heath tundra community and lichen-rock community.		
Lichen-Rock Community	Bedrock, boulder fields	Gently-sloping, rocky, or bouldery sites. Low moisture and nutrient regime. Thin or absent soils. Frequent occurrences of felsenmeer.	R.SC
Eskers Ridge Crest Community – Sand Association Ridge Crest Community – Cobble Association	Glaciofluvial	Steep-sided, coarse textured deposits with a low nutrient and moisture regime. High proportion of bare ground.	R.SC
Sand/Gravel	No specific soil and terrain characteristics		
Disturbed Sites	Variable and site-specific soil and terrain characteristics		

Notes: 1 Refer to Section 4.3.4.2 for descriptions of the soil subgroups.

sandy loam or gravelly material. These sites generally have a high nutrient and moisture regime due to the movement of nutrient-rich groundwater through the substrate. Soils are frequently saturated and may contain standing water. Soil types associated with sedge communities are potentially Gleysolic Static Cryosols, due to long periods of the year in which the soil is saturated, and to the absence of cryoturbation. In areas where the period of soil saturation is less, Histic Static Cryosols or Histic Regosolic Static Cryosols may develop.

4.3.4.2 Moss Community

This ELC unit occurs in shoreline areas or where solifluction reaches local base level on morainal slopes. It generally has a 0-2% slope, and the soil texture is commonly sandy loam over gravel. Surface coverage of organic material is nearly continuous with the remainder covered by rocks. The moisture level is generally high, and the nutrient regime varies from medium to high. The soil is frequently saturated and may contain standing water. Profiles may be cryoturbated, which would lead to the formation of Gleysolic Static Cryosols or Gleysolic Turbic Cryosols.

4.3.4.3 Birch Seep Community

This ELC unit generally occurs at the toe of a gentle slope (0-6%) at the outflow of groundwater from the active layer. This unit may also be present at the edge of sedge communities where the moisture regime is transitional between the saturated conditions of the sedge community and the moderately well-drained conditions of the heath tundra. The moisture regime is generally medium to high, and the nutrient regime is medium. Coverage of organic material at the surface is high (approximately 80%), and rocks are common with approximately 20% coverage. Soil is generally thin and consists of a thin layer of humus over sandy loam-textured material, followed by gravel. Cryoturbation may be present in these areas, resulting in soils such as Orthic Turbic Cryosols, Orthic Static Cryosols, Brunisolic Turbic Cryosols, or Brunisolic Static Cryosols. Thinner soils such as Regosolic Static Cryosols or Regosolic Turbic Cryosols may also occur.

4.3.4.4 Riparian Shrub Community – Birch Association

This ELC unit is associated with drainage areas between lakes and transitory ponds. The drainage areas frequently have a boulder substrate through which water flows. These sites have a medium to high moisture regime, and a medium nutrient regime. Slopes are gentle (0-2%). Soil is generally thin or nonexistent, and may consist of just an accumulation of organic material or litter perched on boulders. Most of the fine particles necessary for soil development have been removed through fluvial action. Soils may be classified as Regosolic Static Cryosols or Regosolic Turbic Cryosols.

4.3.4.5 Heath Tundra Community

This ELC unit is the most abundant unit in the three study areas. It occurs on gently sloping (0-10%) upland areas. These sites have a low to medium nutrient and moisture regime. The majority of the terrain within this unit is covered by an organic surface layer scattered with surface stones except for some non-vegetated areas associated with frost boils (non-sorted circles). Cryoturbation is common on these sites, and results in the formation of Orthic Turbic Cryosols and Brunisolic Turbic Cryosols. Parent material is predominantly morainal and demonstrates sandy loam surface textures over material with increasing coarse fragment content.

4.3.4.6 Snowbank Community

This ELC unit occurs on the leeward sides of hills, outcrops, eskers, or banks of stream valleys. Slopes range from 0-15%, and are predominantly east, southeast, or south-facing. The moisture regime is generally high as these sites are at the base of hills and receive runoff, especially in the spring, but the nutrient regime is low because soils are often thin over bedrock or coarse textured substrates such as colluvium or glaciofluvial material. Soils may be classified as Regosolic Static Cryosols or Orthic Static Cryosols.

4.3.4.7 Avens Community

This ELC unit is associated with dry sites such as ridge tops where there is a thin layer of soil over bedrock. These conditions produce a low moisture and nutrient regime. These sites are frequently rocky with a thin humus layer over sandy loam soil underlain by bedrock. Despite the thin soils, cryoturbation may be present and produce frost boils at the surface. Soil development is poor, and sites are likely associated with Regosolic Turbic Cryosols or Orthic Turbic Cryosols.

4.3.4.8 Heath Tundra – Lichen-Rock Community

This ELC unit is a transitional unit and has soil and terrain characteristics that intergrade between those of the heath tundra community and the lichen-rock community.

4.3.4.9 Lichen-Rock Community – Boulder & Bedrock Associations

These ELC units occur in areas containing numerous boulders or exposed bedrock. Bedrock may take the form of felsenmeer that has been cracked through freeze-thaw processes. Slopes are gentle (0-6%). These sites contain little soil and, therefore, have a low moisture and nutrient regime. A thin layer of organic material (<5 cm thick), referred to as a tundra mat, is occasionally perched on boulders. Any thin soils that are present will be poorly developed and likely classified as Regosolic Static Cryosols.

4.3.4.10 Ridge Crest Community – Sand & Cobble Associations

These two ELC units are typically associated with eskers. Soil and terrain characteristics are the same as those described below for eskers.

4.3.4.11 Eskers

Eskers are steep-sided deposits of coarse-textured glaciofluvial material with a high proportion of coarse fragments. The moisture and nutrient regimes are low creating conditions conducive to the development of Regosolic Static Cryosols. Eskers frequently have large proportions of bare ground with patchy vegetation coverage. Although mapped as a distinct ELC unit in the RSA, eskers are typically a complex of ELC units such as ridge crest community, heath tundra community, and avens community.

4.3.4.12 Sand/Gravel

No specific soil and terrain characteristics are associated with this ELC unit.

4.3.4.13 Disturbed Sites

Disturbed sites may occur on any substrate. No specific soil and terrain characteristics are associated with this ELC unit.

4.4 REFERENCES

Agriculture and Agri-Food Canada (AAFC), 1996. Soil landscapes of Canada. Version 2.2. Canadian Soil Information System (CanSIS). http://sis.agr.gc.ca/cansis/nsdb/ slc/webmap.html

Bliss, L.C., 1979. Vegetation and revegetation within permafrost terrain. *In* Volume 2, Proceedings of the Third International Conference on Permafrost. National Research Council of Canada. Edmonton, AB.

Bockheim, J.G. and C. Tarnocai, 1998. Recognition of cryoturbation for classifying permafrost-affected soils. Geoderma 81:281-293.

Ecological Stratification Working Group (ESWG), 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada and Environment Canada. Ottawa, ON. http://sis.agr.gc.ca/cansis/publications/ecostrat/intro.html

Gregorich, E.G., L.W. Turchenek, M.R. Carter and D.A. Angers, 2001. Soil and environmental science dictionary. CRC Press, New York, NY.

Howes, D.E. and E. Kenk, 1997. Terrain classification system for British Columbia, Version 2. Fisheries Branch, B.C. Ministry of Environment, and Surveys and Resource Mapping Branch, B.C. Ministry of Crown Lands, Victoria, BC.

Jenny, H., 1941. Factors of soil formation. McGraw-Hill, New York, NY.

Natural Resources Canada. National topographic sheets 66H, 56E, 66A, 56D. UTM Zone 14, NAD 83. Natural Resources Canada. 1:250,000 scale.

Permafrost Subcommittee, 1988. Glossary of permafrost and related ground-ice terms. Associate Committee on Geotechnical Research, National Research Council of Canada, Ottawa, ON. 156 pp.

Shilts, W.W. ,1978. Physical and chemical properties of unconsolidated sediments in permanently frozen terrain, District of Keewatin. Geological Survey of Canada, Paper 74-1A:229-235. *As Cited in*: Zoltai, S.C. and C. Tarnocai. 1981. Some nonsorted patterned ground types in northern Canada. Arctic and Alpine Research 13(2):139-151.

Soil Classification Working Group (SCWG), 1998. The Canadian system of soil classification. Research Branch, Agriculture and Agri-Food Canada, Ottawa, ON.

Tarnocai, C., C.A.S., Smith and C.A. Fox, 1993. International tour of permafrost affected soils: The Yukon and Northwest Territories of Canada. Centre for Land and Biological Resources Research, Research Branch, Agriculture Canada, Ottawa, ON.

Trenhaile, A.S., 1990. The geomorphology of Canada: An introduction. Oxford University Press, Toronto, ON. 240 pp.

Williams, P.J. and M.W. Smith, 1989. The frozen earth: fundamentals of geocryology. Cambridge University Press, Cambridge, UK. 306 pp.

Zoltai, S.C., C. Tarnocai and W.W. Pettapiece, 1978. Age of cryoturbated organic materials in earth hummocks from the Canadian Arctic. *In*: Proceedings of the Third International Conference on Permafrost. July 10-13, Edmonton, AB.

SECTION 5 • WILDLIFE

5.1 INTRODUCTION

5.1.1 Background

Due to the extreme northern climate and low structural heterogeneity, relatively few terrestrial vertebrates are found in the Meadowbank area: approximately 15 mammalian species, 60 avian species, and no amphibians or reptiles (Appendices A.6 and A.7). Some species, such as barren-ground caribou, are of very high value to people in Baker Lake and other communities, both traditionally and currently. In many cases, however, little information is available on local population parameters, distribution, abundance, and migration corridors.

5.1.2 Objectives

The focus of this assessment was 29 key wildlife species that were selected based on their abundance and conservation concern in the Meadowbank area. Other factors such as importance in the subsistence economy, importance of role in predator-prey systems, sensitivity of their habitat requirements, and certain local area concerns (e.g., range expansion) were also considered.

The primary objectives of the assessment were to document relevant existing knowledge on key wildlife species and to supplement this knowledge with dedicated wildlife surveys in the Meadowbank area. Comprehensive information on species status, biology, distribution and abundance will assist in determining potential project effects on wildlife resources.

5.2 METHODS

5.2.1 Literature Review

A comprehensive literature review of the wildlife resources of the Meadowbank area was conducted (see Section 5.4 references). Additional knowledge of wildlife values in the Meadowbank area came from discussions with Government of Nunavut wildlife biologists, and from the local community through a meeting with the Baker Lake HTO in September 2002.

5.2.2 Field Surveys

5.2.2.1 Overview

Baseline wildlife surveys were initiated in 1999 in support of Cumberland's proposal to develop the Meadowbank Gold property north of Baker Lake, Nunavut. The intent of these surveys was to document the seasonal numbers and distribution patterns of wildlife in the Meadowbank area.

Baseline wildlife surveys (Table 5.1) related to the proposed development were conducted in spring (May) 1999, summer (July) and fall (September) of 2002, and winter (March) and summer (June) of 2003. In addition, Baker Lake residents visited 11 ground observation stations over 8 days between May and September 2003. Incidental wildlife observations were recorded by camp personnel from

1996 to 1999 and from 2002 to 2003, and by personnel involved in the baseline vegetation surveys in 1999, 2002, and 2003.

During aerial surveys, more cryptic species (e.g., caribou) were considered observable up to a distance of 300 m on either side of a transect, while more conspicuous species (e.g., muskox) were considered observable up to a distance of 800 m on either side of a transect.

Table 5.1: Baseline Survey Sessions in Meadowbank Study Areas, 1999, 2002-2003

Survey Session	RSA Aerial Survey Date	Winter Road Corridor Survey Date	LSA Aerial Survey Date	LSA Ground Survey Date
1999 – Spring	May 29-June 3	Not done	Not done	May 25-31
2002 – Summer	July 27-30	Not done	Not done	July 23-27
2002 – Fall	September 13-16	Not done	September 21	September 17-21
2003 – Winter	March 28-31	March 29, 31	April 2	March 29-April 2
2003 – Summer	Not done	Not done	June 19	June 17-26
2003 – Fall	Not done	Not done	September 11	Not done
Target Species Groups	Ungulates, large carnivores, waterfowl, ptarmigan, raptors.	Ungulates, large carnivores, waterfowl, ptarmigan, raptors.	Ungulates, large carnivores, waterfowl, ptarmigan, raptors.	Ungulates, large carnivores, furbearers, ptarmigan, raptors, small mammals (arctic hare, arctic ground squirrel), migratory birds.

5.2.2.2 Local Study Area

Aerial Surveys

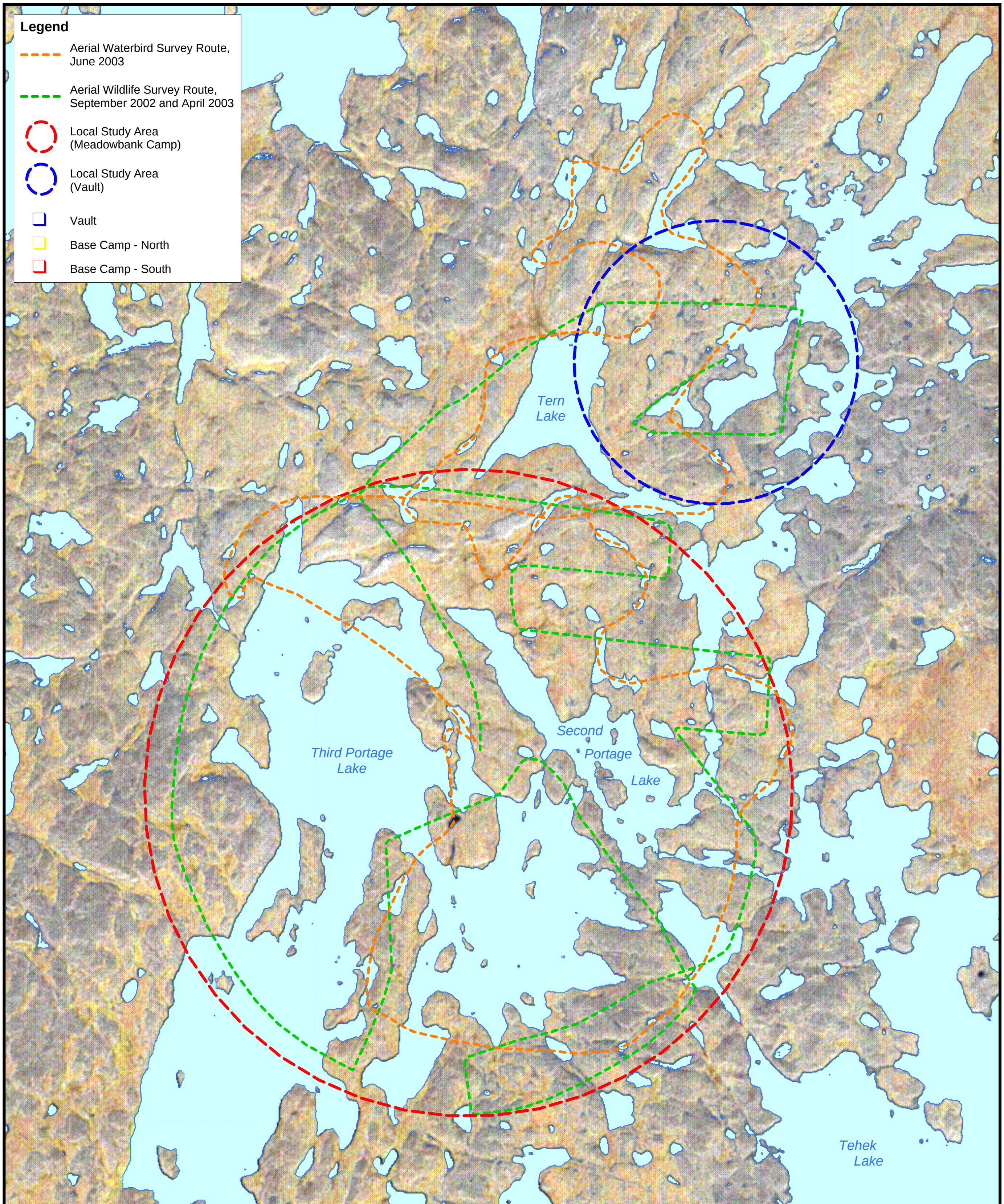
Aerial wildlife surveys were conducted by helicopter on 21 September 2002, 2 April 2003, and 11 September 2003 along predetermined transects designed to maximize coverage of the LSA (Figure 5.1). The GPS locations of all wildlife sightings or observations of clearly identifiable wildlife signs (e.g., dens, nests, craters) were recorded. At minimum, the number of individuals was determined and, if possible, information on sex and age class was recorded.

On 19 June 2003, an aerial survey was conducted of lakes and wetlands within the LSA to identify the occurrence and distribution of waterbirds (Figure 5.1). The flight path was selected to maximize the number of wetlands habitats (e.g., ponds, lake margins) visited.

Transect Ground Surveys

Transect ground surveys were conducted in spring 1999, summer and fall 2002, and winter 2003. The spring 1999 ground surveys did not include the 2 km radius area surrounding the Vault deposit. Transects connecting high elevation vantage points (i.e., observation stations) were surveyed. Observation stations and transects were located to maximize coverage of the LSA (Figure 5.2).

Data were collected more systematically in 2002 and 2003 than during the preliminary work in 1999. Wildlife and wildlife sign were recorded within a 5 m -radius circular plot centered on each observation station. A transect was then walked (or driven by snowmobile) to the next observation

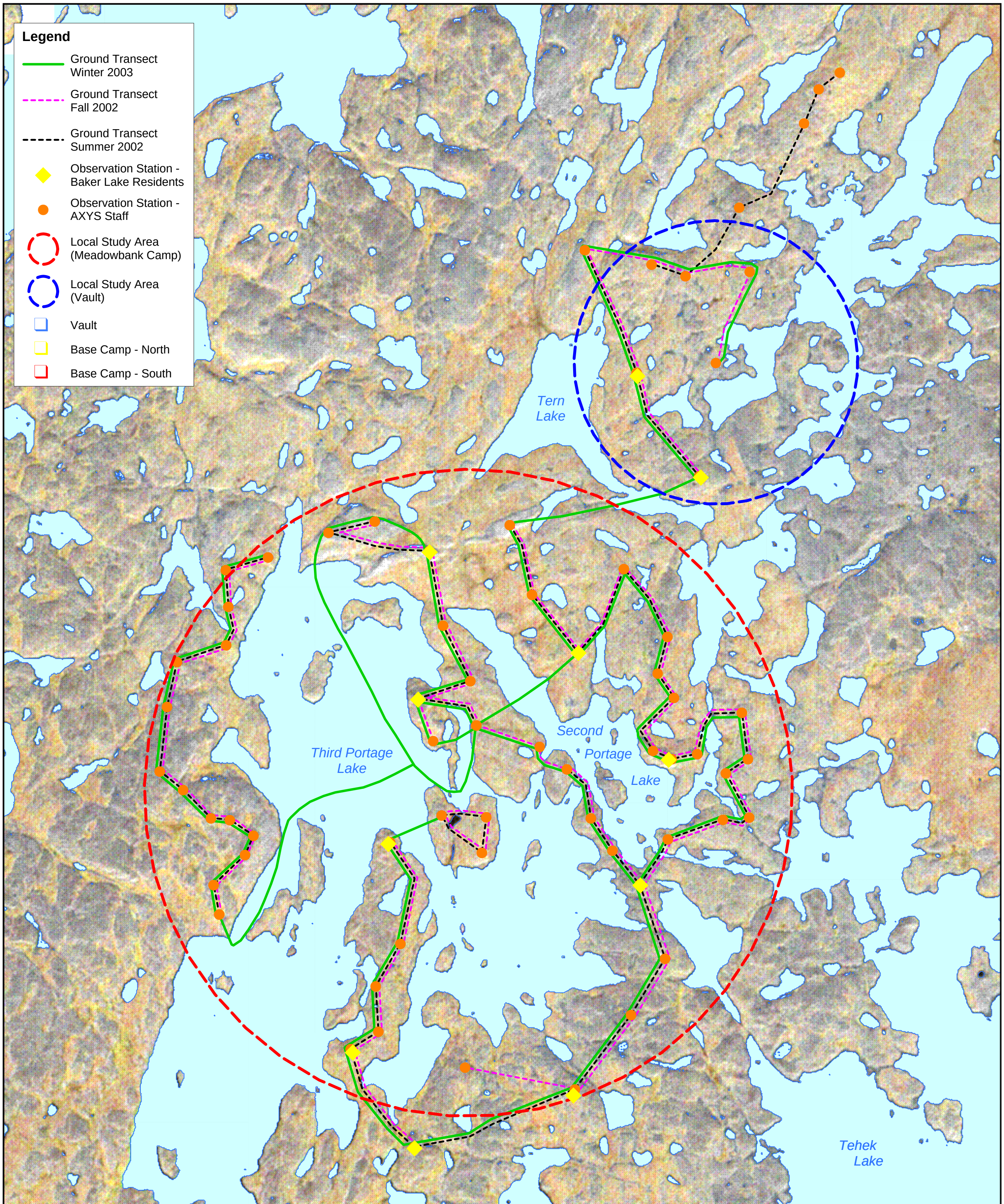


Aerial survey transects in the LSA,Fall 2002 and Winter 2003

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 26 September, 2003		SCALE 1:85,000	
DRAWN PM	CHECKED CB	FIGURE NO. 5.1	REV 3
REVIEWED CB	PROJECT KA9007		VOL -



Ground survey transects and observation stations in the LSA, 1999, 2002-2003

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 26 September, 2003		SCALE 1:85,000	
DRAWN PM	CHECKED CB	FIGURE NO. 5.2	REV 4
REVIEWED CB	PROJECT KA9007		VOL -

station and all wildlife or wildlife sign within a 2 m wide belt centered on this transect was recorded. Observations outside the belt transect were recorded as incidentals. GPS locations of all wildlife sightings and sign observations were recorded, and number, sex, age class, and behaviour were noted whenever possible.

Pellet groups were recorded within the circular plots and belt transects. A pellet group was defined as a concentration of at least five pellets within a pellet length of each other. Pellets groups were counted for caribou, muskox, and ptarmigan, while individual pellets were counted for arctic hare, arctic ground squirrel, and geese. Predator scats and raptor pellets were also counted individually. Only fresh (<1 year old) pellets were counted.

Habitat types were assigned to wildlife observations made during the fall 2002 aerial surveys in the LSA. Eight habitat types were recognized: sedge, transition, birch seep, snowbank, heath tundra, lichen-rock, esker and water (Note that these habitat types were designated before the ELC was developed for the study areas so, while similar, are not identical to the ELC units described in Section 2).

Observation Station Ground Surveys

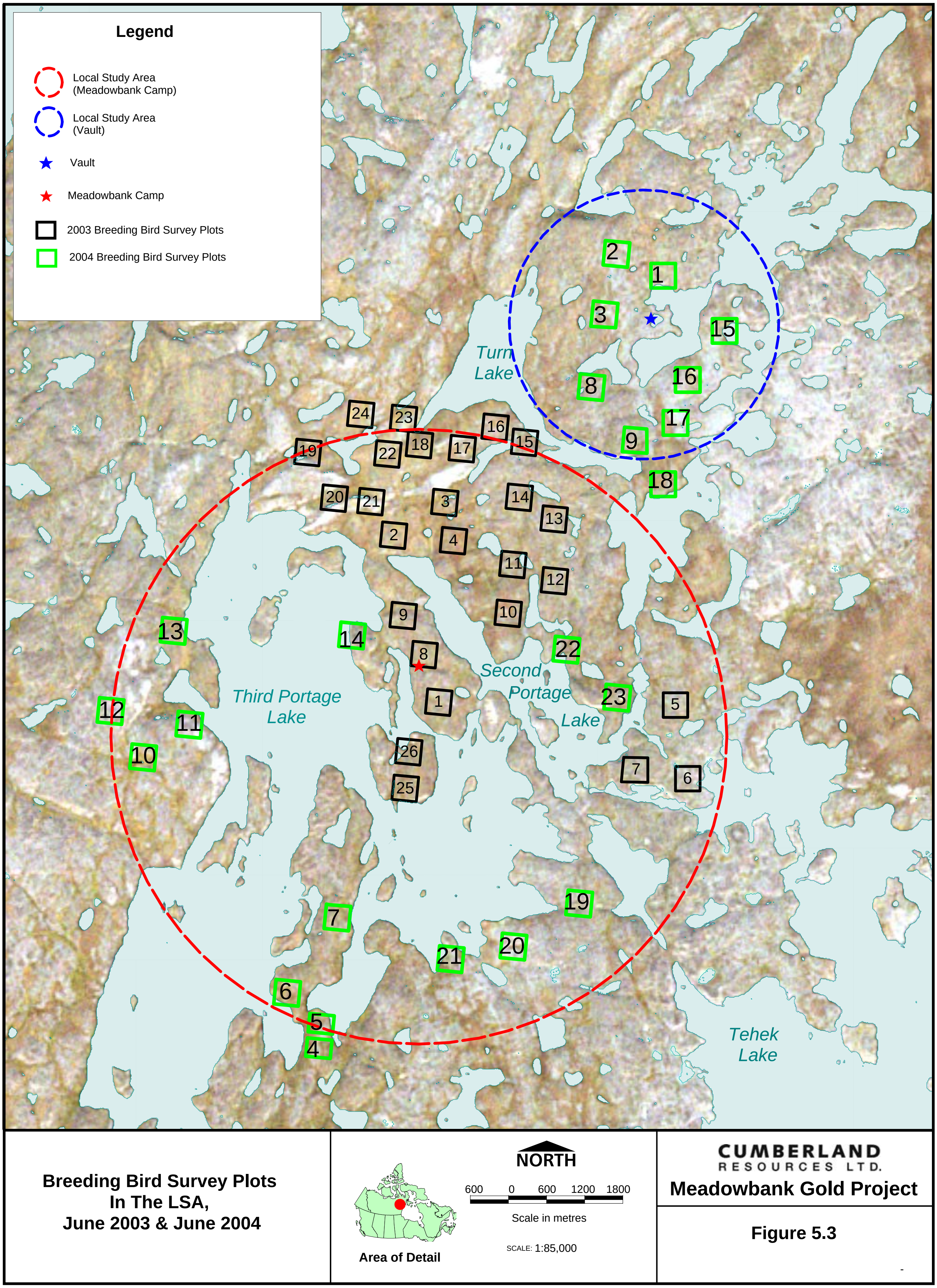
Eleven stations were established at high points within the LSA (Figure 5.2). These stations were surveyed over four survey periods in 2003 (i.e., May 15/16 and August 7/8, 2002; August 21/22, and September 11/12) by two field personnel based in Baker Lake. All wildlife observations, including animals seen, pellets/scats, feathers, burrows, dens, antlers, bones, and carcasses, were recorded on datasheets. A minimum of 10 minutes was spent at each station and the surrounding area was scanned with binoculars. Wildlife sign was searched for within a 10 m radius of each observation point.

Breeding Bird Surveys

Breeding bird surveys were conducted according to the PRISM (Program for Regional and International Shorebird Monitoring) survey protocols established by the Canadian Wildlife Service (Bart et al, 2003). The protocols were originally established for monitoring of shorebird populations; however, the methodology is also an excellent way to monitor most species of land-nesting birds.

The general methodology involved a “rapid survey” of 400 x 400 m plots (see Bart et al, 2003 for details on survey methodology). Two observers, spaced at 25 m intervals, walked back and forth across each plot and recorded all birds and nests observed. Orientation on the plot was accomplished with handheld GPS units. Sightings were recorded on plot maps (Appendix A.8) using pre-determined codes for nests, probable nests, pairs, males, females, birds of unknown sex, and groups. Direction of flight, interactions, and other behaviours were also recorded. Following the survey, a summary was prepared and an estimate of the number of territorial male birds present was made (Appendix A.8 for form).

Twenty-six plots were surveyed within the LSA from 17 to 26 June 2003 (Figure 5.3). Survey time varied from one and a half to three hours depending on weather conditions and the number of birds observed.



Breeding Bird Survey Plots In The LSA, June 2003 & June 2004

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

Figure 5.3

Checklist Bird Surveys

A checklist bird survey protocol has been developed by Canadian Wildlife Service. The survey simply involves a day's end estimation of the total number of individuals and species recorded within a 10 x 10 km area. A checklist survey form was completed for every day that breeding bird surveys were conducted within the Meadowbank LSA. All forms were submitted to Canadian Wildlife Service personnel in Yellowknife, who are compiling bird records for the Arctic.

Wildlife Log Book

Meadowbank camp staff reported incidental observations on a wildlife log data sheet. Observations were made between 1996-1999, and 2002-2003 (Appendix A.9).

5.2.2.3 Regional Study Area

The RSA was surveyed only from the air. Aerial surveys were conducted by helicopter or fixed-wing aircraft along eleven 100 km long transects oriented east to west, spaced 10 km apart, and centered on the Meadowbank field camp (Figure 5.4).

The aerial surveys were conducted in spring 1999 (29 May to 3 June), summer 2002 (27 to 30 July), fall 2002 (13 to 16 September), and winter 2003 (28 to 31 March). The GPS locations of all wildlife sightings or observations of clearly identifiable wildlife sign (e.g., dens, nests, caribou craters) were recorded. At minimum, the number of individuals was determined and, if possible, information on sex and age class was recorded. Aerial surveys were also conducted along specific habitat features (i.e., eskers, shorelines, rivers, south-facing cliffs) that had high potential for wildlife (referred to as off-transect observations).

During aerial surveys, more cryptic species (e.g., caribou) were considered observable up to a distance of 300 m on either side of a transect, while more conspicuous species (e.g., muskox) were considered observable up to a distance of 800 m on either side of a transect.

Habitat types were assigned to wildlife observations made during the fall 2002 aerial surveys in the RSA. The same eight habitat types recognized for the LSA were also used in the RSA.

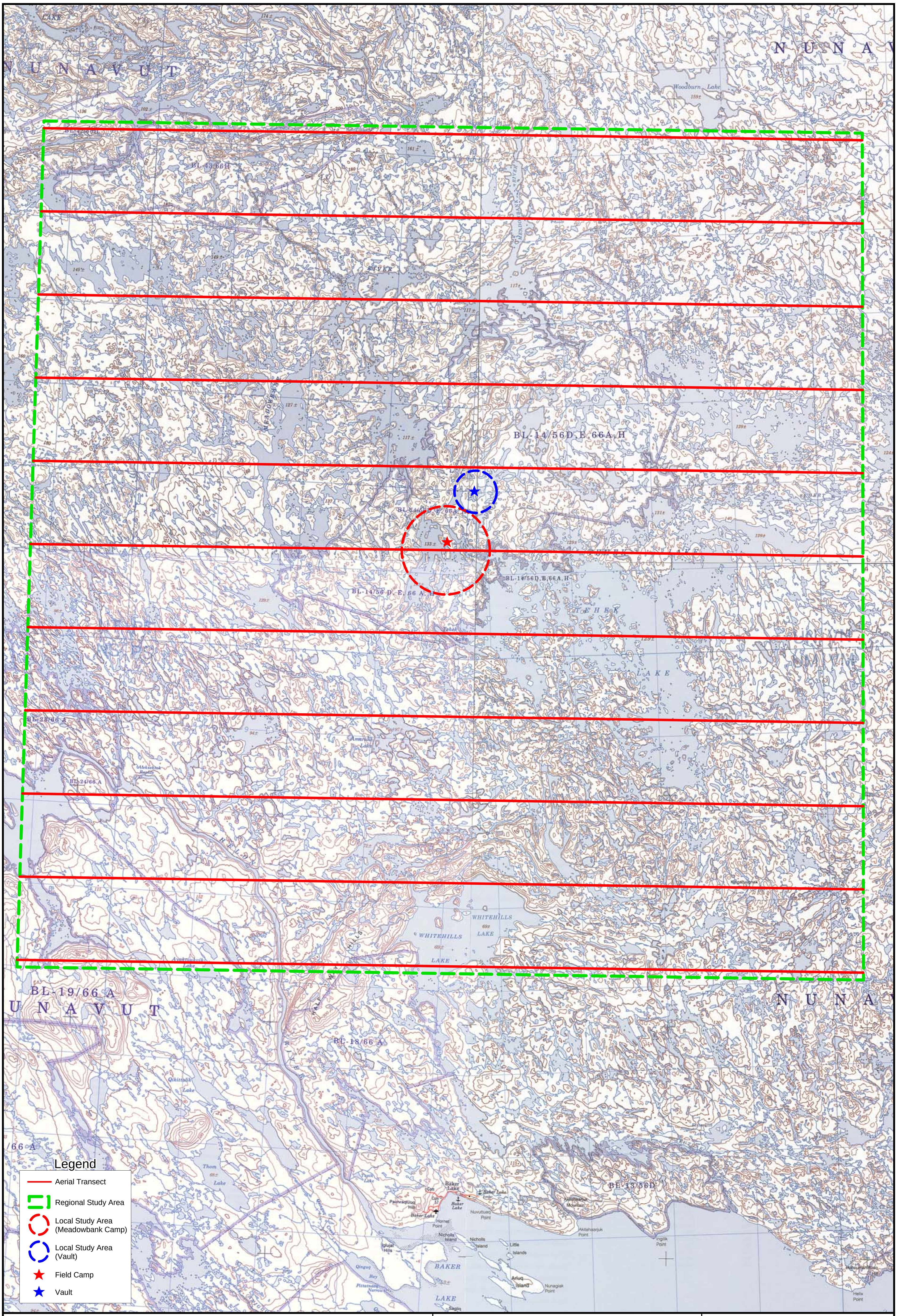
5.2.2.4 Winter Road Corridor

The winter road corridor was surveyed only from the air. It was flown in two sections on different days, 29 and 31 March 2003. In addition, the corridor was crossed by five transects that were part of the RSA aerial surveys (see above, Section 5.2.2.3). GPS locations of all wildlife sightings and sign observations were recorded, and number, sex, age class, and behaviour were noted when possible.

5.2.3 Habitat Suitability

A general assessment of habitat suitability for the key wildlife resources in the Meadowbank area was made based on the known habitat requirements of the species of concern, and on the biophysical conditions associated with ELC units within the LSA (Figure 3.2), and the RSA and winter road corridor (Figure 3.3).

Source: KAVIK-AXYS Inc.



CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

Figure 5.4

Aerial Survey Transects In The RSA, 1999, 2002 & 2003

5.3 RESULTS & EXISTING CONDITIONS

5.3.1 Overview

Of the 74 terrestrial wildlife species expected to occur in the Meadowbank area (15 mammals, 59 birds), 47 (11 mammals, 36 birds) were recorded during baseline surveys related to the proposed development (Appendices A.6 and A.7).

Barren-ground caribou, snow geese, and Canada geese (see Appendix A.6 for scientific names) were observed in far greater numbers than any other species encountered during the baseline surveys. Caribou were most abundant in the fall, as were snow geese. Canada geese were most abundant in the summer. Other mammal species recorded in the Meadowbank area, in approximate order of abundance were:

- muskoxen
- arctic hare
- arctic ground squirrel
- arctic fox
- wolf
- grizzly bear.

Lemmings and voles were only seen occasionally, but are likely common in the area.

Other bird species observed in significant numbers in the study areas were horned lark, Lapland longspur, snow bunting, sandhill crane and ptarmigan. Several species of raptors were recorded occasionally during baseline surveys.

Table 5.2 links the biophysical characteristics (e.g., vegetation, soils, and terrain) of the ELC units identified and mapped for the LSA and RSA/winter road corridor with potential wildlife habitat use.

Eleven species were selected as key terrestrial mammal wildlife resources: barren-ground caribou, muskox, grizzly bear, wolf, wolverine, arctic fox, ermine, arctic hare, arctic ground squirrel, collared lemming, and northern red-backed vole.

Eighteen species were selected as the key avian wildlife resources: greater white-fronted goose, snow goose, Ross' goose, Canada goose, long-tailed duck, rough-legged hawk, gyrfalcon, snowy owl, peregrine falcon, rock ptarmigan, willow ptarmigan, American golden plover, semipalmated sandpiper, horned lark, American pipit, white-crowned sparrow, snow bunting, and Lapland longspur.

These species are discussed individually in more detail below in Sections 5.3.6 (mammalian) and 5.3.7 (avian).

Table 5.2: Summary of the Vegetation, Soils & Terrain & Potential Wildlife Use of the ELC Units Identified in the Meadowbank Study Areas

ELC Unit	Proportion of RSA (%)	Proportion of LSA (%)	Proportion of Winter Road Corridor (%)	Vegetation Characteristics	Soils and Terrain Characteristics	Potential Wildlife Use
Deep Water	18	40[1]	29	N/A	N/A	Waterfowl staging and foraging
Shallow Water	6	40[1]	5	N/A	N/A	Waterfowl staging and foraging
Sedge Community	3	6	2	Dominated by sedges and cottongrass, small willows often present; four associations identified but not mapped.	Shallow organic over lacustrine, fluvial or morainal; depressions, drainage basins, shorelines; poorly drained soils with peaty surface layer; high moisture and nutrient regimes.	Caribou spring and early summer foraging; muskox foraging; waterfowl and shorebird nesting and foraging (shorelines); grizzly bear early summer foraging; brown lemming summer use; passerine foraging.
Moss Community	Not mapped at this scale	<1	Not mapped at this scale	Mixture of mosses (primarily *Sphagnum*) and a variety of vascular plants; two associations identified but not mapped.	Lacustrine, morainal; nearly level shoreline or toe slope areas; high moisture regime; medium to high nutrient regime; saturated soils; cryoturbation may be present.	Shorebird staging, foraging and nesting (shorelines); muskox foraging where grasses and sedges present; brown lemming summer use.
Birch Seep Community	5	7	9	Dominated by dwarf birch, willow may occur; ground cover variable depending on amount of seepage – ranges from heaths to sedges, lichen sparse.	Morainal; toe of gentle slope with groundwater outflow; medium to high moisture regime; medium nutrient regime; cryoturbation may be present.	Passerine nesting; muskox foraging where grasses and sedges present and accessible; grizzly bear denning.
Riparian Shrub Community	1	Mapped more specifically at this scale (see riparian shrub community – birch association)	1	Dominated by dwarf birch or willow; ground cover generally sparse.	Fluvial, boulder fields; gently sloping drainage areas with high boulder content or transitory ponds; high moisture regime; medium nutrient regime; thin or absent soils.	Passerine nesting; muskox foraging where grasses and sedges present; caribou summer foraging (willow); grizzly bear denning and foraging (sedge, willow buds, horsetail); potential wolverine use.

Table 5.2 – Continued

ELC Unit	Proportion of RSA (%)	Proportion of LSA (%)	Proportion of Winter Road Corridor (%)	Vegetation Characteristics	Soils and Terrain Characteristics	Potential Wildlife Use
Riparian Shrub Community – Birch Association	Not mapped at this scale	2	Not mapped at this scale	Dominated by dwarf birch with some willow; ground cover sparse but tundra mats may be present; a willow-dominated association is postulated but has not been confirmed in the LSA.	Fluvial, boulder fields; gently sloping drainage areas with high boulder content or transitory ponds; high moisture regime; medium nutrient regime; thin or absent soils.	Passerine nesting; muskox foraging where grasses and sedges present; caribou summer foraging (willow); grizzly bear denning and foraging (sedge, willow buds, horsetail); potential wolverine use.
Heath Tundra Community	26	34	33	Dominated by bog blueberry, lingonberry, white arctic heather, Labrador tea, bearberry and crowberry; four associations identified but not mapped.	Morainal; gently sloping uplands; low to medium moisture and nutrient regimes; cryoturbation occurs.	Caribou foraging year-round; grizzly bear spring and late summer foraging (berries) and denning; passerine and ptarmigan nesting and foraging; small mammals common year-round occupancy (northern red-backed voles in wetter areas, collared lemmings in drier areas); arctic hare year-round use; ptarmigan use; raptor foraging.
Snowbank Community	Not mapped at this scale	1	Not mapped at this scale	Indicator species are least willow, Labrador tea and white arctic heather; steeper areas may have mountain heather, few-flowered anemone, mustards, mountain sorrel, pygmy buttercup, and fleabane.	Bedrock, colluvial, glaciofluvial; leeward side of hills, outcrops, eskers; gentle to moderate E-, SE-, or S-facing slopes; thin soils; high moisture regime in spring; low nutrient regime.	Passerine foraging; small mammals year-round occupancy (prolonged subnivean activity possible).
Avens Community	Not mapped at this scale	<1	Not mapped at this scale	Similar to heath tundra community but drier and dominated by mountain avens, grasses, and xeric sedges.	Bedrock, shallow lithic morainal; dry ridge tops; low moisture and nutrient regimes; rocky with thin soils; cryoturbation occurs.	Passerine nesting (e.g., horned lark); small mammals year-round occupancy (particularly collared lemming).

Table 5.2 – Continued

ELC Unit	Proportion of RSA (%)	Proportion of LSA (%)	Proportion of Winter Road Corridor (%)	Vegetation Characteristics	Soils and Terrain Characteristics	Potential Wildlife Use
Heath Tundra/Lichen-Rock Community	1	Not identified for this area	2	Transitional between heath tundra and lichen-rock communities.	Transitional between heath tundra and lichen-rock communities.	Caribou foraging year-round (most use in winter); arctic hare winter sheltering; small mammals year-round occupancy (brown lemming and northern red-backed voles in wetter areas, collared lemmings in drier areas); ptarmigan use; raptor foraging; grizzly bear denning.
Lichen-Rock Community - Boulder Association	26	6	10	Dominated by foliose and fruticose lichens on a boulder or felsenmeer substrate.	Bedrock or boulder fields; gently sloping; low moisture and nutrient regimes; thin or absent soils; felsenmeer frequently occurs.	Caribou foraging year-round (most use in winter); arctic hare winter sheltering; raptor hunting posts; small mammals year-round occupancy (northern red-backed voles in wetter areas, collared lemmings in drier areas); potential wolverine use; ptarmigan use.
Lichen-Rock Community - Bedrock Association	14	4	7	Dominated by crustose lichens on exposed bedrock outcrops.	Bedrock or boulder fields; gently sloping; low moisture and nutrient regimes; thin or absent soils; felsenmeer frequently occurs.	Caribou foraging year-round (most use in winter); small mammals year-round occupancy (red-backed voles in wetter areas, collared lemmings in drier areas); ptarmigan use.
Eskers	<1	Not mapped specifically but see ridge crest communities	0	Support a variety of ELC units.	Glaciofluvial; steep-sided; high proportion of bare ground; coarse textured deposits; low nutrient and moisture regimes; esker crests; dry and unstable.	Denning habitat for arctic fox, grizzly bear, arctic ground squirrel, wolf; small mammals year-round occupancy (northern red-backed voles in wetter areas, collared lemmings in drier areas); grizzly bear foraging (arctic ground squirrels); potential wolverine use; ptarmigan use; potential raptor nesting; caribou insect relief.

Table 5.2 – Continued

ELC Unit	Proportion of RSA (%)	Proportion of LSA (%)	Proportion of Winter Road Corridor (%)	Vegetation Characteristics	Soils and Terrain Characteristics	Potential Wildlife Use
Ridge Crest Community – Sand Association	Not mapped at this scale	<1	Not mapped at this scale	Dense vegetation mats that may include bog blueberry and other heaths, crowberry, pussytoes and saxifrage, lichen sparse; vegetation cover typically non-contiguous.	Glaciofluvial; steep-sided; high proportion of bare ground; coarse textured deposits; low nutrient and moisture regimes; esker crests; dry and unstable.	Denning habitat for arctic fox, grizzly bear, arctic ground squirrel, wolf; small mammals year-round occupancy (particularly collared lemming); grizzly bear foraging (arctic ground squirrels); potential wolverine use; ptarmigan winter use; caribou insect relief.
Ridge Crest Community – Cobble Association	Not mapped at this scale	<1	Not mapped at this scale	Similar to lichen-rock community – boulder association; vegetation cover typically non-contiguous.	Glaciofluvial; steep-sided; high proportion of bare ground; coarse textured deposits; low nutrient and moisture regimes; esker crests; dry and unstable.	Denning habitat for arctic fox, grizzly bear, arctic ground squirrel, wolf; small mammals year-round occupancy (particularly collared lemming); grizzly bear foraging (arctic ground squirrels); potential wolverine use; ptarmigan winter use; caribou insect relief.
Sand/Gravel	<1	Not identified for this area	1	N/A	N/A	Shorebird staging, foraging, and nesting.
Disturbed Sites	<1	<1	1	Variable and site-specific; may be non-vegetated.	Variable and site specific.	Limited wildlife use.
Unclassified	<1	N/A	<1	N/A	N/A	N/A

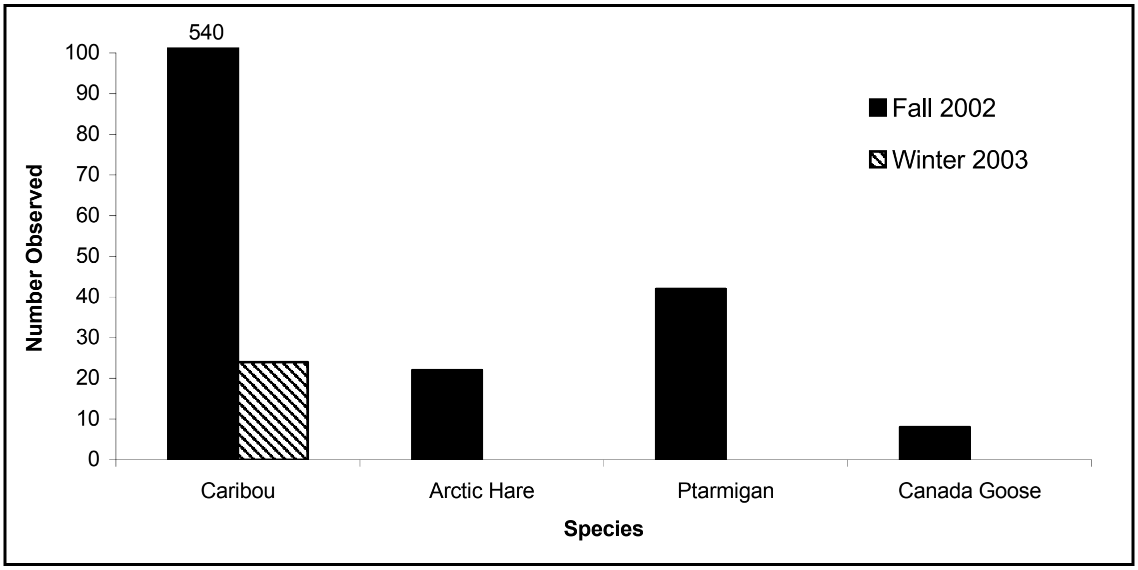
Notes: 1 Not distinguished by depth.

5.3.2 Local Study Area

5.3.2.1 Aerial Surveys

Barren-ground caribou were the most abundant mammalian species observed on aerial surveys within the LSA in both fall (mid-September) 2002 and winter (late March) 2003 (Figure 5.5; Appendix A.10). Arctic hare and ptarmigan were also observed in relatively high numbers.

Figure 5.5: Seasonal Frequency Distribution of Mammals & Birds Observed on 2002-2003 Aerial Surveys in the LSA



5.3.2.2 Transect Ground Surveys

Mammals

Ground surveys were conducted within the LSA in summer and fall 2002 and in winter 2003. The most common species observed in fall and winter was caribou, with a maximum of 924 individuals on 21 September 2003 (Figure 5.6). Fewer individuals (i.e., ~90) were observed in late winter (2 April). Arctic hare, arctic fox, and arctic ground squirrel were also commonly recorded in fall, and a herd of approximately 35 muskox was present in the winter.

High densities of arctic hare and caribou pellets/pellet groups were recorded during the ground surveys (Figure 5.7). Densities for caribou were similar on both the fall and winter, whereas densities for arctic hare were considerably higher in the winter. Higher densities may occur in winter because hare are often found on windswept and snow-free ridges during that time.

