Agnico Eagle Mines Limited

Terrestrial Baseline Characterization Report

Amaruq Project Exploration Road

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EXECUTIVE SUMMARY

This Terrestrial Baseline Characterization Report has been prepared in support of the proposal by Agnico Eagle Mines (AEM) to construct an exploration road from the existing Meadowbank Mine to the Amaruq exploration site (Amaruq). Amaruq is located approximately 50 km northwest of the Meadowbank mine, and approximately 150 km north of Baker Lake, Kivalliq Region, Nunavut. The studies for this report, including vegetation and wildlife field investigations, were undertaken to document baseline terrestrial conditions along the proposed road alignment.

Two study areas, a Regional Study Area (RSA) and a Local Study Area (LSA), were established for this project. The RSA is a 50 km corridor centered on the road (i.e., 25 km on either side) with a total area of 459,223 km^2. The LSA is a 3 km corridor centered on the road (i.e., 1.5 km on either side) with a total area of 18,912 km^2.

Baseline field studies conducted for this report are as follows:

Vegetation

- Plot-based vegetation surveys to ground-truth existing ELC mapping, August to September, 2014.

Wildlife

- Incidental observations during vegetation field work, August to September, 2014;
- Wildlife observation log book, May to October, 2014; and
- Aerial survey of the road corridor, October 2014.

Extensive field studies were carried out for the 2005 Meadowbank Baseline Terrestrial Ecosystem Report, and monitoring has been ongoing since 2007 in accordance with Meadowbank's Terrestrial Ecosystem Management Plan. Where appropriate, information collected under these programs was used to supplement data collected during the 2014 Amaruq field studies.

Ecological Land Classification (ELC) mapping for the study area was developed by the Government of Nunavut for the Kivalliq Ecological Land Classification Map Atlas (Map Atlas). The digital ELC data in GIS format were used to develop ELC mapping for the RSA and LSA, as well to create wildlife habitat suitability maps. The Map Atlas was also used in the ground-truthing exercise and to inform research on soils, plant associations, and general physiography of the Wager Bay Plateau, in which the study site lies.

During the 2014 vegetation baseline surveys, 78 vascular plants and 33 non-vascular plants were identified. The most common ELC unit in the RSA is Water, with 26% cover. The most common vegetated community in the RSA is Lichen/Rock Complex (23%), followed by Heath Upland (16%), Heath Tundra (12%), Boulder/Gravel (9%), and Lichen Tundra (4%). All other communities were <2% cover in the RSA. In the LSA, proportions of ELC communities only differ in that Water is the second most abundant type at 22%, and the Lichen/Rock complex is higher at 27%. This is to be expected, as the road alignment has been developed to minimize impacts to water and wetlands.

During the 2014 baseline wildlife surveys, 27 terrestrial wildlife species (i.e., 10 mammals, 17 birds) were recorded through direct observation or sign. The most common mammal and bird species recorded were Barren-ground Caribou (*Rangifer tarandus* ssp. *groenlandicus*) and Snow Goose (*Chen caerulescens*), respectively. 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*), while common bird species included Canada Goose (*Branta canadensis*), Lapland Longspur (*Calcarius lapponicus*), and Sandhill Crane (*Grus canadensis*). Collaring data and knowledge of calving ground locations in Nunavut indicate that the study area is a migratory corridor in spring and fall, and is not close to any documented calving grounds. Literature reviews suggest that the esker features located within the RSA and portions of the LSA may have the potential for denning, nesting, and wildlife movement. Further field studies will be required to determine the current use of these eskers by wildlife.

Using the ELC mapping and wildlife habitat suitability rankings developed through extensive literature review, habitat suitability maps were generated for key terrestrial wildlife species. Recommendations for supplemental field work in 2015 have been provided as well as general conclusions for consideration in the future impact assessment phase of the Amaruq project.