Figure 5.6: Seasonal Frequency Distribution of Mammals Observed on 2002-2003 Ground Surveys in the LSA.

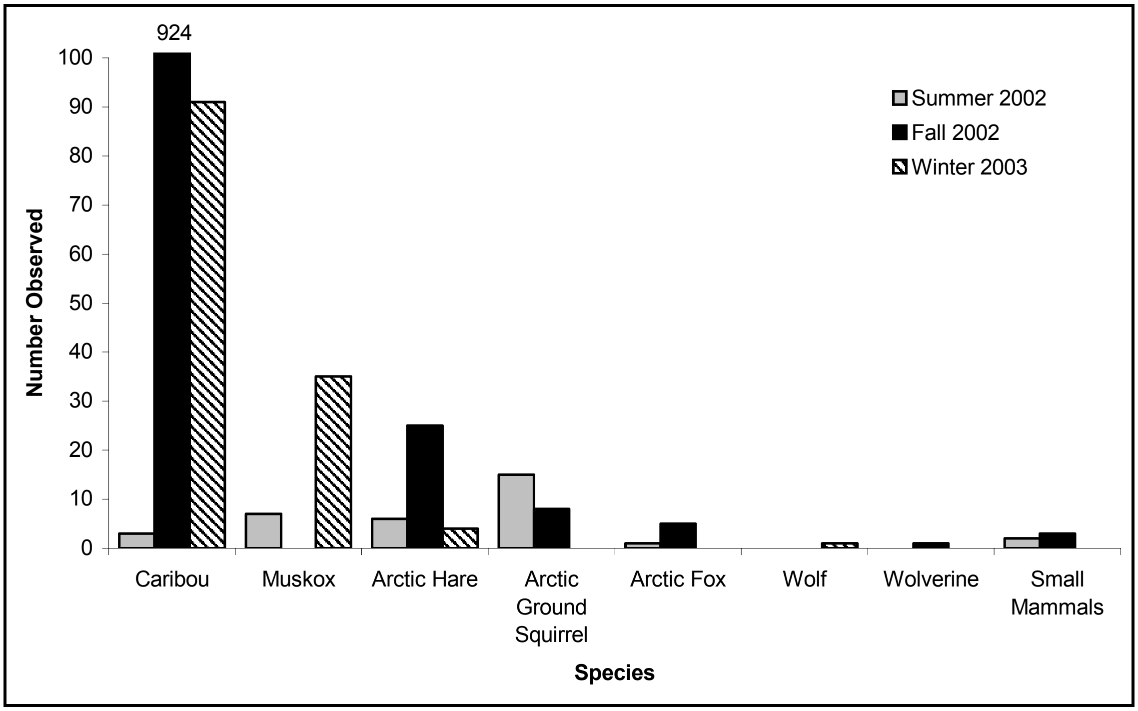
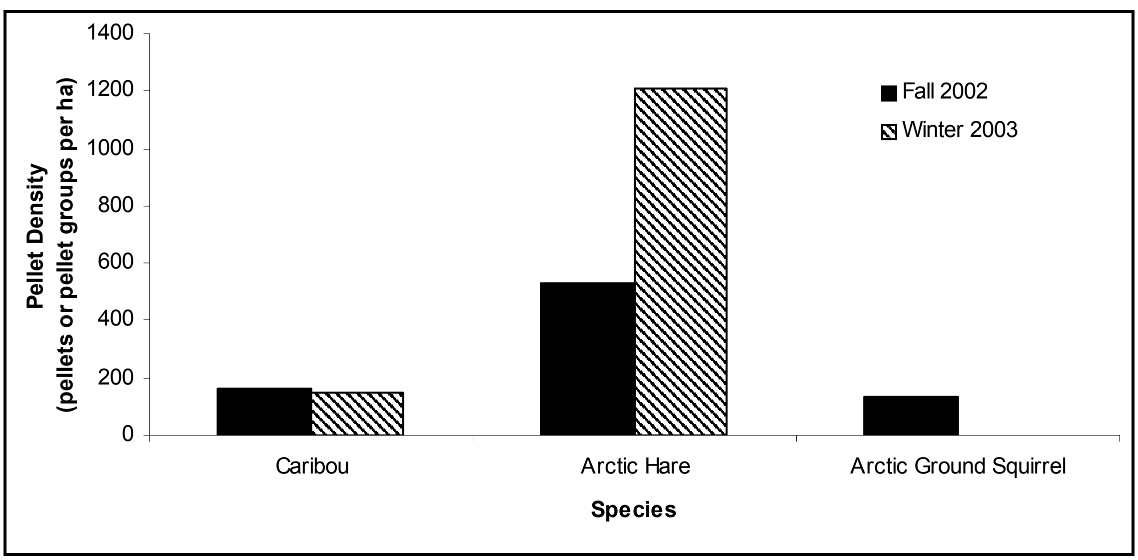


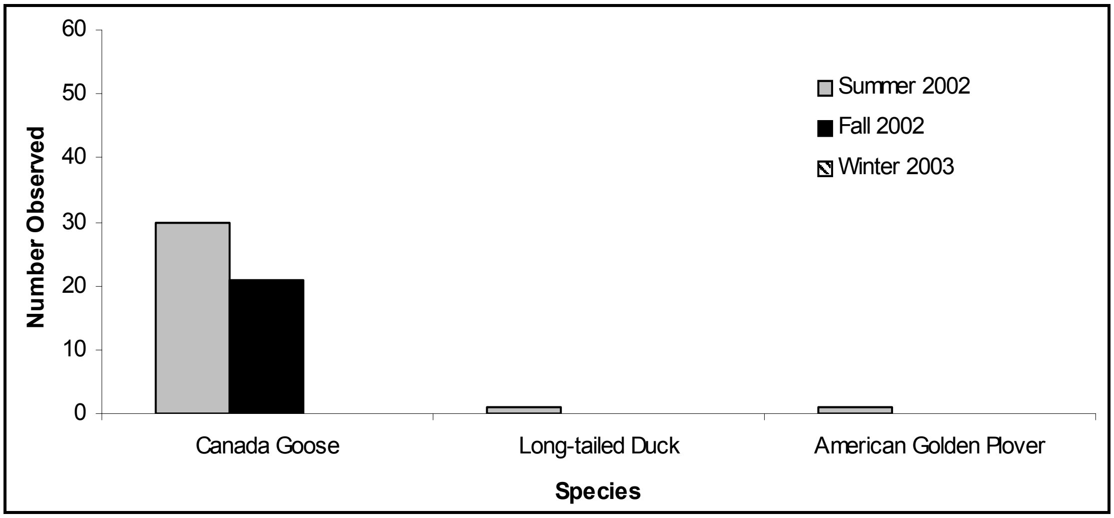
Figure 5.7: Seasonal Pellet Density for Mammals Recorded on 5 m Radius Plots within the LSA in 2002-2003.



Waterfowl & Shorebirds

Canada geese were the most common bird species recorded within the LSA on ground surveys. The relatively high numbers of individuals recorded in summer may represent post-breeding congregations. Birds observed in fall are migrants foraging on berries and other foods in upland areas. Two other species, long-tailed duck and American golden plover, were observed at very low densities (Figure 5.8).

Figure 5.8: Seasonal Frequency Distribution of Waterfowl & Shorebirds Observed on 2002-2003 Ground Surveys in the LSA.



Passerines

Horned lark and Lapland longspur were the most common bird species observed during the late summer (end of July) ground transects (Figure 5.9). Horned larks were observed more frequently than Lapland longspurs although breeding bird surveys in mid-June (see Section 5.3.2.4) indicate that Lapland longspur is by far the most common breeding passerine species within the LSA. Relatively few American pipit and snow bunting were observed in summer, which corresponds with the low numbers recorded during breeding bird surveys (Figure 5.9; also see Section 5.3.2.4). Higher numbers of snow buntings in the fall indicate that individuals migrate through the LSA. White-crowned sparrow was also reported, but not on the June breeding bird surveys, suggesting that late July sightings may represent individuals dispersing from breeding areas outside the LSA.

Ptarmigan & Raptors

Ptarmigan and raptors were observed at low densities in all seasons, although raptors were not observed during the winter ground transects (Figure 5.10). Snowy owl, the most common raptor recorded, was most common in September.

Figure 5.9: Seasonal Frequency Distribution of Passerines Observed on 2002-2003 Ground Surveys in the LSA.

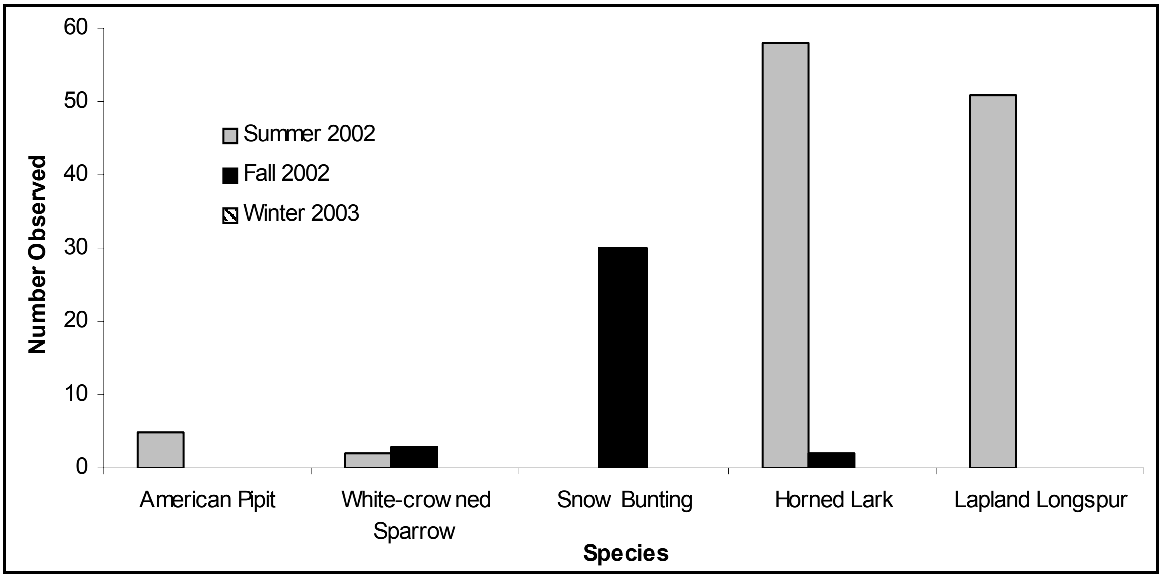
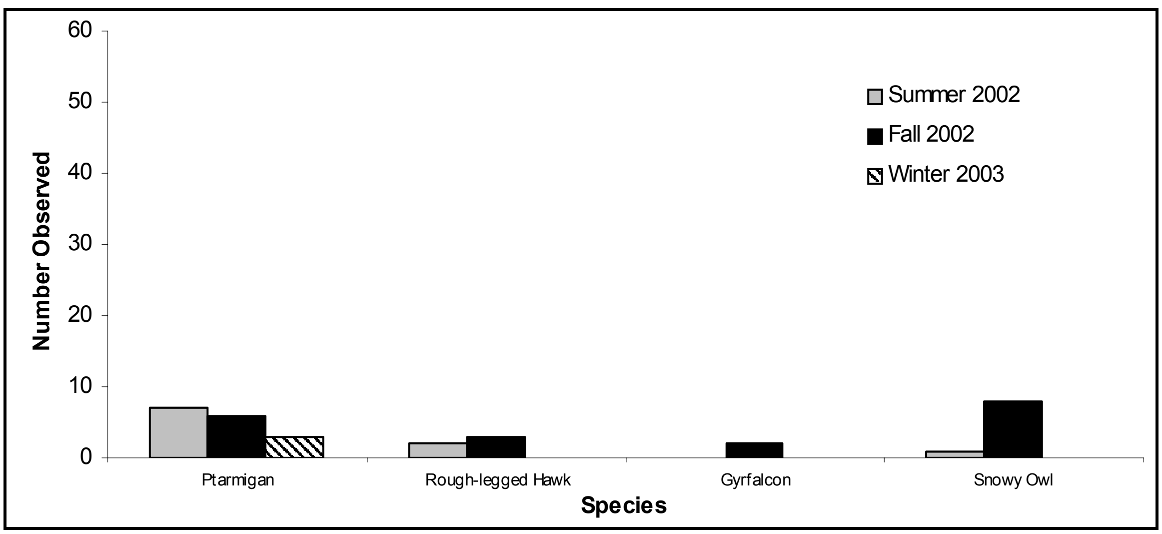


Figure 5.10: Seasonal Frequency Distribution of Ptarmigan & Raptors Observed on 2002-2003 Ground Surveys in the LSA.



5.3.2.3 Observation Station Ground Surveys

Field personnel from Baker Lake recorded wildlife observations from 11 stations established within the Meadowbank LSA. Caribou was the most common species recorded, although a number of other species were also noted. A summary of wildlife and sign is summarized in Table 5.3. Snow and ice conditions in mid-May provided easy access by snowmobile to all 11 points. Fewer points were

Table 5.3: Recorded Observations of Wildlife Species & Sign at 11 Observation Points within the LSA

	Date (2003)			
Species and Sign	**May 15, 16 Pts 1-11**	**Aug 7, 8 Pts 1-4, 7-11**	**Aug 21,22 Pts 1-4, 9-11**	**Sep 10,11 Pts 3-4, 9-10**
Mammals				
Arctic fox	1 individual			
Arctic Hare	6 individuals; many pellets	2 individuals		
Barren-ground caribou	69 individuals; foraging sign; many pellet groups; some tracks; 1 carcass	1 individual; old scats	108 individuals	25 individuals
Muskox	some wool; some tracks			13 individuals; 1 lone bull
Sik Sik (Ground Squirrel)		several around		
Birds				
Canada goose	several flying N			
Gull sp.		several flying		
Hawk sp.	1 individual			
Horned lark		several observed		
Lapland longspur		many observed	several observed	
Peregrine falcon			1 observed	
Red-throated loon			2 individuals	
Rock ptarmigan	3 individuals; 1 crowing; some pellets	1 individual		10 individuals
Rough-legged hawk	1 individual			
Sandhill crane	2 individuals; 2 calling birds	1 calling bird	2 individuals	
Snow bunting	4 individuals			
Snow goose	31 individuals		46 individuals	140 resting/ feeding; 50 flying S
Unidentified small bird	2 individuals			

visited in August and September because access to points by boat and foot took a considerable amount of time.

Caribou were commonly observed in the spring and early fall. Snow geese were commonly observed during the spring and fall migratory period, with some observed foraging and resting within the LSA. Observations of 13 muskox (likely cows and calves) and a lone bull are also of note.

5.3.2.4 Breeding Bird Surveys

Habitat Characteristics of Plots

A total of 26 plots were established according to the PRISM methodology. Habitats within each of the plots were determined from Ecological Land Classification data within the LSA (Figure 3.2). A summary of habitat characteristics based on the ELC analysis is provided in Table 5.4.

Table 5.4: Habitat Characterization of the Area (ha) in Bird Survey Plots into the ELC Classes for Meadowbank LSA

Bird Plot	Outside LSA	Avens Community	Birch Seep	Disturbed Features	Heath Tundra	Lakes or Ponds	Lichen Rock on Outcrops	Lichen Rock with Boulders	Riparian shrub	Sedge Community	Snowbank Community	Total Area
1	0.00	0.00	0.92	0.00	8.69	0.00	0.31	4.41	0.00	1.65	0.00	15.99
2	0.00	0.31	0.89	0.00	11.08	0.00	0.98	0.00	0.02	2.72	0.00	16.00
3	0.00	0.55	2.92	0.00	8.77	1.60	0.28	0.00	0.00	1.80	0.07	16.00
4	0.00	0.00	4.78	0.00	11.22	0.00	0.00	0.00	0.00	0.00	0.00	16.00
5	0.00	0.00	1.54	0.00	10.90	0.00	0.00	0.53	0.48	2.27	0.26	15.98
6	0.00	0.05	1.84	0.00	9.46	0.41	0.31	2.82	0.84	0.24	0.03	15.99
7	0.00	0.15	0.27	0.00	12.78	0.00	0.75	1.50	0.00	1.06	0.00	16.51
8	0.00	0.00	1.15	0.00	7.77	0.00	0.51	2.74	0.00	3.83	0.00	16.00
9	0.00	0.00	1.24	0.00	10.20	0.00	0.79	0.00	0.99	2.78	0.00	16.01
10	0.00	0.02	2.76	0.00	10.44	0.00	0.00	2.04	0.72	0.02	0.00	16.00
11	0.00	0.99	3.82	0.00	8.16	1.72	0.19	0.00	0.00	0.73	0.37	15.98
12	0.00	0.03	1.26	0.00	12.40	0.00	0.00	0.14	0.00	2.15	0.00	15.97
13	0.00	0.00	2.66	0.00	12.87	0.00	0.11	0.00	0.00	0.25	0.11	16.00
14	0.00	0.00	2.57	0.00	12.32	0.47	0.00	0.00	0.00	0.64	0.00	16.00
15	12.40	0.53	0.00	0.00	1.16	0.01	0.76	0.59	0.00	0.05	0.49	16.00
16	15.29	0.00	0.26	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.00	16.00
17	0.00	0.42	4.24	0.00	7.92	0.00	0.44	0.00	0.00	2.98	0.00	16.00
18	0.00	0.00	0.30	0.00	12.90	0.09	0.48	1.07	0.00	0.91	0.24	16.00
19	2.37	0.00	3.63	0.00	7.08	0.00	1.89	0.46	0.00	0.00	0.58	16.00
20	0.00	0.24	2.59	0.00	10.06	0.00	1.48	0.00	0.46	0.34	0.81	15.99
21	0.00	0.56	1.95	0.00	6.92	0.00	3.34	0.58	0.12	1.25	1.30	16.02
22	0.00	0.24	2.39	0.00	8.62	0.00	2.89	1.15	0.00	0.01	0.70	16.00
23	13.39	0.00	0.86	0.00	1.05	0.07	0.03	0.00	0.00	0.60	0.00	16.00
24	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00
25	0.00	0.00	7.18	0.00	6.25	0.85	0.31	0.31	0.00	0.27	0.83	16.00
26	0.00	0.12	2.74	1.34	5.81	3.06	0.00	1.73	0.00	1.20	0.00	16.00
Total	59.45	4.21	54.76	1.34	215.28	8.28	15.85	20.07	3.63	27.75	5.79	416.44

Note: All numbers are in hectares

Of the 416 ha sampled, heath tundra was the most common habitat type (i.e., 215 ha, or 52%). Two other common habitat types were birch seep (55 ha, or 13%), sedge community (28 ha, or 7%), and lichen rock with boulders (20 ha, or 5%).

Breeding Bird Survey Results

Twelve of the bird species observed on survey plots were thought to be nesting within the LSA (see Table 5.5).

Table 5.5: Number of Pairs of Breeding Birds Recorded on Plots within the Meadowbank LSA, June 2003. A question mark indicates that breeding may not be occurring.

Plot #	LALO[1]	HOLA	ROPT	SVSP	SESA	AMPI	HORE	CORE	AMGP	SACR	BASA	LTDU
1	13	1	1	-	1	-	-	-	-	-	-	-
2	10	2	1	-	-	1	-	-	-	-	1	-
3	10	2	1	-	2	1	-	-	-	-	1	1
4	12	2	-	-	-	-	-	-	-	-	-	-
5	8	3	1	-	-	-	-	-	-	-	-	-
6	3	-	-	-	-	-	-	-	-	-	-	-
7	8	2	-	-	-	1	-	-	-	-	-	-
8	12	1	-	-	1	-	-	-	-	-	-	-
9	10	2	-	-	-	-	-	-	-	-	-	-
10	9	3	-	-	-	-	-	-	-	-	-	-
11	5	1	-	1	-	-	-	-	-	-	-	-
12	7	1	1	-	1	-	-	-	-	-	-	-
13	8	5	-	-	-	-	-	-	-	-	-	-
14	6	1	-	-	-	-	-	-	-	-	-	-
15	8	2	-	-	-	-	1	-		-	-	-
16	10	2	1	-	-	-	1	-	1	-	-	-
17	10	2	-	-	-	-	-	-	-	-	-	-
18	5	3	-	1	-	-	-	1	-	-	-	-
19	10	2	1	1	-	-	-	-	-	-	-	-
20	6	1	-	1	-	-	-	-	-	-	-	-
21	3	2	2	-	-	-	-	-	-	-	-	-
22	6	1	-	-	-	-	-	-	-	-	-	-
23	8	2	-	1	-	-	-	-	-	-	-	-
24	7	1	-	1	-	-	-	-	-	-	-	-
25	8	-	2	-	-	1	-	-	-	1	-	-
26	7	-	1	-	-	-	-	-	-	-	-	-
Total	**209**	**44**	**12**	**6**	**5**	**3**	**2**	**1**	**1**	**1**	**1**	**1**

Notes: 1 Definition of bird codes used above are as follows: LALO = Lapland longspur, HOLA = horned lark, ROPT = rock ptarmigan, SVSP = savannah sparrow, SESA = semipalmated sandpiper, AMPI = American pipit, HORE = hoary redpoll, CORE = common redpoll, AMGP = American golden plover, SACR = sandhill crane, BASA = Baird's sandpiper, and LTDU = long-tailed duck.

By far the most common breeding bird species encountered on survey plots was Lapland longspur. Lapland longspurs composed 219 of the 286 (i.e., 77%) breeding bird pairs observed within plots. Two other species that were commonly encountered were horned lark (44 pairs, or 15%), and rock ptarmigan (12 pairs, or 4%). The most common shorebird species was semipalmated sandpiper (5 pairs, or 2%). Uncommon breeding birds included savannah sparrow, American pipit, hoary and common redpolls, American golden plover, and sandhill crane. Breeding status of Baird's sandpiper and long-tailed duck was considered to be uncertain.

A number of non-breeding species were observed. All three species of jaeger, including the regionally rare pomarine jaeger, were observed on plots. Long-tailed and parasitic jaegers are expected to nest in the region, but the pomarine jaeger is likely a transient bird moving through the area. A number of glaucous and herring gulls were observed flying to the north, presumably to breeding areas on the Arctic coast and islands. Several small flocks of Canada and snow geese were also observed flying to the north.

5.3.2.5 Checklist Bird Survey

Twenty-six bird species were recorded on the checklist surveys. A list of bird species and estimated numbers of individuals sighted each day within the LSA is provided in Table 5.6.

The five most common species observed, in order of abundance, included Lapland longspur (376 individuals, or 46%), Canada goose (146, or 18%), horned lark (85, or 10%), snow goose (69, or 8%), and rock ptarmigan (36, or 4%).

5.3.3 Wildlife Log Book

Data recorded in the Meadowbank Camp wildlife logbook is provided in Appendix A.9. A summary of the total number of observations made, by species, is provided in Table 5.7.

Over the five years of wildlife logbook records, 345 entries were made. The most frequently recorded species was barren-ground caribou, with a total of 108 sightings (~ 31%). Arctic fox (39 entries) and arctic hare (36) were also reported on a regular basis. The most frequently recorded bird species were ptarmigan (26 entires), sandhill crane (19), and geese (16).

Caribou were most frequently recorded in the spring and fall seasons, whereas arctic fox and arctic hare were distributed more evenly across the months of record (Table 5.8). Bird species were most frequently observed in the spring and fall migratory periods, and during the summer months.

Table 5.6: Seasonal Occurrence of Frequently Reported Wildlife in the Camp Wildlife Logbook

Species	Feb (1)[1]	Mar (5)	Apr (5)	May (5)	Jun (4)	Jul (4)	Aug (4)	Sep (2)	Oct (1)
Caribou	1	58	291	408	21	24	170	12	6,000
Arctic fox	-	2	9	8	5	8	7	2	-
Arctic Hare	-	9	6	16	4	15	2	4	4
Ptarmigan	-	2	3	18	4	19	6	20	-
Sandhill Crane	-	-	-	12	7	6	24	-	-
Goose sp.	-	-	-	219	48	-	288	130	-

Notes: 1. Numbers in brackets indicate the number of years for which monthly data exists. Numbers are cumulative across all years.

Table 5.7: Birds Recorded on Checklist Surveys within the Meadowbank LSA, June 2003

	June 2003 Survey Dates										
Common Name	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**
American golden-plover	-	-	-	-	-	-	2	-	-	-	2
American pipit	5	2	2	-	-	-	-	-	-	1	10
Baird’s sandpiper	-	2	-	-	-	-	-	-	-	-	2
Canada goose	15	80	15	-	2	30	2	-	-	2	146
Common loon	-	-	-	-	2	1	-	-	-	-	3
Common redpoll	2	-	-	-	-	-	4	-	-	-	6
Glaucous gull	3	-	2	1	1	-	-	-	-	-	7
Herring gull	6	1	2	1	-	-	-	-	1	-	11
Hoary redpoll	-	-	-	-	-	2	2	-	-	-	4
Horned lark	8	23	6	5	8	10	12	5	6	2	85
Lapland longspur	60	65	35	38	40	28	32	24	27	27	376
Long-tailed duck	-	2	8	-	-	2	-	-	-	-	12
Long-tailed jaeger	-	1	1	1	-	-	-	-	-	-	3
Mallard	-	1	-	-	-	-	-	-	-	-	1
Northern pintail	-	1	-	-	-	-	-	-	-	-	1
Parasitic jaeger	-	-	-	-	-	-	-	1	-	-	1
Pomarine jaeger	-	1	1	-	-	-	-	-	-	-	2
Red-breasted merganser	-	-	4	-	-	-	-	-	-	-	4
Red-throated loon	-	-	1	-	2	-	-	-	-	-	3
Rock ptarmigan	8	5	3	2	3	2	4	4	-	5	36
Rough-legged hawk	-	1	-	-	-	-	-	-	-	-	1
Sandhill crane	-	1	3	2	-	1	-	-	-	2	9
Savannah sparrow	-	1	-	-	2	-	2	2	2	-	9
Semipalmated sandpiper	3	7	2	2	1	-	-	-	-	1	16
Snow bunting	2	-	-	-	-	-	-	-	-	-	2
Snow goose	-	20	-	-	-	9	-	-	40	-	69
Total # Individuals	**112**	**214**	**85**	**52**	**61**	**85**	**60**	**36**	**76**	**40**	**821**
Total # Species	**10**	**17**	**14**	**8**	**9**	**9**	**8**	**5**	**5**	**7**	**26**

Table 5.8: Number of Sightings Recorded in Wildlife Log Book, by Year & Species, at Meadowbank Camp, 1996-1999 & 2002-2003

Species	1996	1997	1998	1999	2002	2003	TOTAL
Mammals							
Arctic fox	1	9	5	1	12	11	39
Arctic hare	3	3	9	-	11	10	36
Barren-ground caribou	5	26	22	4	24	27	108
Ermine	-	-	-	-	2	-	2
Muskox	-	-	1	-	6	13	20
Sik Sik (Ground Squirrel)	-	-	-	-	4	4	8
Wolf	2	4	5	-	8	3	22
Wolverine	-	-	-	-	1	1	2
Birds							
Baird's sandpiper	-	-	-	-	-	1	1
Canada goose	-	-	1	-	1	2	4
Common loon	-	-	-	-	-	1	1
Common raven	3	2	-	-	-	-	5
Eagle sp.	-	-	-	-	1	-	1
Falcon sp.	-	-	-	-	-	1	1
Glaucous gull	-	-	-	-	-	1	1
Goose sp.	-	-	-	1	1	4	6
Gull sp.	-	2	-	-	-	2	4
Hawk sp.	-	-	-	-	1	2	3
Herring gull	-	-	-	-	-	1	1
Horned lark	-	-	-	-	-	1	1
Lapland longspur	-	-	-	-	-	3	3
Loon sp.	-	1	-	-	1	2	4
Peregrine falcon	-	-	1	-	-	1	2
Ptarmigan sp.	1	1	4	-	9	9	24
Red-throated loon	-	-	-	-	-	1	1
Rock ptarmigan	-	-	-	-	-	2	2
Rough-legged hawk	-	-	1	-	2	1	4
Sandhill crane	1	2	5	-	5	6	19
Shorebird sp.	-	-	-	-	-	1	1
Short-eared owl	-	-	-	-	-	1	1
Small unidentified bird	-	-	-	-	1	-	1
Snow bunting	-	1	-	-	-	2	3
Snow goose	-	-	-	-	2	6	8
Snowy owl	-	3	-	-	-	-	3
White-crowned sparrow	-	-	-	-	-	1	1
Yellow-billed loon	-	-	-	-	2	-	2
Total number of entries	**16**	**54**	**54**	**6**	**94**	**121**	**345**

5.3.4 Regional Study Area

5.3.4.1 Mammals

By far the most common mammal species observed during aerial surveys was caribou (Figure 5.11; Appendix A.11). An average density of 1.01 individuals per km surveyed was recorded in September 2002. This peak seasonal density represents an average of 1.68 caribou/km^2, or approximately 16,800 caribou within the 10,000 km^2 RSA. Winter (i.e., late March) densities of 0.45 caribou per km, or 0.75 caribou per km^2, represent a total winter population in the RSA of approximately 7,500 animals. Similarly, RSA caribou populations in the RSA in spring (late May/early June) and summer (late July) are estimated at 3,000 and 100 animals, respectively.

Muskoxen were recorded at similar densities in all seasons (Figure 5.11; Appendix A.12). An estimated 300 to 400 animals are estimated to be present within the RSA in any given season. Wolves were recorded at low densities in all seasons (Figure 5.11; Appendix A.13).

5.3.4.2 Birds

As expected, larger bird species such as geese were recorded at higher densities than smaller bird species. Snow goose was the most common bird species recorded and was most common during the fall migratory period (Figure 5.12; Appendix A.14). The 3.3 snow geese/km represents 5.5/km^2 (assuming survey distance of 300 m on either side of transects), or an estimated 55,000 snow geese in the RSA during the mid-September survey period. Snow geese are known to migrate through the barrenlands to and from their breeding grounds in northern areas of Nunavut. Canada geese were also recorded at high numbers in the fall, but were most common in the summer when an average of 1.62 birds/km or 2.7/km^2 (i.e., 27,000 in RSA) was recorded. Raptors and ptarmigan were observed at relatively low densities (Figure 5.12; Appendices A.15 and A.16).

5.3.5 Habitat Considerations & Suitability

5.3.5.1 Suitability

Species-specific habitat suitability is similar among the three study areas due to the relative uniformity of the landscape across the region, and the overlapping nature of the study areas. A summary of the habitat suitability rankings for the mammal key wildlife resources is presented in Table 5.9. In general, across the Meadowbank area, habitat suitability was moderate to high (all seasons) for small mammals and furbearers. For large carnivores, it was low to moderate in the spring and winter, very low to moderate in the summer, and moderate to high in the fall. For ungulates, it was low to high in spring, fall, and winter, and low to moderate in summer, with habitat suitability for caribou ranked higher than for muskoxen in all but the summer.

Given the extent of wetlands and water bodies that are associated with heath tundra communities across the Meadowbank area, habitat suitability for breeding and staging shorebirds and waterfowl could be moderate to high; however, suitable foraging habitat is likely limited because the wetlands in these areas are considered to be relatively unproductive. Habitat suitability for breeding falcons and hawks is difficult to assess because the ELC identifies only boulder, bedrock, or esker units, rather than cliff habitats, which are used for nesting. The Meadowbank area, however, contains large areas of heath tundra and shallow and deep-water habitats, which could support prey such as rodents,

Figure 5.11: Relative Seasonal Abundance of Mammals Observed on 1999, 2002-2003 Aerial Surveys in the RSA

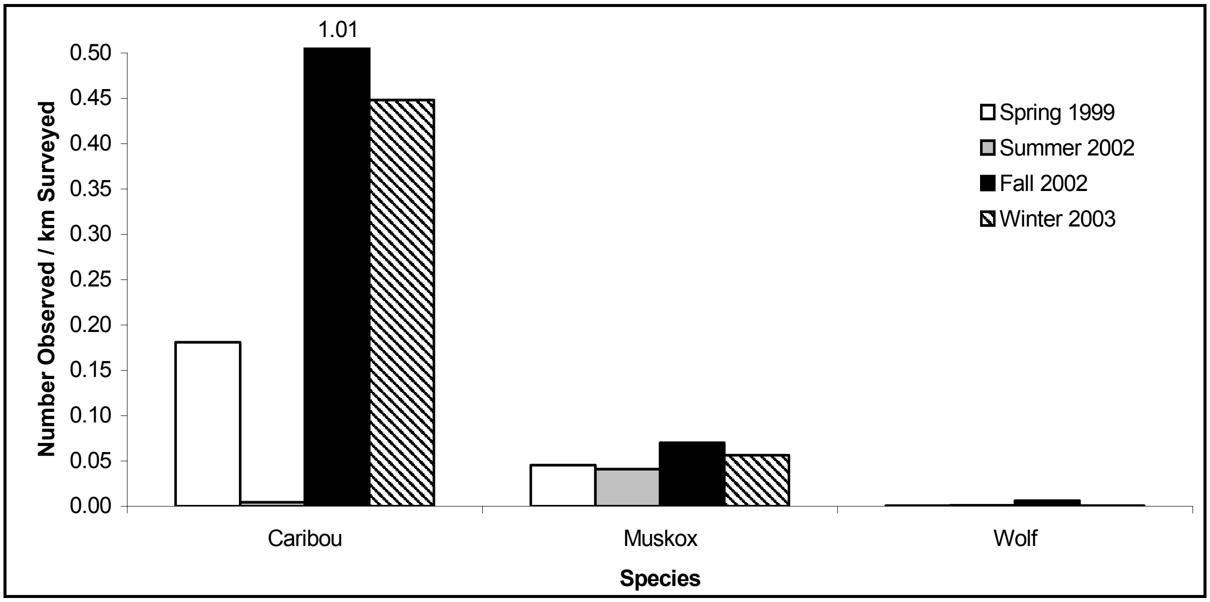


Figure 5.12: Relative Seasonal Abundance of Waterfowl, Raptor & Ptarmigan Observed on 1999, 2002-2003 Aerial Surveys in the RSA

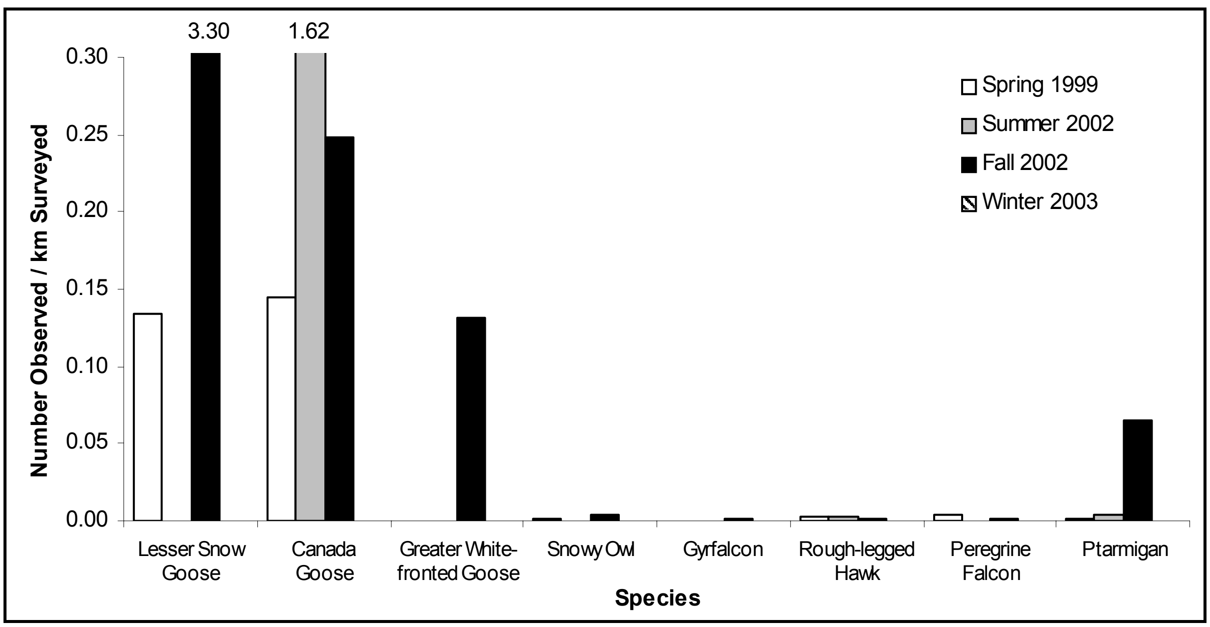


Table 5.9: Summary of Habitat Suitability Rankings for Mammalian Key Wildlife Resources in the Meadowbank Area

Mammalian Key Wildlife Resource	Habitat Suitability Ranking			
	Spring	**Summer**	**Fall**	**Winter**
Ranked the same for RSA, LSA, and winter road corridor except where noted otherwise.				
Barren-ground Caribou	moderate to high	low to moderate	moderate to high	high
Muskox	low to moderate	moderate	low to moderate	low to moderate
Grizzly bear	low to moderate	low to moderate	moderate	low to moderate
Wolf	moderate	very low	high	moderate
Wolverine	RSA: moderate; LSA/winter road corridor: low to moderate	RSA: low; LSA/winter road corridor: very low	RSA: high; LSA/winter road corridor: moderate to high	RSA: moderate; LSA/winter road corridor: low to moderate
Arctic fox	moderate	moderate	moderate	moderate
Ranked for LSA only.				
Ermine	moderate to high	moderate to high	moderate to high	moderate to high
Arctic Hare	high	high	high	high
Arctic Ground Squirrel	moderate	moderate	moderate	moderate
Collared lemming	moderate	moderate	moderate	moderate
North. Red-backed Vole	high	high	high	high

passerines, ptarmigan, shorebirds, and waterfowl; hence, habitat suitability for snowy owls is likely moderate to high. Habitat suitability for ptarmigan is high since there is an abundance of tundra habitat associated with eskers and rocky areas, or with moist, shrubby habitats. Given the extent of open tundra combined with grassy meadows, rocky patches, bare ground, and shrubby patches, habitat suitability for nesting and foraging passerines was moderate to high.

5.3.5.2 Habitat Distribution

The distribution of wildlife observations within various habitat types was determined. Heath-Tundra was by far the most common habitat type where caribou and muskox were recorded (Figure 5.13). Wolves and arctic hare were most commonly observed in lichen-rock habitats, and arctic ground squirrel was observed most frequently in esker habitats.

As expected, most waterfowl were sighted in Water habitats (Figure 5.14). Canada geese were also regularly observed in Heath-Tundra habitats, presumably because of foraging opportunities on fall berries and other food sources.

Most sightings of raptors were in heath-tundra habitats, although peregrine falcon was only observed in esker habitats (Figure 5.15). Ptarmigan were most frequently observed in lichen-rock habitats.

Figure 5.13: Habitat Distribution of Mammal Observations in the RSA & LSA During Fall 2002 Aerial Surveys

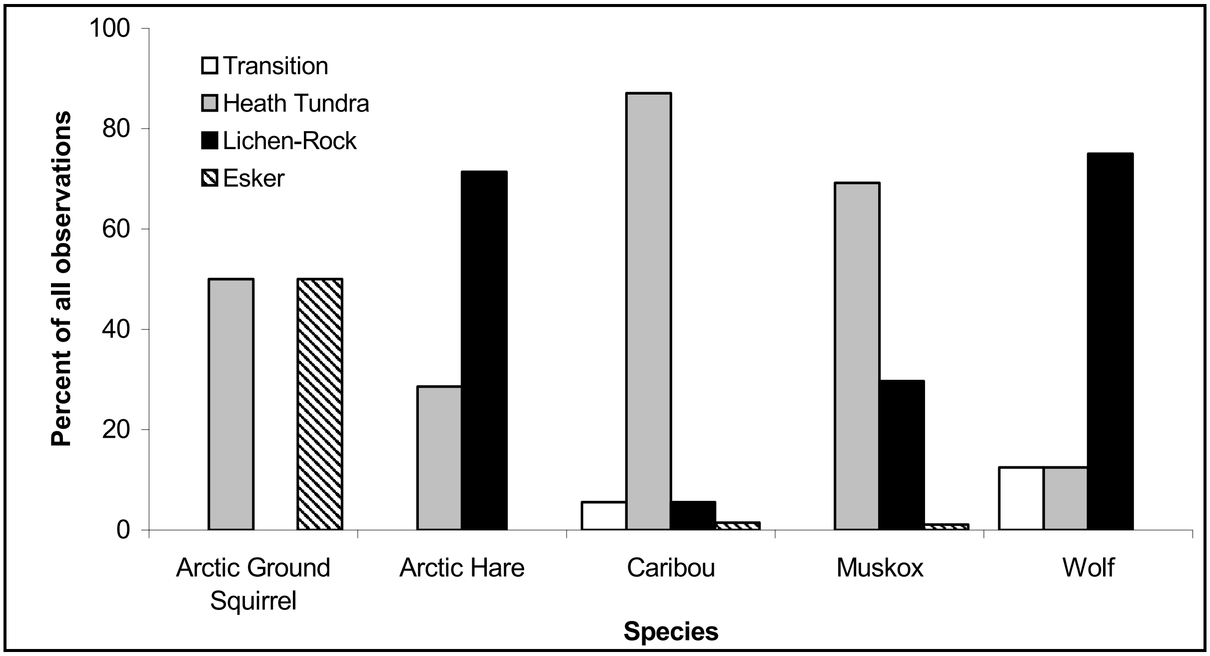


Figure 5.14: Habitat Distribution of Waterfowl Observations in the RSA & LSA During Fall 2002 Aerial Surveys

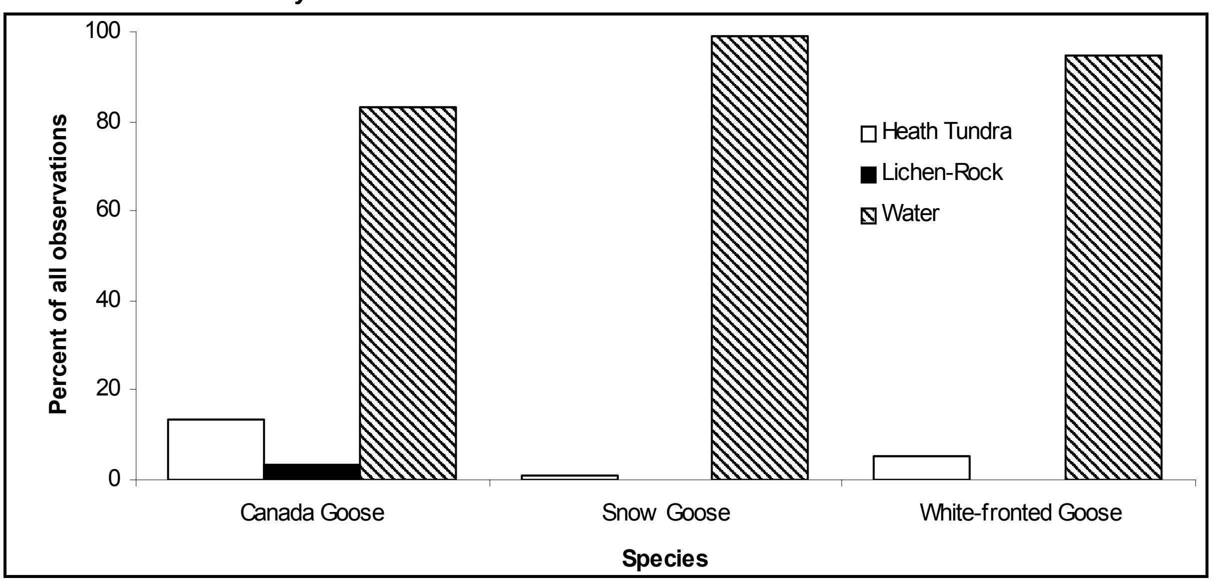
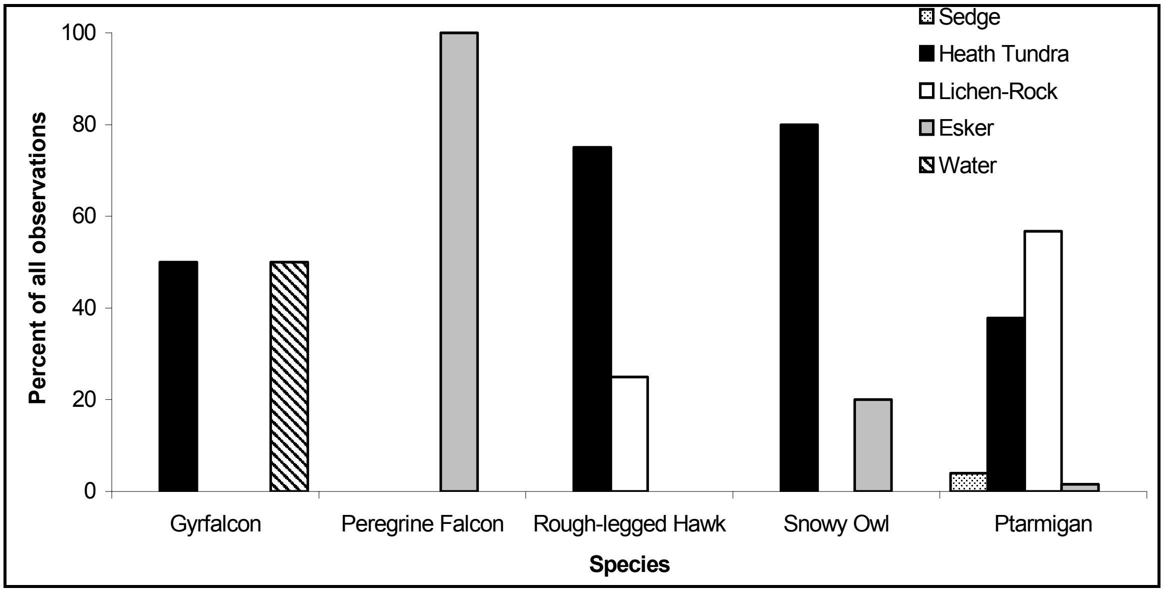


Figure 5.15: Habitat Distribution of Raptor & Ptarmigan Observations in the RSA & LSA during Fall 2002 Aerial Surveys



5.3.6 Terrestrial Mammals

5.3.6.1 Ungulates

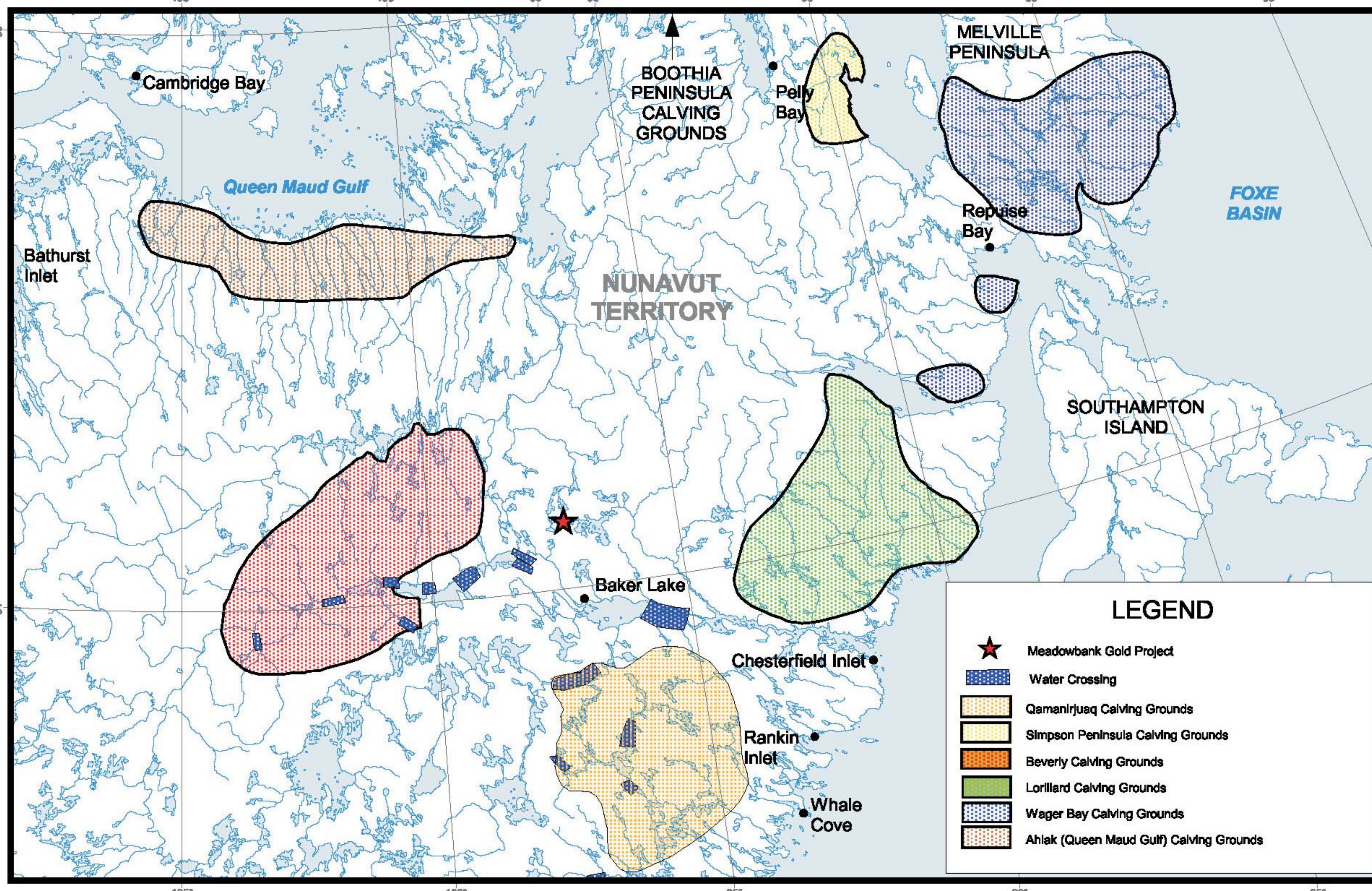
Two ungulate species are considered key wildlife resources with respect to the proposed mine development. They are the barren ground caribou and the muskox. Caribou were selected because they are the most vital component of the subsistence economy in the Baker Lake region. Muskoxen were selected because of concerns related to the ongoing success of their recent movement back into the region.

Barren-ground Caribou

Status

The Barren-ground Caribou is listed as secure in Nunavut (Government of Nunavut, 2001), and is not listed federally (COSEWIC, 2002); however, community concerns have been expressed regarding the numbers and health of one of these herds—the Lorillard herd (Campbell, 2002).

No caribou calving grounds are found within the RSA (Figure 5.16). The Beverly and Qamanirjuaq calving grounds are west and south of the RSA, respectively, and primary water crossings are not located in the vicinity of the Meadowbank project (BQCMB, 1999; Figure 5.16). The Beverly herd does move closer to the Meadowbank area during other periods. During the post-calving and late summer periods (e.g., August and September), the Beverly herd ranges into the western half of the RSA (BQCMB, 1999) and likely as far west as the Meadowbank Camp (Figure 5.17; Appendix A.11). The Qamanirjuaq herd may range north as far as Baker Lake in some winters (D. Akesawne, pers. comm., 2003). The Ahiak (previously Queen Maud Gulf) herd's range between 1986 and 1998 was



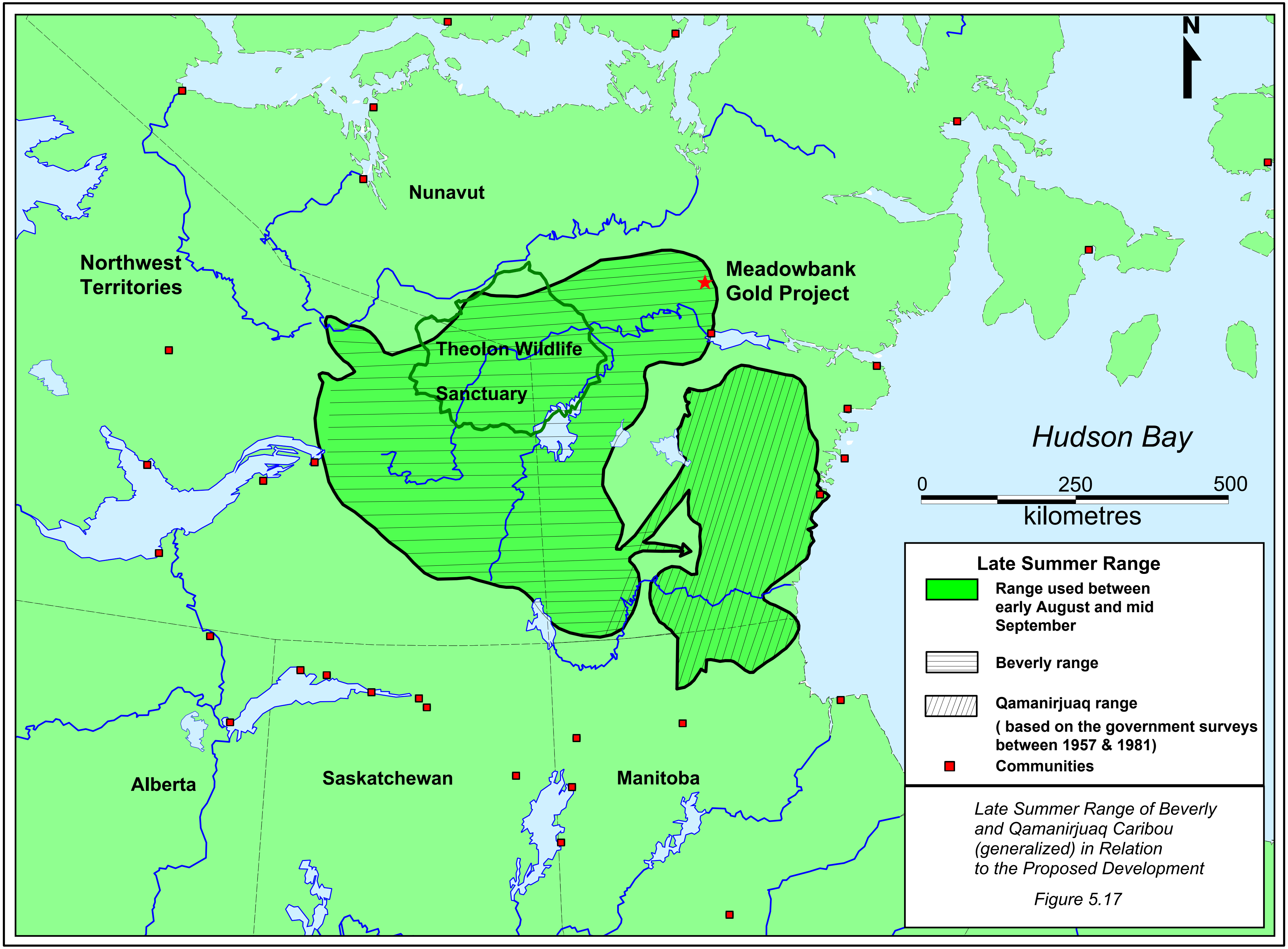
Location of the Meadowbank Gold Project in Relation to Known Caribou Calving Grounds and Water Crossings in Nunavut

Acknowledgements: Caribou calving locations from Ferguson 1987.

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

Figure 5.16



Late Summer Range of Beverly and Qamanirjuaq Caribou (generalized) in Relation to the Proposed Development

Figure 5.17

well west of the RSA throughout the year (Gunn et al, 2000a). Recent radio-collaring data supports this observation (A. Gunn, Department of Resources, Wildlife and Economic Development, GNWT, pers. comm., 2003) with the exception that one radio-collared caribou did wander just north of Tehek Lake in 2003 (Debbie Johnson, A. Gunn, Department of Resources, Wildlife and Economic Development, Government of Northwest Territories, pers. comm., 2003).

Ten cows from the Wager Bay and ten cows from the Lorillard herds have been satellite-monitored since 1999 by the Department of Sustainable Development, Nunavut (Campbell, 2002). The Lorillard and Wager Bay calving grounds are well to the east and northeast of the RSA, respectively (Figure 5.16), however, the Lorillard study animals have been located in the eastern half of the RSA in the winter and fall (Figure 5.18), and the Wager Bay study animals have been located in the northern half of the RSA in the winter (Figure 5.19; Campbell, 2002).

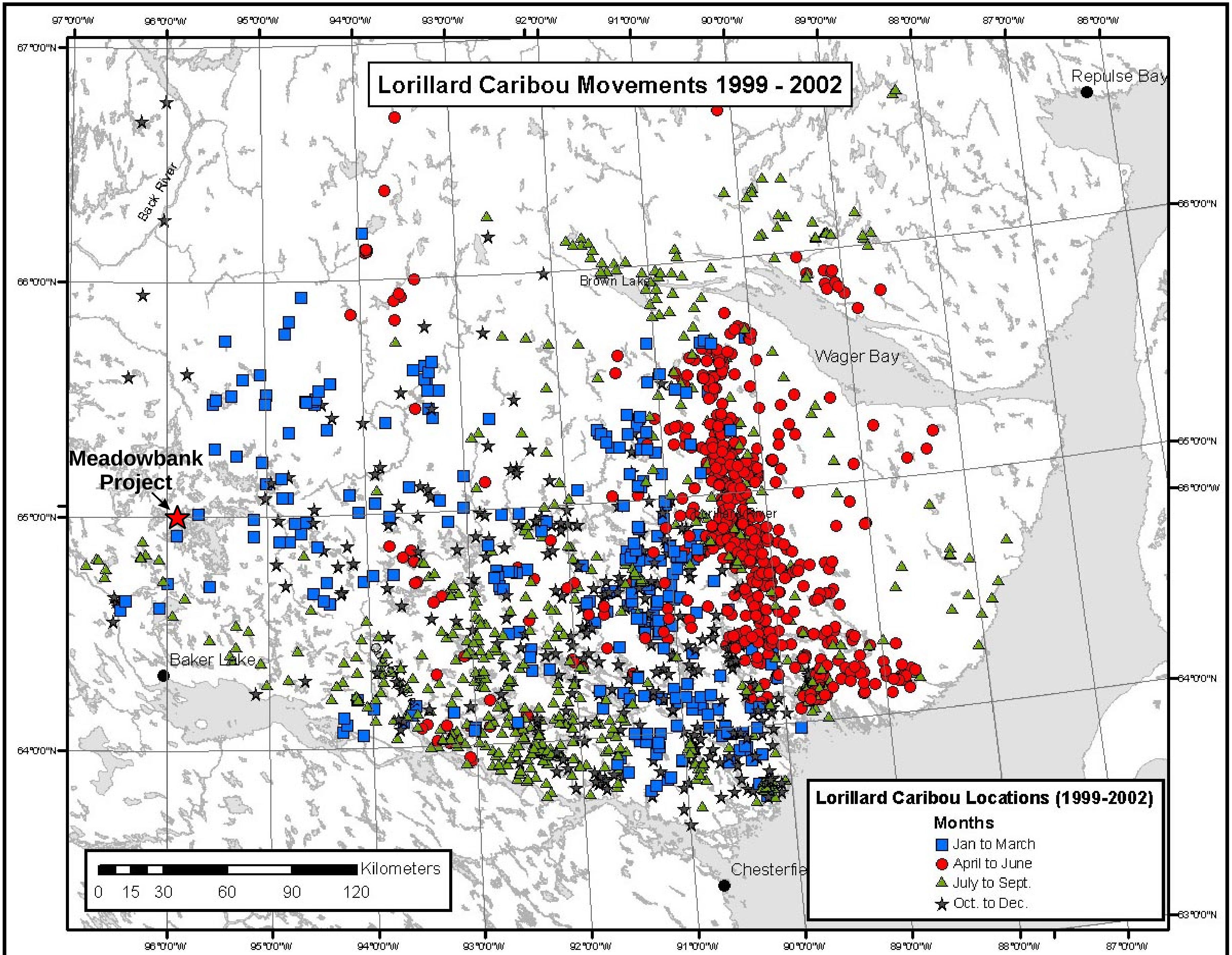
Little is known of the movements of herds to the north of Meadowbank Camp. These herds have not been studied in detail, and distribution and areas of seasonal concentrations are generally poorly defined. A recent publication by Gunn et al (2000b) provides some information on movements of caribou collared in the Boothia Peninsula. One of these animals moved down to the Meadowbank area and RSA during one winter (early November 1992), suggesting that at least some of the northern herds winter in the Meadowbank RSA (Figure 5.20).

The overall density of caribou on the northeast mainland of Nunavut was estimated at 0.23 caribou per km^2 in spring 1995, but within the zone that encompasses the RSA, the density was only 0.06 per km^2 (Buckland et al, 2000). This estimate represents approximately 1,500 animals, and is less than half of the number estimated in 1983 (Buckland et al, 2000).

Results of Baseline Surveys

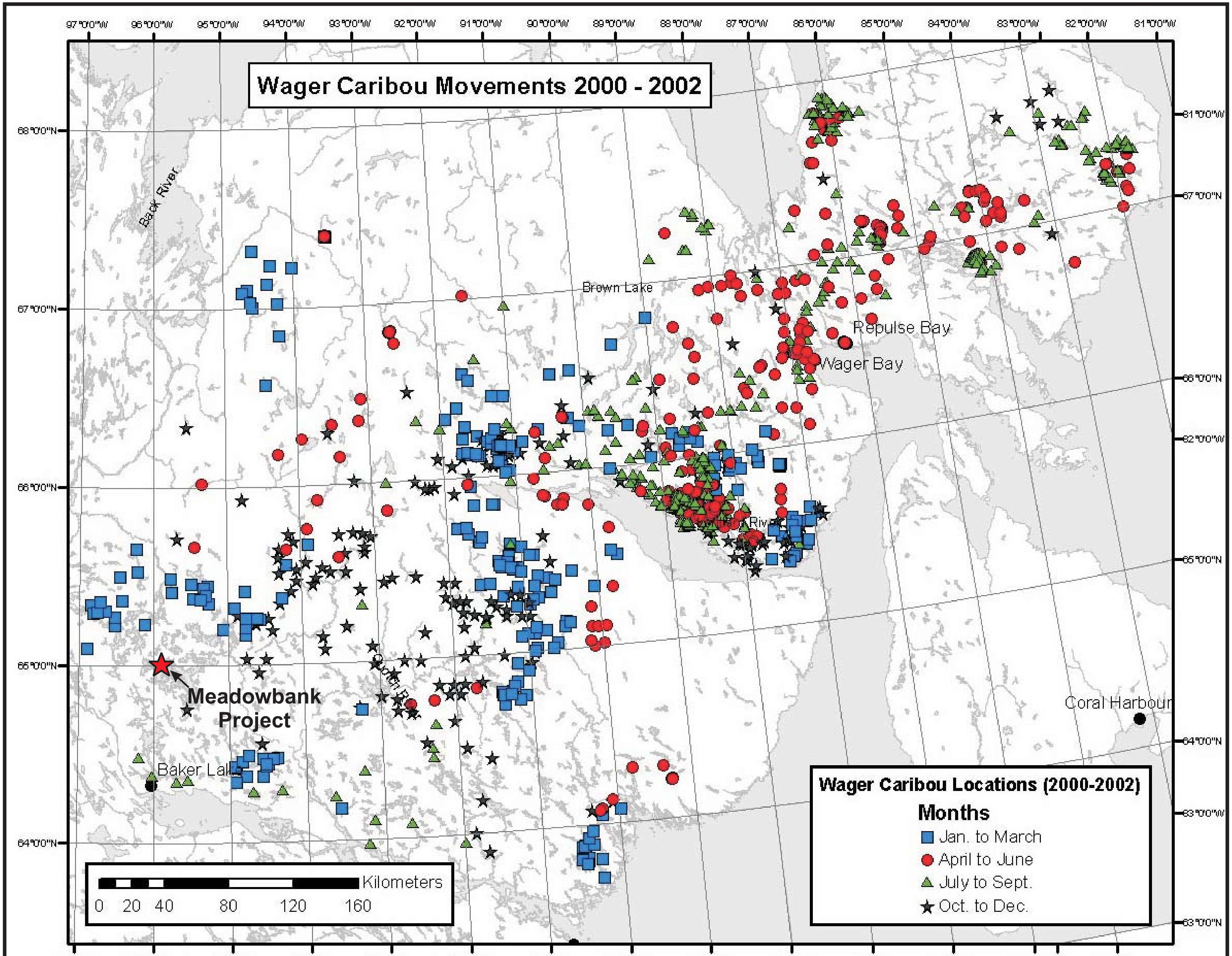
Results from the baseline surveys indicate that caribou are present in the Meadowbank area in all four seasons, but are observed in greatest abundance in the fall (Figures 5.5, 5.6, and 5.11) and in lowest abundance in the summer (Figures 5.5 and 5.11). Wildlife logbook entries (Table 5.8) also support this finding with higher numbers reported in spring and fall than in summer. The approximate density of caribou (caribou per km^2) within the RSA was estimated as 0.30 in spring (i.e., an estimated 3,000 animals in the RSA, based on numbers per survey kilometre and a survey corridor width of 600 m), 0.01 in summer (100 animals in RSA), 1.69 in fall (16,900) and 0.75 in winter (7,500). These seasonal abundance patterns correspond to migration from post-calving areas to winter habitat (M. Campbell, Nunavut Department of Sustainable Development, pers. comm., 2002), and suggest that the Meadowbank area does not represent critical habitat during spring migration, calving, or post-calving (summer) periods. Incidental observations by camp personnel also support this assertion. Few or no caribou have been recorded during June when calving would be expected to occur, but there have been large groups of caribou observed in the Meadowbank area in the fall (e.g., 2000-3000 individuals were observed 1 km north of the field camp in October 2002).

In the fall, caribou were observed most commonly in the western half of the RSA and, within that area, were concentrated in the southwest portion (Appendix A.11). The spring observations are distributed in a similar pattern to those in the fall but in much lower numbers (Figure 5.11 and Appendix A.11). In the winter, most observations were in the eastern half of the RSA, and were relatively evenly distributed within that area (Appendix A.11).



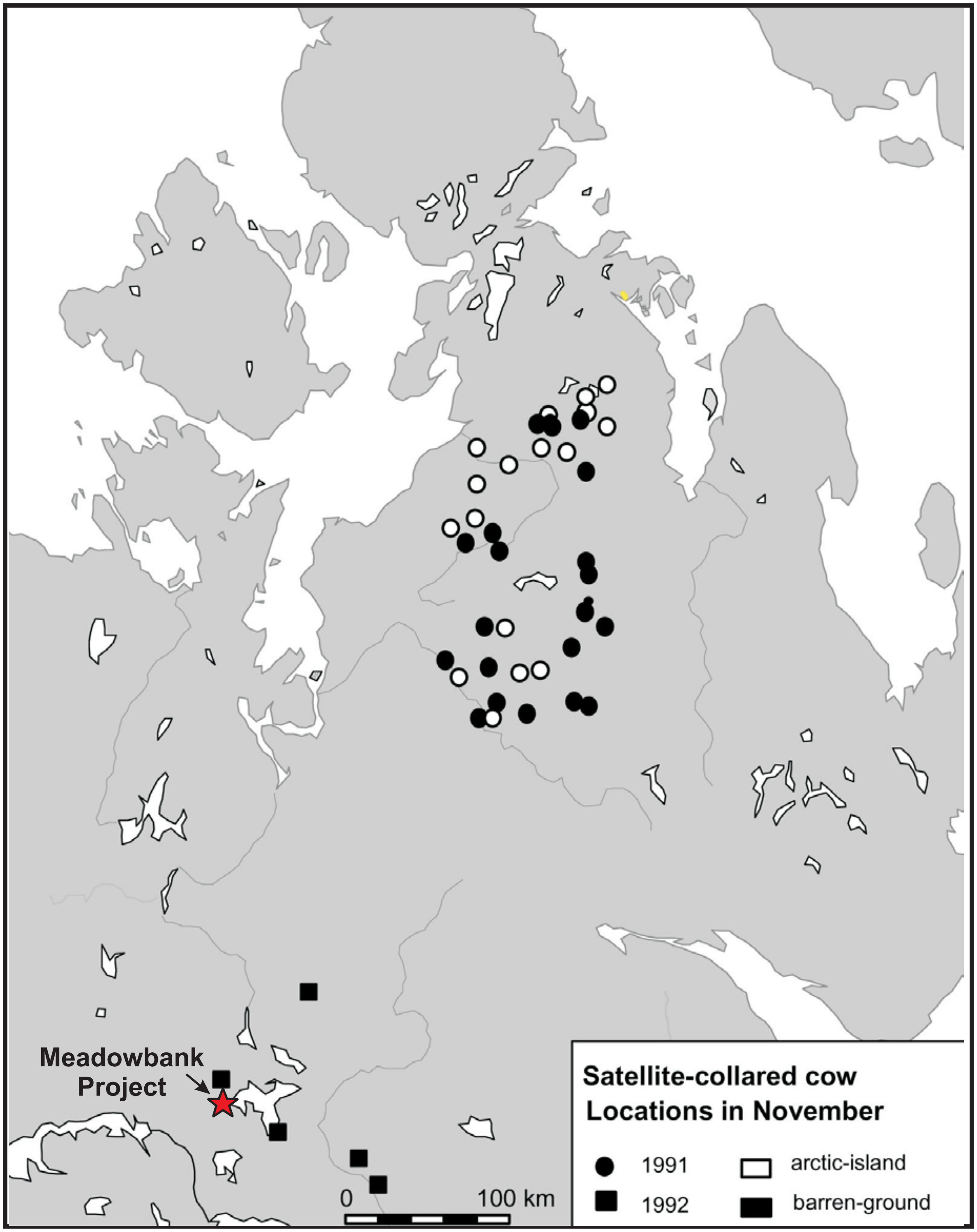
Source: Department of Sustainable Development, Government of Nunavut, Arviat, Nunavut)

Location of radio-collared Lorillard Caribou, 1999-2002
Figure 5.18



(Source: Department of Sustainable Development, Government of Nunavut, Arviat, Nunavut)

Location of radio-collared Wager Bay Caribou 2000-2002
Figure 5.19



(Source: Gunn et al. 2000. Department of Resources, Wildlife and Economic development, Government of The Northwest Territories, Yellowknife, NWT)

Location of Radio-collared Boothia Peninsula Caribou in Novermber
Figure 5.20

The vast majority of the caribou observed in the RSA in spring 1999 were young males and yearlings (>95%). The majority of the caribou observed in the RSA in fall 2002[1] were females (54%), followed by calves (33%), and males (13%).

Caribou density along the winter road corridor outside of the RSA during winter 2003 was estimated at approximately 1.2 individuals per km^2 (34 individuals observed).

Caribou were most frequently observed in the LSA in the fall (Figures 5.5 and 5.6). In the spring[2] and winter[3] in the LSA, caribou were recorded in similar numbers (Figure 5.5). During the fall in the LSA, caribou were most abundant in the southeast section of the study area (Appendix A.10). There were relatively few individuals observed during the winter LSA survey, but their distribution was similar to the previous fall (Appendix A.10).

Contrary to the pattern of abundance suggested by the observation records, pellet group density estimates were almost the same in the fall and winter in the LSA (Figure 5.7). Although the differential detectability of pellet groups in the fall and winter likely underestimates caribou abundance in the fall, it does appear that a significant number of caribou also spend time in this area during the winter. Additionally, local residents have historically observed caribou in the area during the winter (Appendix A.1).

Ecology

Little is known about the ecology of caribou in the Meadowbank area; however, for caribou resident on the Arctic tundra (i.e., arctic tundra caribou), such as those in the Lorillard and Wager Bay herds, winter range is probably more important than summer range as a limiting factor (Ferguson et al, 2001).

Caribou wintering on the tundra seek areas such as ridge tops where snow is relatively shallow (BQCMB 1999). On Victoria Island in the High Arctic, caribou pellet sign was most strongly correlated with upland vegetation (e.g., sedges, lichens, and saxifrage) in the winter (Schaeffer et al, 1996). In early winter, the Qamanirjuaq herd consistently fed in horsetail and sedge communities along lake and stream shores, but in mid- and late winter, lichens were the dominant forage (Miller, 1976). Labrador tea and blueberry were the most common woody plants eaten from mid- to late winter by this herd (Miller, 1976). Upland habitats dominated by heaths and lichens (e.g., heath tundra community and lichen-rock community associations), in combination with the sedge community ELC unit, are relatively common in the Meadowbank area, composing 70% of the RSA, 54% of the winter road corridor, and 50% of the LSA (Table 5.2).

In the spring, caribou tend to forage on ridges and other high points of land where the snow is relatively shallow (BQCMB, 1999). Later in the season, once green-up has begun, meadows are also used (BQCMB, 1999). The spring diet of the Qamanirjuaq herd consists primarily of grasses and woody plants, and to a lesser extent, lichens (Miller, 1976). In the Meadowbank area, suitable spring

[1] Only four caribou were observed in summer 2002 (one adult male, one adult female, one juvenile male, and one unknown). Caribou were not classified into age and sex classes in winter 2003.
[2] 64 observations in the southern section of the LSA
[3] 91 observations in the entire LSA

forage is found within the same ELC units as are used in the winter (see preceding paragraph), although the lichen-rock community associations are of less importance as spring progresses.

Late summer habitat is important for growth and the restoration of fat reserves (AXYS and Penner & Associates Ltd., 1998). Caribou summer diet in the central Canadian Arctic is dominated by willow (Van Egmond and Rowell, 1998). ELC units with a significant willow component, such as the sedge and riparian shrub communities, are available to a limited extent in the study areas (combined coverage <10%; Table 5.2).

Caribou also use eskers in the summer for insect avoidance (Mueller, 1995), and caribou may use persistent snow patches, such as the snowbank community ELC unit, and lake and river shorelines to reduce insect harassment (AXYS and Penner & Associates Ltd., 1998). With the exception of the shorelines, which are relatively common in the area, insect avoidance habitat is limited in the Meadowbank study areas (combined coverage <5%; Table 5.2).

Migration to winter range and rutting occurs in the fall (BQCMB, 1999). The fall diet of the Qamanirjuaq herd is varied, consisting of grasses, woody plants, lichens, and mushrooms (Miller, 1976). In the Meadowbank area, suitable fall forage is likely found within the same ELC units as are used in the spring (see above).

Caribou may experience a trade-off between foraging value and predator avoidance at certain times of the year. For example, while heath tundra[1], heath boulder[2], and tall shrub[3] are ranked as high suitability for summer foraging in the central Canadian Arctic (AXYS and Penner & Associates Ltd., 1998), caribou tend to avoid habitats such as boulder fields[4], birch seeps[5], and tall shrub communities that can conceal predators (Curatolo, 1975; Heard and Gray, 1989).

Habitat Association

During the fall, almost all observations of caribou in the Meadowbank area were associated with heath tundra (Figure 5.13). There were a small number of observations associated with eskers, lichen-rock, and transitional habitats (Figure 5.13).

The three Meadowbank study areas are ranked the same for caribou habitat suitability – high in winter, moderate to high in spring and fall, and low to moderate in summer (Table 5.9). These habitat suitability rankings are for life requisites other than calving (e.g., foraging), because the Meadowbank area is not within any calving grounds.

Summary

Based on previous studies on caribou in the area (see Existing Information above), the greater concentrations of caribou in fall may be Beverly animals moving from post-calving areas to wintering

[1] Similar ELC unit: Heath Tundra Community
[2] Similar ELC unit: Lichen-Rock Community – Boulder Association
[3] Similar ELC unit: Riparian Shrub Community
[4] Similar ELC unit: Lichen-Rock Community – Boulder Association
[5] Similar ELC unit: Birch Seep Community

areas. Caribou in winter and spring are likely from a number of herds, including Beverly, Lorillard, Wager Bay, Boothia Peninsula, and other undescribed northern herds.

There is evidence that Arctic tundra caribou make frequent and unpredictable winter range shifts (Ferguson et al, 1998; Buckland et al, 2000; Ferguson et al, 2001), thus, the importance of the Meadowbank area as winter range may vary over the long term. Continued monitoring, such as that being undertaken by DSD, will provide valuable information in this regard.

Muskox

Status

The Muskox is listed as secure in Nunavut (Government of Nunavut, 2001) and is not listed federally (COSEWIC, 2002); however, the species is sensitive to disturbance and over-hunting and has only recently begun to re-establish populations in parts of Nunavut (Campbell and Setterington, 2001). Baker Lake residents suggest that the muskox herd has increased since the 1960s, and may have moved into the Meadowbank area from the Thelon Wildlife Sanctuary (Appendix A.1).

Surveys in the central Kivalliq Region undertaken by DSD in the summers of 1999 and 2000 estimated a density of 0.043 muskoxen per km^2 in an area that included the western half of the RSA (Campbell and Setterington, 2001). This density was considered to be fairly low compared to areas surveyed to the southwest (density range from 0.105-0.110 muskoxen per km^2; Campbell and Setterington, 2001).

Results of Baseline Surveys

Results from the baseline surveys indicate that Muskoxen are present in the Meadowbank area in small numbers throughout the year (Figures 5.5 and 5.11). Their approximate density (muskoxen per km^2) within the RSA varied little throughout the year; estimates were 0.03 (i.e., 300 animals in the RSA) in spring, summer, and winter, and 0.04 (400) in fall. Herds of 40-50 animals (including calves) have been observed in the same general area north of the LSA since the spring of 1999 (Appendices A.9 and A.12). Few observations of muskoxen were made during baseline surveys in the southern half of the RSA in any season (Appendix A.12). The majority of observations were concentrated in the northwest portion of the RSA (Appendix A.12); however, several incidental observations in 2003 (i.e., from helicopter flights between Meadowbank Camp and Baker Lake) indicated that a herd of 24 animals (i.e., 21 adults and subadults, 3 calves) was present approximately 35 km south of Meadowbank Camp. A small group of four muskox was observed 15 km south of Camp in 2002 (Appendix A.9).

Muskoxen were observed in the LSA during the summer and winter baseline surveys (Figure 5.5). Camp personnel also recorded small numbers of muskoxen within 5 km of the field camp on several days in July 2002. In June 2003, a herd of 35 animals (i.e., 29 adults and subadults, 6 calves) was present in the eastern portion of the LSA near the outlet of Second Portage Lake. A lone bull was also observed nearby.

Ecology

Muskoxen feed on grasses and sedges in the winter (Nellemann and Reynolds, 1997; Gunn and Sutherland, 1997). The dominant plants detected in winter pellet analysis from Victoria Island in the High Arctic were sedge, cotton grass, and willow (Schaeffer et al, 1996). ELC units with a significant component of grasses and sedges are sedge community, avens community, and some birch seep communities (combined coverage 8-14%; Table 5.2).

Muskoxen are known to move to higher windswept terrain in the winter where forage is more accessible (Banfield, 1974; Nellemann and Reynolds, 1997). In northeastern Alaska, muskoxen showed a preference for rugged terrain in the late winter as less snow made access to forage easier (Nellemann and Reynolds, 1997). In contrast, on Victoria Island in the High Arctic, muskoxen pellet sign was most strongly associated with lowland vegetation in the winter (Schaeffer et al, 1996). The impact of snow load on forage accessibility is unlikely to be a significant concern in the Meadowbank area during a typical winter. Muskox winter habitat use in the Meadowbank area is likely intermediate between that observed in Alaska and that observed in the High Arctic.

Muskoxen feed on willow in the summer (Nellemann and Reynolds, 1997; Gunn and Sutherland, 1997). ELC units with a significant willow component, such as sedge community and riparian shrub community, are available to a limited extent in the study areas (combined coverage <10%; Table 5.2). Earlier in the summer, muskoxen are known to feed on sedges as they are greening up (Gunn, 1984). Muskoxen in the Queen Maud Gulf area use wetlands[1] and tussock/hummock tundra[2] habitats in the summer (Gunn and Sutherland, 1997). The inclusion of ELC units that are not typified by willow forage (e.g., heath tundra community) but which may have other values (e.g., resting habitat), increases the area of potential summer habitat in the study areas to a combined coverage that ranges from 35% in the RSA to 50% in the LSA. Gunn and Sutherland (1997) also found that single bulls and bachelor groups used the immediate vicinity of waterbodies more often than any other age or sex class. Small waterbodies are relatively common in the Meadowbank area. Area coverage ranges from 24% in the RSA to 40% in the LSA (Table 5.2). The fringes of these waterbodies may support Muskox forage such as sedges.

Habitat Association

During the fall, the majority of observations of muskoxen in the Meadowbank area were associated with heath tundra, and to a lesser extent, lichen-rock habitat (Figure 5.13). There was also a single observation associated with esker habitat (Figure 5.13).

Information on spring and fall habitat use by muskoxen in the eastern Arctic was not found. Habitat use in these seasons is presumed to be similar to that of other seasons, that is, wetter habitat types that support abundant sedges and grasses are preferred.

The three Meadowbank study areas are ranked the same for muskox habitat suitability – low to moderate in spring, fall, and winter, and moderate in summer (Table 5.9).

[1] Similar ELC units: Sedge, Birch Seep, Riparian Shrub, and Moss communities
[2] Similar ELC unit: Heath Tundra Community

5.3.6.2 Large Carnivores

Three large carnivores are considered key wildlife resources based on their conservation status. They are grizzly bear, wolf, and wolverine.

Grizzly Bear

Status

The grizzly bear is designated as sensitive in Nunavut (Government of Nunavut, 2001), and is listed as a species of special concern by COSEWIC (2002). There is no demographic data for grizzly bears in Kivalliq, but the west Kitikmeot population is thought to be stable or slightly increasing (McLoughlin, 2001).

Grizzly bears are distributed across most of mainland Nunavut except for the northeast (including Boothia and Melville Peninsulas) and the coastal fringe south of Chesterfield Inlet (McLoughlin, 2001). They are also found on some of the larger islands (e.g., Banks; McLoughlin, 2001). Population density decreases from west to east, but traditional knowledge suggests that the grizzly bear's range is expanding east (McLoughlin, 2001). Information on the ecology of the grizzly bears in Kivalliq is extremely limited (McLoughlin, 2001).

Results of Baseline Surveys

Baseline surveys indicated limited use of the Meadowbank area by grizzly bears. The only observation was a sow and two cubs observed in spring of 1999 northeast of the LSA (Appendix A.17). Evidence of bears digging out arctic ground squirrels was noted in a few locations in the RSA (Appendix A.17); however, no grizzly bear dens were identified in the study area. These data are consistent with what would be expected for grizzly bears in the north, given that this is a wide-ranging species that occurs at low densities (e.g., 3.5 individuals/1,000 km^2 in the west Kitikmeot-NWT border area [McLoughlin, 2001]).

Ecology

Eskers[1] and tall shrub riparian[2] habitats were preferred throughout the year by grizzly bears in the central Canadian Arctic (McLoughlin et al, 2002a). Home ranges contained more esker, tussock/hummock successional tundra[3], lichen veneer, birch seep[4], and tall shrub riparian, relative to the availability of other habitats (McLoughlin et al, 2002a). Habitat preference varied among the active seasons, and there was some variation in habitat preference among males and females with cubs. In general, females with cubs avoided the habitats preferred most strongly by males (McLoughlin et al, 2002a).

Research by Gau et al (2002) in the central Canadian Arctic indicated that caribou are a very important food for barren-ground grizzly bears, particularly during spring and fall migration when

[1] Similar ELC units: Ridge Crest communities, Eskers and Avens Community
[2] Similar ELC unit: Riparian Shrub Community
[3] Similar ELC unit: Heath Tundra Community
[4] Similar ELC unit: Birch Seep Community

caribou were plentiful in the study area (Gau et al, 2002). In early summer, when caribou were uncommon in the area, grizzly bears foraged on horsetail, cotton grass, and sedges (Gau et al, 2002). The preferred habitat in this season was tall shrub riparian (McLoughlin et al, 2002a). Although the riparian shrub community ELC unit is rare in the study areas (≤2%; Table 5.2), bears in the Meadowbank area may use the sedge community ELC unit for early summer forage (e.g., horsetails and sedges). This unit is available to a small extent in the study areas (<6% coverage; Table 5.2).

Berries are fed on to some extent in the spring, and then again later in the year (Gau et al, 2002). In the late summer in the central Arctic, crowberry, bog blueberry, cranberry, and bearberry were more commonly eaten than at any other time of the year (Gau et al, 2002). Berry-producing habitats, represented by the Heath Tundra Community ELC unit, are relatively common in the study areas (25 to 34% coverage; Table 5.2).

Although eskers are often cited as being the predominate habitat used for denning (Mueller, 1995), research in the central Canadian Arctic suggests that, while they are used, they are not the most common denning habitat (McLoughlin et al, 2002b). Dens were also found in heath tundra, tall shrub riparian, birch seep, and heath tundra-boulder[1] habitats (McLoughlin et al, 2002b). Eskers and esker-type ELC units (e.g., ridge crest community associations and avens community) are uncommon in the three study areas (RSA: <1%; LSA: <3%; winter road corridor: none; Table 5.2). Some of the other potential denning habitats, however, are common in the area: heath tundra, heath tundra-lichen-rock community and lichen-rock community – boulder association (combined coverage = RSA: 53%; LSA: 40%; winter road corridor: 45%) (see Table 5.2).

Habitat Association

The relatively low abundance of caribou in the spring and summer in the Meadowbank area suggests that the area may not be particularly high value for grizzly bears at this time of the year. In the fall, when caribou are more abundant, the Meadowbank area may have higher value for grizzly bears. Otherwise, any bears in the area may be relying more on plant matter and arctic ground squirrels than on caribou. Arctic ground squirrels frequently occurred as a food item in all active seasons in the central Canadian Arctic (Gau et al, 2002). Baseline surveys indicate that squirrels are present in the RSA and LSA, but their abundance is unknown.

The three study areas are ranked the same for grizzly bear habitat suitability—low to moderate in spring, summer, and winter, and moderate in fall. Females with cubs may find the area of higher value than any other sex, age, and reproductive classes because of the potential for avoidance of adult males. No observations of grizzly bear habitat use in the Meadowbank area were collected during the baseline surveys.

Wolf

Status

The wolf is listed as sensitive in Nunavut (Government of Nunavut, 2001), but is not federally listed (COSEWIC, 2002). Wolf populations are stable or increasing within their range, except in northern

[1] Similar ELC units: Lichen-Rock Community – Boulder Association and Heath Tundra-Lichen-Rock Community

Alberta and some parts of the NWT (Hayes and Gunson, 1995). Baker Lake residents have indicated that the wolf harvest in the Meadowbank area has increased in recent years (Appendix A.1); however, regional population numbers and trends remain poorly understood.

Wolves are distributed throughout the NWT and Nunavut (Banfield, 1974). Their patterns of distribution, densities, territory boundaries, and dispersal movements are influenced by interactions between packs, and by prey abundance and distribution (Fuller and Keith, 1980; Ballard et al, 1987). Densities in northern Canada have been recorded as low as one wolf per 944 km^2 (van Zyll de Jong and Carbyn, 1998).

The annual ranges of arctic wolves are much larger than those of wolves that rely on resident rather than migratory (i.e., barren-ground caribou) prey (Walton et al, 2001). A study in the central Canadian Arctic estimated annual range sizes of approximately 63,000 km^2 for males, and approximately 45,000 km^2 for females (Walton et al, 2001). The same study also indicated that winter ranges were larger than summer ranges.

Results of Baseline Surveys

Wolves were observed infrequently throughout the RSA during all survey sessions, but were most common in the fall (1 to 7 observations; Figure 5.11; Appendix A.13), perhaps in response to the increased caribou abundance at that time of the year. Wolves apparently reproduce in the area as two young pups were observed with two adults during the fall 2002 RSA survey. Camp personnel also observed wolf pups within the LSA, on the east side of Tern (John) Lake, in July 2002 (Appendix A.9). Incidental observations of wolves have been made regularly close to camp during most months of camp operation (Appendix A.9). Wolves tend to be observed farther from camp than foxes. Tracks from a pair of wolves were recorded in the LSA in spring 1999. No den site locations have been found in the LSA, and only two have been confirmed in the RSA, although numerous dens of unknown species have been recorded there (Appendix A.18).

Ecology

Caribou are essential to the existence of wolves in the Arctic. In the Thelon River area, caribou was the main prey species in the spring and summer (Kuyt, 1972). Other prey items (i.e., muskoxen, ermine, wolverine, wolf, fox, arctic hare, arctic ground squirrel, lemmings, voles, geese, ptarmigan, fish, and insects) were taken only rarely during that period (Kuyt, 1972). In winter in the same area, wolves appeared to feed almost exclusively on caribou (Kuyt, 1972).

Mueller (1995) found that wolves in the central Canadian Arctic denned almost exclusively on sandy eskers; however, Heard et al (1996) found that the dens of ‘tundra’ wolves (resident all year round above the tree line) might sometimes be simple scrapes on the tundra. Eskers and esker-type ELC units (e.g., ridge crest community associations and avens community) are uncommon in the three study areas (RSA: <1%; LSA: <3%; winter road corridor: none; Table 5.2).

Habitat Association

During the fall, the majority of observations of wolves in the Meadowbank area were associated with lichen-rock habitat, although a few observations were also recorded in transitional and heath tundra habitats (Figure 5.13).

In the Meadowbank area, caribou is the only ungulate that occurs in sufficient numbers to support wolves; therefore, prey (i.e., caribou) availability, rather than habitat availability, is most likely to be the determining factor regarding the suitability of the Meadowbank area for wolves. For this reason, wolf habitat suitability in the three study areas reflects caribou abundance patterns—moderate in winter and spring, very low in summer, and high in fall. The apparently limited denning habitat in the area also accounts for the very low ranking for wolf summer habitat suitability.

Wolverine

Status

The wolverine is listed as sensitive in Nunavut (Government of Nunavut, 2001), and the western Canadian population (which includes Nunavut) is considered vulnerable (COSEWIC, 2002). Wolverine is an important furbearing species for residents of Baker Lake, and the maintenance of a healthy population of the species is important for local trappers.

Wolverines are solitary animals that occur at densities that are generally low relative to other carnivores (Banci, 1994). Trapping data indicate that wolverine populations have decreased in many regions of the NWT in the last 20 years (Banci, 1994; Peterson, 1997); however, population estimates for the NWT (including Nunavut) suggest there is a stable (or increasing), sparsely distributed population of more than 3000 animals (Dauphiné, 1989; NWTRWED, 2001a). Wolverines are less abundant in the eastern Canadian Arctic than in the west and central Canadian Arctic (Dauphiné, 1989).

Results of Baseline Surveys

Records of wolverine sightings or their sign were infrequent in the Meadowbank area. Camp personnel observed a lone wolverine south of camp in April 2002 (Appendix A.9), and wolverines have been seen in the Aberdeen area (southwest of the RSA) in groups of five or six during March and April (Appendix A.1). There was one wolverine recorded during the fall 2002 ground survey in the LSA (Figure 5.6), and tracks were seen during a spring reconnaissance flight in the area. Similar to grizzly bears, the limited evidence for wolverine in the area is not surprising given their wide-ranging movements and characteristically low population density.

Ecology

Food availability is the fundamental factor influencing movement patterns and home range selection by wolverines, although the habitat use patterns of adult males are also influenced by breeding activities (Banci, 1994). During the winter, wolverine distribution is determined by the distribution of ungulates because wolverines rely on the availability of ungulate carrion (Banci, 1987). Wolverine productivity then is closely tied to the status of caribou and wolf populations (Dauphiné, 1989; Mulders, 1999).

Key habitats for wolverines in the central Canadian Arctic included boulder fields[1], and riparian tall shrub[2] and fractured bedrock[3] sites (AXYS and Penner & Associates Ltd., 1998). These habitats are relatively common in the RSA (combined coverage: 41%), but less common in the LSA (combined coverage: LSA: 12%; winter road corridor: 18%; Table 5.2).

Habitat Association

No observations of wolverine habitat use are available for the Meadowbank area. Given the link between wolverines and caribou, with respect to food availability, wolverine habitat suitability in the RSA is ranked according to caribou abundance—moderate in spring and winter, low in summer, and high in fall (Table 5.9). The lower coverage of potentially important wolverine habitat (e.g., lichen-rock community associations) in the LSA and winter road corridor reduces wolverine habitat suitability in these study areas to low to moderate in winter and spring, very low in summer, and moderate in fall.

5.3.6.3 Small Carnivores

The arctic fox and ermine were selected as key wildlife resources for the furbearer group because of their importance to local trappers. The red fox was not considered a key wildlife resource because, although it is sympatric with the Arctic fox in the low Arctic (Elmhagen et al, 2002), it occurs only sparsely in the Baker Lake area (NWTRWED, 1999) and was not identified as being important for local trappers.

Arctic fox

Status

The arctic fox is considered secure in Nunavut (Government of Nunavut, 2001) and is not listed federally (COSEWIC, 2002). Population numbers show dramatic fluctuations with peaks approximately every four years, following lemming population peaks (Novak et al, 1987). The population size in Nunavut is unknown.

Arctic foxes are widely distributed throughout the tundra regions of northern Canada (NWTRWED, 2001b). The natural southern limit of their distribution is the treeline, but some foxes venture into the boreal forest, especially when their food supply becomes limited on the tundra (NWTRWED, 2001b). Arctic foxes are known to make long distance movements on land or across the sea ice (Eberhardt and Hanson, 1978; NWTRWED, 2001b).

[1] Similar ELC unit: Lichen-Rock Community – Boulder Association
[2] Similar ELC unit: Riparian Shrub Community
[3] Similar ELC unit: Lichen-Rock Community – Bedrock Association

Results of Baseline Surveys

Arctic foxes were observed infrequently during the baseline surveys in the LSA (5 or fewer observations, Figure 5.6). No foxes were recorded during the winter survey (Figure 5.6). Camp personnel, however, have regularly observed arctic foxes close to camp and in and around camp buildings during most months of operation, including winter (Table 5.8; Appendix A.9). There were no observations of arctic foxes during the RSA baseline aerial surveys. The apparent low abundance of foxes in the Meadowbank area may be due to poor survey detectability, or to the population being in the low phase of their population cycle at the time of the baseline surveys. Six fox dens were positively identified in the RSA, although numerous dens of unknown species have been recorded there (Appendix A.18). Only one fox den has been found in the LSA. Fox den density in the Aberdeen Lake area, approximately 110 km southwest of the RSA, was estimated as one per 36 km^2 (Macpherson, 1969).

Ecology

Arctic foxes are dependent on dens for rearing their young (Smits et al, 1989). Den sites in central Kivalliq (formerly Keewatin) typically occurred on sandy, well-vegetated gentle slopes (Macpherson, 1969). Areas where eskers or moraines overlooked broad valleys or river flats appeared to have the most den sites (Macpherson, 1969). Dens were sparse in areas where bedrock and boulders[1] were common (Macpherson, 1969). Research in the central Canadian Arctic found that arctic foxes denned almost exclusively on sandy eskers (Mueller, 1995). Eskers and esker-type ELC units (e.g., ridge crest community associations and avens community) are uncommon in the three study areas (RSA: <1%; LSA: <3%; winter road corridor: none; Table 5.2); however, arctic foxes are adaptive and opportunistic in den site selection (Smits et al, 1988), and denning habitat may not be as limited in the Meadowbank area as the ELC suggests. For example, foxes may den among boulders rather than excavating a site (Macpherson, 1969).

Habitat Association

No observations of arctic fox habitat use are available for the Meadowbank area. Similar to the large carnivores, prey (e.g., small mammals) availability is a significant factor in determining habitat suitability for the arctic fox. Extrapolating the moderate to high suitability of the LSA for lemmings and voles to the RSA/winter road corridor, and considering the potentially limited availability of denning sites, arctic fox habitat suitability in the three study areas is likely moderate in all seasons.