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

1.1. PURPOSE

1.1.1. BACKGROUND

The Amaruq project (formerly the 'IVR' project) is an exploration property located on mainland Nunavut approximately 150 km north of Baker Lake and 50 km northwest of the existing Meadowbank mine (Figure 1). The 408 km^2 Amaruq property is located on Inuit Owned Land, and was acquired by Agnico Eagle Mines (AEM) in April 2013 subject to a mineral exploration agreement with Nunavut Tunngavik Incorporated (NTI).

A drilling program from July 2013 to October 2014 revealed promising gold mineralization. In order to access the property by land and facilitate further exploration drilling, construction of a road to connect the Amaruq site to the existing Meadowbank mine site is being proposed.

This terrestrial baseline characterization report has been undertaken to evaluate the existing flora and fauna observed or likely to exist along the proposed road alignment. Terrestrial baseline and monitoring studies were carried out for the adjacent Meadowbank mine from 1999 to 2014. Relevant findings from these studies and information from the Government of Nunavut (GN)'s Kivalliq Ecological Land Classification Map Atlas (2012; Map Atlas) have been used to supplement field data collected along the Amaruq exploration road alignment in 2014.

1.1.2. OBJECTIVES

The objectives of this study are to characterize baseline plant communities and wildlife use of the study area through a combination of field studies and literature review.

The intent of this work is to inform decisions for construction and to support the environmental impact assessment for the exploration road.

1.1.3. SCOPE

This study investigates the terrestrial ecological features of the study area, including:

- Vascular and non-vascular plants;
- Vegetation communities;
- Mammals; and
- Birds.

Soils and terrain features have been identified and discussed as they relate to the features itemized above. Given the background data available, ground-based soil studies were not conducted as part of this report.

The geographic scope of this study has been defined as encompassing the Regional Study Area (RSA) and Local Study Area (LSA) as subsequently defined in Section 1.3.1.

Field reconnaissance for this study was carried out in 2014, but available data from the Meadowbank Mine collected since 2005 have been incorporated into sections of the report.

1.2. SETTING

1.2.1. TERRESTRIAL BIOPHYSICAL ENVIRONMENT

The Amaruq study area is located in the Kivalliq Region of Nunavut, which comprises the most southern portion of mainland Nunavut, situated adjacent to Manitoba and the Northwest Territories, extending eastward to Hudson Bay, and encompassing Coats and Southampton islands to just north of Repulse Bay. The study site is located approximately 200 km inland from Hudson Bay and 150 km north of Baker Lake in an ecoregion known as the Wager Bay Plateau (see Figure 1). The Wager Bay Plateau is part of the northern Arctic, but the site is close to regions considered to be southern Arctic. The GN's Map Atlas describes the Wager Bay Plateau as follows:

> *Wager Bay Plateau is a large ecoregion covering the northeastern District of Keewatin extending westward from the northern portion of Southampton Island on Hudson Strait to Chesterfield Inlet in the south, and as far west as Back River. The mean annual temperature is approximately -11°C with a summer mean of 4.5°C and a winter mean of -26.5°C. The mean annual precipitation ranges from 200-300 mm. This ecoregion is classified as having a low arctic ecoclimate. It is characterized by a discontinuous cover of tundra vegetation, consisting of dwarf birch, willow, northern Labrador tea, Dryas spp., and Vaccinium spp. Taller dwarf birch, willow, and alder occur on warm sites; wet sites are dominated by willow and sedge. Lichen-covered rock outcroppings are prominent throughout the ecoregion, and towards the south the vegetation becomes a mix of tundra vegetation and open, dwarf coniferous forest. This ecoregion is composed of massive Archean rocks of the Canadian Shield that form broad, sloping uplands, plains, and valleys. It rises gradually westward from Chesterfield Inlet to 600 m asl elevation, where it is deeply dissected. Turbic and Static Cryosols developed on discontinuous, thin, sandy moraine and alluvial deposits are the dominant soils in the ecoregion, while large areas of Regosolic Static Cryosols are associated with marine deposits along the coast. Permafrost is continuous with low ice content. Characteristic wildlife includes Caribou, muskox, wolverine, Arctic hare, fox, walrus, seal, whale, polar bear, raptors, shorebirds, and waterfowl. Land uses include trapping, hunting, fishing, and mineral exploration and extraction. Repulse Bay and Baker Lake are the main settlements. The population of the ecoregion is approximately 1,700.*