Ermine

Status

The ermine is considered to be secure in Nunavut (Government of Nunavut, 2001) and is not listed federally (COSEWIC, 2002). It is considered an important species for local trappers.

[1] Similar ELC units: Lichen-Rock Community – Boulder Association and Lichen-Rock Community – Bedrock Association

The ermine is circumboreal in distribution, and is found throughout the Canadian Arctic (King, 1983). Ermine populations fluctuate in relation to changes in prey abundance (King, 1983). Data on the ecology and demography of the arctic ermine are very limited.

Results of Baseline Surveys

There is some evidence of the presence of ermine in the Meadowbank area. Tracks were recorded in spring 1999 in the LSA, and camp personnel have observed an ermine around camp twice in mid-May 2002 (Appendix A.9). In June 2003, an ermine was observed during surveys for breeding birds. Despite relatively few sightings, it is likely that ermine are relatively common in the Meadowbank area.

Ecology

In cold climates, ermine hunt under the snow, and their diet may be almost entirely lemmings and voles (King, 1983). In the winter, ermine will occupy the nests of their prey (Reid and Krebs, 1996).

Habitat Association

No observations of ermine habitat use are available for the Meadowbank area. Given the relatively small annual range of the ermine, habitat suitability was assessed for the LSA only. Ermine distribution is closely related to that of lemmings and voles. For this reason, ermine habitat suitability in the LSA is ranked the same as for the collared lemming and northern red-backed vole (Section 5.3.6.5); that is, ranked from moderate to high in all seasons.

5.3.6.4 Small Mammals

Small mammals are important prey species for mammalian and avian predators in the Arctic, and for this reason, they are considered collectively as a key wildlife resource. The arctic hare, arctic ground squirrel, collared lemming, and northern red-backed vole were selected as representative species for this key wildlife resource group. There were no baseline surveys designed specifically for lemmings and voles in the Meadowbank area.

Arctic Hare

Status

The arctic hare is considered to be secure in Nunavut (Government of Nunavut, 2001) and is not listed federally (COSEWIC, 2002).

The species is widely distributed north of the treeline in Canada (Best and Henry, 1994; Atlantic Canada CDC, 2003). Hares in the southern part of their range may move into the boreal forest in the winter (Best and Henry, 1994). Likely predators of the arctic hare in the Meadowbank area are raptors, arctic foxes, wolves, and wolverines.

Results of Baseline Surveys

Arctic hares were recorded in relatively small numbers in the spring, summer, and fall in the LSA (2-25 observations, Figure 5.6). They were, however, the most frequently observed mammal species, after caribou, in the LSA in the fall (Figures 5.5 and 5.6). Hare pellet densities in the LSA were higher in the winter than in the fall (Figure 5.7), but this may be an artifact of increased detection when snow is present. Pellet densities were particularly high at observation stations (i.e., high points on the landscape) where hares may have been seeking shelter behind boulders, or watching out for potential predators. The apparent greater abundance of hares in the fall relative to the other seasons (Figures 5.5 and 5.6) is, again, more likely the result of increased detectability (i.e., white hares are visible against dark vegetation) rather than an indication of high productivity. Camp personnel frequently observed hares in camp throughout the operating period (Table 5.8; Appendix A.9).

Ecology

Arctic hares in the central Canadian Arctic use bouldery heath tundra, tussock/hummock, and sedge habitats[1] during the spring and summer (AXYS and Penner & Associates Ltd., 1998). In the winter, they use exposed ridges of heath tundra, esker tops, and other snow-free areas that are typically associated with boulder and fractured bedrock (AXYS and Penner & Associates Ltd., 1998). Boulders are used for thermal and hiding cover throughout the year (AXYS and Penner & Associates Ltd., 1998). High value arctic hare ELC units (e.g., heath tundra community, sedge community and lichen-rock community – boulder association) are common in the LSA (combined coverage: 46%; Table 5.2).

Habitat *Association*

During the fall, the majority of observations of arctic hares in the Meadowbank area were associated with lichen-rock habitat and, to a lesser extent, heath tundra (Figure 5.13). Given the relatively small annual range of the arctic hare, habitat suitability was assessed for the LSA only, where it was ranked as high in all seasons.

Arctic Ground Squirrel

Status

The arctic ground squirrel is considered to be secure in Nunavut (Government of Nunavut, 2001) and is not listed federally (COSEWIC, 2002).

Arctic ground squirrels are found throughout the northern boreal forest and Arctic tundra (Hubbs and Boonstra, 1997); however, information on the abundance and distribution of this species in the Arctic is scarce. The main predator of the arctic ground squirrel in the Meadowbank area is likely the grizzly bear, which is easily capable of excavating squirrel colonies.

[1] Similar ELC units: Heath Tundra Community, Sedge Community, and Lichen-Rock Community – Boulder Association

Results of Baseline Surveys

Arctic ground squirrels were recorded in relatively small numbers in the spring, summer, and fall in the LSA (4-15 observations; Figure 5.6). They were, however, the most frequently observed mammal species in the LSA in the summer (Figure 5.6). Their pellet densities in the fall were lower than for arctic hare (Figure 5.7). Camp personnel recorded no observations of arctic ground squirrels until mid-May, when a few individuals were reported in and around camp (Appendix A.9). Ground squirrels were observed regularly during June 2003 breeding bird surveys. Arctic ground squirrel burrows were observed occasionally during off-transect aerial surveys along three eskers in the RSA (Appendix A.18).

Ecology

Arctic ground squirrel colonies are usually found in sandy or gravelly soil on steep slopes or ridge tops, and along riverbanks (Martell et al, 1984), and they are known to be common in esker habitats (Mueller, 1995; McLoughlin et al, 2002a). Esker-type ELC units (e.g., ridge crest community associations and avens community) are, however, uncommon in the LSA (<3% coverage; Table 5.2).

Habitat Association

During the fall, all observations of arctic ground squirrels in the Meadowbank area were associated with either heath tundra or eskers (Figure 5.13). Burrows noted during baseline surveys were typically concentrated in areas with sandy substrates suitable for digging, such as eskers or grassy slopes. Given the relatively small annual range of the arctic ground squirrel, habitat suitability was assessed for the LSA only, where it was ranked as moderate in all seasons.

Collared Lemming

*Statu*s

The status of the Collared lemming in Nunavut is undetermined (Government of Nunavut, 2001) and the species is not listed federally (COSEWIC, 2002).

Collared lemmings have a nearly circumpolar distribution (Federov et al, 1999), and genetic analyses suggest that they disperse long distances over sea ice (Ehrich et al, 2001). This species is well known for its population cycles (Ehrich et al, 2001; Wilson and Bromley, 2001), although Krebs et al (1995) and Predavec et al (2001) provide evidence of non-cyclic populations. Synchrony between the population abundance of lemmings and voles has been demonstrated in the Canadian Arctic (Krebs et al, 2002). There are also links between lemming cycles, arctic fox predation, and the reproductive success of geese in the Arctic as explained by the alternate prey hypothesis (Wilson and Bromley, 2001; Bêty et al, 2001).

Results of Baseline Surveys

Although the collared lemming has not yet been confirmed in the Meadowbank area, it is highly probable that it occurs there. Likely predators of this lemming in the Meadowbank area are rough-legged hawk, arctic fox, and ermine. Grizzly bears, arctic ground squirrels, and snowy owls may also prey on this species (Reid et al, 1995).

Ecology

Collared lemmings appear to be very selective in their habitat use and home range characteristics across their distribution (Predavec and Krebs, 2000). They are found in relatively dry tundra habitats such as ridges and hummocks, and areas with an abundance of low willow shrubs (Martell and Pearson, 1978; Rodgers and Lewis, 1986; Larter 1998; Predavec and Krebs, 2000; Wilson and Bromley, 2001; Calef and Hubert, 2002). Comparable ELC units, such as the ridge crest community associations and avens community, are uncommon in the LSA (<5% coverage; Table 5.2); however, drier associations within some other ECL units (e.g., heath tundra community) may also provide suitable habitat, and are more common in the LSA (34% coverage; Table 5.2).

Winter nests of the collared lemming in the western Arctic were strongly associated with remnant snow in the spring, which indicates that they were selecting for deep snow areas (Reid and Krebs, 1996). The snowbank community ELC unit, which holds snow longer than other habitats in the LSA, is very uncommon (<1% coverage) in the Meadowbank area (Table 5.2).

Habitat Association

Given the relatively small annual range of the collared lemming, habitat suitability was assessed for the LSA only; however, even for this smaller study area, the scale at which the ELC units were mapped is not particularly informative for an animal that is likely selecting for microhabitats. It is apparent, though, that suitable habitat for these small mammals exists in patches throughout the LSA. Collared lemming habitat suitability in the LSA then, is ranked moderate in all seasons.

Northern Red-Backed Vole

Status

The status of the northern red-backed vole in Nunavut is undetermined (Government of Nunavut, 2001) and the species is not listed federally (COSEWIC, 2002).

The northern red-backed vole is found throughout much of northern Canada. In the south, it is replaced by the southern red-backed vole (*C. gapperi*); however, the exact distributions of these species are unknown due to the difficulties in distinguishing between them (Banfield, 1974; NWTRWED, 2000). This species exhibits marked population fluctuations (Douglass, 1984; Gilbert and Krebs, 1991).

Results of Baseline Surveys

The northern red-backed vole has been recorded incidentally six times in the Meadowbank area, and is expected to be common throughout the area.

Ecology

Likely predators of this vole in the Meadowbank area are rough-legged hawk, arctic fox, and ermine. As with the collared lemming, grizzly bears, arctic ground squirrels, and snowy owls may also prey on this species.

Northern red-backed voles occur in all tundra habitats except those that are exclusively sedges and grasses[1] (Martell and Pearson, 1978). Their niche is broad because their morphological, physiological, and ecological characteristics can be variable (Whitney, 1976; Douglass, 1984).

Habitat Association

Given the relatively small annual range of the northern red-backed vole, habitat suitability was assessed for the LSA only; however, even for this smaller study area, the scale at which the ELC units were mapped is not particularly informative for an animal that is likely selecting for microhabitats. It is apparent, though, that suitable habitat for this generalist small mammal exists throughout the LSA. Northern red-backed vole habitat suitability in the LSA then, is ranked as high in all seasons.

5.3.7 Birds

More than 160 species of birds have been recorded within the mainland region of Nunavut (Richards et al, 2002). A literature review of all these species was not possible for this report; consequently, the following five guilds of birds, which were considered representative of the bird community in the Meadowbank proposed project area, were selected for review: waterfowl, raptors, ptarmigan, shorebirds, and passerines. Within each guild, species were selected as key wildlife resources according to one or more of the following criteria: conservation status; abundance and distribution in the proposed project area, as known from the baseline surveys and literature review; importance to subsistence harvest; importance of role in predator-prey systems; and sensitivity of critical habitat requirements. The following review highlights those select species. Where information on bird species population trends for Nunavut was lacking, information from the Northwest Territories was used.

5.3.7.1 Waterfowl

Twenty-eight species of waterfowl have been recorded within the mainland region of Nunavut. These include five species of geese, two species of swans, and 21 species of ducks (Richards et al, 2002). Twenty species have been recorded as breeding on the mainland and one other species is suspected to be breeding (Richards et al, 2002).

The Canadian Wildlife Service identified two key habitat sites for migratory birds in the region. The first site is on the Thelon River and includes the area from Eyeberry Lake to Aberdeen Lake, plus a portion of the Dubawnt River. This site provides habitat for summer moulting Canada geese, breeding greater white-fronted geese and snow geese, and breeding and moulting tundra swans (Alexander et al, 1991). The second site, the Middle Quoich River, which includes the Tehert River and the east end

[1] Similar ELC unit: Sedge Community

of Tehek Lake (which is within the RSA), was identified as important summer moulting ground for Canada geese (Alexander et al, 1991).

During baseline surveys, 10 waterfowl species were recorded: tundra swan, greater white-fronted goose, snow goose, Ross' goose, brant goose, Canada goose, mallard, northern pintail, long-tailed duck, and red-breasted merganser (Appendices A.14 and A.19). Waterfowl were found throughout the RSA, although more sightings and larger numbers of waterfowl were recorded in the southern half of the RSA than in the northern half (Appendices A.14 and A.19). No evidence of reproduction was documented during any of the baseline surveys, although it likely occurred in the area.

None of the waterfowl species recorded in the RSA are considered at risk by COSEWIC (2002); however, Ross' goose is listed as sensitive by the Canadian Endangered Species Conservation Council (2001). It is also listed as sensitive by the Government of Nunavut (2003), as is the northern pintail.

Key wildlife resources within the waterfowl guild were selected based on their apparent abundance in the general region of the RSA, conservation status, and/or their use in the subsistence harvest. Residents of Baker Lake hunt geese and ducks in late spring and early summer (Interdisciplinary Systems Ltd., 1978). The species selected for this review are greater white-fronted goose, snow goose, Ross' goose, Canada goose, and long-tailed duck. Additionally, in North America, the breeding range of all these species, except the Canada goose, occurs primarily in arctic or subarctic regions.

The waterfowl key wildlife species arrive in the general area of the proposed project from mid- to late May, but fall departure dates differ considerably among species (Table 5.10). Departure dates for snow geese may be protracted throughout August and September because birds from west Hudson Bay and the central Arctic seemingly migrate through interior southern Keewatin (McLaren and McLaren, 1982). Egg laying generally occurs in June to early July, and hatching occurs from late June through late August (Table 5.11).

Table 5.10: Spring Arrival & Fall Departure Dates for Waterfowl Recorded in the Warden Grove Area, Thelon River, 1977-1978 (Norment, 1985)

Species	Arrival Date	Departure Date
Greater white-fronted goose	17 May	16 August
Snow goose	18 May	not reported
Ross' goose	30 May	not reported
Canada goose	13 May	6 October
Long-tailed duck	30 May	24 September

Table 5.11: Waterfowl Breeding Chronology

Species	Location	Egg laying	Hatching	Reference
Greater white-fronted goose	North-central NWT	4-9 June	-	Ely and Dzubin, 1994
	Yukon	12-24 June	21 June-1 August	Sinclair et al, 2003
Snow goose	Southampton Island, Nunavut	4 June-23 June	-	Bellrose, 1976
	Yukon	-	26 June	Sinclair et al, 2003
Ross' goose	Karrak Lake, Nunavut	First three weeks of June	Late June-mid-July	Ryder and Alisauskas, 1995
Canada goose	Central Yukon	-	12 July-5 August	Sinclair et al, 2003
Long-tailed duck	Chesterfield Inlet, Nunavut	23 June-7 July	10 July	Hohn, 1968
	Yukon	17 June-9 July	4 July-21 August	Sinclair et al, 2003

Summer and fall aerial surveys conducted in the RSA indicated that, in terms of relative abundance, the snow goose was the most common waterfowl key wildlife species, followed by the Canada goose, and greater white-fronted goose (Figure 5.12; Appendix A.14). The snow goose was also the most frequently observed waterfowl key wildlife species during the fall survey, whereas the Canada goose was most common during the summer survey (Figure 5.12; Appendix A.14). Both snow goose and Canada goose were regularly reported by camp personnel during the migratory periods (Table 5.7; Appendix A.9).

During fall aerial surveys in the RSA and LSA, observations of waterfowl were most commonly associated with aquatic habitats, although heath tundra and lichen-rock sites were also used (Figure 5.14).

The only waterfowl key wildlife species recorded during 2002 and 2003 fall ground survey in the LSA were Canada goose and long-tailed duck (Figure 5.8). Both species were observed on an aerial survey of the LSA in June 2003 (Appendix A.20).

Greater White-fronted Goose

Status

The greater white-fronted goose is listed as secure in Nunavut (Government of Nunavut, 2001). Population estimates were not found for Nunavut, but in the Northwest Territories, its numbers are estimated at 10,000 (NWTRWED, 2000). Greater white-fronted geese that occur in the project area belong to the mid-continent population, which is believed to be increasing (Ely and Dzubin, 1994; Canadian Wildlife Service Waterfowl Committee, 2000).

Results of Baseline Surveys

Within the general area of the proposed Meadowbank project, the greater white-fronted goose was recorded only during fall aerial surveys in the RSA (Figure 5.12, Appendix A.14). No observations were made during other seasons, or in the LSA.

Ecology

Breeding habitat in the Arctic typically includes hummocky ground in lowland and upland areas, raised edges of polynas, dry slopes, dry grassy areas at the edge of rocky outcroppings, and areas around streams, small ponds, and shallow lakes. The species will often nest in areas used in previous years. Greater white-fronted geese do not replace lost clutches, but will continuing laying if the first few eggs in a clutch are lost (Ely and Dzubin, 1994). In inland Kivalliq (Keewatin) and the Queen Maud Gulf lowlands, greater white-fronted geese moult on flat plains, sedge-graminoid meadows, and stream and lake edges (Alexander et al, 1991). Migration habitat in the Arctic consists of sheltered estuaries and brackish intertidal zone marshes, wetlands, and riparian and river delta areas (Ely and Dzubin, 1994). Plant matter forms the bulk of the species' diet (Ely and Dzubin, 1994).

Habitat Association

During the fall, observations of greater white-fronted geese in the Meadowbank area were associated primarily with aquatic habitats, although heath tundra sites were also used (Figure 5.14). Results of previous aerial surveys for waterfowl that were conducted as part of the Polar Gas development suggested that the Meadowbank region did not provide significant habitat for waterfowl (Allen and Hogg, 1978). Additionally, no Important Bird Areas (IBAs) have been identified for this region (M. Setterington, pers. comm., 2002). Results of the ELC indicate that 24% of the RSA, and 40% of the LSA (Table 5.2) consists of water bodies that are associated with heath tundra communities. Although this would suggest that both the LSA and RSA provide abundant habitat for breeding and staging waterfowl, suitable foraging habitat is likely limited because the wetlands in these areas are considered to be relatively unproductive.

Snow Goose

Status

In Nunavut, the snow goose is listed as secure (Government of Nunavut, 2001). Although estimates of its numbers in Nunavut were not found, its population in the Northwest Territories is considered to be 1.4 million (NWTRWED, 2000).

Results of Baseline Surveys

The snow goose was the most common key waterfowl species recorded during aerial surveys in the RSA (Figure 5.12, Appendix A.14). Greater numbers were recorded in the fall than in the spring, and no observations were made during the summer survey (Figure 5.12). No observations were made in the LSA. Camp personnel recorded snow geese on several occasions during the spring and fall migratory period (Appendix A.9).

Ecology

The snow goose nests in colonies on low, grassy tundra plains, along shallow rivers and streams, near ponds and shallow lakes, and on islands in shallow lakes (Bellrose, 1976; NWTRWED, 2000). In southern Kivalliq (Keewatin), major nesting colonies are located along the west coast of Hudson Bay, although colonies also occur inland around such areas as Pitz and Baker Lakes (McLaren and McLaren, 1982). Snow geese often re-use nest sites that were occupied in previous years (Mowbray et al, 2000). They are not known to replace lost clutches (Mowbray et al, 2000). Snow geese feed primarily on sedges, grasses, horsetails, and berries (Bellrose, 1976).

Habitat Association

During the fall, observations of snow geese in the Meadowbank area were associated almost exclusively with aquatic habitats, but heath tundra sites were also used occasionally (Figure 5.14). Results of the ELC indicate that 24% of the RSA and 40% of the LSA (Table 5.2) consist of water bodies that are associated with heath tundra communities; however, these wetlands are considered to be relatively unproductive.

Ross' Goose

Status

The Government of Nunavut (2001) and the Canadian Endangered Species Conservation Council (2001) lists the Ross' goose as sensitive. Most of the population breeds in the Queen Maud Gulf Migratory Bird Sanctuary, but small numbers also nest in the western Arctic, on Southampton and Baffin Islands, and on the south and west coasts of Hudson Bay.

Results of Baseline Surveys

The only observation of the Ross' goose was of a single bird on the northern border of the RSA during the spring aerial survey (Appendix A.14).

Ecology

The species typically nests in colonies, often in association with the snow goose. Nesting occurs on sparsely vegetated islands in shallow lakes, and on adjacent mainland areas. Nest sites are often protected from the wind. Fidelity to nest sites has not been recorded, but some sites are used annually. Information on migratory habitat used between the breeding grounds and northern Alberta is lacking. Primary food items include grasses, sedges, and legumes (Ryder and Alisauskas, 1995).

No observations of habitat use are available for the Meadowbank area.

Canada Goose

Status

The Canada goose is listed as secure in Nunavut (Government of Nunavut, 2001). Population estimates were not found for Nunavut, but in the Northwest Territories, the species is expected to number around 300,000, although numbers of tundra nesting geese are increasing (NWTRWED, 2000).

Results of Baseline Surveys

Within the LSA, the Canada goose was observed in low numbers, and only during the fall aerial survey (Figure 5.5). Greater numbers were recorded in that area, however, during the summer and fall ground surveys (Figure 5.8). Migrating flocks of Canada geese were observed regularly during the June 2003 breeding bird surveys (Table 5.6 or 5.7). Within the RSA, most observations of Canada geese were made in summer, followed by fall, and then spring (Figure 5.12; Appendix A.14).

Ecology

Canada geese nest individually or semicolonially (Mowbray et al, 2002). In the Arctic, this species generally nests in short vegetation (e.g., sedges, dwarf shrubs, lichens) on islands in small tundra lakes and ponds, or in riparian borders of lakes, ponds, and rivers (Mowbray et al, 2002). At McConnell River, Nunavut, Canada geese nested on small, hummocky, moss-covered islands in an area of coastal marshes that were dissected by braided streambeds and small ponds (MacInnes, 1962). In the Thelon River valley, colonies of Canada geese nest on cliffs and steep rock slopes of the Clarke River (Norment et al, 1999). Fidelity to breeding sites is not known, but is believed to be high (MacInnes et al, 1974). In temperate areas, Canada geese may lay replacement clutches if the first is lost during laying or incubation (Mowbray et al, 2002). Brood-rearing and moulting habitats are similar to breeding habitat, and generally consist of ponds, lakes, and rivers with abundant food resources (Mowbray et al, 2002). Similar habitats, plus coastal salt marshes, brackish ponds, tidal flats and sand and gravel bars, upland health, and grassy fields are used during migration (Mowbray et al, 2002). Canada geese are primarily herbivorous; their main food sources include grasses, sedges, seeds, and berries (Mowbray et al, 2002).

Habitat Association

Small flocks of Canada geese were observed during the summer in the Meadowbank area in 2002. During the fall, observations of Canada geese in the Meadowbank area were associated primarily with aquatic habitats, although heath tundra and lichen-rock sites were also used (Figure 5.14).

Results of previous aerial surveys for waterfowl that were conducted as part of the Polar Gas development suggested that the Meadowbank region did not provide significant habitat for waterfowl (Allen and Hogg, 1978). The Canadian Wildlife Service, however, identified the Middle Quoich River area, which includes the eastern portion of Tehek Lake, as a key habitat site for moulting Canada geese (Alexander et al, 1991).

Long-tailed Duck (previously Oldsquaw)

Status

The long-tailed duck is listed as secure in Nunavut (Government of Nunavut, 2001). Although its population size is unknown, its numbers in the Northwest Territories are estimated at greater than 10,000 (NWTRWED, 2000). The western population of the species has been declining since 1977; the eastern population is likely stable (NWTRWED, 2000).

Results of Baseline Surveys

The long-tailed duck was observed during ground surveys within the LSA; however, only very low numbers were recorded, and only during the summer survey (Figure 5.8). Eight long-tailed ducks were observed on a June 2003 waterbird survey of the LSA (Appendix A.20). Only a single observation of this species was made during surveys conducted in the RSA (Appendix A.19).

Ecology

The long-tailed duck tends to nest in small colonies in tundra or tundra-like habitats in Arctic coastal and inland areas (Bellrose, 1976; Johnson and Herter, 1989). Nests are generally built close to the water's edge along ponds or lakes, or on islands, although site selection may be influenced by predation pressure from foxes, jaegers, gulls, and ravens (Bellrose, 1976; Johnson and Herter, 1989). In Manitoba and Iceland, the species has shown fidelity to breeding sites (Bellrose, 1976). Females will continue to re-lay if partial clutches are lost, but re-nesting is unlikely if the clutch is lost after incubation has begun (Bellrose, 1976). Moulting habitat consists of deep, open lakes, and coastal lagoons (Robertson and Savard, 2002). Migration usually takes place close to shore, in the offshore following ice leads, or through inland regions if ice cover is extensive (Robertson and Savard, 2002). The long-tailed duck feeds primarily on animal matter such as aquatic insects, crustaceans, and fish matter, although some plant matter is also taken (Robertson and Savard, 2002).

Habitat Association

Results of previous aerial surveys for waterfowl that were conducted as part of the Polar Gas development suggested that the Meadowbank region did not provide significant habitat for waterfowl (Allen and Hogg, 1978). Results of the ELC indicate that 27% of the RSA, and 46% of the LSA (Table 5.2) consist of wetlands (e.g., sedge communities) and water bodies that are associated with heath tundra communities. Some of these wetlands, especially smaller waterbodies with emergent vegetation edges, are suitable for long-tailed ducks.

5.3.7.2 Raptors

Sixteen species of raptors have been recorded within the mainland region of Nunavut, and eight of these are known to breed there (Richards et al, 2002). The other eight species are considered to be hypothetical or accidental occurrences; or they are visitors which are uncommon and outside their normal range (Richards et al, 2002).

Baseline surveys indicate the presence of four raptor species in the Meadowbank area: rough-legged hawk, gyrfalcon, snowy owl, and peregrine falcon (Appendix A.15). Of these four, only one, peregrine falcon (i.e., *anatum* subspecies), has been identified as a species of special concern by COSEWIC (2002). All four species were selected as key wildlife resources and are described in further detail below. Key wildlife resources within the raptor guild were selected based on their conservation status, apparent abundance in the general region of the RSA, and apparently limited and potentially vulnerable nesting habitat.

Most wildlife resource sightings were made in the western half of the RSA, particularly in the northwestern portion (Appendix A.15; Figures 5.10 and 5.12). Fall surveys found that observations of raptors were most often associated with heath tundra and esker habitats, presumably because such sites provide potential foraging and nesting habitat. Peregrine falcons have been confirmed as nesting in the RSA. It is possible that the other three raptor key wildlife resources also breed in the area (Richards et al, 2002); however, suitable nesting cliffs are not widespread in the RSA.

Information on raptor migration in the general area of the proposed project was obtained only for rough-legged hawks and peregrine falcons in the Warden Grove area along the Thelon River. Those species arrived in that area from early to mid-May, and departed in late September (Table 5.12). Gyrfalcons overwintered in the area (Norment, 1985).

Breeding chronology varies among rough-legged hawks, gyrfalcons, peregrine falcons, and snowy owls (Table 5.12). Gyrfalcons and snowy owls generally lay eggs and fledge young earlier than rough-legged hawks and peregrine falcons (Table 5.13). Norment (1985) stated that in the Thelon River area, the peregrine falcon's breeding cycle is about one month later than that of the gyrfalcon.

Table 5.12: Spring Arrival & Fall Departure Dates for Raptors Recorded in the Warden Grove Area, Thelon River, 1977-1978 (Norment, 1985)

Species	Arrival Date	Departure Date
Rough-legged hawk	3 May	24 September
Peregrine falcon	18 May	21 September

Table 5.13: Raptor Breeding Chronology

Species	Location	Egg laying	Hatching	Fledging	Reference
Rough-legged hawk	Central Nunavut	28 May-23 June	-	August	Kuyt, 1980; Poole and Bromley, 1988a
	Warden Grove area, Nunavut	28 May-25 June	-	-	Norment, 1985
Gyrfalcon[1]	Kilgavik, Nunavut	Late April to late May	Throughout June	Late July to early August	Poole and Bromley, 1988b; Martin, 1978
	Warden Grove area, Nunavut	20 May	25 June	-	Norment, 1985
Peregrine falcon	Rankin Inlet, Nunavut	Throughout June	Beginning to the third week of July	Mid-August to 1st week of September	Court et al, 1988
Snowy owl	Baffin Island	Early May to early June	-	Mid-July to late August	Watson, 1957

Notes: 1. Pair formation generally starts in late February (Poole and Bromley, 1988b; Martin, 1978). Adult birds often remain around the nest site during winter (Sinclair et al, 2003).

Rough-legged Hawk

Status

The rough-legged hawk is listed as secure in Nunavut (Government of Nunavut, 2001). Nationally, its population is thought to be declining, but in Nunavut, the population appears to be stable (NWTRWED, 2000). This hawk's population abundance tends to follow small mammal populations cycles (Shank, 1997).

Results of Baseline Surveys

The rough-legged hawk was recorded in low numbers (<5 visuals per season) in the Meadowbank RSA and LSA in the spring, summer, and fall (Figures 5.10 and 5.12, Appendix A.15). Camp personnel also reported several scattered sightings of this species (Table 5.7; Appendix A.9)

Ecology

In North America, the rough-legged hawk breeds in taiga or tundra in arctic and subarctic regions. In open tundra areas, the species typically nests on ledges of cliffs, escarpments, rocky outcroppings, and eroded riverbanks. Nests are built of sticks. Rough-legged hawks may re-nest if a clutch is lost early in the breeding season. There is little information on fidelity to a site by individual birds, but nest sites may be used over successive generations. During the breeding season, the rough-legged hawk forages in open tundra primarily for lemmings and voles, although mice and shrews are also taken (Bechard and Swem, 2002).

Habitat Association

During the fall, observations of rough-legged hawks in the Meadowbank area were associated primarily with heath tundra habitats, although observations were also made in lichen-rock sites (Figure 5.15). Habitat suitability for breeding raptors in the RSA and LSA is difficult to assess because the ELC identifies only boulder, bedrock, or esker units (Table 5.2), rather than cliff habitats, which are used for nesting. Both the RSA and LSA, however, contain large areas of heath tundra and shallow and deep-water habitats (Table 5.2), which could support prey species.

Gyrfalcon

Status

The gyrfalcon is listed as secure in Nunavut (Government of Nunavut, 2001). In this region, the gyrfalcon population declined between 1991 and 1996, possibly in response to a decline in the rock ptarmigan population that occurred between 1985 and 1996 (NWTRWED, 2000).

Results of Baseline Surveys

Gyrfalcons were recorded in low numbers (<5 visuals per season) in the Meadowbank LSA in the spring and fall (Figure 5.10), but were seen only in the fall in the RSA (two observations; Figure 5.12;

Appendix A.15). Gyrfalcons were not observed during the summer (June 2003) breeding bird surveys within the LSA.

Ecology

In North America, the gyrfalcon typically breeds in arctic and alpine tundra areas near water (Court et al, 1988; Clum and Cade, 1994; Sinclair et al, 2003). Gyrfalcons generally use little if any nesting material, but they will often use abandoned stick nests built by rough-legged hawks, common ravens, and golden eagles (*Aquila chrysaetos*) (Martin, 1978; Poole and Bromley, 1988b; Sinclair et al, 2003); consequently, nest sites are usually located on cliff ledges (Clum and Cade, 1994). Gyrfalcons are known to continue laying if eggs are taken from their nests (Clum and Cade, 1994), although no information was found on whether this is true in arctic regions. Gyrfalcon nest sites may be used for generations, although there is little information on fidelity to a site by individual birds (Clum and Cade, 1994).

Gyrfalcons typically feed on birds ranging in size from passerines to geese, but mammals the size of mictrotines to hares are also taken (Clum and Cade, 1994). Ptarmigans are their most common prey item (Clum and Cade, 1994). In the central Arctic of the NWT, gyrfalcons preyed primarily on rock ptarmigan early in the breeding season and on arctic ground squirrels during the mid-nestling period (Poole and Bromley, 1985). In the Yukon, gyrfalcons have been found hunting at waterfowl staging areas during the non-breeding season, especially in years when ptarmigan are scarce (Sinclair et al, 2003).

Habitat Association

During the fall, observations of gyrfalcons in the Meadowbank area were associated equally with heath tundra and aquatic habitats (Figure 5.15). Habitat suitability for breeding raptors in the RSA and LSA is difficult to assess because the ELC identifies only boulder, bedrock, or esker units (Table 5.2), rather than cliff habitats, which are used for nesting. Both the RSA and LSA, however, contain large areas of heath tundra and shallow and deep-water habitats (Table 5.2), which support gyrfalcon prey such as rodents, passerines, ptarmigan, shorebirds, and waterfowl.

Peregrine Falcon

Status

The peregrine falcon is listed as “may be at risk” by the Canadian Endangered Species Conservation Council (2001) and the Nunavut Government (Government of Nunavut, 2001). *Falco peregrinus tundrius*, the subspecies that breeds north of the treeline (Fyfe et al, 1976), is listed as of special concern in Canada (COSEWIC, 2002).

Results of Baseline Surveys

Only one peregrine falcon was sighted (spring) during the LSA baseline surveys; however, in spring 1999, an inactive nest site within 2.5 km of the field camp was noted incidentally. Peregrine falcons were recorded in the RSA in the spring and fall in low numbers (5 or fewer visuals per season; Figure 5.12; Appendix A.15).

In the summer of 1998, camp personnel observed a nesting falcon along the Meadowbank River (Appendix A.9). No peregrine falcons were observed during the summer (June 2003) breeding bird surveys within the LSA.

Ecology

The peregrine falcon's breeding habitat in Arctic regions generally consists of nesting cliffs near water and open landscapes for foraging (White et al, 2002; Sinclair et al, 2003). Peregrine falcons generally use little if any nesting material, but will often use abandoned stick nests built by rough-legged hawks, common ravens, and golden eagles (Sinclair et al, 2003). Peregrine falcons are known to continue laying if eggs are taken from their nests (White et al, 2002), but no information was found on whether this is true in Arctic regions. In a seven-year study at Rankin Inlet, peregrine falcons showed strong fidelity to nest sites. Changes in nest sites usually followed nesting failures at previously used sites (Court et al, 1989).

The peregrine falcon feeds primarily on birds. In a two-year study conducted at Rankin Inlet, the peregrine's most common prey items were passerines (i.e., snow buntings, Lapland longspurs, horned larks, and American pipits), followed by collared lemmings, shorebirds, and arctic ground squirrels (Bradley and Oliphant, 1991). In an earlier study, Court et al (1989) suggested that the size and productivity of the peregrine falcon population in the Rankin Inlet area varied with the abundance of microtine rodents.

Habitat Association

During the fall, observations of peregrine falcons were associated exclusively with esker sites in the Meadowbank area (Figure 5.15). Habitat suitability for breeding raptors in the RSA and LSA is difficult to assess because the ELC identifies only boulder, bedrock, or esker units (Table 5.2), rather than cliff habitats, which are used for nesting; however, tundra habitat supports prey species selected by peregrine falcons.

Snowy Owl

Status

The snowy owl is listed as secure in Nunavut (Government of Nunavut, 2001). This species' population trend tends to follow cycles in the lemming population, but is considered to be stable overall (NWTRWED, 2000).

Results of Baseline Surveys

Snowy owls were seen during baseline surveys in the summer and fall in the LSA (Figure 5.10). They were the most frequently recorded raptor (10 visuals) during the fall 2002 ground survey in the LSA

(Figure 5.10). Additionally, camp personnel recorded three observations of snowy owls in the LSA in early spring in 1997 (Appendix A.9). Snowy owls were observed in low numbers (<5 visuals per season) in the spring and fall in the RSA (Figure 5.12; Appendix A.15). Breeding status in the Meadowbank is uncertain since snowy owls were not observed during the summer (June 2003) breeding bird surveys in the LSA.

Ecology

In North America, the snowy owl breeds in open tundra from near the treeline to Arctic coastal areas (Parmelee, 1992). Breeding habitat generally consists of hummocky or rolling tundra with promontories that are used for nest sites or perches (Godfrey, 1976; Parmelee, 1992). Snowy owls may re-nest if a clutch is lost early in the breeding season, but this has not been confirmed (Parmelee, 1992). The species' fidelity to breeding areas has not been well documented (Parmelee, 1992).

Mammals, ranging in size from small rodents to large hares, form the largest component of the snowy owl's diet. Lemmings are the most common prey item taken. Other prey include birds, ranging in size from songbird nestlings to medium-sized geese, and, less commonly, fish and other small aquatic animals (Parmelee, 1992).

Habitat Association

During fall, observations of snowy owls in the Meadowbank area were made mainly in heath tundra areas, although some sightings from esker habitats were also recorded (Figure 5.15). According to the ELC, both the RSA and LSA contain large areas of heath tundra and shallow and deep-water habitats, which could support prey such as rodents, passerines, ptarmigan, shorebirds, and waterfowl (Table 5.2); hence, habitat suitability for snowy owls in the proposed project area is likely moderate to high.

5.3.7.3 Ptarmigan

The rock ptarmigan and willow ptarmigan breed in the mainland region of Nunavut, whereas the white-tailed ptarmigan (*Lagopus leucurus*) is considered to be of rare or accidental occurrence (Richards et al, 2002). The rock ptarmigan has been commonly recorded in the RSA; the willow ptarmigan has not been recorded but is expected to occur in areas with suitable habitat (Appendix A.16).

Ptarmigan as a group were selected as a key wildlife resource for this review because they are an important prey item for carnivores and for raptors such as gyrfalcons. They are also hunted by Baker Lake residents (ISL, 1978).

Rock Ptarmigan & Willow Ptarmigan

*Status*The Canadian Endangered Species Conservation Council (2001) and Government of Nunavut (2001) list rock ptarmigan as sensitive. The rock ptarmigan population declined by 86% from 1987 to

1996 in the central part of its range, near Hope Bay, Nunavut, but the reason for the decline is unknown (Calef and Hubert, 2002). Population trends for the species since 1996 are also unknown (NWTRWED, 2000). The willow ptarmigan is listed as secure in Nunavut (Government of Nunavut, 2001). Its population is probably stable (NWTRWED, 2000).

Results of Baseline Surveys

Ptarmigan were not identified to species in the surveys that were conducted in the general area of the proposed project; therefore, the species are treated collectively in this summary of field observations. Aerial surveys of the RSA recorded more ptarmigan sightings in fall than in any other season (Figure 5.12), and most sightings were made in the western portion of the RSA (Appendix A.16). More than 40 ptarmigan were observed during the fall 2002 aerial survey of the LSA (Figure 5.5); lower numbers were recorded during each of the ground surveys of that area (Figure 5.10). A few more ptarmigan were recorded in summer and fall than in winter during the ground surveys of the LSA (Figure 5.10).

Rock ptarmigan were the third most common breeding bird species observed during June 2003 breeding bird surveys of the LSA, with 12 breeding pairs recorded in the 26 survey plots (Table 5.5). Evidence of breeding included females with chicks, a nest with eggs, pair courtship behaviour, and other breeding-related behaviours.

Ecology

Rock ptarmigan breed in well-drained, hummocky artic and alpine tundra habitats with mixed vegetation and eskers, and rocky ridges or outcroppings. Similar habitats are generally used for wintering (Holder and Montgomerie, 1993). Willow ptarmigan tend to nest in moister, shrubbier habitats (e.g., those with abundant birch and willow) than rock ptarmigan, and they tend to avoid dry, rocky areas (Holder and Montgomerie, 1993; Hannon et al, 1998). They also typically leave their breeding areas to winter south of the treeline in muskeg, riparian areas, and forest openings (Godfrey, 1976). Male ptarmigan of both species are highly philopatric to their breeding territories; females are less so, although they will return to the same general breeding area (Holder and Montgomerie, 1993; Hannon et al, 1998). Little information was found on ptarmigan breeding chronology for Nunavut; however, records from the Yukon suggest that egg laying occurs in June, and chicks are present from late June to mid- to late August (Sinclair et al, 2003; Table 5.14). Willow and rock ptarmigan feed primarily on plant material (leaves, stems, flower buds, berries, seeds, moss, twigs, catkins), but insects are also taken (Holder and Montgomerie, 1993; Hannon et al, 1998).

Table 5.14: Breeding Chronology of Rock & Willow Ptarmigan in the Yukon & at Chesterfield Inlet

Species	Location	Eggs	Young	Reference
Rock ptarmigan	Yukon	6-22 June	24 June-15 August	Sinclair et al, 2003
	Chesterfield Inlet, Nunavut	Mid-June	Mid-July	Hohn, 1968
Willow ptarmigan	Yukon	6-24 June	24 June-20 August	Sinclair et al, 2003

Habitat Association

During the fall, observations of ptarmigan in the Meadowbank area were associated most often with lichen-rock habitats, followed by heath tundra, sedge, and esker communities (Figure 5.15). In summer, rock ptarmigan were most frequently observed in heath tundra and lichen rock with boulder areas (Table 5.4). On Victoria Island in the High Arctic, ptarmigan pellet sign was most strongly correlated with lowland vegetation, particularly that associated with willow-sedge meadows (Schaeffer et al, 1996). This habitat is similar to the sedge community and riparian shrub community ELC units, which are available only to a limited extent in the study areas (combined coverage <10%; Table 5.2). Results of the ELC suggest that habitat suitability for ptarmigan in the RSA and LSA could be high because there is an abundance of tundra habitat associated with eskers and rocky areas, or with moist, shrubby habitats (Tables 5.2 and 3.9).

5.3.7.4 Shorebirds

Twenty-eight species of shorebirds have been recorded within mainland Nunavut, but five of these are considered accidental occurrences (Richards et al, 2002). Twenty species are known to breed, and two species are suspected of breeding, in the mainland region of Nunavut (Richards et al, 2002). Hohn (1968) found that semipalmated plover was the most common breeding shorebird in the Chesterfield Inlet area.

Relatively few shorebirds were recorded in the Meadowbank area during the aerial and ground baseline surveys (Appendix A.7). The most common species was the semipalmated sandpiper, which was recorded in several extensive sedge meadows during the breeding bird surveys. The American golden-plover was one other shorebird species recorded in the area. Both species were selected as a key wildlife resource because of their conservation status and their role as a food source for rough-legged hawks, gyrfalcons, and peregrine falcons (Johnson and Connors, 1996). Additionally, the breeding ranges of these species are restricted to northern regions of North America.

Semipalmated Sandpiper

*Status*The semipalmated sandpiper is listed as sensitive by the Government of Nunavut (2001), but has not been reviewed by COSEWIC (2002).

Results of Baseline Surveys

The semipalmated sandpiper was observed regularly during the June 2003 breeding bird surveys within the Meadowbank LSA. A total of five pairs were documented within breeding bird survey plots, but others were observed incidentally between plots during the survey period.

Ecology

The semipalmated sandpiper typically nests near water in dry shrubby areas of willow and birch, and mixed sedges and grasses, moist or wet sedge-grass, and heath tundra (Gratto-Trevor, 1992; Sinclair et al, 2003). Near Chesterfield Inlet, nest with eggs of semipalmated sandpipers were reported from 25 June to 14 July (Hohn, 1968). Records from the Yukon indicate that local egg laying extends from

5 to 30 June (Sinclair et al, 2003). Flightless young have been found from 25 June to 20 July, and fledged young have been observed as early as 16 July, (Sinclair et al, 2003). Return rates to previous breeding areas are very high (Gratto-Trevor, 1992).

During migration, edges of lakes, shallow freshwater wetlands, or marshy areas are used (Gratto-Trevor, 1992). Diet consists primarily of benthic invertebrates but also includes some terrestrial invertebrates (Gratto-Trevor, 1992).

The semipalmated sandpiper has been recorded arriving in the Thelon River area on 30 May (Norment, 1985) and the Chesterfield Inlet area on 8 June (Hohn, 1968). Fall migration from the breeding grounds appears to occur in August (Hohn, 1968).

Habitat Association

Semipalmated sandpipers recorded during breeding bird surveys were primarily associated with wet sedge meadows adjacent to small lakes and ponds. Because these habitats are relatively common throughout the LSA and RSA, semipalmated sandpipers are expected to be relatively common breeders in the area.

American Golden-plover

Status

The American golden-plover is listed as sensitive by the Canadian Endangered Species Conservation Council (2001) and by the Government of Nunavut (2003). Although population estimates were not found for Nunavut, numbers of American golden-plovers in the Northwest Territories are estimated at more than 40,000 (NWTRWED, 2000). Declines in this species population have been reported during migration, and from one Arctic location (NWTRWED, 2000).

Results of Baseline Surveys

The American golden-plover has been recorded only twice in the Meadowbank area. A single bird was observed in the LSA during the summer 2002 ground survey, and a pair of birds was seen on Plot 16 during the June 2003 breeding bird surveys.

Ecology

The American golden-plover typically nests in low, sparsely vegetated sites on well-drained, rocky slopes, upland tundra, eskers, and beach ridges (Johnson and Connors, 1996; NWTRWED, 2000). No information was found on breeding chronology for this species in Nunavut; however, records from the Yukon indicate that egg laying extends from 9 June to 13 July (Sinclair et al, 2003). Flightless young have been found from 1 to 25 July; fledged young have been observed on 2 August, but fledging may occur earlier than that (Sinclair et al, 2003). Fledging male American golden-plovers show fidelity to breeding sites (Johnson and Connors, 1996). Females may lay replacement clutches if eggs are lost early in the incubation stage (Johnson and Connors, 1996).

During migration, various inland and coastal habitats are used, although snow-free ridges and hillsides appear to be especially important areas in early spring (Johnson and Connors, 1996). The diet of this species is primarily composed of terrestrial invertebrates, but freshwater and marine invertebrates are also taken, along with berries, leaves, and seeds (Johnson and Connors, 1996). The American golden-plover has been recorded arriving in the Warden Grove area on the Thelon River on 3 June (Norment, 1985). Hohn (1968) recorded the species at Chesterfield Inlet on 2 June 1967. Fall migration from the breeding grounds usually occurs in August (Johnson and Connors, 1996).

Habitat Association

The pair of American golden-plover recorded during June 2003 surveys was observed in rocky heath tundra. Upland tundra and rocky slopes are relatively common within the LSA providing some suitable habitat for this species.

5.3.7.5 Passerines

Fifty-two species of passerines have been recorded within mainland Nunavut, although half of these (26) are classed as visitors or accidental or hypothetical occurrences (Richards et al, 2002). Twenty-four species have been recorded as breeding on the mainland; another two species are suspected to be breeding (Richards et al, 2002).

Nine passerine species were recorded incidentally during baseline surveys in the RSA: horned lark, common raven, American pipit, savannah sparrow, white-crowned sparrow, Lapland longspur, snow bunting, common redpoll, and hoary redpoll (Appendix A.7). Of these, four (horned lark, American pipit, white-crowned sparrow, and snow bunting) have been listed as sensitive by the Canadian Endangered Species Conservation Council (2001). The others are considered secure.

Key wildlife resources within the passerine guild were selected based on their conservation status, apparent abundance in the general region of the RSA, and their role as a food source for raptors such as the peregrine falcon. The species selected for this review are horned lark, American pipit, white-crowned sparrow, snow bunting, and Lapland longspur. Although not a conservation concern, the Lapland longspur was included because it appears to be one of the most commonly observed passerines in the area in the late spring and summer (Figure 5.9).

Passerine species highlighted in this review arrive in the general area of the proposed project from mid-April to mid-June and usually depart by early September (Table 5.15). There is considerable overlap between egg laying, hatching, and fledging periods for the passerine key wildlife resources, but in general, egg laying occurs in June, hatching occurs from mid- June to late July, and fledging occurs from late June to early August (Table 5.16).

Table 5.15: Spring Arrival & Fall Departure Dates for Passerines Recorded in the Warden Grove Area, Thelon River & at Chesterfield Inlet

Species	Location	Arrival Date	Departure Date	Reference
Horned lark[1]	Chesterfield Inlet	21 May	1 September	Saville, 1951
American pipit	Warden Grove area, Thelon River	14 June	3 September	Norment, 1985
	Chesterfield Inlet	21 May	-	Saville, 1951
White-crowned sparrow	Warden Grove area, Thelon River	21 May	3 September	Norment, 1985
Lapland longspur	Warden Grove area, Thelon River	17 May	23 September	Norment, 1985
	Chesterfield Inlet	19 May	-	Saville, 1951
Snow bunting	Warden Grove area, Thelon River	1 May	29 October	Norment, 1985
	Chesterfield Inlet	Mid-April	-	Hohn, 1968

Notes: 1 Migratory periods for the horned lark are not often well defined due to confusion over morphological differences among subspecies (Beason, 1995)

Table 5.16: Passerine Breeding Chronology

Species	Location	Egg laying	Hatching	Fledging	Reference
Horned lark	Warden Grove area, Nunavut	By 19 June	-	First two weeks of July	Norment, 1985
	Chesterfield Inlet, Nunavut	14 June	-	-	Hohn, 1968
	Yukon	8-24 June	Late June and 16 July	4 July-7 August	Sinclair et al, 2003
American pipit	Chesterfield Inlet, Nunavut	4 July	-	-	Saville, 1951
	Yukon	8 June-4 July	19 June-18 July	7 July-4 August	Sinclair et al, 2003
White-crowned sparrow	Northwest Territories	Mid-June	Late June	First two weeks of July	Norment, 1992
	Yukon	1 June-2 July	11 June-9 July	22 June-28 July	Sinclair et al, 2003
Lapland longspur	Chesterfield Inlet, Nunavut	30 June	9 July	-	Hohn, 1968
	Yukon	8-25 June	16-27 June	23 June	Sinclair et al, 2003
Snow bunting	Chesterfield Inlet, Nunavut	19 June-7 July	11and 12 July	-	Hohn, 1968
	Yukon	5 June-17 July	15 June-26 July	27 June-31 July	Sinclair et al, 2003

Horned Lark

Status

The horned lark has been listed as sensitive by the Canadian Endangered Species Conservation Council (2001), and by Government of Nunavut (2001). No information on population estimates was found for Nunavut, but numbers in the Northwest Territories are believed to be greater than 10,000 (NWTRWED, 2000). Nationally, trends in the horned lark population are considered to be stable, although significant declines have occurred over the past 30 years (NWTRWED, 2000). Trends for northern populations have not been confirmed (NWTRWED, 2000).

Eight subspecies of horned larks have been identified in Canada (NWTRWED, 2000). One subspecies, *E.a. hoyti*, has a breeding range that includes the proposed project area. Its breeding range extends from northern Baffin Island to northern Alberta, and east to western Ontario (Beason, 1995).

Results of Baseline Surveys

The horned lark was the second most frequently recorded passerine species in the LSA, and it was most commonly seen during the summer (Figure 5.9; Table 5.5). Forty-four breeding pairs were recorded on 23 of 26 breeding bird survey plots. The maximum number of breeding pairs recorded on a plot (i.e., 400 x 400 m) was three pairs. Only a few horned larks were recorded in the fall ground surveys of that year (Figure 5.9). Evidence of breeding included a nest with eggs (19 June 2003).

Ecology

Throughout its breeding range, the horned lark nests in open areas with bare ground or short vegetation. In the Arctic, it is restricted to tundra and barren steppes (Beason, 1995). The short breeding season at high latitudes limits this species to producing one clutch per season (Verbeek, 1967), but re-nesting may occur if eggs or nests are destroyed, presumably early in the breeding season (Beason, 1995). During the breeding season, seeds form the bulk of the adults' diet, whereas chicks are fed insects. During spring and fall migration, adults include more insects in their diet than at other times of the year (Beason, 1995).

Habitat Association

Horned larks observed during the 2003 breeding bird survey were primarily associated with heath tundra and heath tundra with boulders. Results of the ELC indicate that the RSA and LSA contain extensive habitats preferred by horned lark; therefore, the study area may represent moderate to high habitat suitability for this species.

American Pipit

Status

The American pipit has been listed as sensitive by the Canadian Endangered Species Conservation Council (2001) and by the Government of Nunavut (2001). Nationally, this species' population is declining (NWTRWED, 2000). Information on population trends in Nunavut was not found, and trends in the Northwest Territories are unknown due to a lack of data (NWTRWED, 2000).

Results of Baseline Surveys

Relatively few American pipits were recorded in the LSA, and the species was observed only during the summer 2002 ground surveys and summer 2003 breeding bird surveys (Figure 5.9; Table 5.5). During 2003 breeding bird surveys, four breeding pairs were identified.

Ecology

The American pipit breeds in arctic and alpine tundra regions of North America (Verbeek and Hendricks, 1994). Breeding habitat in the Arctic generally consists of grassy meadows with mesic vegetation, or moist, sloping, hummocky tundra (Verbeek and Hendricks, 1994; Sinclair et al, 2003). American pipits typically lay larger clutches in northern versus southern breeding areas (Verbeek, 1970); however, prolonged snow cover can delay egg laying, which in turn tends to result in smaller clutch sizes (Hendricks, 1993). Disturbances during nest building, egg laying, or early incubation can cause some pipits to abandon their nests (Verbeek and Hendricks, 1994). No information was found on incidences of replacement clutches or fidelity to breeding sites. Habitat used during migration includes open tundra, mudflats, wetlands, roadways, fields, meadows, and coastal beaches and marshes (Verbeek and Hendricks, 1994; Sinclair et al, 2003). The American pipit's diet consists primarily of seeds and terrestrial and freshwater invertebrates (Verbeek and Hendricks, 1994). Mining activities may cause long-term damage to vegetation, thus reducing habitat quality for this species (Verbeek and Hendricks, 1994).

Habitat Association

American pipits observed during 2003 breeding bird surveys were associated with lake margins and wetland edges. Results of the ELC suggest that the RSA and LSA may represent moderate to high habitat suitability for this species because of good availability of moist habitat adjacent to heath tundra areas (Table 5.2).

White-crowned Sparrow

Status

The white-crowned sparrow has been listed as sensitive by the Canadian Endangered Species Conservation Council (2001) and by the Government of Nunavut (2001). Nationally, this species' population is declining (NWTRWED, 2000). Information on population trends in Nunavut was not found, and trends in the Northwest Territories are unknown due to a lack of data (NWTRWED, 2000).

Four subspecies of white-crowned sparrows have been identified in Canada (NWTRWED, 2000). One subspecies, *Z.l. gambelii*, has a breeding range that includes the proposed project area. Its breeding range covers much of Alaska, northern mainland Canada, British Columbia east of the Cascade Mountains, and southwestern Alberta (Chilton et al, 1995).

Results of Baseline Surveys

Of the passerine key wildlife resources, the white-crowned sparrow was the least commonly recorded species overall in the LSA (Figure 5.9). It was marginally more abundant in the fall than in the summer (Figure 5.9). White-crowned sparrows apparently occur at very low breeding densities within the LSA because no birds were recorded during June 2003 breeding bird surveys. Birds observed in summer 2002 (late July) might have been early migrants or post-breeding dispersing birds, rather than local breeders.

Ecology

Characteristic breeding habitat of this species includes a patchy distribution of grass, bare ground for foraging, and dense shrubs or small conifers for roosting and nest concealment (Chilton et al, 1995). *Z.l. gambelii* is not known to lay replacement clutches if the first clutch or brood is destroyed (Farner and Lewis, 1973). No information was found on fidelity to breeding sites by *Z.l. gambelii*. During the breeding season, insects, other arthropods, and seeds are the main components of the white-crowned sparrow's diet (Chilton et al, 1995).

Habitat Association

No observations of habitat use are available for the Meadowbank area. Results of the ELC suggest that the RSA and LSA may represent moderate suitability for white-crowned sparrow because some shrubby habitats, preferred breeding habitats for this species, are available (Table 5.2).

Lapland Longspur

Status

The Lapland longspur has been listed as secure by the Canadian Endangered Species Conservation Council (2001) and the Government of Nunavut (2001). No information on population estimates was found for Nunavut, but numbers in the Northwest Territories are believed to be greater than 10,000 (NWTRWED, 2000). Nationally, this species' population is considered to be stable; however, data are needed to confirm trends in the north (NWTRWED, 2000).

Results of Baseline Surveys

The Lapland longspur was the most commonly observed passerine in the LSA, but it was recorded only during the summer (Figure 5.9). A total of 209 breeding pairs were recorded on 26 plots (i.e., average of 8 pairs per plot) during June 2003 breeding bird surveys. Numbers of pairs per plot ranged from three to a maximum of 13. This maximum number of pairs represents close to one pair per ha.

Ecology

The Lapland longspur breeds across the Arctic region of North America and is one of the most abundant breeding songbirds in the north (Hussell and Montgomerie, 2002). The species typically nests on relatively flat ground in wet, hummocky, tundra meadows, but well-vegetated drier slopes are also used (Hussell and Montgomerie, 2002). The short period when snow-free tundra is available generally prevents more than one brood from being raised successfully; however, replacement clutches are occasionally laid if the first clutch is lost during laying or early incubation (Hussell and Montgomerie, 2002). Fidelity to breeding sites is considered to be high (Hussell and Montgomerie, 2002). The Lapland longspur's diet consists primarily of plant seeds at the beginning and end of the breeding season, while arthropods (mainly dipterans and hymenopterans) are taken throughout the rest of the season (Hussell and Montgomerie, 2002). Jaegers are believed to be the most common predator of the Lapland longspur (Hussell and Montgomerie, 2002). All three species of jaeger--long-tailed, pomarine, and parasitic--were observed during the June 2003 breeding bird surveys.

Habitat Association

Lapland longspurs show a strong association to heath tundra habitats. Because these habitats are widespread within the RSA and LSA, the area is considered to be highly suitable for Lapland longspurs.

Snow Bunting

Status

The snow bunting has been listed as sensitive by the Canadian Endangered Species Conservation Council (2001) and Government of Nunavut (2001). Nationally, this species' population is declining (NWTRWED, 2000). Information on population trends in Nunavut was not found, and trends in the Northwest Territories are unknown due to a lack of data (NWTRWED, 2000).

Results of Baseline Surveys

The snow bunting was the most commonly recorded passerine in the LSA in the fall (Figure 5.9). Only one pair was observed during June 2003 breeding bird surveys, suggesting that the Meadowbank area is not a prime breeding area for this species.

Ecology

In North America, the snow bunting breeds in high Arctic regions (Lyon and Montgomerie, 1995). Typical nesting sites include rocky patches or boulder screes near foraging sites such as well-vegetated *Dryas*-lichen tundra or wet sedge meadows that experience early snow melt (Lyon and Montgomerie, 1995). The species also occurs around human settlements in early spring, and may nest in human-made structures (Hohn, 1968; Lyon and Montgomerie, 1995). Replacement clutches may be laid if the first is lost; however, they will probably be smaller because clutch size can decrease significantly as the breeding season progresses (Lyon and Montgomerie, 1995). The snow bunting shows low fidelity to breeding sites, but they may return to general breeding areas (Lyon and

Montgomerie, 1995). The snow buntings' diet in early spring consists mainly of weed and grass seeds; summer and early fall diets include seeds, buds, and invertebrates (Lyon and Montgomerie, 1995).

Habitat Association

No observations of habitat use are available for the Meadowbank area. The ELC of the RSA and LSA suggest that some suitable breeding habitat for snow bunting is likely available.

5.4 REFERENCES

Alexander, S.A., R.S. Ferguson, and K.J. McCormick, 1991. Key migratory bird terrestrial habitat sites in the Northwest Territories (2nd edition). Occasional Paper No. 71. Canadian Wildlife Service, Western and Northern Region, Yellowknife, NT. 182 pp.

Allen, D.L. and H. Hogg, 1978. Bird studies in the Keewatin District. Canadian Wildlife Service, Fisheries and Environment Canada.

Anand-Wheeler, I. 2002. Terrestrial Mammals of Nunavut. Department of Sustainable Development, Iqaluit, NU.

Atlantic Canada CDC (Conservation Data Centre), 2003. Arctic Hare (*Lepus arcticus*). Available at: www.accdc.com/products/profiles/arctichare.html. Accessed May 2003.

AXYS Environmental Consulting Ltd. (AXYS) and Penner & Associates Ltd., 1998. Diavik Diamond project: Environmental effects report, wildlife. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT.

Ballard, W.B., J.S. Whitman, and C.L. Gardner, 1987. Ecology of an exploited wolf population in south-central Alaska. Wildlife Monographs 98:1-54.

Banci, V., 1987. Ecology and behaviour of wolverine in the Yukon. M.Sc. Thesis, Simon Fraser Univ., Burnaby, B.C.

Banci, V., 1994. Wolverine. *In* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski (eds.). The scientific basis for conserving forest carnivores: American Marten, fisher, lynx, and wolverine in the western United States. USDA Forest Service. General Technical Report RM-254. p. 99-127.

Banfield, A.W., 1974. The Mammals of Canada. University of Toronto Press, Toronto, ON.

Bart, J., C. Wightman, B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, R. Lanctot, B. McCaffrey and G. Morrison. 2003. PRISM breeding surveys in the Arctic: a review of past work and a proposal for completing the surveys. Unpublished report of Canadian Wildlife Service, Yellowknife, NWT.

Beason, R.C., 1995. Horned Lark *Eremophila alpestris*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 195. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Bechard, M.J. and T.R. Swem, 2002. Rough-legged Hawk *Buteo lagopus. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 641. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Bellrose, F.C., 1976. ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA.

Best, T.L. and T.H. Henry, 1994. *Lepus arcticus*. Mammalian Species. No. 457. 9 pp.

Bêty, J., G. Gauthier, J.F. Giroux, and E. Korpimaki, 2001. Are goose nesting success and lemming cycles linked? Interplay between nest density and predators. Oikos 93:388-400.

Beverly and Qamanirjuaq Caribou Management Board (BQCMB), 1999. Protecting Beverly and Qamanirjuaq Caribou and Caribou Range. Part 1: Background. Beverly and Qamanirjuaq Caribou Management Board, Ottawa, ON.

Bradley, M. and L.W. Oliphant, 1991. The diet of Peregrine Falcons in Rankin Inlet, Northwest Territories: An unusually high proportion of mammalian prey. Condor 93:193-197.

Buckland, L., J. Dragon, A. Gunn, J. Nishi, and D. Abernethy, 2000. Distribution and abundance of caribou on the northeast mainland, NWT in May 1995. NWT Department of Resources, Wildlife and Economic Development, Manuscript Report No. 125. Yellowknife, NT.

Calef, G. and B. Hubert, 2002. Terrestrial Wildlife of Hope Bay, Nunavut: An integration and overview of data collected from 1994-2002. Prepared for Miramar Hope Bay Ltd., North Vancouver, BC.

Campbell, M., 2002. The seasonal distribution and herd delimitation of northeastern mainland caribou (*Rangifer tarandus groenlandicus*). Status report to the Nunavut Wildlife Research Group. NWMB Project 110-02-4. Arviat, NU. Draft manuscript.

Campbell, M. and M. Setterington, 2001. The re-evaluation of Kivalliq and northeast Kitikmeot Muskox (*Ovibos moschatus*) populations, management zones and quotas. Technical Report Series 2001, No. 1-02, Department of Sustainable Development, Nunavut Wildlife Services, Arviat, NU. Draft manuscript.

Canadian Endangered Species Conservation Council, 2001. Wild Species 2000: The General Status of Species in Canada. Minister of Public Works and Government Services Canada. Ottawa.

Canadian Wildlife Service Waterfowl Committee, 2000. Population status of migratory game birds in Canada. Canadian Wildlife Service, Migratory Birds Regulatory Rep. No. 1.

Chilton, G., M.C. Baker, C.D. Barrentine, and M.A. Cunningham, 1995. White-crowned Sparrow *Zonotrichia leucophrys*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 183. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Clum, N.J. and T.J. Cade, 1994. Gyrfalcon *Falco rusticolus. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 114. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

COSEWIC, 2002. COSEWIC Species Database. Available at: www.cosewic.gc.ca. Accessed May 2003.

Court, G.S., D.M. Bradley, C.C. Gates, and D.A. Boag, 1989. Turnover and recruitment in a tundra population of Peregrine Falcons *Falco peregrinus*. Ibis 131: 487-496.

Court, G.S., C.C. Gates, and D.A. Boag, 1988. Natural history of the Peregrine Falcon in the Keewatin District of the Northwest Territories. Arctic 41(1): 17-30.

Curatolo, J.A., 1975. Factors influencing local movements and behaviour of Barren-ground Caribou, *Rangifer tarandus granti*. M.Sc. thesis. University of Alaska, Fairbanks, AK. *Cited in:* AXYS Environmental Consulting Ltd. and Penner & Associates Ltd., 1998. Diavik Diamond project: Environmental Effects Report, Wildlife. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT.

Dauphiné, T.C., 1989. Updated status report on the Wolverine *Gulo gulo* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON.

Douglass, R.J., 1984. Ecological distribution of small mammals in the De Long Mountains of northwestern Alaska. Arctic 37:148-154.

Eberhardt, L.E. and W.C. Hanson, 1978. Long-distance movements of Arctic foxes tagged in northern Alaska. Canadian Field-Naturalist 92:386-389.

Ehrich, D., P.E. Jorde, C.J. Krebs, A.J. Kenney, J.E. Stacy, and N.C. Stenseth, 2001. Spatial structure of lemming populations (*Dicrostonyx groenlandicus*) fluctuating in density. Molecular Ecology 10: 481-495.

Elmhagen, B., M. Tannerfeldt, and A. Angerbjörn, 2002. Food-niche overlap between Arctic and Red foxes. Canadian Journal of Zoology 80:1274-1285.

Ely, C.R. and A.X. Dzubin, 1994. Greater White-fronted Goose *Anser albifrons. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 131. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Farner, D.S. and R.A. Lewis, 1973. Field and experimental studies of the annual cycles of White-crowned Sparrows. J. Reprod. Fert. Suppl. 19: 35-50. *Cited in:* G. Chilton, M.C. Baker, C.D. Barrentine, and M.A. Cunningham, 1995. White-crowned Sparrow *Zonotrichia leucophrys*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 183. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Federov, V.B., K. Fredga, and G.H. Jarrell, 1999. Mitochondrial DNA variation and the evolutionary history of chromosome races of Collared lemmings (*Dicrostonyx*) in the Eurasian Arctic. Journal of Evolutionary Biology 12: 134-145.

Ferguson, M.A., L. Gauthier, and F. Messier, 2001. Range shift and winter foraging ecology of a population of Arctic tundra caribou. Canadian Journal of Zoology 79: 746-758.

Ferguson, M.A., R.G. Williamson, and F. Messier, 1998. Inuit knowledge of long-term changes in a population of arctic tundra caribou. Arctic 51: 210-219.

Fuller, T.K. and L.B. Keith, 1980. Wolf population dynamics and prey relationships in northeastern Alberta. Journal of Wildlife Management 44:583-602.

Fyfe, R.W., S.A. Temple, and T.J. Cade, 1976. The 1975 North American Peregrine Falcon survey. Canadian Field-Naturalist 90: 225-277.

Gau, R.J., R. Case, D.F. Penner, and P.D. McLoughlin, 2002. Feeding patterns of barren-ground Grizzly Bears in the Central Canadian Arctic. Arctic 55:339-344.

Gilbert, B.S. and C.J. Krebs, 1991. Population dynamics of *Clethrionomys* and *Peromyscus* in southwestern Yukon 1973-1989. Holarctic Ecology 14:250-259.

Godfrey, W.E., 1976. The Birds of Canada. National Museum of Canada. Bulletin No. 203, Biological Series No. 73.

Government of Nunavut, 2001. Nunavut Wild Species 2000. Government of Nunavut, Dept. Sustainable Development. Iqaluit, NU.

Government of Nunavut, 2003. Nunavut Wild Species 2000. Government of Nunavut, Dept. Sustainable Development. Iqaluit, Nunavut. Available at: http://www.wildspecies.ca/wildspecies2000/en/home_E.html. Accessed July 2003.

Gratto-Trevor, C.L. 1992. Semipalmated Sandpiper *Calidris pusilla In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 198-199. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Gunn, A., 1984. Aspects of the management of Muskoxen in the Northwest Territories. *In:* D.R. Klein, R.G. White, and S. Keller (eds.). 1984. Proceedings of the First International Muskox Symposium. Institute of Arctic Biology, Biol. Pap. Univ. Alaska Special Report No. 4. p. 33-40.

Gunn, A., B. Fournier, and J. Nishi, 2000a. Abundance and distribution of the Queen Maud Gulf caribou herd, 1986-1998. NWT Department of Resources, Wildlife and Economic Development, File Report No. 126. Yellowknife, NT.

Gunn, A., B. Fournier, and R. Morrison, 2000b. Seasonal movements and distribution of satellite-collared caribou cows on the Boothia and Simpson Peninsula areas, Northwest Territories, 1991-93. NWT Department of Resources, Wildlife and Economic Development, Manuscript Report No. 126. Yellowknife, NT.

Gunn, A. and M. Sutherland, 1997. Muskox diet and sex-age composition in the Central Arctic coastal mainland (Queen Maud Gulf area), 1988-1991. NWT Department of Resources, Wildlife and Economic Development, Manuscript Report No. 95. Yellowknife, NT.

Hannon, S.J., P.K. Eason, and K. Martin, 1998. Willow Ptarmigan *Lagopus lagopus*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 369. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Hayes, R.D. and J.R. Gunson, 1995. Status and management of wolves in Canada. *In:* L.N. Carbyn, S.H. Fritts, and D.R. Seip (eds.), Ecology and Conservation of Wolves in a Changing World. p.21-33

Heard, D.C. and P. Gray, 1989. Habitat. *In:* E. Hall (ed.). People and Caribou in the Northwest Territories. NWT Department of Renewable Resources, Yellowknife, NT. p 74-79. *Cited in:* AXYS Environmental Consulting Ltd. and Penner & Associates Ltd., 1998. Diavik Diamond project: Environmental Effects Report, Wildlife. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT. .

Heard, D.C., T.M. Williams, and D.A. Melton, 1996. The relationship between food intake and predation risk in migratory caribou and implications to caribou and wolf population dynamics. Rangifer Spec. Issue 9:37-44. *Cited in:* Calef, G. and B. Hubert, 2002. Terrestrial Wildlife of Hope Bay, Nunavut: An Integration and Overview of Data Collected from 1994-2002. Prepared for Miramar Hope Bay Limited, Miramar Mining Corporation, North Vancouver, BC.

Hendricks, D.P., 1993. Clutch- and egg-size variation of American Pipits in alpine environments. Ph.D. diss., Washington State Univ., Pullman, WA. *Cited in:* N.A.M. Verbeek and P. Hendricks, 1994. American Pipit *Anthus rubescens*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 95. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Hohn, E.O., 1968. The birds of Chesterfied Inlet, District of Keewatin, N.W.T., Canada. Canadian Field-Natuarlist 82: 244-262.

Holder, K. and R. Montgomerie, 1993. Rock Ptarmigan *Lagopus mutus*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 51. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Hubbs, A.H. and R. Boonstra, 1997. Population limitation in Arctic Ground Squirrels: effects of food and predation. Journal of Animal Ecology 66: 527-541.

Hussell, D.J. and R. Montgomerie, 2002. Lapland Longspur *Calcarius lapponicus*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 656. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Interdisciplinary Systems Ltd (ISL), 1978. Effects of exploration and development in the Baker Lake area. Vol. 1 – Study area. Prepared for the Department of Indian Affairs and Northern Development, Ottawa, ON. 309 pp. + maps.

Johnson, O.W. and P.G. Connors, 1996. American Golden-plover *Pluvialis dominica*, Pacific Golden-plover *Pluvialis fulva*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 201-202. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Johnson, S.R. and D.R. Herter, 1989. The birds of the Beaufort Sea. BP Exploration (Alaska), Inc., Anchorage, AK.

King, C.M., 1983. *Mustela erminea*. Mammalian Species. No. 195. 8 pp.

Krebs, C.J., R. Boonstra, and A.J. Kenny, 1995. Population dynamics of the Collared lemming and the Tundra Vole at Pearce Point, Northwest Territories, Canada. Oecologica 103: 481-489.

Krebs, C.J., A.J. Kenney, S. Gilbert, K. Danell, A. Angerbjörn, S. Erlinge, R.G. Bromley, C. Shank, and S. Carrière, 2002. Synchrony in lemming and vole populations in the Canadian Arctic. Canadian Journal of Zoology 80:1323-1333.

Kuyt, E., 1972. Food habits and ecology of wolves on barren-ground caribou range in the Northwest Territories. Canadian Wildlife Service Report Series Number 21. Ottawa, ON.

Kuyt, E., 1980. Distribution and breeding biology of raptors in the Thelon River area, Northwest Territories, 1957-1969. Canadian Field-Naturalist 94:121-130. *Cited in:* M.J. Bechard and T.R. Swem, 2002. Rough-legged Hawk *Buteo lagopus. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 641. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Larter, N.C., 1998. Collared lemming abundance, diet and morphometrics on Banks Island, 1993-1996. NWT Department of Resources, Wildlife and Economic Development, Inuvik, NT.

Lyon, B. and R. Montgomerie, 1995. Snow Bunting *Plectrophenax nivalis,* McKay's bunting *Plectrophenax hyperboreus*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 198-199. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

MacInnes, C.D., 1962. Nesting of small Canada Geese near Eskimo Point, Northwest Territories. J. Wildl. Manage. 26:247-256. *Cited in:* T.B. Mowbray, C.R. Ely, J.S. Sedinger and R.E. Trost, 2002. Canada Goose *Branta canadensis*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 682. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

MacInnes, C.D., R.A. Davis, R.N. Jones, B.C. Lieff, and A.J. Pakulak, 1974. Reproductive efficiency of McConnell River small Canada Geese. Journal of Wildlife Management 36: 414-422. *Cited in:* T.B. Mowbray, C.R. Ely, J.S. Sedinger, and R.E. Trost, 2002. Canada Goose *Branta canadensis*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 682. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Macpherson, A.H., 1969. The dynamics of Canadian Arctic fox populations. Canadian Wildlife Service Report Series: Number 8. Department of Indian and Northern Development, Ottawa, ON.

Martell, A.M. and A.M. Pearson, 1978. The small mammals of the Mackenzie Delta region, Northwest Territories, Canada. Arctic 31:475-488.

Martell, A.M., D.M. Dickinson, and L.M. Casselman, 1984. Wildlife of the Mackenzie Delta. Occasional Publication No. 15, Boreal Institute for Northern Studies, University of Alberta, Edmonton, AB.

Martin, M., 1978. Status report on endangered wildlife in Canada: Gyrfalcon. Committee on the Status of Endangered Wildlife in Canada. 26 pp.

McLaren, P. L. and M.A. McLaren, 1982. Migration and summer distribution of Lesser Snow Geese in interior Keewatin. Wilson Bull. 94:494-504.

McLoughlin, P.D., 2001. The ecology of barren-ground Grizzly Bears in Nunavut: Volume I: State of Knowledge. Prepared for Department of Sustainable Development, Government of Nunavut, Iqaluit, NU.

McLoughlin, P.D., R.L. Case, R.J. Gau, H.D. Cluff, R. Mulders, and F. Messier, 2002a. Hierarchical habitat selection by barren-ground Grizzly Bears in the central Canadian Arctic. Oecologia 132:102-108.

McLoughlin, P.D., H.D Cluff, and F. Messier, 2002b. Denning ecology of barren-ground Grizzly Bears in the central Arctic. Journal of Mammalogy 83:188-198.

Miller, D.R., 1976. Biology of the Kaminuriak population of Barren-ground Caribou. Part 3: Taiga winter range relationships and diet. Canadian Wildlife Service Report Series Number 36. Ottawa, ON.

Mowbray, T.B., F. Cooke, and B. Ganter, 2000. Snow Goose *Chen caerulescens. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 514. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Mowbray, T.B., C.R. Ely, J.S. Sedinger, and R.E. Trost, 2002. Canada Goose *Branta canadensis*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 682. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Mueller, F.P., 1995. Tundra esker systems and denning by Grizzly Bears, wolves, foxes, and ground squirrels in the Central Arctic, Northwest Territories. NWT Department of Renewable Resources, File Report No. 115. Yellowknife, NT.

Mulders, R., 1999. Conservation of Arctic flora and fauna: Wolverine. Draft. *Cited in*: Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 2000. NWT Species 2000: General status ranks of wild species in the Northwest Territories. Available at: www.nwtwildlife.rwed.gov.nt.ca/ monitor/htm. Accessed May 2003.

Nellemann, C. and P.E. Reynolds, 1997. Predicting late winter distribution of Muskoxen using an index of terrain ruggedness. Arctic and Alpine Research 29:334-338.

Norment, C.J., 1985. Observations on the annual chronology for birds in the Warden's Grove area, Thelon River, Northwest Territories, 1977-1978. Canadian Field-Naturalist 99(4): 471-483.

Norment, C.J., 1992. Comparative breeding biology of Harris' Sparrow and Gambel's White-crowned Sparrows in the Northwest Territories, Canada. Condor 94: 955-975. *Cited in:* G. Chilton, M.C. Baker, C.D. Barrentine, and M.A. Cunningham, 1995. White-crowned Sparrow *Zonotrichia leucophrys*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 183. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Norment, C.J., A. Hall, and P. Hendricks, 1999. Important bird and mammal records in the Thelon River Valley, Northwest Territories: Range expansions and possible causes. Canadian Field-Naturalist 113(3): 375-385.

Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 1999. Arctic and Red Foxes in the Northwest Territories. 2nd Edition. NWT Wildlife Sketches. Yellowknife, NT.

Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 2000. NWT Species 2000: General status ranks of wild species in the Northwest Territories. Available at: www.nwtwildlife.rwed.gov.nt.ca/monitor/htm. Accessed May 2003.

Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 2001a. NWT Species at Risk Fact Sheets: Wolverine. Available at: http://www.nwtwildlife.rwed.gov.nt.ca/Publications/speciesatriskweb/wolverine.htm

Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 2001b. Arctic fox. Available at: http://www.nwtwildlife.rwed.gov.nt.ca /NWTwildlife/foxes/arcticfox/arcticfoxtop.htm

Novak, M., J. Baker, M. Obbard, and B. Malloch (eds.), 1987. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ottawa, ON.

Parmelee, D.F., 1992. Snowy Owl *Nyctea scandiaca. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 10. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Petersen, S., 1997. Status of the Wolverine (*Gulo gulo*) in Alberta. Alberta Wildlife Status Report No. 2. Alberta Environmental Protection, Edmonton, AB.

Poole, K. and R. Bromley, 1985. Aspects of the ecology of the Gyrfalcon in the Central Arctic, Northwest Territories, 1983 and 1984. NWT Renewable Resources File Report No. 52. Government of the N.W.T., Yellowknife, Northwest Territories. 65 pp.

Poole, K.G. and R.G. Bromley, 1988a. Interrelationships within a raptor guild in the central Canadian Arctic. Canadian Journal of Zoology 66:2275-2282. *Cited in:* M.J Bechard and T.R. Swem, 2002. Rough-legged Hawk *Buteo lagopus. In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 641. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Poole, K.G. and R.G. Bromley, 1988b. Natural history of the Gyrfalcon in the central Canadian Arctic. Arctic 41(1): 31-38.

Predavec, M. and C.J. Krebs, 2000. Microhabitat utilization, home ranges, and movement patterns of the Collared lemming (*Dicrostonyx groenlandicus*) in the central Canadian Arctic. Canadian Journal of Zoology 78: 1885-1890.

Predavec, M., C.J. Krebs, K. Danell, and R. Hyndman, 2001. Cycles and synchrony in the Collared lemming (*Dicrostonyx groenlandicus*) in Arctic North America. Oecologica 126: 216-224.

Reid, D.G. and C.J. Krebs, 1996. Limitations to Collared lemming population growth in winter. Can. J. Zool. 74:1284-1291.

Reid, D.G., C.J. Krebs, and A. Kenney, 1995. Limitation of Collared lemming population growth at low densities by predation mortality. Oikos 73:387-398.

Richards, J.M., Y.R. Tymstra, and A.W.White, 2002. Birds of Nunavut: A checklist. A Birders Journal Publication.

Robertson, G.J. and J-P. L. Savard, 2002. Long-tailed duck *Clangula hyemalis*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 651. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Rodgers, A.R. and M.C. Lewis, 1986. Diet selection in Arctic lemmings (*Lemmus sibiricus* and *Dicrostonyx groenlandicus*): Demography, home range, and habitat use. Canadian Journal of Zoology 64:2717-2727.

Ryder, J.P. and R.T. Alisauskas, 1995. Ross' Goose *Chen rossii*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 162. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Saville, D.B.O., 1951. Bird observations at Chesterfield Inlet, Keewatin, in 1950. Can. Field-Nat. 65:145-157. *Cited in:* E.O. Hohn, 1968. The birds of Chesterfied Inlet, District of Keewatin, N.W.T., Canada. Canadian Field-Naturalist 82: 244-262.

Schaeffer, J.A., S.D. Stevens, and F. Messier, 1996. Comparative winter habitat use and associations among herbivores in the High Arctic. Arctic 49:387-391.

Shank, C.C., 1997. The Northwest Territories small mammal survey: 1990-1996. Department of Resources, Wildlife and Economic Development, Yellowknife, NT. Manuscript Report No. 96.

Sinclair, P.H., W.A. Nixon, C.D. Eckert, and N.L. Hughes (eds), 2003. Birds of the Yukon. UBC Press, University of British Columbia, Vancouver, BC. 595 pp.

Smits, C. M. M., B.G. Slough, and A. Angerbjörn, 1989. Abundance and summer occupancy of Arctic fox dens in northern Yukon Territory. Yukon Department of Renewable Resources, Whitehorse, YK.

Smits, C.M., C.A. Smith, and B.G. Slough, 1988. Physical characteristics of Arctic fox (*Alopex lagopus*) dens in northern Yukon Territory, Canada. Arctic 41:12-16.

Staniforth, R.J., 2002. Effects of urbanization on bird populations in the Canadian Central Arctic. Arctic 55:87-93.

Van Egmond, T. and R. Rowell, 1998. Caribou diet composition analysis in the Diavik regional study area, August 1997. Prepared for Diavik Diamonds project by AXYS Environmental Consulting Ltd., Calgary, AB. *Cited in:* AXYS Environmental Consulting Ltd. (AXYS) and Penner & Associates Ltd., 1998. Diavik Diamond project: Environmental Effects Report, Wildlife. Prepared for Diavik Diamond Mines Inc., Yellowknife, NT.

van Zyll de Jong, C.G. and L.N. Carbyn, 1998. Status report on the Gray Wolf, *Canis lupus*, in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. *Cited in*: Northwest Territories Resources, Wildlife and Economic Development (NWTRWED), 2000. NWT Species 2000: General status ranks of wild species in the Northwest Territories. Available at: www.nwtwildlife.rwed.gov.nt.ca/monitor/htm. Accessed May 2003.

Verbeek, N.A.M., 1967. Breeding biology and ecology of the Horned Lark in alpine tundra. Wilson Bull. 79:208-218. *Cited in:* R.C. Beason, 1995. Horned Lark *Eremophila alpestris*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 195. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Verbeek, N.A.M., 1970. Breeding ecology of the Water Pipit. Auk 87:425-451. *Cited in:* N.A.M. Verbeek and P. Hendricks, 1994. American Pipit *Anthus rubescens*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 95. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Verbeek, N.A.M. and P. Hendricks, 1994. American Pipit *Anthus rubescens*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 95. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Walton, L.R., H.D. Cluff, P.C. Paquet, and M.A. Ramsay, 2001. Movement patterns of barren-ground wolves in the central Canadian Arctic. Journal of Mammalogy. 82:867-876.

Watson, A., 1957. The behaviour, breeding, and food-ecology of the Snowy Owl *Nyctea scandiaca*. Ibis 99: 419-462.

White, C.M., N.J. Clum, T.J. Cade, and W. Grainger Hunt, 2002. Peregrine Falcon *Falco peregrinus*. *In:* A. Poole and F. Gill (eds.). The Birds of North America. No. 660. Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Whitney, P., 1976. Population ecology of two sympatric species of subarctic microtine rodents. Ecological Monographs 46:85-104.

Wilson, D.J. and R.G. Bromley, 2001. Functional and numerical responses of predators to cyclic lemming abundance: Effects on loss of goose nests. Canadian Journal of Zoology 79: 525-532.

Personal Communications

Akesawne, D., Hunters and Trappers Association, Baker Lake, NU

Campbell, M. Regional Biologist, Department of Sustainable Development, Arviat, NU.

Gunn, A Department of Resources, Wildlife and Economic Development, Government of Northwest Territories

Johnson, D, Department of Resources, Wildlife and Economic Development, Government of Northwest Territories.

Setterington, M. Ecosystem Monitoring Biologist, Department of Sustainable Development, Arviat, NU.

APPENDIX A

Minutes of Meeting with the Baker Lake Hunters' & Trappers' Organization, 19 September 2002 **A.1**

Project Area Plant Communities & Associations **A.2**

List of Vascular Plant Species Identified in the LSA during Baseline Vegetation Surveys in August 1999 & 2002 **A.3**

List of Vascular Plant Species Likely to Occur in the LSA, but Not Collected during the 1999 & 2002 Baseline Vegetation Surveys **A.4**

List of Non-vascular Plant Species Identified in the LSA during Baseline Vegetation Surveys in August 1999 & 2002 **A.5**

Mammal Species Known or Expected to Occur in the Meadowbank Study Areas **A.6**

Bird Species Known or Expected to Occur in the Meadowbank Study Areas **A.7**

Breeding Bird Survey Data Forms **A.8**

Incidental Wildlife Observations from the Meadowbank Camp Logbook, 1996-2003 **A.9**

Caribou Observations Recorded during Aerial Surveys in the LSA in Fall 2002 & Winter/Fall 2003 **A.10**

Seasonal Number & Distribution of Caribou Recorded during Aerial Surveys in the RSA & Winter Road Corridor **A.11**

Seasonal Number & Distribution of Muskoxen Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.12**

Seasonal Number & Distribution of Wolves Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.13**

Seasonal Number & Distribution of Geese & Swans Recorded during Aerial Surveys in the RSA & Winter Road Corridor: Baseline Aerial Surveys, 1999-2003 **A.14**

Seasonal Number & Distribution of Raptors Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.15**

Seasonal Number & Distribution of Ptarmigan Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.16**

Seasonal Number & Distribution of Grizzly Bears Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.17**

Seasonal Number & Distribution of Dens & Burrows Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.18**

Seasonal Number & Distribution of Ducks Recorded during Aerial Surveys in the RSA & Winter Road Corridor, 1999-2003 **A.19**

Waterbird Observations recorded during Aerial Surveys in the LSA in June 2003 **A.20**

APPENDIX A.1

Minutes of Meeting with the Baker Lake Hunters' & Trappers' Organization, 19 September 2002

Original transcription appears in Appendix F of KAVIK-AXYS 2002.

Location: Inuit Cultural Center, Baker Lake, Nunavut

Attendees:

Baker Lake HTO

David Aksawnee (Chairman)

Phillip Putumiraqtuq (Secretary/Treasurer)

Thomas Kudloo (Board Member)

Harold Etegoyok (Board Member)

Josiah Nuilalik (Elder)

Norman Attungala (Elder)

Joe Niego (Wildlife Officer/Mayor)

Thomas Elydook (Board Member)

Joedee Joedee (Vice-Chairman)

Cumberland Resources Ltd. Representatives:

Scott Grindal (Wildlife Biologist: KAVIK-AXYS)

Peter Balagus (Wildlife Biologist: KAVIK-AXYS; Recorder)

Martin Gebauer (Gebauer & Associates)

Others:

Thomas Mannik (Interpreter/Translator)

Hattie Mannik (Interpreter/Translator)

Basil Aptanik (Office Manager)

Michael Setterington (Ecosystem Monitoring Biologist: Department of Sustainable Development, Arviat)

Natasha Thorpe (Golder Associates)

Call to order

1340 hr: Meeting opened by David; agenda approval seconded by Harold. Opening prayer by Joedee Joedee. Introduction of Board Members, Cumberland representatives, and others.

1355 hr: Scott introduces Cumberland Resources Ltd. proposal of a gold mine exploration program approximately 80 km north of Baker Lake. The project is in a feasibility assessment phase that includes wildlife and fisheries components. The purpose of this meeting was to communicate the status of wildlife and fisheries studies conducted to date as well as on-going studies.

Wildlife Surveys

The objectives of wildlife surveys are to document baseline conditions of wildlife species in the Meadowbank area in July 2002 and September 2002 (ongoing). Survey information will be included in a project Proposal Report to be submitted to the Nunavut Impact Review Board (NIRB). Approaches in both survey periods included helicopter (July) and fixed-wing (September) aerial surveys of a regional study area centered on the exploration site (regional map presented). Eleven transects, each 100 kilometres in length and separated by 10 kilometres and oriented in an east-west direction, were surveyed. Intensive ground-based surveys were conducted within a 5-kilometer radius of the exploration site (local map presented). Pellet group / fecal scat counts, as well as incidental records of wildlife species and/or species sign (e.g., feathers, antlers, burrows) were recorded on transects.

Preliminary July survey results (mapped) included 4 caribou observations in the regional study area; muskox observations, totalling 34 animals, were predominantly north of the Meadowbank area; evidence of bear excavations at sik sik burrow sites were recorded northeast of Meadowbank; 1 wolf was observed north of the camp site; and Canada geese were recorded throughout the regional study area. Other wildlife species observed in low densities were also mapped. September aerial survey results recorded much larger concentrations of caribou predominantly north and west of the Whitehills Lake area. Caribou numbers were highest in the central portion of the regional study area. Muskox were observed in similar numbers and locations as in July. Several wolf and fox were observed.

Conclude: July and September surveys are only a small window of field survey time. Additional surveys in other seasons may be required.

David: suggests HTO should be involved in spring surveys.

Phillip: questions why fisheries study areas are not mapped and what are the results.

Scott: responds that the map was for wildlife surveys and no fisheries data was intended.

1415 hr: Martin introduces fisheries component on behalf of Randy Baker who conducted the preliminary field surveys in July and August 2002.

Fisheries Surveys

The objectives if the surveys were to identify fish species, the health of the population and water quality in the Meadowbank area. Fisheries surveys have been conducted in the region since 1996. Surveys were focused in the local study area in Tehek, Second Portage, and Third Portage lakes. Five fish species were caught including lake trout, arctic char, arctic cisco, burbot, and lake whitefish. The fish appeared healthy even though they had some parasites. Because of limited food source, the growth rate is slow but the largest fish caught was a 44 lb. lake trout. Oxygen and mineral content was measured. Water quality was considered healthy. A low concentration of metals were detected in the fish but are still considered of good food value to people.

Conclude: Data collected provide important baseline information to monitor future changes locally.

1430 hr: Floor open to questions/comments.

QUESTION:

Hattie: Found out from Craig Goodings that several fish collected by Randy were dead. How come and what were done with them?

Martin: The fish had died in the gills nets. The smallest ones were thrown overboard while some were included in the sample of tissue and stomach analysis. Others were taken back to camp with the intent of distributing to Baker Lake residents.

David: No fish were turned over to HTO. He suggests fish should be turned over to HTO. Who will distribute them to town elders?

Martin: Will communicate request by David to Randy for future distribution of fish.

QUESTION:

Joe: Dykes will be required in the construction phase. What effect will dyke release have on the fishery?

Martin: Fisheries studies to date are preliminary. No impact assessment can be made until the exploration phase progresses and a final construction plan is made public. Plans continue to change as hydrology and coring samples are analyzed.

Joe: It is actually illegal to throw dead fish back. The fish should have been turned over to F & W. HTO would have distributed the fish as either food to elders or as dog food.

QUESTION:

Norman: When flying the aerial surveys, how do the animals react? Do they appear stressed?

Scott: The survey was conducted at approximately 300-400 feet in elevation. No apparent reaction was evident. No running or disturbed behaviour was observed. If the animal appeared stressed we would increase our altitude.

Norman: In the old days the animals would run from unfamiliar sounds. They seem more accustomed to the sounds now. They seem to be able to sense things so early; before they almost appeared to act as if they were reacting to evil spirits.

1445 hr: BREAK

1455 hr: RESUME

Phillip: I notice your map has very few camps and archaeological sites and what kind of noise monitoring is going to happen?

Scott: Additional camp locations were noted during the September survey and those will be added to the next map. Flight lines were at 10-kilometer intervals so some camp locations were probably missed. Similarly the additional archaeological sites will also be mapped. Noise will be appropriately monitored. This may be done through behavioural monitoring studies of caribou during construction activities.

Peter: The 25-50 caribou observed within 500 meters of camp do not appear disturbed by the noise levels at this time.

Phillip: Repeats Norman's concerns of caribou's reaction to noise disturbances.

Scott: Politely re-states survey methods protocols.

QUESTION:

Phillip: Historical low disturbance levels. What effect will this have on the caribou?

Scott: Information on caribou numbers, distribution and movements is limited in this area. The information we gather from our surveys plus trend information from local people will be important in understanding the possible effects. Government biologists in Arviat have been studying movements regionally over the last several years to address information gaps.

QUESTION:

Joedee: What wildlife species were identified in the local study area?

Scott: The regional map identifies the wildlife species recorded during the aerial surveys. A similar map for the local study area (presented to the group) shows the areas where observations were conducted, but the wildlife sightings have yet to be mapped in the local study area.

Thomas M.: There is a wildlife sightings record sheet in the camp. All wildlife sightings in the area of the camp can be recorded by anyone at anytime.

Scott: These records give us a larger database that we can use to assess wildlife occurrence over longer times. This can be used with the data we collect during our short survey periods.

QUESTION:

Joedee: What is the shaded border area on the regional map?

Natasha: I do believe it is an Inuit Land Use Zone.

Joe: It is a boundary between Inuit owned land and Government crown land.

QUESTION:

Scott: Are there any wildlife species that we may have not recorded?

Joe: Wolverines.

Phillip: Plant, vegetation and habitat communities.

Scott: Another person is collecting this information.

Thomas K.: Arctic hare, snowy owl and sik sik.

Scott: We have observed these species during the September surveys, and these species will be mapped in the next regional and local maps.

Joe: Muskox appear to be moving in from the west, possibly the Thelon Game Reserve. The local population seems to be increasing since the 1960s. Historically they stayed in the Thelon area.

Joe: Wolverine have been seen traveling south from the Aberdeen area in groups of 5 or 6. They probably are not family groups because they are seen in March-April.

QUESTION:

Scott: What about wolf numbers and movements?

Phillip: Trappers harvest numbers are increasing throughout the area.

Joe: He believes they are moving out of the tree line in the west (along with grizzlies).

QUESTION:

Scott: Are there any important traditional hunting areas?

David: Everywhere!

Josiah: He has commonly encountered caribou in the local study area. The animals don't appear as disturbed as before. If he finds some animals he knows he can still go and meet other hunters and return to find the animals still there. They would leave the area in the past.

Norman: He does not have a traditional area. He just goes out and looks.

QUESTION:

Scott: Have you noticed a change in numbers of wildlife since you were young?

Josiah: In the past we used to kill about 200 caribou for the winter, now 5-8 families are able to cache about 500 animals for the winter. He thinks the caribou used to be displaced by any noises. (See Norman's concerns above).

QUESTION:

Thomas E.: How do you sample or monitor fish?

Martin: Fish species numbers and health are sampled within and outside the local study area. Studies are being conducted to determine if the char are land-locked or if they move back to the salt water.

QUESTION:

Michael to HTO: The information presented today is the scientific approach to studying local fish and wildlife. What is the best way to acquire the types of information you can provide?

David: This is our first meeting between the HTO and Cumberland where the wildlife information has been presented. We will try to provide information to fill in the gaps where applicable with open communication on progress.

Thomas K: HTO appreciates the communication. Suggests that a Communication Officer between Baker Lake and Cumberland would be useful.

Phillip: A Liaison Officer in Baker Lake is currently being investigated.

Norman: He believes that once the HTO receives more of our information and express support of residents concerns then the residents can and will help with future meetings and exchange information.

Scott: Reiterates that Cumberland will attempt to provide good communication for future work and looks forward to a mutually beneficial exchange of information.