The landscape traversed by the proposed all-weather access road is comprised of rolling hills with many lakes and ponds. Habitats are primarily lichen and rock in the uplands and wet graminoid-dominated lowlands, with heath tundra of varying wetness in between. Eskers occurring between the existing Meadowbank mine and the Amaruq study area are prominent linear features in the local landscape but are not common in the region.

Table 1 shows recorded temperatures from Baker Lake, the nearest climate station to the Amaruq study area. Expected temperatures at the Amaruq study area and along the exploration road will be slightly different because the presence of Baker Lake moderates temperatures within the community of Baker Lake.

Table 1: 1981 to 2010 Canadian Climate Normals Station Data (in degrees Celsius)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average	-31.3	-31.1	-26.3	-17.0	-6.4	4.9	11.6	9.8	3.1	-6.5	-19.3	-26.8
Daily Maximum	-27.7	-27.4	-22.0	-12.3	-3.0	9.3	17.0	14.3	6.4	-3.4	-15.5	-23.1
Daily Minimum	-34.8	-34.8	-30.6	-21.5	-9.8	0.5	6.1	5.3	-0.2	-9.5	-23.1	-30.5

Environment Canada, 2014

1.2.2. HUMAN ENVIRONMENT

The closest community to the Amaruq study area is the Hamlet of Baker Lake, which is located on the northwest shore of Baker Lake near the mouth of the Thelon River, approximately 75 km from the existing Meadowbank mine. The population in 2011 was 1,865, an increase from 1,726 from the 2006 census (Statistics Canada, 2013). The majority of the population are Inuit, with <10% identified as having non-Inuit ethnic origins (Statistics Canada, 2013). The next closest communities are Rankin Inlet, Whale Cove, and Chesterfield Inlet. The community of Baker Lake is accessible by air year-round or by water in the summer when the route from Chesterfield Inlet to Baker Lake is ice-free.

Baker Lake, Nunavut's only inland non-coastal Inuit community, was permanently established in the 1950s (CEDO, 2011). Traditionally, the Inuit of the Baker Lake area were highly nomadic, moving with Caribou (*Rangifer tarandus* ssp. *groenlandicus*) from season to season. 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) and Baker Lake elders (AEM, 2005). Until relatively recently, subsistence hunting was the only human activity regularly carried out in the Kivalliq Region.

Mining exploration and mine development have been occurring in the Kivalliq region since the 1950s when the North Rankin nickel mine was opened at Rankin Inlet (the mine closed in the early 1960s). Exploration of uranium deposits began in the 1970s and continues today with the Kiggavik project west of Baker Lake (AANDC, 2014). The Meadowbank Mine, operational since 2010, is the first active mine near Baker Lake.

1.3. STUDY AREA

1.3.1. REGIONAL & LOCAL STUDY AREAS

An RSA and a LSA were established for the purposes of conducting baseline plant and wildlife surveys along the proposed Amaruq exploration road alignment. The RSA is a 50 km corridor centered on the proposed road alignment (i.e., 25 km on either side of the road) and the LSA is a 3 km corridor (i.e. 1.5 km on either side of the road). Total area of the RSA is 459,223 ha, while the total area of the LSA is 18,912 ha. Figures 1 and 2 illustrate the extent of the RSA and LSA, respectively.

1.4. FOCUS SPECIES

Terrestrial Valued Ecosystem Components (VECs) were established for the Meadowbank project in 2005 based on their abundance and conservation concern in the area. These VECs, which provided the focus for this baseline study, are presented in Table 2.