QUESTION:

David: Do you have any more surveys proposed?

Scott: We are considering a late winter aerial survey.

1600 hr: David thanks us for our presentation and willingness to communicate. He requested a Cumberland representative at an upcoming Keewatin Wildlife Board (KWB) meeting on October 7-11, 2002 in Chesterfield Inlet.

1605 hr: Final exchange of thanks (and business cards). END meeting. HTO agenda continues.

APPENDIX A.2

Project Area Plant Communities & Associations

The following descriptions of plant communities and associations found during the baseline studies for the Meadowbank Gold project are based on observable features in each grouping, species composition in conjunction with terrain features, or ecological conditions in the immediate vicinity.

Terrain features are the basis for, and control the development of, plant communities. At the same time, the plant communities overlay terrain features, and it is possible to have several types in the same geographic area. For example, boulders bear a complex lichen flora, yet the boulders themselves may be completely surrounded by heath tundra. Alternatively, heath tundra mats may be perched on boulders and surrounded by a boulder field. Each category is simply a human effort to label, to categorize and define situations that occur as a continuum in the natural world, situations that are always changing.

The term community has been used to refer to the larger, more distinct categories (such as sedge, heath tundra, or lichen-rock), most of which are mappable. The term association has been used to refer to subgroups of the communities, such as the non-tussock sedge association as a subgroup of the sedge community. Common names of plants have been used wherever these are available (see Appendix A.3 for scientific names). For plants without common names, scientific names were used.

1.0 Sedge Communities

In these communities, the dominant vegetation is composed of sedges and Arctic cotton (cottongrass). Sedge communities are located in depressions or drainage basins, sometimes in shallow lake edges or at the edges of ponds. Small willows (arctic willow, blue-green willow, Tyrell's willow) are often found in the sedge communities, especially where the ground is not flooded.

The sedge community can be divided into three associations, each slightly different. These include the emergent association at the edges of lakes or ponds, the non-tussock association in the centre or deepest part of drainage basins, and the tussock association, which occupies the sides of a drainage basin. These cannot be mapped separately because the delineations are not clear.

Sedge communities are important to caribou, especially lactating cows, which feed selectively on the emerging leaves of the sedges immediately post-calving, seeking out even small sedge basins in the upland tundra. Sedge associations are also important to small mammals such as voles and lemmings, providing year-round nutrients in the form of green shoots at the bases of the sedge plants.

1.1 Emergent association

This association is characterized by standing water, sometimes up to 30 cm in depth, with emergent plants. It usually occurs in ponds, or in shallow bays or lake margins. Transition to the shore may be gradual or abrupt. Robust sedges, such as water sedge, russet sedge, or round sedge, or large cottongrasses, such as narrow-leaved or short-anthered cottongrass, inhabit this community. Forbs such as cuckoo-flower and Sudetan lousewort may grow in the shallows.

Moss mounds often border the emergent association; these are composed mostly of *Sphagnum* moss with heaths. These mounds seem to build up by a slow downslope migration of the active layer, causing terraces or hummocks of moss to develop. Tussock sedges are not common in this association. Willows, mostly Tyrell's willow and *S. arctophila*, but also arctic willow and *S. fuscescens*, often become established in the moss mounds or even in the shallow water.

Birds such as red-throated loon (see Appendix A.7 for scientific names), yellow-billed loon, and pacific loon, and red-necked phalaropes often nest in the vegetation at the shoreline edges of the emergent associations.

1.2 Non-tussock sedge association

The non-tussock sedge association occurs in the center or deepest portion of drainage basins. Non-tussock sedges (either *Carex* or cottongrass) tend to grow where there is standing water or a slow flow of water over the land for some weeks at a time. These sedges occur in almost pure stands, and are usually not the species that form tussocks, but grow as individual plants from an underground rhizome; round sedge, fragile sedge, and narrow-leaved cottongrass are the most common, but other frequently encountered members of the sedge family include hairlike sedge, arctic marsh sedge, looseflower alpine sedge, sheathed sedge, and short-anthered cottongrass. Wood rushes such as arctic woodrush, confused woodrush, and small-flowered woodrush also occur here, though in lower concentrations. Sudetan lousewort and slimstem reedgrass often occur in this association. Small prostrate willows may occur amidst the sedges, usually the trailing arctic willow, *S. arctophila* or *S. fuscescens*. Upright willows such as tea-leaved willow or Tyrrell's willow also occur here.

Occasionally, the drainage channels are clearly visible because these are occupied by pure stands of sedges, cottongrasses, or both. Higher areas on each side support a more diverse community of sedges, cottongrasses, and a few grasses, and blend into the tussock sedge association.

1.3 Tussock Sedge Association

The edges of drainage basins or depressions receive more water than the surrounding upland, but the water drains off into the center of the depression, and does not stand for days at a time. A tussock sedge community usually occupies these basin edges. Here, cottongrass or *Carex* sedge tussocks form a tufted pattern over the ground, extending up the edges of the basin until they blend into the surrounding heath tundra, or reach a bedrock outcrop. Common tussock species in this area include short-anthered cottongrass and sea sedge, darkbrown sedge, cordlike sedge, lakeshore sedge, fragile sedge, and northern single-spike sedge. Wood rushes also occasionally occur here, including small-flowered woodrush and confused woodrush.

Due to the slow infilling of drainage basins, most tussock associations are in a state of change. As tussocks age, they increase in size due to accumulation of roots, stems and leaves, and of deposition of organic matter within the tussock itself. Heaths like bog rosemary, bog blueberry, lingonberry or mountain cranberry, bearberry, and Labrador tea become established in each tussock. Moss (*Sphagnum* sp.) begins to build up in and around the base of each clump. Cloudberries, or aqpik, often form a ring in the top of the tussock, and crowberry also may occur on the tops of the tussocks. Small willows (e.g., arctic willow) and dwarf birch become established in the tussocks, often forming a crown. Grasses are not common, but polargrass and alpine holygrass do occur in drier spots. This is the only place we found the small butterwort in the study area; this species occurs only in *Sphagnum* mats.

The sedges and cottongrasses persist for years in the tussock association.

1.4 Tussocks Being Invaded by Heaths

At the edges of the drainage basins, the tussock sedge association yields gradually to heath tundra and a transitional zone is apparent. Tussock-based mounds usually have a certain resiliency to them, due to the flexible connection of the interior tussock to the soil via the roots. The shapes of the tussocks are still visible and each "gives" when kicked. Stems, leaves, and (in season) flowers of the underlying cottongrass structure are also still visible, but heaths have become established in each tussock, and are becoming dominant.

The basic tussock structure in this area is based mostly on cottongrass tussocks, most frequently short-anthered cottongrass. These develop to maturity, usually about 20 to 30 cm diameter, and as they mature, seeds drift in, become lodged in the tussock, and other plants begin to grow on the substrate provided. In some areas, the small tufted bulrush carpets the ground.

Bog rosemary is usually among the first heaths to invade a tussock area, and tends to grow around the edges of a tussock. Sphagnum moss also becomes established in the base of the tussocks, and then heaths begin to grow in the moss and in the head of the tussock. Bog blueberry and lingonberry are most predominant, but Labrador tea and occasionally Lapland rosebay also becomes established. Dwarf birch takes root in the tops of the mounds, as does the willow *Salix arctophila*. Lapland lousewort, Richardson's bittercress, common false asphodel, and *Polygonum viviparum* (bistort) soon occupy the mounds as well. The legume (liquorice-root, or mahok) is occasionally found in the drier parts of this association.

Both the tussock association and the tussock association being invaded by heaths provide good nesting habitat for Lapland longspur and common redpoll, as well as, occasionally, semipalmated sandpiper.

2.0 Moss Community

Plant communities with a high percentage of sphagnum mosses occur sporadically on the study area. These tend to occupy shoreline areas where the ground is fairly level and where solifluction reaches local base level and tends to pile up mounds of vegetation in wet areas. Moss communities are also found at the bases of cliffs, including those that face the prevailing winds (NW), but these are uncommon in the local study area (LSA) due to the lack of cliffs.

2.1 Mossy Lakeshore

The mossy lakeshore association is a mixture of mosses (mostly *Sphagnum* sp.) and vascular plants, occurring where water seeps out of the base of a slope onto level ground, usually at the edge of a lake or pond. It is usually limited to only a few metres along the shore, but may occur sporadically around a lake or pond, and may occur along streamcourses.

The moss occurs in joined cushions or mounds, holding water through most of the dry summer season. Heaths, including bog rosemary, white arctic heather, bog blueberry, and red bearberry, plus a few sedges (lakeshore sedge, fragile sedge, looseflower alpine sedge, sheathed sedge, and narrow-leaved and short-anthered cottongrass), wood rushes (confused woodrush), and grasses (polargrass, slimstem reedgrass, and alpine holygrass) grow in the moss, adding diversity. Less common, but still present, are common horsetail, *Polygonum viviparum*, Sudetan lousewort, crowberry, and cloudberry. Mosses are the dominant plants. Mossy lakeshore associations usually occupy only a few hundred square meters at the most, occur sporadically, and are often elongated, following the shoreline.

In this study, cloudberry was found in quantity only in the mossy lakeshore association.

Parasitic jaegers often nest in the mossy lakeshore association, sometimes in small colonies or groups of several nesting pairs; however, no evidence of nests of this species were found within the LSA.

2.2 Mossy Cliff Base

Cliffs are rare in the study area, so this type of association is not commonly found. Snowdrifts usually accumulate at the bases of cliffs, even those that face the prevailing winds. These snowdrifts hold water on the land until late in the growing season, affecting the plants that can grow there. *Sphagnum* moss is dominant, but at the edges a grey moss (possibly *Racomitrium lanuginosum*) is common as well. Plants associated with this association include white arctic heather, Labrador tea, least willow, bluegreen chickweed, and bluegrass (*Poa* sp.), although this species also occurs around dens. Large-flowered wintergreen was found only in this association in the study area.

Areas where snow accumulates at the bases of small cliffs provides protected habitat for a number of mammals, including voles and lemmings, which burrow under the snow, leaving their runs, latrines, and nests as evidence, and feeding on the shoots of green vegetation that survive the winter under the drifts. Arctic hares also shelter here in fall and winter, burrowing into the snow, or crouching in the lee of the ridge.

3.0 Heath Tundra Community

The heath tundra is the climax community on the uplands in the Meadowbank area. It consists of a complex web of vegetation, dominated by woody plants in the ericaceae or heath family. As the moisture in the soil or exposure to wind varies, so does the vegetation. In addition, different substrates support different types of heath tundra associations.

There are five heath species that are found throughout the area. In most communities these include: bog blueberry, lingonberry, white arctic heather, Labrador tea, and bearberry, and the closely related crowberry.

The heath associations provide important foraging and nesting habitat for small tundra birds like redpolls, Lapland longspur, horned lark, savannah sparrow, and, in rocky areas, snow bunting. On dry ridge crests, American golden plover, Baird's sandpiper, and long-tailed jaegers may nest in shallow depressions in the heath tundra. The abundant berries and buds provide forage for ptarmigan, gulls, foxes, ground squirrels, and even grizzlies, although the latter are not common near Meadowbank.

Heath tundra in all its variations covers thousands of hectares across the mainland Arctic. It covers most uplands and gentle slopes, drapes like a net over flat areas and low ridges covered with glacial erratic boulders, and forms mats on top of boulder fields and felsenmeer. It can be broken down into several relatively similar associations.

3.1 Heath Tundra, Hummock Association

This complex association occurs at the edge or at the head of drainage basins, and consists of firmly attached mounds, which do not have the resiliency of tussock-based mounds. These seem to have an ice origin, forming from small ice lenses that grow mostly in the fall, due to accretion of water against the ice lens as water percolates through the active layer.

Because mounds of tussock origin and those of ice origin are both covered by heaths and other plants, and surrounded by moss, it is often difficult to visually determine the origin. Probing the hummock with a wand or giving it a kick will reveal the presence of an ice or frozen soil core.

Whatever the origin, the mounds are externally similar. Most have a high percentage of *Sphagnum* moss, especially around the base. Heaths crown the mound, including bog blueberry, Labrador tea, and mountain cranberry. Occasionally, bog rosemary grows on the edges of the mound, and cloudberry becomes rooted in the upper portion of the edges. Dwarf birch also become established, usually on the top of the mound, but occasionally in channels between mounds, especially on exposed sites where erosion by wind and blowing snow is a factor. Willows such as Arctic willow, *S. Arctophila*, and net-veined willow are common. Mountain avens, Lapland lousewort, fireworks flower, false asphodel, and bistort are often present, and alpine holygrass and polargrass occur as scattered plants.

Heath tundra hummocks with ice cores are not common in the study area; most mounds we encountered are flexible, and of tussock origin.

3.2 Heath Tundra, Upland

Where there is adequate moisture, or where the snow layer protects the vegetation in winter, the mat of vegetation consists of bog blueberry, lingonberry, Labrador tea, and white arctic heather with black bearberry and Lapland rosebay on the drier, more exposed areas. There are also scattered dwarf birch and prostrate willows (arctic willow, net-veined willow, and, occasionally, Tyrrell’s willow or least willow). Small sedges and grasses, including Bigelow’s sedge, fragile sedge, curly sedge, arctic bluegrass, polargrass, Lapland reedgrass, and alpine holygrass, and the woodrush, confused woodrush, occur as small tufts or individual plants, not dense stands, except where influenced by disturbances such as animal diggings or solifluction. Forbs such as louseworts, false asphodel (common false asphodel and, less commonly, northern false asphodel), fireworks flower, Richardson’s bittercress, and *Polygonum viviparum* are scattered throughout the tundra. Red bearberry occasionally occurs in the wetter areas, but is not common anywhere on the study area. The peas, including yellow crazyweed and Bell’s crazyweed and the alpine milkvetch, are present in varying quantities. Moss campion is uncommon in this association, but still present.

Lichens occur in varying quantities, with higher percentages of hair lichen (*Alectoria* sp.) on dry ridges, and ragged paperdoll (see Appendix A.4 for scientific names) on gentle slopes. The antler lichen, common across most of the central arctic, was found in only one association, the upland heath tundra, at Meadowbank. This lichen does not grow attached to the ground, but blows around like tumbleweeds, collecting in depressions. Glove lichen and grey mealy lichen as well as a grey moss (probably *Racomitrium lanuginosum*) are present in varying quantities, controlled by the amount of moisture in the immediate area.

3.3 Heath Tundra with Boulders

In places, heath tundra occurs in areas where the ground is liberally sprinkled with glacial erratic boulders or where bedrock outcrops occur. This creates a mosaic of two communities – a heath tundra substrate, and elevated lichen-rock communities on the boulders or outcrops. This type of mixed community may form a gradual continuum to felsenmeer or a boulder field.

Due to this gradual transition, it is extremely difficult to map the boundary of heath tundra with boulders to boulder fields or felsenmeer. For convenience, anything with more than 70% boulders is considered boulder field.

The heath tundra component of this association is typical of upland heath tundra, although the presence of the boulders may affect areas immediately around the boulders. Snowdrifts and later water runoff from the boulders creates microhabitats with a higher percentage of grasses around each boulder. Boulders also create protected habitat for animals; arctic hares and ptarmigan often take shelter at their bases, and ground squirrels dig burrows beneath them. Hawks use the larger boulders for lookouts and feeding posts.

3.4 Heath Tundra with Frost Scars

Permafrost (permanently frozen ground) underlies all the area encompassed by the Meadowbank project, and extends down to approximately 500 m underground. The top layer thaws in summer, and is called the active layer. Thaw depth varies with the type of soil, proximity to lakes, and exposure to the sun. The term frost scar is used as a collective term for the small landforms that are developed and modified by frost action.

When thawed, the active layer acts like a viscous liquid, moving downslope in some places, and setting up internal convection currents in others. The plants that become established on these unstable sites include a number of species that cannot compete with the heaths and other woody plants for a place in the upland heath tundra, but which are adapted to the constant movement of the soil on frost scars.

Frost scars, such as hummocks, frost boils, or small solifluction slopes, will support vegetation that is quite different from that on the upland heath tundra. Convection currents in the active layer or movement of the active layer over the permafrost cause an unstable substrate, and many plants simply cannot become established here. In addition, the elevation of the tops of hummocks above the normal winter snow level may allow the wind to erode the vegetation in winter, exposing the subsoil. Few plants can maintain a toehold in these situations.

In drier spots, or where frost boils elevate the soil, the mat of vegetation becomes thin and may include mountain avens, some of the legumes (yellow crazyweed, Bell's crazyweed, and alpine milkvetch), or Lapland rosebay. Mats of black bearberry, prickly saxifrage and crowberry may occur.

3.5 Lichen-Heath Tundra

In some areas, the heath tundra supports a higher percentage of lichens than in others. These areas usually occur on the tops of ridges or over sand or fine gravel on gentle slopes, all areas that are generally well-drained.

Lichens often account for more than 60% of the ground cover in some places, but heaths and other vascular plants grow in or through the lichen carpet. These include lingonberry, bog blueberry, and black bearberry, and sometimes mountain avens or diapensia. Glove lichen and whiteworm lichen also occur here.

3.5.1. Hair Lichen Association

This plant community is very common in the Kivalliq region, and is reported in all papers describing plant associations in the region. It occurs on the tops of dry ridges, drumlins or eskers, and consists of a matrix of grey witches' hair and green witch's hair lichens in which heath species, especially mountain cranberry and Labrador tea, have become established. Other heath and related species occur less frequently, including bog blueberry, white arctic heather, black bearberry, and crowberry. Legumes such as alpine milkvetch and yellow crazyweed also occur sporadically, as does the dwarf fireweed and mountain avens.

Small willows occur sparsely in this association, mostly arctic willow. Sedges and wood rushes are not common in this association, but the species that do occur include northern single-spike sedge and confused woodrush.

Grey witches' hair usually occurs on the crests of dry ridges, and the green witches' hair occurs in depressions or on slopes of these ridges. This association usually occurs on thin sandy loam soils.

Hair lichens have always been important to the Inuit of the Interior Kivalliq region as a source of tinder for their summer cooking fires, and are collected with the use of a digger made from the shovel part of a caribou antler.

3.5.2. Cetraria Lichen Association

Cetraria associations occur on the sides of drumlin ridges and in areas where there have been shallow slips in the past. It appears yellowish from the air, due to the high percentage of ragged paperdoll and other species. Woody plants include lingonberry, Labrador tea, crowberry, black bearberry, bog blueberry, and dwarf birch. Intermingled in the carpet of lichens are small sedges, including Bigelow's sedge, fragile sedge, and northern single-spike sedge, grasses, most often alpine holygrass, polargrass, arctic bluegrass, and slimstem reedgrass, and occasionally the woodrushes, confused woodrush or common woodrush. Club mosses (*Huperzia selago*) and common horsetail also frequently occur in this association.

4.0 Birch Seep Community

In areas where seepage occurs through the active layer, with an outflow of water at the base of a slight slope, low forests of dwarf birch often develop. From the air, these appear as darker areas on the land. Dwarf birch is a water-loving species, and dense growths develop where the water source is more reliable than on the upland heath tundra, yet not so abundant as to support a sedge community.

Birch seeps differ from the riparian birch shrub association in that the riparian associations occur in much more defined drainage systems, and most frequently on a boulder substrate, whereas a birch seep can occur in areas without large numbers of boulders. They occur on the downslope margins of solifluction lobes, and at the edges of sedge associations.

The plant species growing under the birches depend upon the amount of water in the soil; sometimes it is composed of heaths such as mountain cranberry, bog blueberry, and white arctic heather, sometimes bearberry and crowberry, and occasionally large-flowered wintergreen. Lichens are usually sparse, due to lack of sunlight, but include ragged paperdoll, glove lichen, grey witches' hair, grey mealy lichen, and whiteworm lichen, as well as a few others, including dragon funnel lichen and mealy pixie-cup. Small willows also occur in this community, including arctic willow, blue-green willow, Tyrrell's willow, scattered plants of least willow, and occasionally, net-veined willow. Often there is a distinct dark colour to the ground, a combination of several lichens (possibly including *Placinthiella* sp.), moss, and algae. The attractive foliose lichen with branching black-edged lobes, monk's hood lichen, often grows on the branches of the birches.

In the larger birch seeps, where the birches form a dense canopy excluding sunlight, there is often little or no understorey or ground cover, just birch leaf litter on the ground. In other spots, where the birches occur in distinct groves, the ground may be covered with a sedge association intermingled with heaths. Sedges here may include Bigelow's sedge, hairlike sedge, lakeshore sedge, fragile sedge, round sedge, and northern single-spike sedge, and there are often wood-rushes (mostly confused woodrush). Grasses include alpine holygrass, arctic bluegrass, polargrass, and slimstem reedgrass. Forbs are less common, but include *Eutrema edwardsii,* fireworks flower, common false asphodel, and *Polygonum viviparum.*

Birch seeps are important as nesting habitat for some species of small passerine birds, especially those that prefer to nest above ground rather than in the tundra itself, including hoary and common redpolls and white-crowned sparrow.

5.0 Riparian Shrub Community, Birch

The term riparian refers to stream habitat. In the Meadowbank area, there are few well-defined streams. The area is relatively level, located on the divide between northward drainage via the Meadowbank River to the Back River system, and the southward drainage to Baker Lake.

The birch riparian association occurs in the drainages between lakes, invariably on a boulder substrate, although plants may be rooted in perched material on the boulders. True soil is at a minimum. These drainage systems usually have a relatively constant flow of water, and often occur between lakes, especially where there is a gradient of more than 1-2%.

In this study area, riparian communities are usually characterized by the presence of upright dwarf birch, as opposed to prostrate specimens. Vegetation is low, with small birches to about 30 cm in height, often forming an unbroken cover.

Because of the boulder substrate, the ground may have little other vegetation except where there are old tundra mats bridging the boulders. These may support low growths of crowberry, lingonberry, and bog blueberry, plus occasional clumps of white arctic heather. Due to shading, there are seldom many lichens on the boulders, but monk’s hood lichen often occurs on the branches of the birch shrubs. Small willows (arctic willow, Tyrrell’s willow, and net-veined willow) also occur here, but seldom exceed the height of the birches.

These associations are often moist, and grasses and sedges sometimes grow profusely, especially at the edges where there is more sunlight. These often include the grasses polargrass, slimstem reedgrass, and alpine holygrass. Sedges include sea sedge, fragile sedge, short-leaved sedge, northern single-spike sedge, and sheathed sedge. Forbs may include surefoot buttercup, Lapland lousewort, bistort, fireworks flower, yellow crazyweed, and alpine milkvetch.

Like birch seeps, the riparian shrub habitat is important for small birds, providing nest sites for redpolls, and some of the sparrows.

6.0 Snowbank Community

Snowbank communities occur on the leeward sides of hills, outcrops, eskers, or banks of stream valleys. They can develop in places where the wind deposits deep drifts over many consecutive winters, and usually occur in areas where the snow lies on the ground until early to mid-July. Because the prevailing winds usually come from the northwest in the Meadowbank area, these communities usually (but not always) occur on east, southeast, or south-facing slopes. This community has been referred to as a snowflush community. Snowflush communities can persist vegetatively for several seasons when thick snowdrifts reduce their growing season to a minimum, and snowflush plants may not flower or fruit for a period of years.

Snowbank communities are associated with an erosional/depositional process called nivation, defined as “the combined action of frost shattering, gelifluction and slopewash processes which operate in the vicinity of snowbanks.” Once the nivation hollow has developed, the process is self-generating because the presence of the snowbank prolongs the effects of the freeze-thaw and particle movement processes, in addition to supplying water, which also assists in particle transport. This all influences the plant communities that can occupy the site; they must not only be able to survive a shorter growing season, but also a constantly changing substrate.

In the Meadowbank area, these communities usually have a mixture of three indicator species: least willow, Labrador tea, and white arctic heather. Where the bank is steep and the drifts very large, mountain heather, few-flowered anemone, some of the mustards (smooth draba and milky draba), northern single-spike sedge, mountain sorrel, pygmy buttercup, and occasionally diapensia and arctic alpine fleabane occur. Snowbank communities are easily recognized in August, as their showier inhabitants are the only ones left blooming so late in the season.

Few other willows can exist in under these conditions; these include arctic willow, and an occasional hybrid of *S. glauca* ssp. *callicarpaea* with arctic willow. Only a few sedges occur, including Bigelow's sedge, northern single-spike sedge, curly sedge, and the wood rush, confused woodrush. Grasses include arctic bluegrass, and polargrass. The grasses spike trisetum and alpine bluegrass are less common; each was found in only one snowbank community on this project, but are not rare plants (they are common elsewhere in the central Arctic and barrenlands).

The fact that the accumulated snow takes weeks to melt also affects the plant communities near a snowbank. Although the growing season for plants under the main part of the snowbank is significantly shorter than the rest of the area, the plants around and downslope from a snowbank community are supplied with abundant water until the snowbank melts completely, and then must make do with little water for the rest of the growing season. Dwarf birch, small willows, bog blueberry, lingonberry, alpine arnica, pussytoes (*Antennaria* sp.), mouse-eared chickweed, snow cinquefoil, moss campion, and *Eutrema edwardsii* are a few of the peripheral species. Lichens are uncommon here, but one, possibly the snow-bed Iceland lichen *(Cetrariella delisei),* occurs in patches in the mosses. Where there are rocks above a snowbank community, several other species of vascular plants cling to cracks in the rocks near the snowbank, including alpine saxifrage, cordate-leaved saxifrage, prickly saxifrage, and the tiny sandwort.

Snowbank communities are examples of some of the strangest Arctic adaptations in plants, the ability to survive but not compete – the ability to exist in an environment with an incredibly short growing season, yet protected by snow from the harshest winter temperatures and drying. The true snowbank species cannot compete with other plants for space where the very precise snowbank conditions do not occur, but they do very well in their own little niche.

7.0 Avens Community

The avens community is similar to the heath tundra community, but occurs in drier areas, usually on ridge tops, often in thin soil over bedrock. It is in some ways similar to heath tundra, but includes such a high percentage of mountain avens (20% to 85%) that it really cannot be called heath tundra. The avens community is not common in the Meadowbank study area and covers only limited areas, but is more common to the west.

Mountain avens is the dominant species in this community, but is often accompanied by other species, such as the heaths (including lingonberry, bog blueberry, black bearberry, Labrador tea, and sometimes Lapland rosebay). In addition, there are mixtures of other species: diapensia, fireworks flower, pussytoes sp., crowberry, snow cinquefoil, moss campion, prickly saxifrage, and others. Peas include alpine milkvetch, yellow crazyweed, and Bell's crazyweed. Thrift was found only in this community during this study.

Dwarf birch, Tyrrell's willow, arctic willow, net-veined willow, and least willow are present in small numbers, and *Salix arctophila* and blue-green willow are occasionally present.

Grasses and xeric sedges are a major component of this community. Grasses usually include alpine holygrass, polargrass, and slimstem reedgrass, and sedges and related groups include Bigelow's sedge, arctic marsh sedge, fragile sedge, spike sedge, northern single-spike sedge, curly sedge, sheathed sedge, and confused woodrush.

Lichens in this community are similar to those in the heath tundra, and include hair lichens, ragged paperdoll, whiteworm lichen, glove lichen, and grey mealy lichen.

The avens community provides good foraging and nesting habitat for several bird species that prefer dry habitats, such as the horned lark, and American golden plover.

8.0 Lichen-Rock Community

Crustose lichen associations occur on rocks throughout the barrenlands, and foliose and fruticose lichen associations occur between the rocks in boulder fields or felsenmeer (shattered bedrock). These associations vary according to the exposure of the rock to winds, the amount of moisture available, and the chemical composition of the rock. Lichen-rock communities are best described based on the physical components of their rock substrates.

8.1 Felsenmeer/Boulder Fields

Felsenmeer is fractured bedrock weathered into relatively sharp-edged boulders, which lie adjacent to each other, forming rubble fields that may cover large areas or be only a few square metres in size. Boulder fields are composed of boulders rounded by abrasion in a continental ice sheet or in outwash from a continental ice sheet, and aggregated by deposition or by frost heaving.

In some areas, boulder fields meander down slopes as boulder festoons or boulder streams. In these, in summer, there is often a considerable flow of water in the channel created by the boulders. This water does not materially affect the plants growing on the boulders, although it may locally raise the humidity slightly.

In the Meadowbank area, the surfaces of the boulders exposed to the sun are 80% to 90% covered by lichen growth. Lichen and/or heath tundra patches often form in protected areas between the boulders. Common lichens found in boulder fields or felsenmeer in the Meadowbank area include yellow map lichen and two-spored map lichen, sunburst lichen, rock tripe (*Umbilicaria* sp.), bloodspot lichen, alpine bloodspot, and several others, including an orange lichen with black apothecia (either orange boulder lichen or halloween lichen*)*, fine rock wool, and several unidentified lichens, including a grey lichen forming smooth round paint ball patches on the rocks, and a black mealy crustose lichen.

Crustose lichens growing on the rocks catch and accumulate debris, gradually forming areas where foliose lichens can grow and rooted plants can become established. These include ragged paperdoll and other *Cetraria* species, including the yellow limestone sunshine lichen and brown brown Icelandmoss, glovelichen, grey mealy lichen, several species of *Cladonia*, including cup lichen and thorn Cladonia. A grey moss, probably *Racomitrium lanuginosum*, is common as well.

Usually the first rooted plants to become established in a boulder field or felsenmeer are the mat-formers, like crowberry, bearberry, mountain avens, or prickly saxifrage, or those that can cling to a crack in the rock, like the fragrant shield fern or pussytoes. These further accumulate debris and provide a foothold for other rooted plants. As humus accumulates, patches of heath tundra develop as a mat draped over the boulders.

A variety of plants invade these vegetation mats, including the heaths (Labrador tea, white arctic heather), willows (arctic willow and net-veined willow), peas (alpine milkvetch and yellow crazyweed), grasses (polargrass, alpine holygrass, and alpine fescue), Bigelow's sedge, dwarf fireweed, common false asphodel, or *Polygonum viviparum*.

Felsenmeer, boulder fields, and boulder streams are common on the study area, especially in the proposed road route from North Portage to the Vault deposit.

8.2 Bedrock Outcrops

Glacially sculpted bedrock outcrops are common in the LSA, usually consisting of whaleback protrusions, often with shattered cliff faces on one side. If these are high enough, the winter winds and blowing snow scour the surface, preventing the growth of plants. Only the low crustose lichens like map lichens, rock tripe, and black and grey crustose lichens can survive.

Most bedrock outcrops in the LSA are composed of siliceous or acidic rock, which support a very specific lichen community, similar to that described above for boulder fields. This includes black and green hair lichens (grey witches' hair and green witches' hair), fine rock wool, sunburst lichen, bloodspot lichen, a variety of rock tripes, and more.

Crevices and fractures in rock surfaces permit additional vascular plant species to become established, including fragrant shield fern, snow cinquefoil, milky draba, crowberry, and a few heaths, including bog blueberry, lingonberry, black bearberry, and Labrador tea. Where there is a lot of protection from the winds, and adequate moisture, another fern, *Woodsia glabella*, is occasionally found. Thin tufts of graminoid plants include alpine holygrass, arctic bluegrass and confused woodrush.

We found a few calcareous outcrops, rock which is of a basic chemical composition and supports a totally different lichen flora. These rocks are easily recognizable by the lichens alone – especially the orange jewel lichen, and a white lichen with black apothecia, possibly cinder lichen. In addition, grey mealy lichen, an unknown black cushion moss, and a grey moss, probably *Racomitrium lanuginosum*, occur here. The soil over these calcareous outcrops often supports a thin growth of small xeric sedges (spike sedge, curly sedge, and northern single-spike sedge), scattered plants of moss campion, and a high percentage of mountain avens. In the LSA, one of the best examples of these outcrops occurs at the northwest end of the arm of the lake by North Camp. The white hill to the northwest of North Portage is possibly similar, but was not visited.

9.0 Disturbed Sites

Disturbed sites develop their own plant communities, which are often quite different from those on the surrounding undisturbed land. Disturbances have several causes, which can be simplified into two main categories: those resulting from the addition of nutrients; and those resulting from the wearing away of the vegetation, or removal of plant cover and soil.

Types of disturbances include those resulting from:

- Animal activity (den sites, bear diggings, caribou trails)
- Human activity (camps, roads, mining sites, grey-water outflow from camps, etc.).

Most of these are small and cannot be mapped, except as points.

9.1 Animal Activity

Animals disturb the ground surface in a number of ways: by digging, or by the passage of large numbers of animals over the land. In most cases, they add significant quantities of nutrients to the immediate vicinity of a den, locally affecting the plant communities.

It may be argued that animal disturbances are natural and should not be considered here, but we have included them as the plant communities that develop as a result, and which are quite different from others observed in the area.

9.1.1. Animal Den Sites

Mammals from voles and lemmings up to the largest predators, such as the grizzly and wolf, make dens for shelter or the rearing of their young. Many of these den sites are located in eskers because the soil is looser, which makes it easier to construct a den. No dens of anything larger than a ground squirrel were observed in the LSA of the Meadowbank project.

Because good burrowing conditions are rare in our area, den sites are reused generation after generation. This traditional use not only maintains the disturbed nature of the sites but also adds nutrients to the soil through feces and decay of nesting material and, in some cases, the bodies of the inhabitants. Relatively high levels of organic matter and exchangeable bases, particularly calcium and potassium, generally occur near den sites. Amounts of available nitrogen, phosphorus, and potassium are considerably greater in the mound than in adjacent soils. Plants, especially the grasses, may respond to this addition of nutrients by developing into lush stands.

Loosening of the soil on the den sites makes it easier for grasses to become established. The plant communities that develop on animal den sites are usually those that respond to fertilization of the soil, and to aeration, loosening of the soil, and deposition of new soil on the surface of the ground.

Den sites support a large variety of plants, including lush growths of grasses like bluejoint (slimstem reedgrass, and Lapland reedgrass), polargrass, alpine holygrass, and bluegrasses (arctic bluegrass, alpine bluegrass, glaucous bluegrass). Small sedges (Bigelow's sedge) and wood rushes (confused woodrush) may also become established. A variety of forbs may grow on the sites, including smooth draba, star chickweed, mouse-ear chickweed, alpine arnica, pussytoes, white bladder campion, Lapland lousewort, birdfoot buttercup and the peas, alpine milkvetch and yellow crazyweed. In addition, mountain avens, snow cinquefoil, dwarf fireweed, moss campion, prickly saxifrage, and narrow-leaved dandelion (*Taraxacum lacerum*) may also occur. Heaths, dwarf birch, and small willows also occur here, as most den sites are limited in area and adjacent to heath tundra.

9.1.2. Caribou Trails

The Meadowbank area is in the general migratory route of the Beverly caribou herd, and possibly a wintering area for herds to the north and east. Caribou follow somewhat traditional routes, and tend to walk in single file, even in the summer, so they can establish well-defined trails on the land.

Where these trails are in regular use (such as around Contwoyto Lake) regular use of trails creates paths across the tundra, where the vegetation is completely removed due to the abrasion by the hooves of the caribou. In wetlands, trails are actually cut into the peat. In addition, the deposit of large quantities of feces on the trails provide nutrients not usually available, encouraging the development of lush plant communities along regularly used routes, especially at the edges of the sedge associations.

In the ILSA for the Meadowbank project, however, we did not find caribou trails in regular and heavy use, and no sites affected by nutrients from caribou feces. Instead, we found many deeply incised caribou trails that show evidence that they are no longer being used at the rate they were in the past. These trails, though deeply worn into the tundra, are thickly revegetated with lichens and mosses. Even light annual use of trails by caribou removes the lichens and mosses from the trails.

Based on our observations, evidence in the Meadowbank area indicates much heavier caribou use of the area in the past, and only light use at present.

9.2 Human-Disturbed Communities

Human disturbance in the LSA takes two major forms: places where the vegetative cover is broken or altered due to abrasion, digging, or to the establishment of trails or roads; and places where nutrients (or perhaps only water) are added to the land.

9.2.1. Vegetation Disruption or Wear

Abrasion breaks the plant cover, compacts the soil, and erodes the surface of the land. This abrasion can be caused by frequent use and pressure due to buildings, vehicles, and items being dragged over the land, such as in the vicinity of a camp, careless drilling, or bulk sampling activities.

Here, the normal plant cover is disrupted or destroyed, resulting in bare scars on the land, or in thick growths of grasses, as opposed to the usual heath tundra communities. This disruption of the plant cover on the land can have long-ranging effects on the terrain, in many cases creating thermokarst topography. Thermokarst topography consists of irregular, hummocky terrain due to the melting of ground ice and the melting process of all ground ice bodies. Melting of ground ice may be initiated by climate change, destruction of an insulating plant cover by fire, animals, or man, or by any other disturbance of the thermal regime of the ground, including the acceleration of the rate of thawing by moving water.

In practical terms, breaking of the plant cover on the land (especially if it exposes dark soil or peat) results in increased thawing of ice in the active layer and upper part of the permafrost, due to solar heat absorption and subsequent removal of particles due to increased flow of water through the area in summer. Effects include subsidence, development of pools of standing water, and mounds of surface debris.

At the Meadowbank project area, all summer transport of equipment, core samples, and supplies has been by helicopter or by hand. Paths were established using pallets, which have been laid on the ground, and though these have killed a small amount of the vegetation under the boards, they have dispersed the pressure on the vegetation and on the soil, and have much reduced the impact of a camp on the land. Vehicles are not used in summer, and winter use is delayed until there is adequate snow cover on the land. Drill moves are accomplished entirely by helicopter, and drill sites are kept clean; however, increased use of the area (camp, roads, airstrip, and pits) will result in some damage to the vegetation. In particular, construction of an airstrip and connecting roads will, in addition to affecting the vegetation under the footing material, eventually create thermokarst situations along roads and strip, and in the borrow pits created to supply building materials.

Camps

A number of plots were done in South Camp, where tents have been removed. Areas where tents had been located for several years were devoid of living vegetation under the tents, and had lush growths of grasses and sedges around the tent perimeter. The lack of vegetation under the tents was likely due to deprivation of sunlight, and the increased grass growth is likely due to increased moisture from run-off from the roof of the tent. Grasses and sedges include polargrass, and alpine holygrass, which may occur in thick clumps, as well as narrow-leaved cottongrass, Bigelow’s sedge, fragile sedge, and sheathed sedge. Heaths such as bog blueberry, lingonberry, bearberry, Labrador tea, white arctic heather, and the related crowberry, survived under the edge of the tentframe, but not under the center.

Trails & Trenches Area

Where roads or trails are constructed, either accidentally or purposely, the vegetative cover is usually broken or material is piled over the vegetation.

Trenches were dug in 1999 to expose the deposits on the Third Portage area, and these and associated roadways for heavy equipment were examined in 2002. There has been virtually no regeneration of vegetation on these sites. Only a few plants of bog blueberry and lingonberry were noted, which may be shoots able to grow from plants buried under the road material because they are at the edge. There are a few isolated plants of alpine milkvetch, and tiny plants of mosses, probably *Aulacomnium* and *Polytrichum*; otherwise, there is no vegetation at all.

9.2.2. Nutrient-Enriched Areas

Another common form of disturbance is water and nutrient-related-- places where greywater is discharged from a camp, or where anything that can add nutrients to the soil is deposited. These areas usually develop dense growths of sedges, grasses, or both, and eventually more willows tend to become established.

There are two areas where this may have happened. Curiously, one is not located near the camp, but near the trenches, and may not be affected by human activities at all, or may have represented a temporary outflow of water during trench construction. A plot located just to the southwest of the trenches is on wet soil on a 2% slope facing SW, and has an unusually high percentage of Lapland reedgrass (25% out of a 65% plant cover). Other vegetation is typical of heath tundra. There is no other area with this density of grasses in the vicinity.

The other area is within the confines of South Camp, under the remains of what is apparently a rack, and probably represents a former greywater outflow. In this small area (about 15 m x 10 m), a lush growth of arctic alkaligrass, purple reedgrass, common horsetail, Bigelow's sedge, fragile sedge, alpine holygrass, and confused woodrush surrounds a small group of boulders.

10.0 Communities Expected, but not Encountered in the Study

The following two plant communities or associations likely occur in the area. They were not encountered in the areas examined in detail in the LSA; however, on the aerial survey in 1999, two areas were observed that may fit into these categories.

10.1 Sandy Esker/Drumlin Complex

Eskers are not common the area, but one area on the western shore of Third Portage Lake appears to be the remnants of an esker or drumlin. It is not large, but appears to be sandy with mats of vegetation; otherwise, the closest esker is about 8 km away, and was not investigated.

Esker complexes support a number of different plant communities, from the Saxifraga-blueberry community of a sandy crest to hair lichen-heath tundra or the lichen-rock community of a cobble crest. Slopes are most often heath tundra, with some *Cetraria* lichen-heath associations on the slopes. Birch seeps or small riparian communities may occur where an esker blocks the flow of water, or downslope from an esker pond where water seeps through the esker.

All assocSiations, other than the sandy crest community, are explained elsewhere in this paper, so the only one discussed here will be the Saxifraga-blueberry association.

10.2 Saxifrage-Blueberry Association

The saxifrage-blueberry association occurs on the sandy crests of eskers. It is similar to the avens community in that it occurs on ridge tops, but usually is on sand rather than sandy loam soil. Blow-outs, where there are no plants at all, are often present.

Plants occur in dense mats, probably by layering or expansion from a common root system. These mats are usually bog blueberry, lingonberry, crowberry, black bearberry, pussytoes, or prickly saxifrage. There may be additional scattered plants of moss campion, snow cinquefoil, alpine holygrass, spike trisetum, or purple reedgrass, and sometimes a few xeric woodrushes like confused woodrush. Lichens are sparse, usually hair lichens (*Alectoria* sp.) and ragged paperdoll. Larger pebbles may sport tufts of fine rock wool.

Both the avens community and the saxifraga-blueberry community are important in the stabilization of esker crests. Exposure to strong winds in winter ensures that a snow cover never develops; the area is constantly exposed to the bitter winds and blowing ice crystals, so a contiguous plant community seldom develops. The plants that grow here are the survivors; those that can become established in an unstable substrate, under very dry conditions. As expected, many show adaptations for water retention – the waxy leaf surfaces of lingonberry and prickly saxifrage, the hairy leaves of pussytoes and snow cinquefoil, succulent growth form of the saxifrage, and very low matlike growth of bog blueberry.

10.3 Riparian Shrub, Willow Riparian

In areas with considerable flow of water through boulders, especially in a stream valley or area protected by adjacent ridges, a further development of a riparian shrub community sometimes occurs. This involves the growth of relatively large willows in the centre of a birch riparian association.

Common to most willow riparian associations in the central Arctic is the fact that they are based on a boulder substrate, usually with a significant flow of water through the boulders, even into late summer. The edges of the drainage basin are occupied by dwarf birch, and the willows are invariably in the centre. Willow species vary, but in this area, Tyrrell’s willow, and Richardson’s willow would be expected. The understory beneath the willows is usually sparse, likely crowberry and lingonberry, and occasionally bog blueberry.

A possible willow riparian community was sighted from the air in 1999, at the northeast end of what is identified on one map as John Lake. This was very small, but sited correctly, and appeared from the air to be occupied by taller willows. This has not been sampled on the ground.

APPENDIX A.3

List of Vascular Plant Species Identified in the LSA during Baseline Vegetation Surveys in August 1999 & 2002

Table A.3: List of Vascular Plant Species Identified in the LSA during Baseline Vegetation Surveys in August 1999 & 2002

Scientific Name	Common Name
Family: POLYPODIACEAE	
Dryopteris fragrans	Fragrant shield fern
Family: EQUISETACEAE	
Equisetum arvense	Common horsetail
Family: LYCOPODIACEAE	
Huperzia selago (was *Lycopodium selago*)	Shining clubmoss
Family: GRAMINAE	
Arctagrostis latifolia	Polargrass
Calamagrostis lapponica	Lapland reedgrass
Calamagrostis stricta ssp. *stricta* (was *C. neglecta*)	Slimstem reedgrass
Calamagrostis purpurascens	Purple reedgrass
Festuca brachyphylla	Alpine fescue
Hierochloe alpina	Alpine holygrass; alpine sweetgrass
Poa alpina	Alpine bluegrass
Poa arctica	Arctic bluegrass
Poa glauca	Glaucous bluegrass
Puccinellia arctica (was *P. borealis*)	Arctic alkaligrass
Trisetum spicatum	Spike trisetum
Family: CYPERACEAE	
Carex aquatilis	Water sedge
Carex atrofusca	Darkbrown sedge
Carex bigelowii	Bigelow's sedge
Carex capillaris	Hairlike sedge
Carex chordorrhiza	Cordlike sedge
Carex holostoma	Arctic marsh sedge
Carex lenticularis	Lakeshore sedge
Carex marina (was *C. amblyorhyncha*)	Sea sedge
Carex membranacea	Fragile sedge
Carex misandra	Shortleaved sedge
Carex nardina	Spike sedge
Carex rariflora	Looseflower alpine sedge
Carex rotundata	Round sedge
Carex rupestris	Curly sedge
Carex saxatilis	Russet sedge, rock sedge
Carex scirpoidea	Northern single-spike sedge
Carex tenuiflora	Sparse-flowered sedge
Carex vaginata	Sheathed sedge
Eriophorum angustifolium	Narrow-leaved cottongrass
Eriophorum brachyantherum	Short-anthered cottongrass
Eriophorum sp.	Arctic cotton, cottongrass, kangoyak
Kobresia myosuroides (was *K. bellardii*)	Bellard's kobresia

Scientific Name	Common Name
Kobresia simpliuscula	Simple bog sedge
Trichophorum caespitosum (was *Scirpus caespitosus*)	Tufted bulrush
Family: JUNCACEAE	
Luzula arctica	Arctic woodrush
Luzula confusa	Confused woodrush
Luzula multiflora	Common woodrush
Luzula parviflora	Smallflowered woodrush
Luzula sp.	Woodrush
Family: LILIACEAE	
Tofieldia coccinea	Northern false asphodel
Tofieldia pusilla	Common false asphodel
Family: SALICACEAE	
Salix arbusculoides	Northern bush willow
Salix arctica	Arctic willow
Salix arctica x Salix glauca callicarpaea	Hybrid willow
Salix arctophila	
Salix fuscescens	
Salix glauca	Blue-green willow; grey-leaved willow
Salix glauca ssp. *callicarpaea*	
Salix herbacea	Least willow
Salix planifolia	Tea-leaved willow
Salix planifolia x Salix tyrrellii	Intergrades or hybrids
Salix reticulata	Net-veined willow; uqaujait
Salix richardsonii	Richardson's willow; kakarutit (buds)
Salix tyrrellii	Tyrrell's willow
Family: BETULACEAE	
Betula nana (was *B. glandulosa*)	Dwarf birch
Family: POLYGONACEAE	
Oxyria digyna	Mountain sorrel; sweetleaf; hiirnat
Polygonum viviparum	Smartweed
Family: CARYOPHYLLACEAE	
Cerastium alpinum	Mouse-ear chickweed
Minuartia rubella	Sandwort
Silene acaulis	Moss campion
Stellaria longipes ssp. *monantha* (was *S. monantha*)	Blue-green chickweed
Stellaria sp.	Star chickweeds; starworts
Family: RANUNCULACEAE	
Anemone parviflora	Few-flowered anemone
Ranunculus pedatifidus	Birdfoot or surefoot buttercup
Ranunculus pygmaeus	Pygmy buttercup
Family: CRUCIFERAE	
Cardamine digitata	Richardson's bittercress
Cardamine pratensis	Cuckoo flower

Scientific Name	Common Name
Draba alpina	Alpine draba
Draba glabella	Smooth draba
Draba lactea	Milky draba
Family: SAXIFRAGACEAE	
Saxifraga cernua	Bulblet saxifrage; nodding saxifrage
Saxifraga nelsoniana ssp. *porsildiana* (was *S. punctata*)	Cordate-leaved saxifrage; kakillanarnaqutit
Saxifraga nivalis	Alpine saxifrage
Saxifraga tricuspidata	Prickly saxifrage; kakilahan; three-toothed saxifrage
Family: ROSACEAE	
Dryas integrifolia	Mountain avens
Potentilla nivea	Snow cinquefoil
Rubus chamaemorus	Cloudberry; aqpik (berries); aqpingnaqutit (leaves)
Family: LEGUMINOSAE	
Astragalus alpinus	Alpine milkvetch
Hedysarum alpinum	Liquorice-root; mahok; bear root; alpine sweetvetch
Oxytropis arctica ssp. *bellii* (was *O. bellii*)	Bell's crazyweed
Oxytropis maydelliana	Yellow or Maydell's crazyweed;
Oxytropis sp.	Crazyweeds; locoweeds
Family: EMPETRACEAE	
Empetrum nigrum	Crowberry; paungait (berries); paungaqutit (leaves)
Family: ONAGRACEAE	
Epilobium latifolium	Dwarf fireweed; river beauty; broad-leafed willowherb
Family: PYROLACEAE	
Orthilia secunda (was *Pyrola secunda*)	Side-flowered wintergreen; one-sided wintergreen
Pyrola grandiflora	Large-flowered wintergreen
Family: ERICACEAE	
Andromeda polifolia	Bog rosemary
Arctostaphylos alpina ssp. *alpina* (was *A. alpina*)	Black bearberry; kablarjuit (berry); kablaqutit (leaves)
Arctostaphylos alpina ssp. *rubra* (was *A. rubra*)	Red bearberry; kablarjuit (berry); kablaqutit (leaves)
Cassiope tetragona	White arctic heather; iksutit
Ledum palustre ssp. decumbens wasLedum decumbens	Labrador tea; qisiqtuti
Loiseleuria procumbens	Alpine azalea
Phyllodoce coerula	Mountain heather
Rhododendron lapponicum	Lapland rosebay
Vaccinium vitis-idaea	Lingonberry; mountain cranberry; kimmingat (berries); atungaujat (leaves)
Vaccinium uliginosum (was *V. u. ssp. alpinum* and *V. u. ssp. uliginosum*)	Bilberry; blueberry; kegotangenak
Family: DIAPENSIACEAE	
Diapensia lapponica	Diapensia
Family: PLUMBAGINACEAE	
Armeria maritima	Thrift
Family: SCROPHULARIACEAE	

Scientific Name	Common Name
Pedicularis lapponica	Lapland lousewort
Pedicularis sudetica	Sudetan lousewort
Family: LENTIBULARIACEAE	
Pinguicula villosa	Small butterwort
Pinguicula vulgaris	Butterwort
Family: COMPOSITAE	
Antennaria alpina (was *A. compacta*)	Dwarf pussytoes
Antennaria sp.	Pussytoes
Arnica angustifolia ssp. *angustifolia* (was *A. alpina*)	Alpine arnica
Erigeron humilis	Arctic alpine fleabane
Saussurea angustifolia	Fireworks flower; northern sawwort

APPENDIX A.4

List of Vascular Plant Species Likely to Occur in the LSA, but not Collected during the 1999 & 2002 Baseline Vegetation Surveys

Table A.4: List of Vascular Plant Species Likely to Occur in the LSA, but Not Collected during the 1999 & 2002 Baseline Vegetation Surveys.

Scientific name	Common name
Family: POLYPODIACEAE	
Cystopteris fragilis	Fragile fern; brittle bladderfern
Woodsia alpina	Alpine woodsia
Family: EQUISETACEAE	
Equisetum variegatum	Variegated horsetail
Family: LYCOPODIACEAE	
Lycopodium annotinum	Bristly club-moss
Family: SPARGANIACEAE	
Sparganium hyperboreum	Bur-reed
Family: POTOMOGETONACEAE	
Potomogeton filiformis	Pondweed
Family: GRAMINAE	
Arctophila fulva	Pendantgrass
Calamagrostis canadensis var. langsdorfii	Reed-bentgrass
Calamagrostis stricta ssp. inexpansa (was C. *inexpansa*)	Northern reedgrass
Deschampsia caespitosa	Tufted hairgrass
Poa pratensis ssp. *alpigena* (was *P. alpigena*)	Kentucky bluegrass
Family: CYPERACEAE	
Carex aquatilis var. *stans*	Water sedge
Carex bigelowii	Bigelow’s sedge
Carex maritima	Marine sedge
Carex microglochin	
Carex subspathecea	
Carex supina	
Carex ursina	
Eriophorum callitrix	Single-headed cottongrass
Family: ORCHIDACEAE	
Corallorhiza trifida	Coralroot orchid
Platanthera obtusata (was *Habenaria obtusata*)	Bluntleaved orchid (was Small northern bog orchid)
Family: SALICACEAE	
Salix alaxensis	Felt-leaf willow
Family: POLYGONACEAE	
Koenigia islandica	Island purslane
Family: CARYOPHYLLACEAE	
Melandrium apetalum	Red bladder campion
Stellaria crassifolia	Star chickweed
Family: RANUNCULACEAE	
Anemone richardsonii	Richardson’s anemone
Caltha palustris var. *arctica*	Marsh marigold
Ranunculus gmelinii	Gmelin’s buttercup
Family: PAPAVERACEAE	
Papaver radicatum	Arctic poppy
Family: CRUCIFERAE	
Arabis arenicola	

Scientific name	Common name
Descurainia sophioides	Tansy-mustard
Draba nivalis	Yellow arctic draba
Family: SAXIFRAGACEAE	
Chrysosplenium tetrandrum	Golden saxifrage
Saxifraga aizoides	Yellow mountain saxifrage
Saxifraga foliolosa	Leafystem saxifrage
Saxifraga hirculus	Yellow marsh saxifrage
Saxifraga oppositifolia	Purple mountain saxifrage
Saxifraga rivularis	Brooklet saxifrage
Family: ROSACEAE	
Potentilla nana (was *P. hyparctica* var. *elatior*)	Arctic cinquefoil
Comarum palustre (was *Potentilla palustris*)	Purple marshlocks (was Marsh five-finger)
Family: LEGUMINOSAE	
Hedysarum boreale ssp. *mackenzeii*	Wild sweet pea
Oxytropis deflexa var. *foliolosa*	Pendant-pod crazyweed
Family: ONAGRACEAE	
Epilobium angustifolium	Tall fireweed
Family: HALORAGACEAE	
Hippuris vulgaris	Common mare's tail
Family: PYROLACEAE	
Orthilia secunda	(was *Pyrola secunda*)
Side-flowered wintergreen	
Family: ERICACEAE	
Kalmia polifolia	Bog laurel
Loiseleuria procumbens	Alpine azalea
Family: PRIMULACEAE	
Androsace septentrionalis	Northern fairy candelabra
Family: SCROPHULARIACEAE	
Castilleja elegans	Paintbrush
Pedicularis capitata	Crowned lousewort
Pedicularis flammea	Flame-tipped lousewort
Pedicularis labradorica	Labrador lousewort
Pedicularis lanata	Woolly lousewort
Family: CAMPANULACEAE	
Campanula uniflora	Arctic harebell
Family: COMPOSITAE	
Antennaria monocephala (was *A. angustata*)	Pygmy pussytoes
Antennaria alpina (was *A. canescens*)	Alpine pussytoes
Antennaria friesiana ssp. *friesiana* (was *A. ekmaniana*)	Fries' pussytoes
Antennaria rosea ssp. *pulvinata* (was *A. isolepis*)	Pulvinate pussytoes
Artemisia campestris ssp. *borealis* (was *A. borealis*)	Field sagewort; Boreal wormwood
Erigeron eriocephalus	Oneflower fleabane
Tripleurospermum maritima ssp. *phaeocephala* (was *Matricaria ambigua*)	False mayweed; Wild chamomile
Senecio congestus	Mastodon flower

APPENDIX A.5

List of Non-vascular Plant Species Idenfied in the LSA during Baseline Vegetation Surveys in August 1999 & 2002

Table A.5: List of Non-vascular Plant Species Identified in the LSA during Baseline Vegetation Surveys in August 1999 and 2002.

Scientific name	Common name
LIVERWORTS	
Marchantia polymorpha	
MOSSES	
Aulicomnium turgidum	
Aulicomnium sp.	
Polytrichum commune	
Polytrichum sp.	Haircap mosses
Racomitrium canescens (formerly *Rhacomitrium*)	Grey rockmoss
Racomitrium lanuginosum (formerly *Rhacomitrium*)	Hoary rockmoss
Sphagnum sp.	
LICHENS (QUAJAUTIT)	
Alectoria sp.	Hair lichen
Alectoria nigricans	Grey witches' hair
Alectoria ochroleuca	Green witches' hair
Arctoparmelia centrifuga	Sunburst lichen
Aspilicea cinerea	Cinder lichen
Cetraria cucullata	Furled paperdoll
Cetraria ericetorum	Icelandmoss
Cetraria islandica	Brown icelandmoss
Cetraria nivalis	Ragged paperdoll
Cetraria tilesii	Limestone sunshine lichen
Cetraria sp.	Brown lettuce lichen
Cladina mitis	Lesser green reindeer lichen
Cladina rangiferina	Grey reindeer lichen
Cladina stellaris	Starred reindeer lichen
Cladina sp.	Reindeer lichens
Cladonia borealis	Boreal pixie-cup
Cladonia chlorophaea	Mealy pixie-cup
Cladonia coccifera or *C. bellidiflora*	Toy soldiers lichen
Cladonia cornuta	Cup lichen
Cladonia pixidata	Pebbled pixie-cup
Cladonia squamosa	Dragon funnel lichen
Cladonia uncialis	Thorn cladonia
Cladonia sp.	Pixie-cup lichen
Coelocaulon aculeatum	Spiny heath lichen
Dactylina arctica	Glove lichen
Hypnogymnia physodes	Monk's hood lichen
Icmadophila ericetorum	Peppermint drop lichen

Scientific name	Common name
Masonhalea richardsonii	Antler lichen, arctic tumbleweed
Nephroma arcticum	Green light lichen
Ophioparma lapponica (was *Haematomma lapponicum*)	Bloodspot lichen
Ophiopharma ventosa (possible)	Alpine bloodspot
Peltigera aphthosa	Freckle pelt
Peltigera sp.	Pelt lichens
Pertusaria dactylina	White finger lichen
Porpidia flavocaerulescens (possible)	Orange boulder lichen
Pseudephebe pubescens	Fine rock wool; brushcut lichen
Rhizocarpon geographicum	Yellow map lichen
Rhizocarpon geminatum	Two-spored map lichen
Stereocaulon tomentosum	Grey mealy lichen; eyed foam
Stereocaulon sp.	Foam lichens
Thamnolia subuliformis	Whiteworm lichen
Tremolecia atrata	Halloween lichen
Umbilicaria hyperborea	Blistered rock tripe
Umbilicaria vellea	Frosted rock tripe
Xanthoria elegans	Jewel lichen

APPENDIX A.6

Mammal Species Known or Expected to Occur in the Study Areas

Table A.6: Survey Observations of Mammal Species Known or Expected to Occur in the Meadowbank Study Areas.

		Survey Session[1]				
Common Name	**Scientific Name**	**Spring 1999**	**Summer 2002**	**Fall 2002**	**Winter 2003**	**Summer 2003**
Barren-ground Shrew	*Sorex ugyunak*					
Arctic Hare	*Lepus arcticus*	X	X	X	X	X
Arctic Ground Squirrel	*Spermophilus parryi*	X	X	X		X
Northern Red-backed Vole	*Clethrionomys rutilus*			X		X
Brown Lemming	*Lemmus sibiricus*					
Collared lemming	*Dicrostonyx groenlandicus*					
Meadow Vole	*Microtus pennsylvanicus*					
Wolf	*Canis lupus*	X	X	X	X	
Arctic fox	*Alopex lagopus*	X	X	X	X	X
Red Fox	*Vulpes vulpes*				X	
Grizzly Bear	*Ursus arctos*	X	X	X		
Ermine	*Mustela erminea*	X	X			X
Wolverine	*Gulo gulo*	X		X		X
Barren-ground Caribou	*Rangifer tarandus groenlandicus*	X	X	X	X	X
Muskox	*Ovibos moschatus*	X	X	X	X	X
Number of Species	15	9	8	9	6	8

Notes: 1. An 'X' indicates that the species was observed during the survey session either incidentally or during baseline surveys. **Source:** Includes Banfield (1974) and Wheeler (2002).

APPENDIX A.7

Bird Species Known or Expected to Occur in the Study Areas

Table A.7: Survey Observations of Bird Species Known or Expected to Occur in the Meadowbank Study Areas.

		Survey Session[1]					
Common Name	**Scientific Name**	**Spring 1999**	**Summer 2002**	**Fall 2002**	**Winter 2003**	**Summer 2003**	**Summer 2003[2]**
Red-throated Loon	*Gavia stellata*					X	
Pacific Loon	*Gavia pacifica*					X	
Common Loon	*Gavia immer*			X			
Yellow-billed Loon	Gavia adamsii		X				
Tundra Swan	*Cygnus columbianus*	X		X			
Greater White-fronted Goose	*Anser albifrons*			X			X
Snow Goose	*Chen caerulescens*	X		X		X	
Ross' Goose	*Chen rossii*	X					
Brant Goose	*Branta bernicla*	X		X			
Canada Goose	*Branta canadensis*	X		X		X	X
Mallard	*Anas platyryhnchos*					X	
Green-winged Teal	*Anas crecca*						X
Northern Pintail	*Anas acuta*	X	X			X	X
Greater Scaup	*Aythya marila*						X
Long-tailed duck	*Clangula hyemalis*		X			X	X
Red-breasted Merganser	*Mergus serrator*	X				X	X
Rough-legged Hawk	*Buteo lagopus*	X	X	X		X	
Peregrine Falcon	*Falco peregrinus*	X	X	X			
Gyrfalcon	*Falco rusticolus*	X		X	X		
Willow Ptarmigan	*Lagopus lagopus*						X
Rock Ptarmigan	*Lagopus mutus*	X	X	X		X	X
Sandhill Crane	*Grus canadensis*	X	X	X		X	X
Black-bellied Plover	*Pluvialis squatarola*						
American Golden Plover	*Pluvialis dominica*		X			X	X
Semipalmated Plover	*Charadrius semipalmatus*						
Ruddy Turnstone	*Arenaria interpres*						
Red Knot	*Calidris canutus*						
Sanderling	*Calidris alba*						
Semipalmated Sandpiper	*Calidris pusilla*					X	X
Least Sandpiper	*Calidris minutilla*						
White-rumped Sandpiper	*Calidris fuscicollis*						
Baird's Sandpiper	*Calidris bairdii*					X	X
Pectoral Sandpiper	Calidris melanotos						
Dunlin	Calidris alpina						

Common Name	Scientific Name	Survey Session[1]					
		Spring 1999	Summer 2002	Fall 2002	Winter 2003	Summer 2003	Summer 2003[2]
Stilt Sandpiper	*Calidris himantopus*						
Buff-breasted Sandpiper	*Tryngites subruficollis*						
Wilson's Snipe	*Gallinago delicata*						
Red-necked Phalarope	*Phalaropus lobatus*						
Pomarine Jaeger	*Stercorarius pomarinus*					X	
Long-tailed Jaeger	*Stercorarius longicaudus*		X			X	
Parasitic Jaeger	*Stercorarius parasiticus*					X	X
Herring Gull	*Larus argentatus*	X		X		X	X
Thayer's Gull	*Larus thayeri*						X
Glaucous Gull	*Larus hyperboreus*					X	X
Arctic Tern	*Sterna paradisaea*						
Snowy Owl	*Nyctea scandiaca*	X	X	X			
Short-eared Owl	*Asio flammeus*						
Horned Lark	*Eremophila alpestris*	X	X	X		X	X
Cliff Swallow	*Petrochelidon pyrrhonota*						
Common Raven	*Corvus corax*	X		X	X		
American Robin	*Turdus migratorius*						X
American Pipit	*Anthus rubescens*		X			X	X
Savannah Sparrow	*Passerculus sandwichensis*		X			X	X
White-crowned Sparrow	*Zonotrichia leucophrys*		X	X			X
Harris' Sparrow	*Zonotrichia querula*						
Lapland Longspur	*Calcarius lapponicus*	X	X	X		X	X
Snow Bunting	*Plectrophenax nivalis*	X		X		X	
Common Redpoll	*Carduelis flammea*					X	X
Hoary Redpoll	*Carduelis hornemanni*					X	X
Number of Species	59	18	15	18	2	26	25

Notes: 1. An 'X' indicates that the species was observed during the survey session either incidentally or during baseline surveys. **2.** Bird species observed at Baker Lake on 16, 20 and 21 June 2003. **Source:** Include Godfrey (1976) and Staniforth (2002).

APPENDIX A.8

Breeding Bird Survey Data Forms

APPENDIX A.8A

PRISM Plot Map – Rapid Surveys

Site:_________ Plot:_____ Date:__________ Time In:_____ Out:_____ Surveyors:___________

400															
350															
300															
250															
200															
150															
100															
50															
25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400

Coordinates: SW NW NE SE

APPENDIX A.8B

PRISM Rapid Summary Form

Site:________ Plot:____ Date:_________ Time In:_____ Out:_____ Surveyor:__________

Incidentals[2]:____

Comments:____

Species	Nests including pair	Prob Nest including pair[3]	Prs[4]	Males	Females	???? sex	Total no. pairs & indicated pairs[5]	Estimate[6]
comments (how did you arrive at final estimate?)								
comments (how did you arrive at final estimate?)								
comments (how did you arrive at final estimate?)								
comments (how did you arrive at final estimate?)								
comments (how did you arrive at final estimate?)								
comments (how did you arrive at final estimate?)								

Notes: **2.** Notable species seen off the plot; Note: flybys and off transect birds can also be added as separate lines at the end of each days form Ensure to make a line between on plot data and these birds and label it INCIDENTALS BELOW in big letters. **3.** Only used when a nest distraction display was seen. **4.** Do not record a pair that was associated with a nest. They are represented by the nest. **5.** Sum of the rows to the left. **6.** Estimated number of nests, pairs without nests and “indicated” pairs (territorial males, lone females) which are believed to be truly associated with the plot (assumed to be on plot at beginning of survey).

APPENDIX A.8C

Habitat Data Sheet

Site:________ Plot no:_____ Date:___________ Surveyors:__________________
% each major hab class in plot: wetland ___ tundra ____ barren ____ water ____

PHYSIOGRAPHY/HABITAT (within each of Tundra, Wetland, Barren do the following: A) identify the amount of standing water present by % of that habitat class; **B)** indicate up to five of the most dominant components in order of dominance (1-5 with 1 being most dominant), then tick off other components present; **C)** indicate by % of the subclass the vegetation types dominant; and **D)** indicate by % of the subclass the % of pond or river present.

Water
_____% ponds
_____% lake
_____% river/stream
_____% other (specify)

Tundra
_____ %standing water[2]
_____ patterned ground
_____ dwarf shrub/heath
_____ shrub (low or tall)
_____ dry graminoid[2]
_____ tussock
_____ hummock

_____ wet sedge/grasses
_____ saltmarsh
_____ mossland
_____ rocky outcrop
_____ sand flats, dunes
_____beach/ridge/esker
_____ cobble/rocks
_____ frost boils/muck
_____ other (specify)

VEGETATION
_____ % graminoid[1]
_____ % dwarf shrub/heath
_____ % shrub (low or tall)
_____ % moss & lichen
_____ % herbs

water
_____ % pond
_____ % river

Wetland
_____% standing water[2]
_____ wet sedge/grasses
_____ patterned ground
_____ tussock
_____ hummock
_____ saltmarsh
_____ mossland

_____ rocky outcrop
_____ sand flats, dunes
_____ beach/ridge/esker
_____ cobble/rocks
_____ frost boils/muck
_____ dwarf shrub/heath
_____ shrub (low or tall)
_____ dry graminoid[2]
_____ other (specify)

VEGETATION
_____ % graminoid[1]
_____ % dwarf shrub/heath
_____ % shrub (low or tall)
_____ % moss & lichen
_____ % herbs

water
_____ % pond
_____ % river

Barren
_____% standing water[2]
_____ rocky outcrop
_____ sand flats, dunes
_____beach/ridge/esker
_____ cobble/rocks
_____ frost boils/muck

_____ wet sedge/grasses
_____ patterned ground
_____ tussock
_____ hummock
_____ saltmarsh
_____ mossland
_____ dwarf shrub/heath
_____ shrub (low or tall)
_____ dry graminoid[2]
_____ other (specify)

VEGETATION
_____ % graminoid[1]
_____ % dwarf shrub/heath
_____ % shrub (low or tall)
_____ % moss & lichen
_____ % herbs

water
_____ % pond
_____ % river

General description of terrain in plot (e.g. flat, sloping, direction of slope, network of ponds, soil moisture characteristics, etc). and Other information

____
____
____
____

[1] grasses and/or sedges
[2] standing water= sheet of water covering vegetation or bare ground that is not part of a permanent or ephemeral pond.

APPENDIX A.9

Incidentail Wildlife Observations from the Camp Logbook, 1996 to 2003

Table A.9: Incidental Wildlife Observations from the Meadowbank Camp Logbook, 1996-2003

Date	Time	Species	Location	Evidence and Comments	Observer
1996					
28-Feb-96		Caribou	3rd Portage	Visual north of lake	
3-Mar-96		Arctic hare	In camp	Droppings, seen by some	
3-Mar-96		Arctic fox	In camp	Fresh scat	
6-Mar-96		Raven	In camp	Flew overhead	
6-Mar-96		Caribou	West of camp	Visual	
9-Mar-96		Raven	N of camp	Visual	
12-Mar-96		Arctic hare	In camp	Visual	
17-Mar-96		Caribou	S of camp	Visual at Inukshuk	
18-Mar-96		Raven	In camp	Visual	
19-Mar-96		Ptarmigan	South of camp	Heard call	
20-Mar-96		Arctic hare	In camp	Visual	
20-Mar-96		Wolf	Near camp	Visual to south; dirty white	
9-Aug-96		Black wolf	NW of camp	Visual	
10-Aug-96		3 Caribou, 1 calf	NW of camp	Visual	
12-Aug-96		1 Caribou	3rd Portage Pen.	Visual	
13-Aug-96		Lake trout	Camp	Caught (6 lbs)	
13-Aug-96		8 Sandhill cranes	Near airstrip	Visual	
1997					
27-Mar-97		3 Caribou (1 Calf)	N of camp	Visual	
27-Mar-97		Snowy owl	Flying south	Visual	
27-Mar-97		3 Caribou	2 km to N	Visual (2 adult, 1 calf)	Jim, Marcel
27-Mar-97		1 Snowy owl	In camp	Flew overhead	Roger
29-Mar-97		Ptarmigan	In camp	Visual flying over	
30-Mar-97		5 Caribou	2 km NE	Visual going East	Jim, Marcel
30-Mar-97		5 Caribou	NE of Camp	Visual	
31-Mar-97		17 Caribou	1 km W of camp	Visual mostly cows, calves	Everybody
31-Mar-97		1 Arctic hare	In camp	Visual	
31-Mar-97		17 Caribou	W of camp	Visual mostly cows, calves	
1-Apr-97		5 Caribou	2 km NE	Visual grazing	Everybody
1-Apr-97		5 Caribou	N of camp	visual 3 cows 2 calves	
4-Apr-97	0900	Arctic fox	Kitchen door	Visual sniffing	Marcel, Richard
4-Apr-97		1 Wolf	1/2 km E	Visual by fuel cache	Gord Davidson
5-Apr-97		7 Caribou	W of camp	Visual on lake	
8-Apr-97		7 Caribou	W of camp	Visual on lake	
11-Apr-97	2030	Arctic fox	Kitchen door	Visual sniffing	Kenny
11-Apr-97	1515	11 Caribou	0.2 km N	Visual	Everybody
11-Apr-97		2 Wolves	NE of camp	Visual	
14-Apr-97		10 Caribou	N of camp	Visual	
15-Apr-97	Early	12 Caribou	1.5 km NE	Visual	Gord Davidson
15-Apr-97		1 Arctic hare	S of camp	Visual	
16-Apr-97	0730	1 Arctic fox	Kitchen door	Visual	Kenny, Marcel
18-Apr-97	1130	2 Caribou	0.2 km W	Visual	Core group
19-Apr-97	2030	Snowy owl	3 km E	Visual	Marcel
19-Apr-97		1 Arctic fox	S of camp	Visual beside hill	
20-Apr-97		6 Caribou	3rd Portage Lake	Visual going SW	Gord Davidson
23-Apr-97	1700	2 Caribou	2 km W	Visual heading N	Kenny
24-Apr-97		1 Raven	In camp	Flew overhead	
28-Apr-97	0717	Arctic fox	In camp	Visual	All
28-Apr-97		50 Ravens	In camp	In flock flying over camp	

Date	Time	Species	Location	Evidence and Comments	Observer
28-Apr-97		2 Caribou	NW of camp	Visual	
30-Apr-97	2000	Wolf	In camp	Visual chewing caribou skin	Everybody
1-May-97		3 Arctic hare	In camp	Visual	
2-May-97		29 Caribou	W of camp	Visual	
2-May-97	1530	1 Snow bunting	Near dump	Visual	
3-May-97	1030	Arctic fox	In camp	Visual	Jennifer, Sandra
5-May-97	AM	1 Wolf	Drill site	Visual	
5-May-97		72 Caribou	S of camp	Visual 500 metres	
10-May-97	1100	11 Caribou	1 km N	Visual going N	Ewald, Kenneth
11-May-97		20+ Caribou	W of camp	Visual	
22-May-97		13 Caribou	W of camp	Visual	
22-May-97		3 Seagulls	Drill site	Flying over	
22-May-97		1 Seagull	Camp	Flying over	
22-May-97		1 Sandhill crane	Hill S of camp	Visual	
24-May-97		3 Sandhill crane	Camp	Flying over	
26-May-97		1 Arctic fox	S of camp	Visual	
27-May-97		1 Arctic fox	N of camp	Visual	
28-Jun-97	1500	5 Caribou	50 m NE	Visual Running	Everybody
2-Jul-97	2100	1 Lake trout	0.8 km NE	Caught (3 Lbs)	Marcel Victor
3-Jul-97		5 Caribou	15 km N of camp	Visual	
9-Jul-97	2000	2 Lake trout	3 km S	Caught By casting	Marcel, Kenny
10-Jul-97	2030	1 Female caribou	0.2 km SSW	Visual going NW	Marcel Victor
13-Jul-97	1000	1 Arctic fox	In camp	Visual	Victor, Marcel
16-Jul-97		2 Loons	N of camp	Visual swimming on lake	
28-Jul-97	1100	1 Caribou	4 km N	Visual from air	Maurice
28-Jul-97	2130	1 Lake trout	In camp	Caught on shore	Kenny
1998					
19-Mar-98		Wolf	N of camp	Visual	
19-Mar-98	1500	1 Wolf	N of camp	Visual	Marcel, Jeff, Vic
31-Mar-98	1600	2 Caribou	0.2 km S	Visual cow and Calf	Jim Marcel
4-Apr-98		5 Caribou	NW of camp	Visual	Tom, Jeff, Joe
9-Apr-98		5 Caribou	In camp	Visual	Joe Kautaq
12-Apr-98		Arctic fox	S of camp	Visual	John
12-Apr-98		Arctic hare	In camp	Visual	Joe Kautaq
14-Apr-98		25 Caribou	Around camp	Visual	Joe, Tom
21-Apr-98		6 Caribou	NE of camp	Visual	Tom
22-Apr-98		1 Caribou	NE of camp	Visual	Tom, Salome
24-Apr-98		1 Caribou	N of camp	Visual	Tom
25-Apr-98		8 Caribou	W of camp	Visual	Workers
29-Apr-98		1 Arctic fox	In camp	Visual	Joe Kautaq
8-May-98	1015	Ptarmigan	W of camp	Visual	Tom Joe
8-May-98	2000	Canada geese	W of camp	Visual	Ewald, Barb
17-May-98	1500	5 Caribou	1 km Sw	Visual	Joe, Tom
17-May-98	1900	1 Arctic fox	W of camp	Visual	Jeff, Jen, Sar
19-May-98	1430	1 Sandhill crane	In camp	Heard call	Tom, Brian
25-Jun-98		3 Sandhill crane	W of 3rd Portage	Visual	E. Zaleski
25-Jun-98		2 Ptarmigan	W Pipedream	Visual	R. L'hereux
25-Jun-98		1 Arctic fox	W Pipedream	Visual	R. L'hereux
27-Jun-98		2 Caribou	SW of Tehek Lake	Visual	E. Zaleski
27-Jun-98		1 Arctic hare	SW of Tehek Lake	Visual	E. Zaleski

Date	Time	Species	Location	Evidence and Comments	Observer
27-Jun-98		1 Ptarmigan	SW of Tehek Lake	Visual	E. Zaleski
28-Jun-98		1 Arctic hare	SW of Tehek Lake	Visual	E. Zaleski
30-Jun-98		Arctic hare	S 3rd Portage Lake	Visual	E. Zaleski
30-Jun-98		Sandhill crane	S 3rd Portage Lake	Visual	E. Zaleski
1-Jul-98		2 Caribou	S of Tehek Lake	Visual	E. Zaleski
1-Jul-98		1 Arctic hare	S of Tehek Lake	Visual	E. Zaleski
5-Jul-98		2 Arctic hare	NW of camp	Visual	E. Zaleski
5-Jul-98		1 Caribou	NW of camp	Visual big racks	E. Zaleski
5-Jul-98		Sandhill crane	NW of camp	Visual	E. Zaleski
13-Jul-98		2 Arctic hare	NW Pipedream	Visual	E. Zaleski
14-Jul-98		1 Caribou	Ukalaiak Lake	Visual	E. Zaleski
15-Jul-98		1 Arctic hare	Meadowbank River	Visual	E. Zaleski
15-Jul-98		Ptarmigan	Meadowbank River	Visual	E. Zaleski
18-Jul-98	Noon	White wolf	N of camp	Visual walking and loping	Norm Duk
18-Jul-98		Caribou	W Pipedream	Visual no rack	Bruce Kjarsg.
18-Jul-98	Noon	Arctic Hare	W Pipedream	Visual	Bruce Kjarsg.
24-Jul-98	1400	Peregrine Falcon	Meadowbank River	Visual; nesting on cliff	Bruce Kjarsg.
3-Aug-98		White wolf	N camp shore	Visual; walking calmly	Lori Wilkinson
9-Aug-98		7 Caribou	E Pipedream	Visual; 6 males 1 female	Lori Wilkinson
12-Aug-98	1530	6 Caribou	Amarulik Lk	Visual; 3 bulls 3 male	Tom Yanik
12-Aug-98	1530	40 Muskox	5 km N of camp	Visual; big bulls scouting	Eva Z. Yannik
14-Aug-98	1400	3 Caribou	1.5 km SW	Visual; 2 bulls, 1 female	Jon, Randy
14-Aug-98	1500	2 Sandhill cranes	0.5 Km SW	Visual	Francois
14-Aug-98	1000	1 Arctic fox	Jon Lake	Looking for food	J. Pameolik
15-Aug-98	PM	Rough-legged hawk	S of camp	Visual	Alec, Jackie
16-Aug-98		Caribou	S of camp	Walking West	Alec, Jackie, Jen
17-Aug-98	PM	Caribou	N of camp	Visual from air	Alec, Jackie
17-Aug-98	0800	Wolf	3 km N	Visual from air	Franc, Utuqaq
21-Aug-98	1330	2 Caribou	0.5 km SW	Visual; 1 bull 1 male	Tom
22-Aug-98	1345	1 Caribou	3 km SW	Eating	Tom, Bettina
24-Aug-98	2000	3 Caribou	0.2 km NE	Eating	Everybody
1999					
25-Apr-99	1500	8 Caribou	1 km SW	Visual	E. Gossner
27-Apr-99	PM	Arctic fox	In camp	Visual	E. Gossner
30-Apr-99	1030	4 Caribou	0.5 km NE	Visual	E. Gossner
9-May-99	1500	25+ Caribou	1 km N	Visual	E. Gossner
21-May-99	1630	1 Goose	In camp	Flying overhead	J. Pameolik
24-May-99	1345	20 Caribou	1 km N	Moving east	Jon and Tom
2002					
11-Mar-02		Wolf	100m W of camp	Visual	M. Utatvaq
12-Mar-02		Arctic hare	Camp	Visual	HGH
20-Mar-02		Arctic fox	Camp	Visual	HGH
24-Mar-02	0900	2 Wolves	2 km N of camp	Visual	Brian McG
24-Mar-02	1800	1 Wolf	Camp	Visual	Brian McG
25-Mar-02	1100	9 Caribou	3 km N of camp	Visual	Brian McG
16-Apr-02		Caribou	30 South of camp	Visual	Jim
17-Apr-02	1000	7 Caribou	1 km W of camp	Moving north	Brian McG
19-Apr-02	1500	Wolverine	1 km S of camp	Visual	?
21-Apr-02	1400	40-50 Caribou	1km W of camp	Moving north	Brian McG
23-Apr-02	1100	40-50 Caribou	1km W of Camp	Moving north	Moses

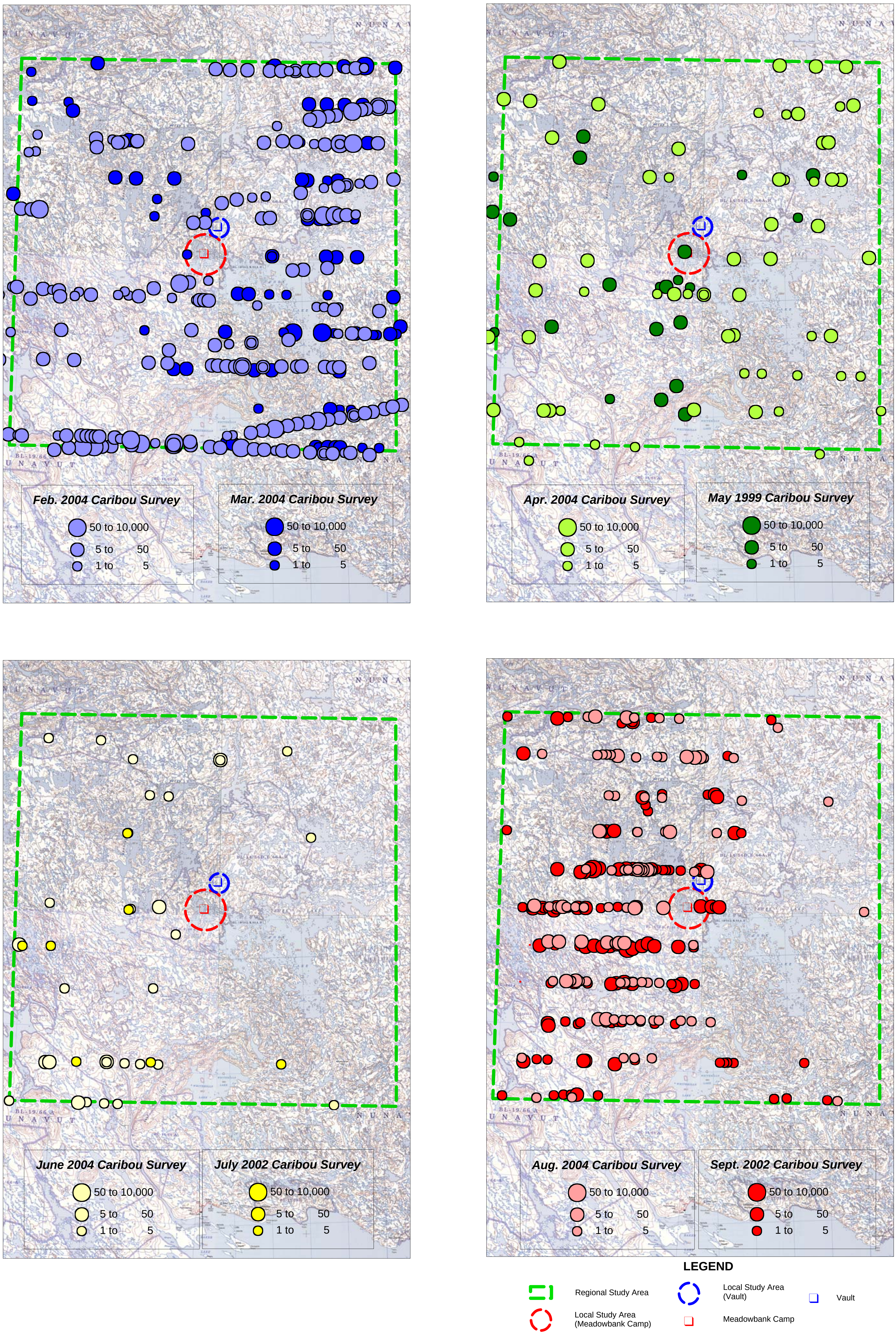
Date	Time	Species	Location	Evidence and Comments	Observer
28-Apr-02	0900	1 Arctic hare	Near core shack	Visual	Brian McG
30-Apr-02		Arctic fox	2 km near by	Visual	HQI
30-Apr-02	0630	3 Ptarmigan	In camp area	Visual	?
1-May-02	0700	8 Arctic hare	S end of camp	Visual	T. Akilak
2-May-02	1500	4 Muskox	15 km S of camp	Visual	Gooding
3-May-02	1300	3 Wolves	7 km N of camp	Visual	Bomb
8-May-02		Arctic hare	At camp	Visual	C. Clayton
9-May-02	1500	1 Ptarmigan	By incinerator	Sitting on rock	G. Davidson
10-May-02		7 Caribou	2nd Portage Lake	Visual	C. Clayton
12-May-02		Arctic fox	2nd Portage Lake	Visual	C. Clayton
12-May-02		14 Caribou		12 Adults, 2 calves	Driller
13-May-02		Arctic fox	At drill	Visual	Scott
14-May-02		6 Caribou	1 km W of camp	6 Adults	Gord
14-May-02		1 Ptarmigan	Beside core shack	Visual	Charlene
14-May-02		Herd of caribou (~50)	Herd (lots)	Visual	Charlene
15-May-02		Arctic Hare	N. Camp perimeter	Visual	Brian McG
18-May-02		Ptarmigan	N End of camp	On top of tent	Brian McG
18-May-02		3 Ptarmigan		Visual	Guillaume
18-May-02		2 Sik-Sik		Visual	Guillaume
18-May-02		Geese (~20)		Many	Guillaume
18-May-02		1 Sandhill crane		Visual	Charlene
18-May-02		2 Ptarmigan	Around cabins	Visual	Holly-Anne
18-May-02		1 Bird (small)	On hill	Visual	Charlene
18-May-02		Sik-Sik	N side of camp	Mating pair	Brian McG
20-May-02		Ermine	Camp	Going into Mark's sleeping bag	Mark
23-May-02		Ermine	5 m S of camp	Visual	Dianne
30-May-02		1 Sik-sik	In the kitchen	Visual	
30-May-02		Ptarmigan	N end of camp	Walking on bare ground	Brian McG
30-May-02	1930	Sandhill crane	Toward Newtown	Visual flying	Brian McG
30-May-02	2100	Arctic hare	E edge of camp	Visual	JC
30-May-02	2100	2 Ptarmigan	E edge of camp	Visual	JC
2-June-02	1000	Sandhill crane	~3 km N of camp	Visual along access trail to Vault	Brian McG
2-June-02	1015	Hawk (?)	~3 km N of camp	From access trail to Vault	Brian McG
3-June-02	1700	Caribou	~2 km W of camp	On lake moving N	Brian McG
5-June-02	1400	25-30 Snow geese	W bound	2 'V' formations	IKE
15-June-02		Arctic fox (Tuktu)		Visual	
17-June-02		Sik-sik	Camp	In kitchen & laundry	Dianne/Phil
26-June-02	1130	Arctic fox	Helicopter pad	Visual	Kenneth
29-June-02	0900	1 Sandhill crane	Vault	Visual	Brian McG
29-June-02	0900	Caribou	N side of camp	Visual	Employee
5-July-02	1400	Arctic fox	Camp	Front of kitchen	Sean
5-July-02	1000	Arctic hare	At Vault	Visual	Brian McG
8-July-02	1130	Caribou	~3 km N of camp	Moving W	Brian McG
8-July-02	1820	4 Caribou	4 km NW of camp	Visual	Brian McG
12-July-02	0830	4 Muskox	4 km N of camp	Visual	CM
13-July-02	0700	3 Muskox	¾ m NE of camp	Visual	CD
12-July-02	2000	2 Arctic fox	New camp	Hanging around drill and tents	Jenate
15-July-02		2 Arctic hare	At Vault drill	Visual	MM
16-July-02		Arctic wolf	At PDF drill	Visual	HB
18-July-02		14 Muskox	At PDF NW	Visual	HB
18-July-02		2 Muskox	4 km N of camp	Visual Cow & Calf	MU

Date	Time	Species	Location	Evidence and Comments	Observer
19-July-02		Caribou	~1km N of Newport	Visual	Brian McG
22-July-02		2pr Yellow billed loon	S of Goose Island	Visual	Baker/Mazur
22-July-02		Arctic fox	In front of tent	Visual	Jairus Kingilik
28-July-02		2 Wolf pups	E shore Turn Lake	Visual	Blair
3-Aug-02	1600	Yellow billed loon	Feeding	Flying N	Burt, M Mannick
3-Aug-02	1530	5+ Canada geese	Portage Lake	From chopper; 4 adults and 1 brood	P Burt
9-Aug-02	2100	1 Caribou	1~1km W of camp	1 bull moving S	Brian McG
9-Aug-02	PM	Eagle?	Around N. Portage	Visual	M Mannick, Burt
10-Aug-02	1400	1 Caribou stag	1 km W of camp	Moving N	Brian McG
11-Aug-02	0800	1 Wolf (adult white)	2 miles N of camp	Visual	Lacasse
10-Aug-02	1000	1 Rough-legged hawk	N Portage	Visual	Lacasse
13-Aug-02	1800	1 Ptarmigan	Camp	1 adult outside tent door	M. Mannik
14-Aug-02	1000	1 Wolf (adult white)	2 m N of camp	Visual	Guy
16-Aug-02	1600	Arctic hare	At S. Camp	Visual	Brian McG
18-Aug-02	1200	Sandhill crane	3 km N of camp	Visual	MAU
22-Aug-02	1400	Muskox		Visual	D. Jones
23-Aug-02		1 Arctic fox	On island	Visual	Brian McG
25-Aug-02		Rough-legged hawk		Visual	Mazur
27-Aug-02	1440	Arctic fox	Camp	Visual	
28-Aug-02	1800	6 Loons?	Over Newport	Flying east	Brian McG
29-Aug-02	0700	12 Caribou	12 S of Vault	Visual	Greg
29-Aug-02	0700	14 Caribou	14 N of Vault	Visual	Greg
29-Aug-02	1500	30-40 Caribou	1km from PDF drill	Visual	Brian McG
5-Sep-02	1500	50 Snow geese	1 km S of camp	Flock flying south	Brian McG.
7-Sep-02	0930	1 Caribou	Camp	Moving NW	Marvin Mannik
9-Sep-02	1200	Arctic fox	Camp	Just N. of S. camp across narrows	Brian McG.
9-Sep-02	1400	Hawk	Camp	On core shack	Marvin Mannik
11-Sep-02	1200	~3 Caribou bulls	N of N. Camp	Wandering around	Utak Mannik
21-Sep-02	1500	4 Caribou bulls	½ km S. of camp	S. of south camp	Brian McG
2?-Sep-02		4 Arctic hare	Camp	2 at N. Camp; 2 at S. Camp	J.K.
?-Oct-02		4 Arctic hare	Camp	2 at N. Camp; 2 at S. Camp	J.K.
10-Oct-02		~3,000 Caribou	N. of N. Camp	Visual	Kenny, Jill
12-Oct-02		~2,000-3,000 Caribou	1 km N. of Camp	Moving in W. and NW direction	Jeff Kellner
2003					
8-Mar-03	1500	2 Caribou	South Camp	Visual moving northwest	Gord Davidson
8-Mar-03	1700	2 Arctic hare	North Camp	Visual	Doug Smith
13-Mar-03		2 Wolves	4 km S of camp	Visual	Many
19-Mar-03	1100	8 Caribou	N end of camp	Visual heading north	Gord Davidson
27-Mar-03	1400	2 Caribou	Vault	Visual	A. Hamilton
27-Mar-03	1400	2 Arctic hare	Vault	Visual	A. Hamilton
1-Apr-03	1400	5 Caribou	Turn Lake	5 adults moving northeast	David Rasool
5-Apr-03	1800	Arctic hare	Vault	Visual at core storage area	Brian McG.
6-Apr-03	1100	2 wolves	20 miles west	Visual heading north	Roy Avaalu
6-Apr-03	1400	6 Caribou	1 km W of camp	Grazing	Brian McG.
9-Apr-03		7 Caribou	NE of camp	Viusal	JM
12-Apr-03	0900	2 Arctic hare	On lake near camp	Visual	
15-Apr-03	2030	6 Caribou	West of camp	Visual on peninsula west of camp	
21-Apr-03	0800	22 Caribou	Camp	Between N and S camp heading E	Gord Davidson
30-Apr-03	0300	5 Caribou	½ km E of camp	Visual	Tom Mannik
6-May-03		14+ Muskox	3 km N of camp	14 adults plus young in circle	Brian McG.
11-May-03	0900	60 Caribou	.5 km W of camp	Grazing	Brian McG.

Date	Time	Species	Location	Evidence and Comments	Observer
13-May-03	1200	Seagull	Camp kitchen	Visual	Brian McG.
13-May-03		25 Muskox	5-10 km S of camp	Visual	B. Hodgins
14-May-03		50 Canada geese	Over camp	Migrating north; first of season	Gord Davidson
14-May-03	1900	5 Sandhill crane	Over camp	Flying northwest	I. Arngnannaq
15-May-03	1800	1 Snow bunting	In camp	On ground at core racks	Brian McG.
17-May-03	1400	Seagull	N of camp	Visual	H. Haqpi
20-May-03	2000	Rough-legged hawk	Camp	Soaring over edge of lake	Brian McG.
22-May-03	1500	Arctic fox	Camp	Hanging around	Gord Davidson
23-May-03	1100	3 Ptarmigan	3rd Portage Lake	Along shore	RM
25-May-03		Arctic fox	Camp	Hanging around kitchen building	M. Anriaiya
26-May-03		60 Caribou	Goose Island	Visual	HB, BD, JD
26-May-03	1530	Sik sik	Camp	Cruising around	Gord Davidson
26-May-03		Lapland longspur	Camp area	Males in courtship flights and songs	Page Burt
26-May-03		20 Snow bunting	Over camp	Passing by camp heading south	Page Burt
26-May-03		22 Unid. geese	Distant	Flock of 15 and flock of 7 in flight	Page Burt
26-May-03		25 Snow geese	Near camp	Heading north	Page Burt
26-May-03		Herring gull	A ways from camp	In flight, heading northeast	Page Burt
26-May-03		Glaucous gull	A ways from camp	In flight, heading northeast	Page Burt
27-May-03	0600	White-crowned sparr.	Below tents	Singing	Page Burt
27-May-03		2 Rock ptarmigan	Hill E of camp	Pair exhibiting courtship behaviour	Page Burt
27-May-03		Rock ptarmigan	Marsh N of camp	Visual	Tom Mannik
27-May-03		Short-eared owl	W of camp	On peninsula to west	Tom Mannik
27-May-03		Snow geese (~100)	W of camp	8-10 flocks flying along end of lake	Tom Mannik
27-May-03		Lapland longspurs	All over	Many observed	Tom Mannik
27-May-03	1630	Wolverine	2.5 km SW	Visual	HB
28-May-03		16 Caribou	3rd Portage Lake	Heading north	Gord Davidson
28-May-03		Baird's sandpiper?	Airstrip area to N	Flying erratically and walking	Page Burt et al
28-May-03		Arctic hare	Airstrip area to N	Visual	Page Burt et al
28-May-03		Arctic fox	Near camp	Visual	Page Burt et al
13-Jun-03	1830	2 Lapland longspurs	In camp	Males	DP
14-Jun-03	0600	6 Geese	Over camp	Flying NW	Brian McG.
14-Jun-03	1900	Sandhill crane	W of camp	Walking	DP
16-Jun-03		6 Caribou	Camp area	Walking west	DA
17-Jun-03		12-18 Muskox	35 km S of camp	Visual from helicopter	Craig Goodings
18-Jun-03		12-18 Muskox	35 km S of camp	Visual from helicopter	Craig Goodings
18-Jun-03		Arctic hare	N of camp	Visual	Hugh Haqpi
18-Jun-03		Hawk	Camp area	Flying northwest	Hugh Haqpi
19-Jun-03		25-28 Muskox	7 km E of camp	Visual from helicopter	Craig Goodings
19-Jun-03		Arctic fox	Vault	Visual	Hugh Haqpi
19-Jun-03		35 Muskox	2nd Portage outlet	Includes 6 calves	Martin Gebauer
24-Jun-03	2000	6 Caribou	South of camp	On 3rd Portage Lake moving east	Brian McG.
26-Jun-03	1900	Arctic fox	Camp	In white molt	Brian McG.
26-Jun-03	2100	Loon	Near S. camp	On 2nd Portage Lake	Brian McG.
26-Jun-03	2200	12 Geese	Camp	Flying over camp to north	Brian McG.
29-Jun-03	1900	Sik sik	Camp	Hanging around	Brian McG.
29-Jun-03	1900	Ptarmigan	Camp	Male flew past kitchen	DP
7-Jul-03		3 Arctic hare	Core Shack	Playing	AM
7-Jul-03		Muskox	PDF Zone	E end of Moraine Lake	Brian McG.
8-Jul-03		Arctic fox	Camp	Near kitchen	Brian McG.
8-Jul-03		9 Ptarmigan	South camp	Female with 8 chicks	IA
9-Jul-03		2 shorebirds	Wally South	Near small pond	Brian McG.