Table 2: Valued Ecosystem Components

VEC	Common Name	Scientific Name
Vegetation (Wildlife Habitat)	See Section 3	*n/a*
Ungulates	Barren-ground Caribou Muskox	*Rangifer tarandus* ssp. *groenlandicus* *Ovibos moschatus*
Predatory Mammals (Carnivores)	Grizzly Bear Wolverine Gray (Arctic) Wolf Arctic Fox	*Ursus arctos* *Gulo gulo* *Canis lupus* *Alopex lagopus*
Small Mammals	Arctic Hare Arctic Ground Squirrel (Sik Sik) Collared Lemming Northern Red-backed Vole	*Lepus arcticus* *Spermophilus parryi* *Dicrostonyx groenlandicus* *Clethrionomys rutilis*
Raptors	Peregrine Falcon Gyrfalcon Rough-legged Hawk Short-eared Owl Snowy Owl	*Falco peregrinus* ssp. *tundrius* *Falco rusticolus* *Buteo lagopus* *Asio flammeus* *Nyctea scandiaca*
Waterbirds	Canada Goose Snow Goose Long-tailed Duck Loons	*Branta canadensis* *Chen caerulescens* *Clangula hyemalis* *Gavia* spp.
Upland Breeding Birds	Rock Ptarmigan Lapland Longspur Horned Lark Savannah Sparrow Semipalmated Sandpiper	*Lagopus mutus* *Calcarius lapponicus* *Eremophila alpestris* *Passerculus sandwichensis* *Calidris pusilla*

The 2014 baseline studies were conducted to determine the presence/absence, distribution, and abundance of the terrestrial vegetation and wildlife that comprise these VECs. Due to their high cultural importance, Caribou have been studied and discussed in this report in greater detail than the other VECs to assist in informing road planning.

2. SOILS

2.1. INTRODUCTION & BACKGROUND

This section provides an overview of the existing terrain and soil conditions along the Amaruq exploration road alignment. A summary of the dominant terrain features of the region are provided, and soil conditions in the Ecological Land Classification (ELC) community types of the LSA and RSA are described.

2.2. METHODS

This overview of existing terrain and soil conditions along the Amaruq exploration road alignment was developed from previous reports for the Meadowbank project, supplemented with information from the GN's Map Atlas and general observations from 2014 field studies.

Baseline information on terrain and soils was developed for the Meadowbank Mine Terrestrial Baseline Ecosystem Report and the ELC work for that project. Information in the Meadowbank report was generated through a literature review and surficial studies conducted as part of the vegetation surveys. Due to the contiguous nature of the Amaruq and Meadowbank study areas, where appropriate, information from the Meadowbank literature review has been included in this report.

The Map Atlas provides a summary of expected soil types by ELC community (see Section 2.4.1.). Soil-specific surveys were not conducted as part of the 2014 field work, but data collected on visible substrates in each of the plots sampled included percent cover of:

- Bedrock;
- Boulders (>50 cm);
- Stones (7.5 to 50 cm);
- Gravel (0.2 to 7.5 cm), and
- Soil (<0.2 cm).

2.3. TERRAIN SUMMARY

According to the Map Atlas, the terrain in the Wager Bay Plateau ecoregion can be summarized as follows:

> *This ecoregion is composed of massive Archean rocks of the Canadian Shield that form broad, sloping uplands, plains, and valleys. It rises gradually westward from Chesterfield Inlet to 600 m asl elevation, where it is deeply dissected.*

The Meadowbank Terrestrial Baseline report elaborates on this information, including sections on permafrost, topography, and surficial geology. These data have been supplemented with 2014 field observations in Sections 2.3.1 to 2.3.3 as follows.