Date	Time	Species	Location	Evidence and Comments	Observer
10-Jul-03	0900	2 Red-throated loon	Wally South	On small pond	Brian McG.
10-Jul-03	1500	2 Horned lark	Wally South	East region of map	Brian McG.
12-Jul-03	0900	2 Sandhill crane	Wally South	Near Marge Lake	Brian McG.
12-Jul-03	1000	Peregrine falcon	Wally South	Visual	Brian McG.
12-Jul-03	1400	2 Ptarmigan	3rd Portage Lake	Visual	
12-Jul-03	1300	Wolf den	W of Wally South	Visual	Dave F.
13-Jul-03	1500	1 Caribou	NW of camp	Bull	Brian McG.
13-Jul-03	2100	Arctic fox	Camp	Hanging around	AA
14-Jul-03	2022	Sik sik	Camp	Visual	A. Aliq
14-Jul-03	2100	3 Caribou	Wally South	At top of Marge Lake	Brian McG.
15-Jul-03		Ptarmigan	Vault	Visual	Roy Avaala
15-Jul-03		Arctic hare	Vault	Visual	Roy Avaala
16-Jul-03		2 Sandhill crane	Amarulik Lake	Visual	Roy Avaala
17-Jul-03		1 Caribou	2 km N of camp	Visual	Debbie Webster
17-Jul-03		Sandhill crane	2 km N of camp	Visual	Travis
17-Jul-03		Ptarmigan	Wally South	At Marge Bay	Brian McG.
19-Jul-03		1 Muskox	Wally South	NW of Marge Bay; grazing	JK
19-Jul-03		1 Caribou	2 km NW of Vault	Visual	Gord Davidson
19-Jul-03		Arctic hare	Camp	Visual	JK
20-Jul-03		Caribou	Quliqtinuaq	Visual	
20-Jul-03		19 Muskox	10 m S of camp	Visual	
28-Jul-03		Ptarmigan & chicks (~5)	Camp	Visual	A. Aliq
31-Jul-03		1 Muskox	Drill at 3P2	Visual	Dale Shard
5-Aug-03		Arctic fox	South Camp	Visual	Hugh Haqpi
9-Aug-03		2 Sik sik	Camp	Resident	AM
9-Aug-03		5 Ptarmigan	Camp	Visual	AM
19-Aug-03	0900	2 Sandhill crane	Vault	300 m W of Vault Baseline	Brian McG.
19-Aug-03	1000	5 Caribou	Vault	100-500 m W of Vault Baseline	Brian McG.
19-Aug-03		20 Caribou	PDF Zone	20 in groups of 1-3 heading north	BH
21-Aug-03		2 Red-throated loon	Turn Lake	Visual	Randy Baker
22-Aug-03	0800	10 Snow geese	Lac de Nez	Visual	Brian McG.
22-Aug-03	1000	4 Caribou	Vault	100 m N of drill at Vault; grazing	Brian McG.
26-Aug-03	1300	13 Canada goose	Camp	Migrating south	M.M.
26-Aug-03	1000	4 Caribou	Wally South	Visual	Brian McG.
26-Aug-03	1200	11 Sandhill cranes	Wally Lake area	Visual	Brian McG.
26-Aug-03	1500	2 Loons	Tuktuk Lake	Visual	Brian McG.
26-Aug-03	1500	50 Canada goose	Tuktuk Lake	Visual	Brian McG.
26-Aug-03	1500	1 Muskox	Tuktuk Lake	North side	Brian McG.
26-Aug-03	PM	Arctic fox	1 km S Turn Lake	Visual	Randy Baker
26-Aug-03	PM	Arctic hare	1 km S Turn Lake	Visual	Randy Baker
26-Aug-03	PM	Geese (~10)	S of Turn Lake	Visual	Randy Baker
26-Aug-03	PM	2 Arctic fox	Camp	Around the core shack	A.M.
29-Aug-03	1000	3 Common loon	Camp	Flying southeast	M.M.
30-Aug-03		20 Caribou	Wally South	Visual	Brian McG.
31-Aug-03		20 Caribou	Wally South	Visual	Brian McG.
30-Aug-03		~200 Snow geese	Camp area	Between camp and Jim Zone	Brian McG.
2-Sep-03	1000	1 Caribou	Camp	20 m from core shack grazing	Brian McG.
4-Sep-03	1400	2 Muskox	Jim Zone Region	Visual	Brian McG.
5-Sep-03	1600	Hawk/falcon?	Lac de Nez	Visual	R.M.
9-Sep-03		18 Muskox	14 m S of camp	Visual	P.S. – INAC

Date	Time	Species	Location	Evidence and Comments	Observer
9-Sep-03		30 Snow geese	Camp	By geology office	L.N.
9-Sep-03		3 Caribou	Camp	In front of tents by lake	L.N.
11-Sep-03		Falcon	Camp	Over core shack	I.A.
12-Sep-03		50 Snow geese	NW of camp	In swamp	Brian McG.
12-Sep-03	1400	Arctic fox	Camp	Two playing by the heli-pads	Brian McG.
17-Sep-03	1100	20 Ptarmigan	Camp	Behind core shack	I.A.



Seasonal Number and Distribution of Caribou Recorded During Aerial Surveys in the Meadowbank RSA

NORTH

4 0 4 8 12

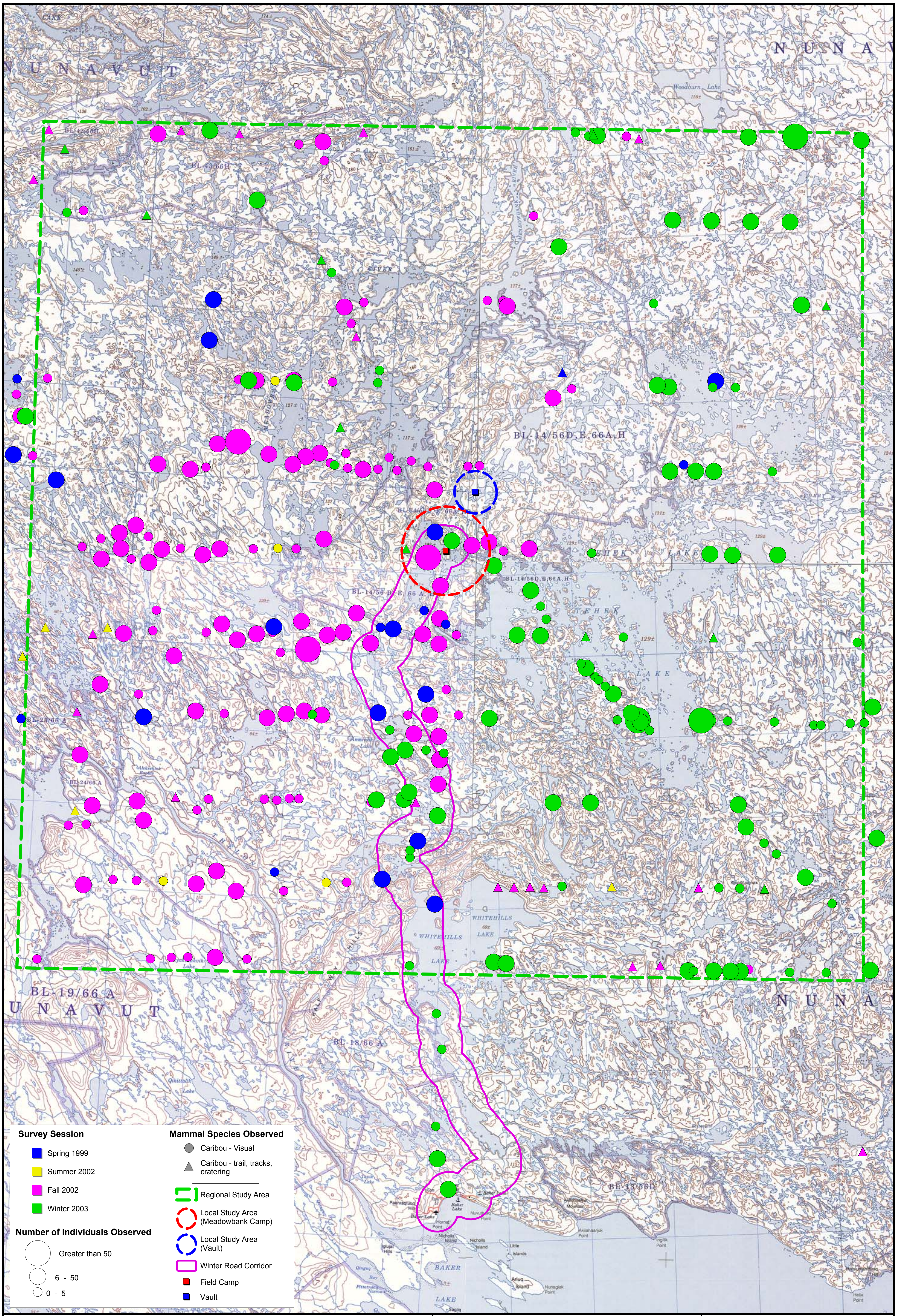
Scale in kilometres

SCALE 1:430,000

CUMBERLAND RESOURCES LTD.

Meadowbank Gold Project

Figure A.10



Seasonal number and distribution of Caribou recorded during aerial surveys in the Meadowbank RSA and winter road corridor

Area of Detail

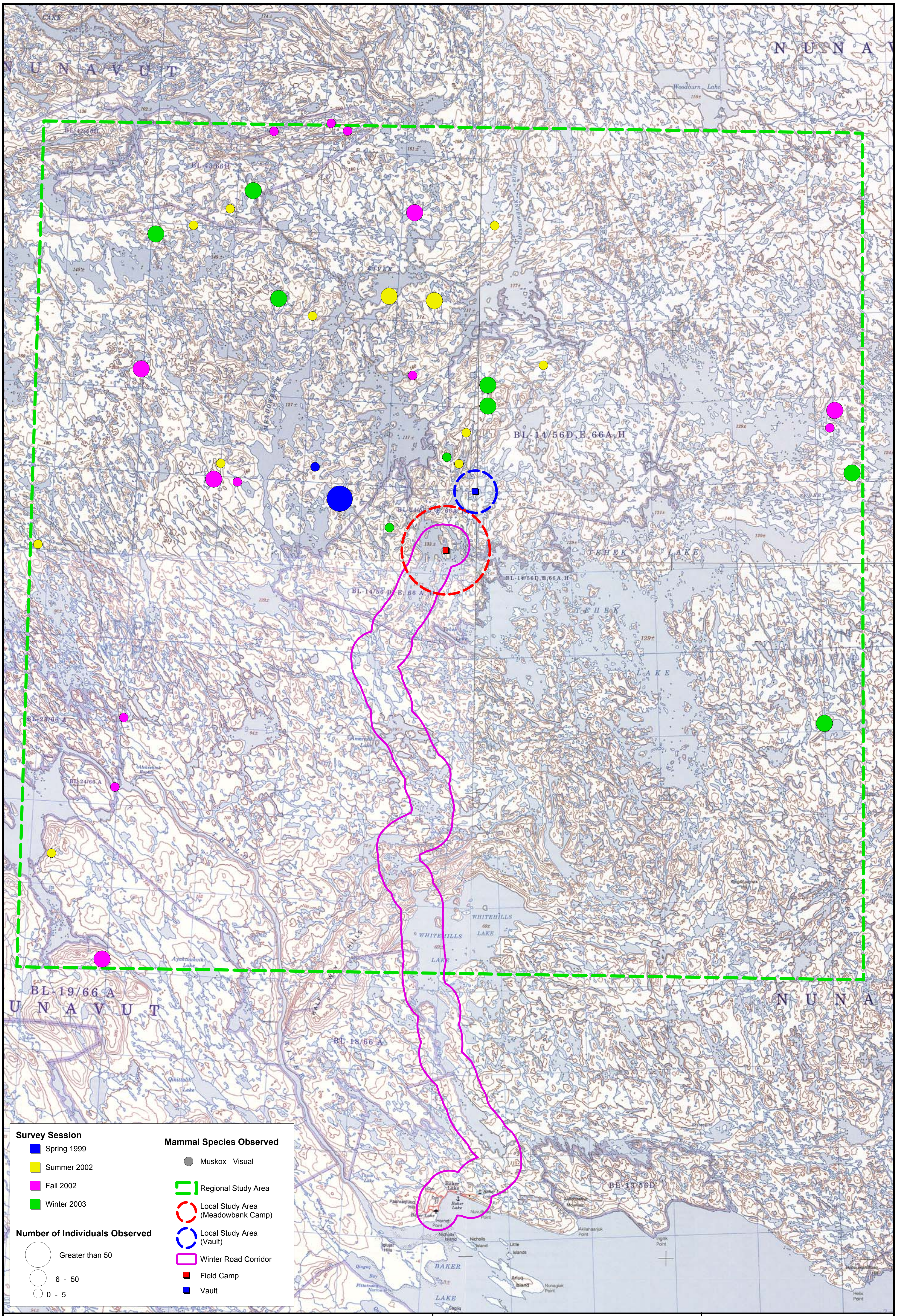
NORTH

4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY		KAVIK-AXYS Inc.	
DATE 25 September, 2003		SCALE 1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO. A.11	REV 4
REVIEWED CB	PROJECT KA9007		VOL -



Seasonal number and distribution of Muskoxen recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

Area of Detail

NORTH

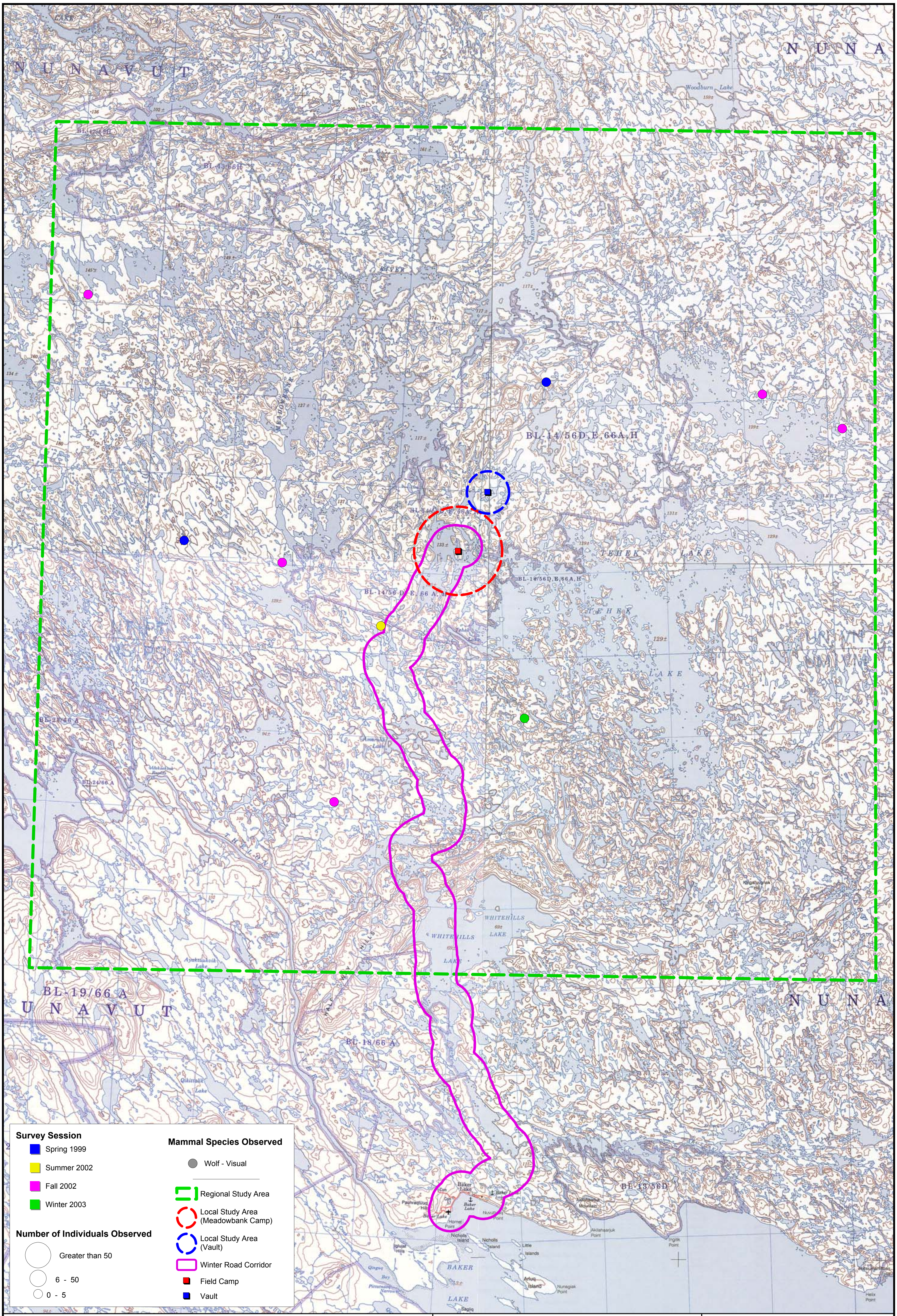
0 4 8 12

Scale in kilometres

CLIENT CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 25 September, 2003		SCALE 1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO.	REV 4
REVIEWED CB	PROJECT KA9007	A.12	VOL -



Seasonal number and distribution of Wolves recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

NORTH

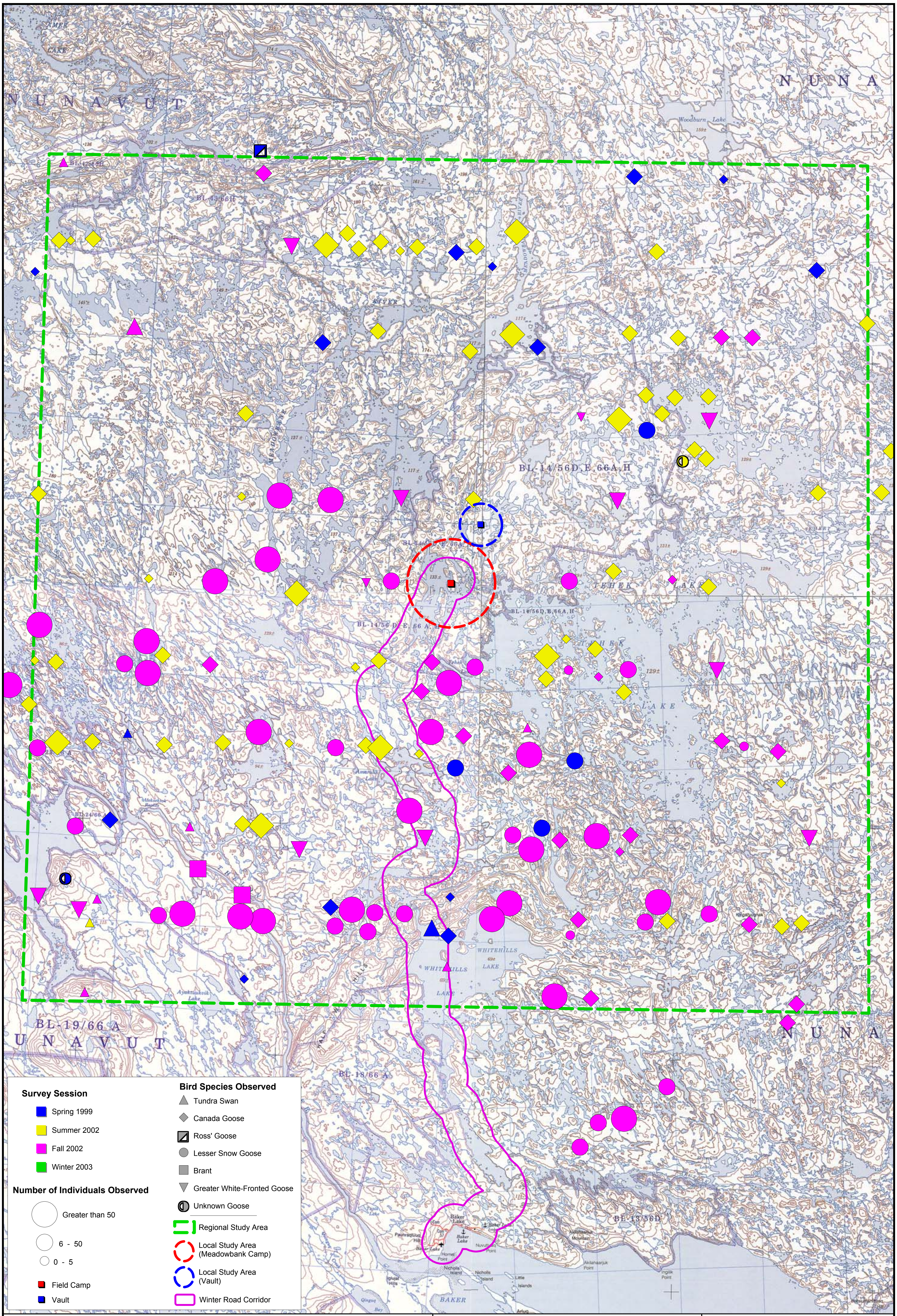
4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE		SCALE	
25 September, 2003		1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO.	REV 4
REVIEWED CB	PROJECT KA9007	A.13	VOL. -



Seasonal number and distribution of geese and swans recorded during aerial surveys in the Meadowbank RSA and winter road corridor: baseline aerial surveys, 1999-2003

NORTH

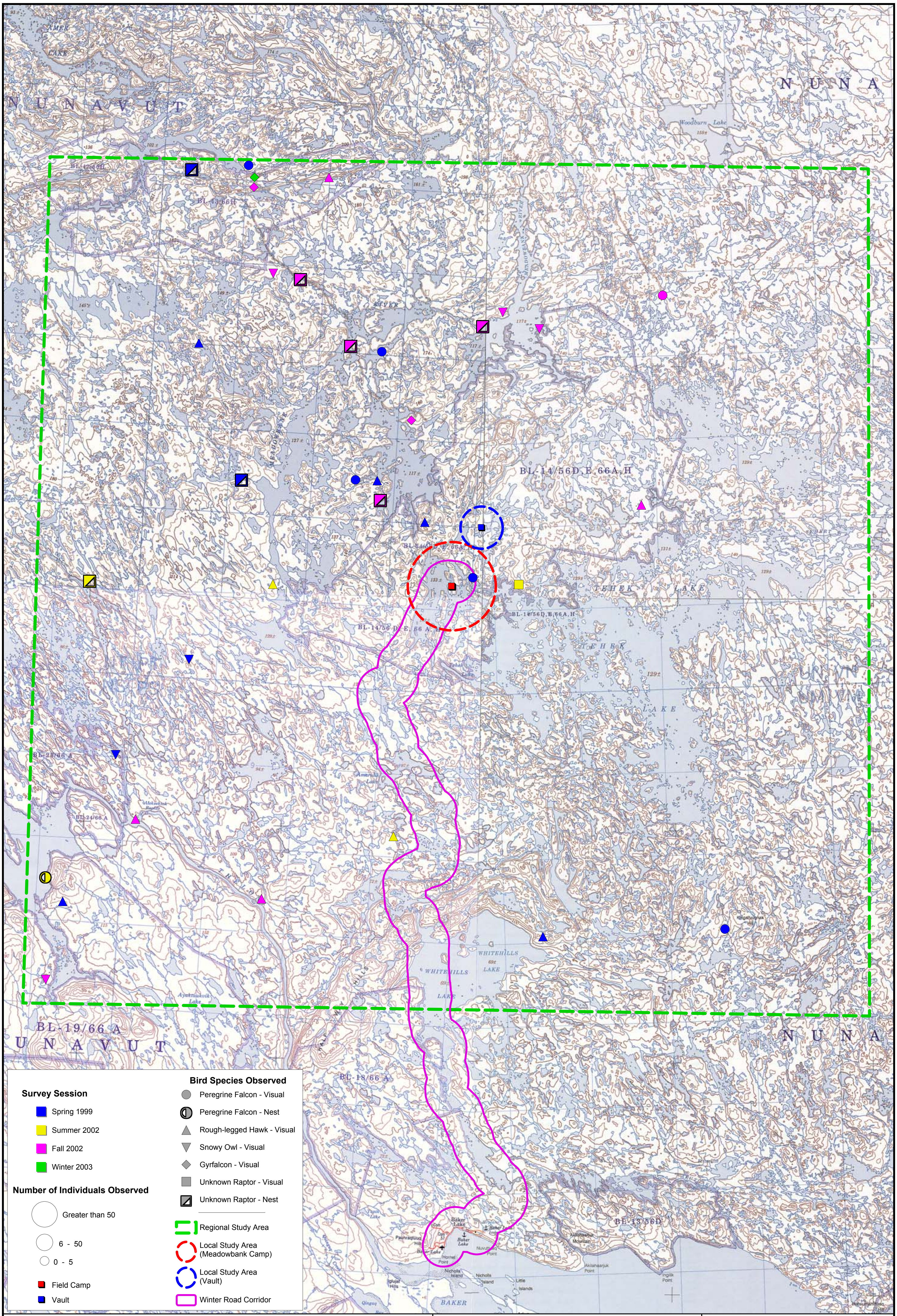
4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE		SCALE	
26 September, 2003		1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO. A.14	REV 4
REVIEWED CB	PROJECT KA9007		VOL -



Seasonal number and distribution of raptors recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

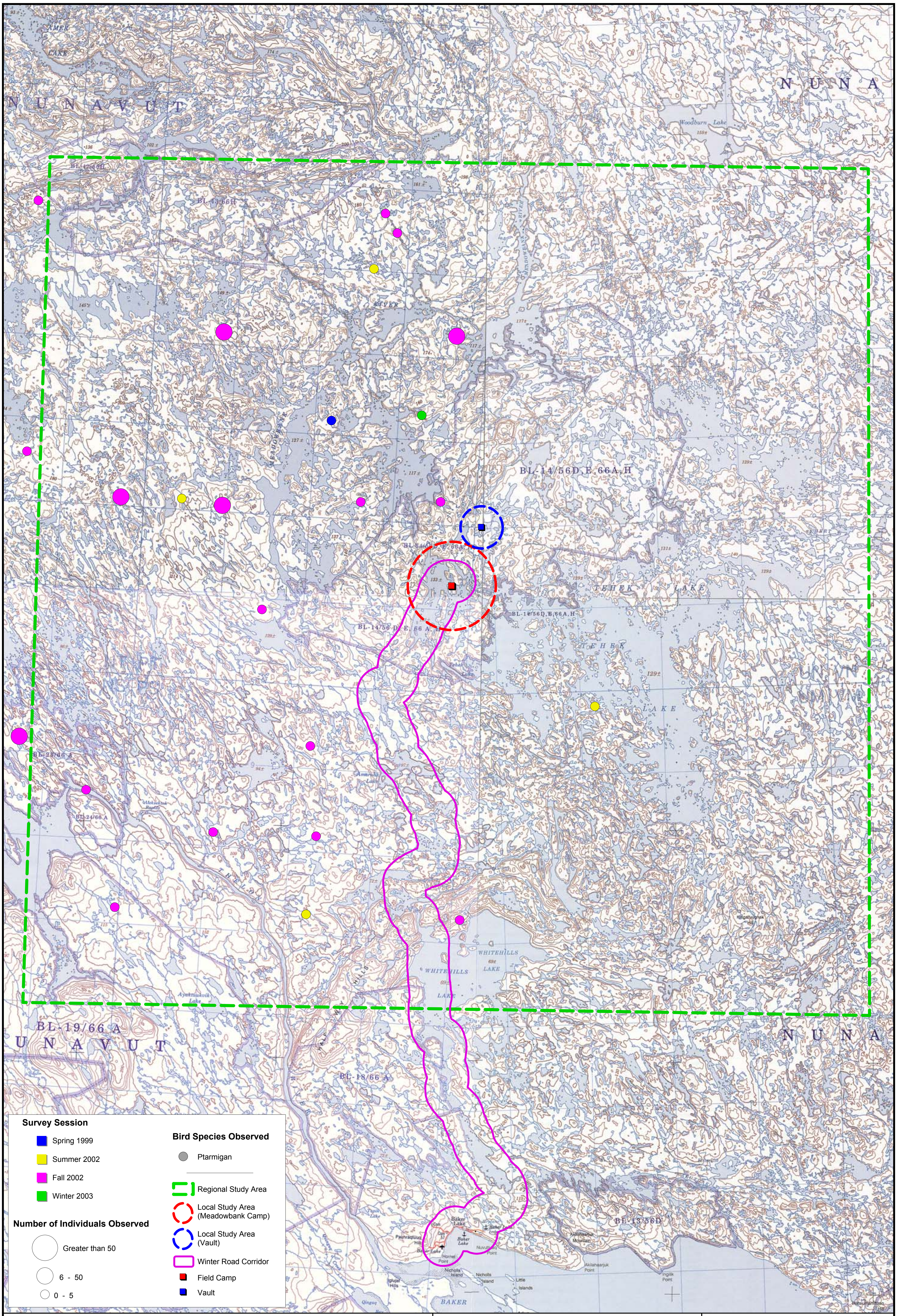
NORTH

Scale in kilometres: 4 0 4 8 12

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 26 September, 2003		SCALE 1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO. A.15	REV 4
REVIEWED CB	PROJECT KA9007		VOL -



Seasonal number and distribution of ptarmigan recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

Area of Detail

NORTH

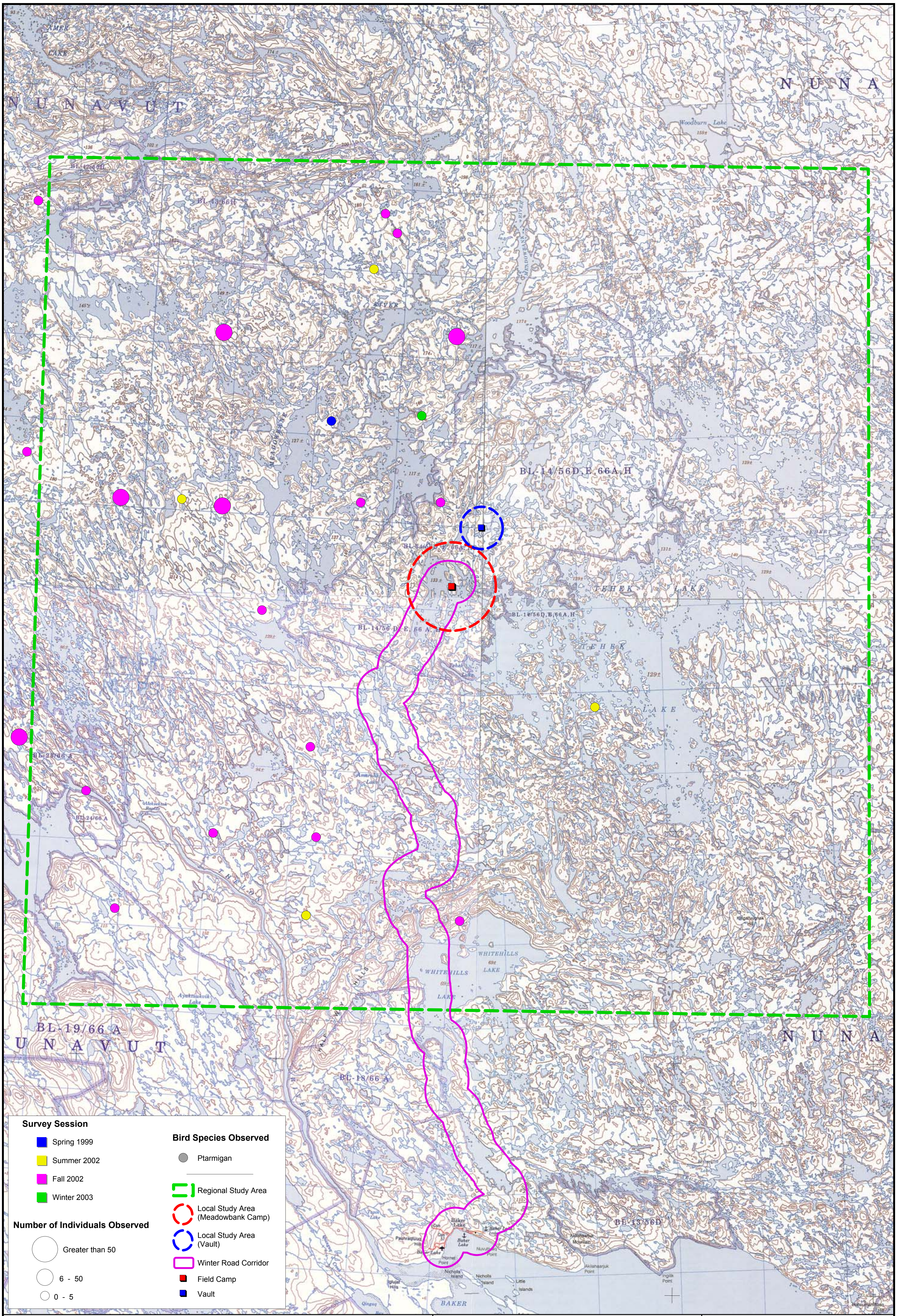
4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 26 September, 2003		SCALE 1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO. A.16	REV 4
REVIEWED CB	PROJECT KA9007		VOL -



Seasonal number and distribution of ptarmigan recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

NORTH

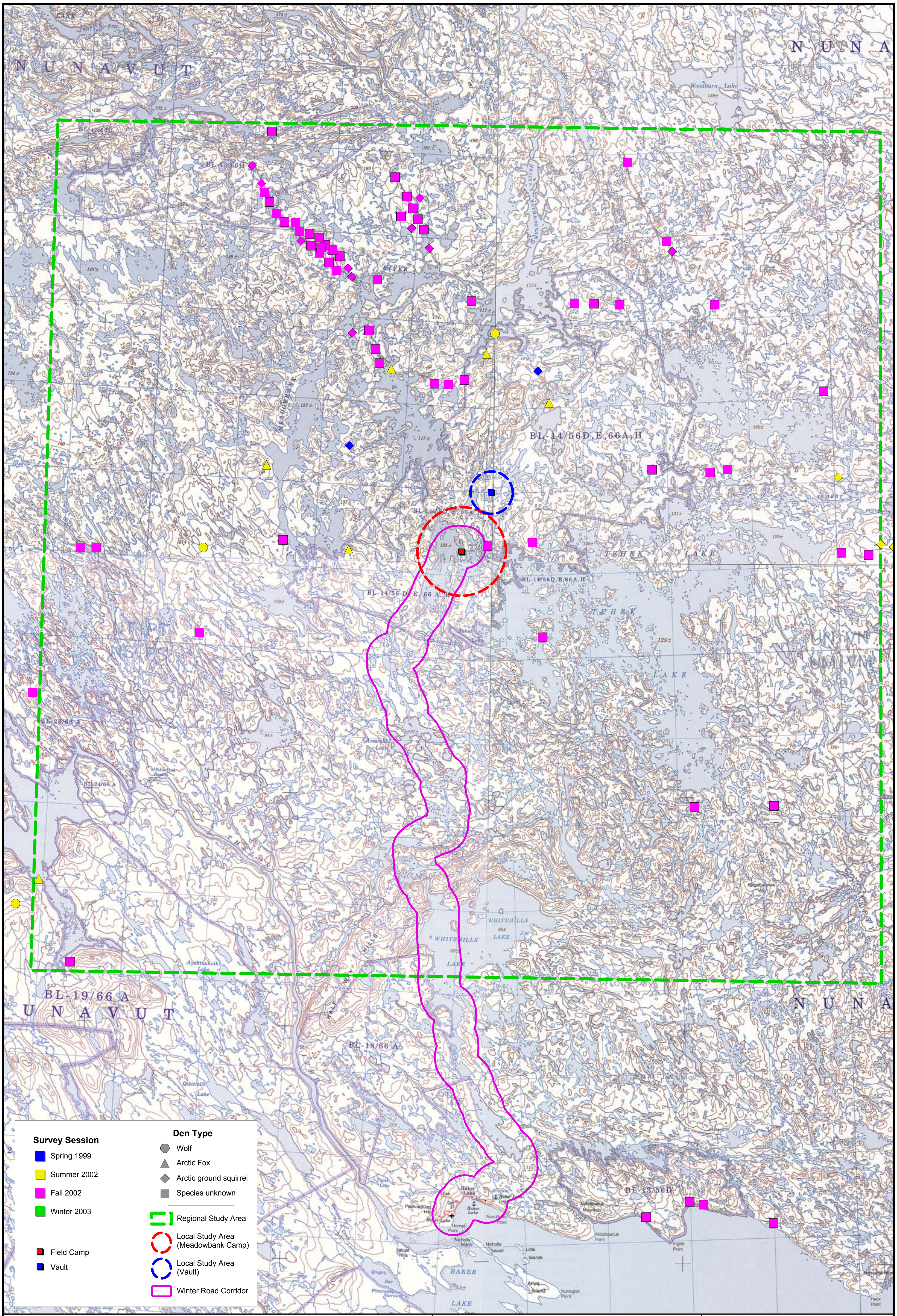
4 0 4 8 12

Scale in kilometres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE 26 September, 2003		SCALE 1:430,000	
DRAWN PM	CHECKED CB	FIGURE NO. A.16	REV 4
REVIEWED CB	PROJECT KA9007		VOL. -

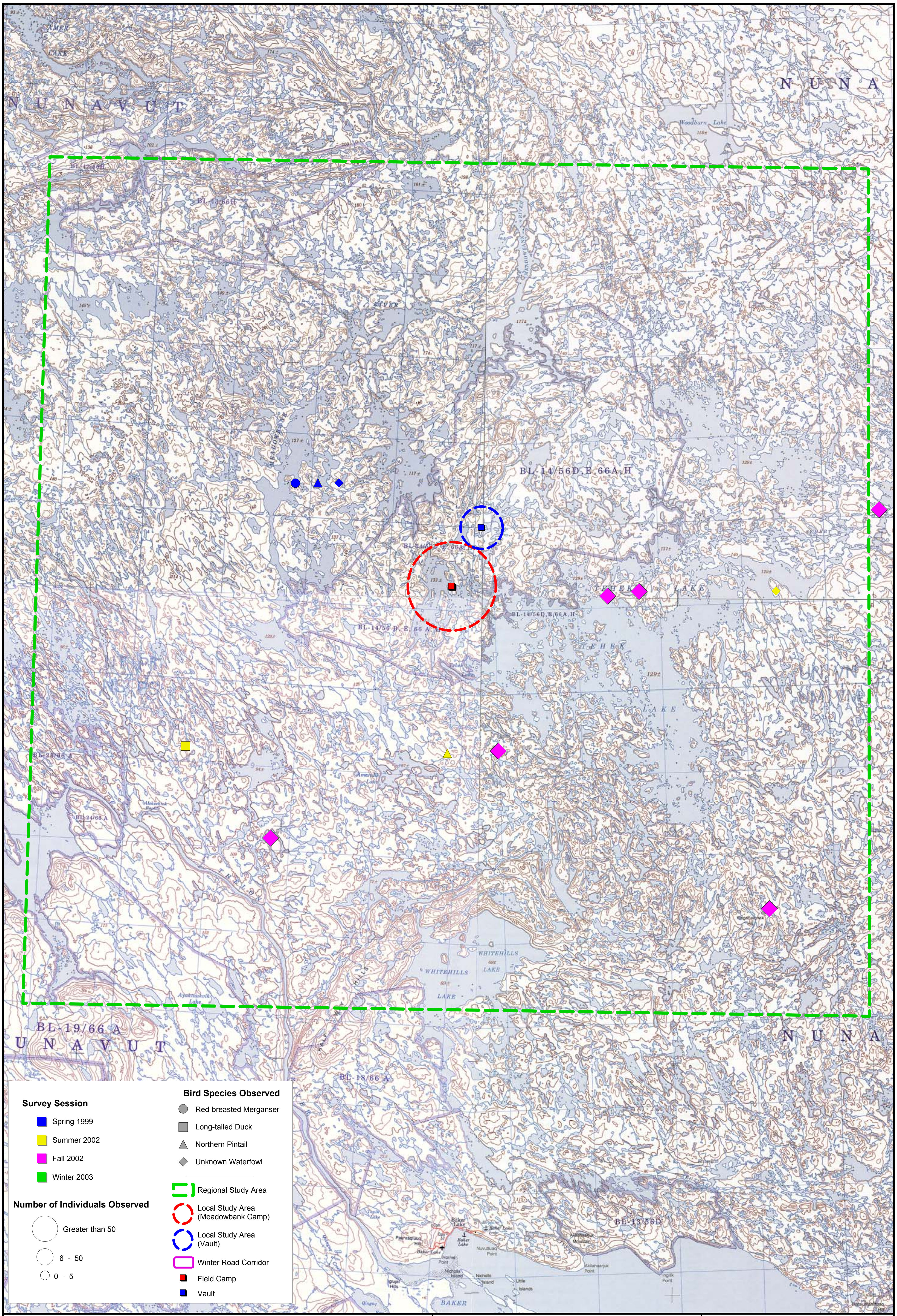


Seasonal number and distribution of dens and burrows recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE		SCALE	
26 September, 2003		1:430,000	
DRAWN	CHECKED	FIGURE NO.	REV
PM	CB	A.18	4
REVIEWED	PROJECT		VOL
CB	KA9007		-



Seasonal number and distribution of Ducks recorded during aerial surveys in the Meadowbank RSA and winter road corridor, 1999-2003

NORTH

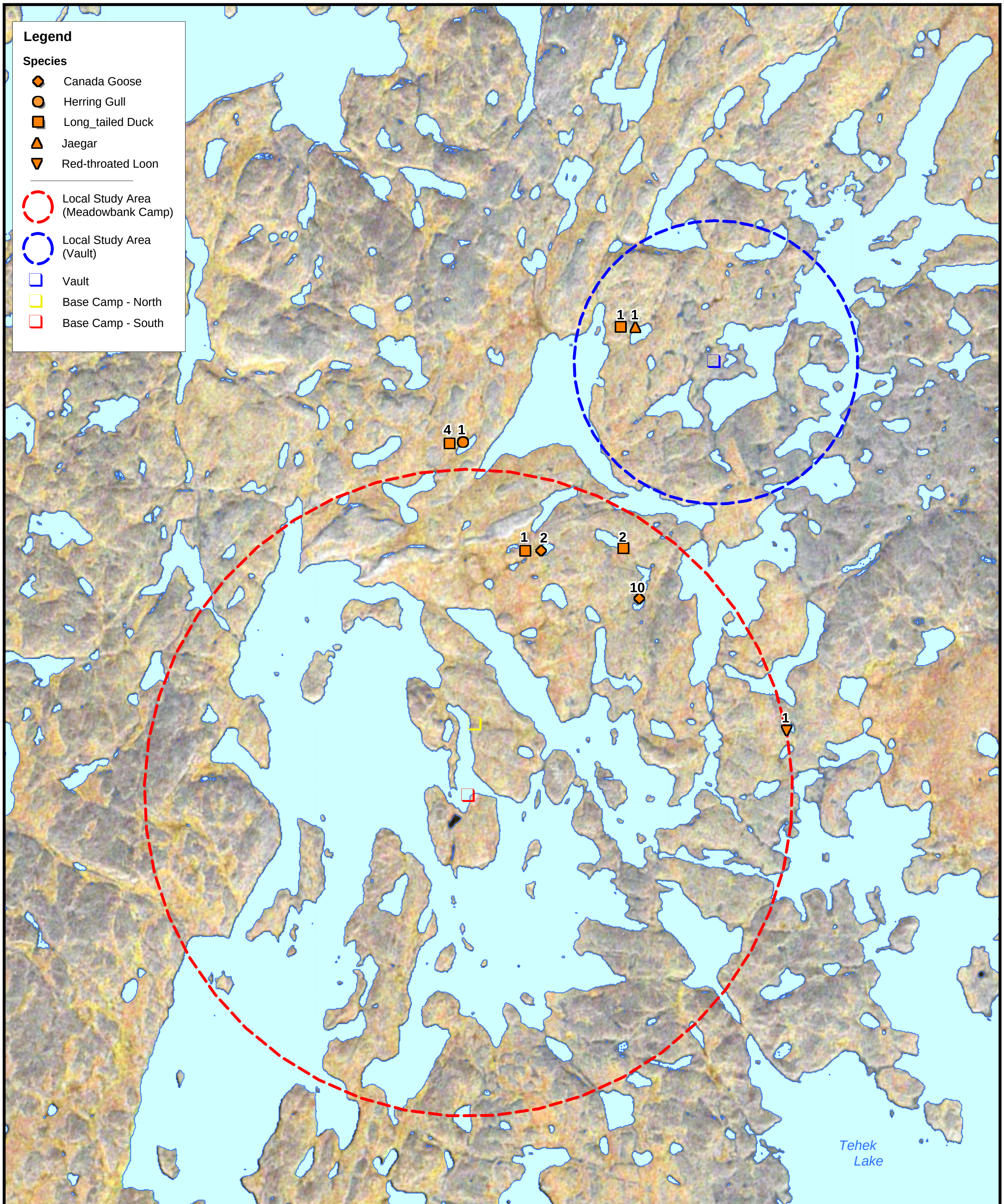
4 0 4 8 12

Scale in kilometres

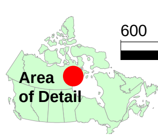
CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE		SCALE	
26 September, 2003		1:430,000	
DRAWN	CHECKED	FIGURE NO.	REV
PM	CB	A.19	4
REVIEWED	PROJECT		VOL
CB	KA9007		-



Waterbird observations recorded during aerial surveys in the Meadowbank LSA in the June 2003



NORTH

600 0 600 1200 1800

Scale in metres

CLIENT: CUMBERLAND RESOURCES LTD.

PREPARED BY KAVIK-AXYS Inc.

DATE	SCALE
26 September, 2003	1:85,000

DRAWN	CHECKED	FIGURE NO.	REV
PM	CB	A.20	6
REVIEWED	**PROJECT**		**VOL**
CB	KA9007		-