2.3.1. PERMAFROST

Permafrost is defined as "ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years." (van Everdingen 1998).The Amaruq study area is within the continuous permafrost zone with low ice content (GN 2012). The Meadowbank Terrestrial Baseline report notes that "Permafrost in this area is considered stable and has temperatures colder than -5°C… depth of the permafrost in the Meadowbank area is estimated to be between 400 and 500 m based on thermistor data." Due to the contiguous nature of the two projects, this information is transferrable to the Amaruq exploration road alignment, but permafrost may be even deeper than in the Meadowbank area because Amaruq is farther north and more separated from the moderating influence of Baker Lake.

2.3.2. TOPOGRAPHY

The RSA is comprised of rolling hills interspersed by lakes, with several eskers of varying scale, substrate, and orientation. Drainage channels of varying sizes exist between many of the lakes. Drainage channels observed during the 2014 field work were often too small to be captured by the ELC mapping, but if communities were assigned they would consist of Wet Graminoid, Shrub Tundra, and Boulder/Gravel.

Most of the topography observed during the 2014 field visits was gently sloping, with most slopes in plots ranging from flat to 5%. Eskers were the most pronounced features in the RSA, with side slopes of up to 30%. The most prominent esker was a large esker extending southwest from the Amaruq study area. The ELC communities comprising the eskers are variable, but commonly include Boulder/Gravel, Lichen Tundra, Lichen/Rock Complex, Upland Tundra/Rock Complex, and Upland Tundra. Several cliffs were observed within the RSA by field staff during helicopter surveys.

2.3.3. SURFICIAL GEOLOGY

The RSA for the Amaruq study area includes 26% Water, which includes many large and small lakes spread across the landscape. There are no major rivers within the RSA. The dominant surficial material is described in the Meadowbank RSA as "morainal, with small amounts of alluvial, lacustrine, glaciofluvial, and colluvial materials, as well as bedrock, boulder fields, and organic accumulations". This general description is applicable to the Amaruq RSA, as it is contiguous with the Meadowbank RSA, with one exception; there are no 'Rock" ELC units within the Amaruq RSA so limited amounts of bedrock can be expected.

2.4. SOIL CONDITION SUMMARY

The description of soils in the Wager Bay Plateau is "*Turbic and Static Cryosols developed on discontinuous, thin, sandy moraine and alluvial deposits are the dominant soils in the ecoregion"* (GN 2012). The following information on soil types expected to be found in each ELC community has been summarized from the Map Atlas and from substrate observations from the 2014 ELC field work.

Wet Graminoid (WG)

The Wet Graminoid community typically occurs on a graminoid/peat substrate in poorly drained areas where standing water is present. Plots within the study were found to have moderate to deep soils with a wet moisture regime. Within the study area, Wet Graminoid was often associated with lake and watercourse edges.

Graminoid Tundra (GT)

The Graminoid Tundra community type, which was also found on graminoid/peat substrates, represents graminoid-dominated communities of imperfect drainage. Soil depth was observed to be moderate to deep and moisture regime was identified as mesic to wet. Field studies identified that Graminoid Tundra often occurred on bottomlands, but in dryer locations than the Wet Graminoid land class.

Graminoid/Shrub Tundra (GS)

The Graminoid/Shrub Tundra community typically occurs on moss/peat substrates with moderate to deep soils, and a mesic moisture regime. Observations from the field indicated that this community was often associated with bottomlands.

Shrub Tundra (ST)

The Shrub Tundra community type typically occurs on moss/peat substrates. Field data indicate moderate to deep soil depth and a mesic moisture regime.

Shrub/Heath Tundra (SH)

The Shrub/Heath Tundra community type occurs on moss/peat substrates in areas with well to moderately-well drained soils with a mesic moisture regime. The community is transitional containing elements of Shrub Tundra and Heath Tundra.

Heath Tundra (HT)

Hetah Tundra is a prominent land class that occurs in areas with a variety of substrates including moss/peat, clay/silt, sand/gravel and boulders. Slope position is variable and includes tablelands, bottomlands, and midslope with shallow to moderate soil depths and dry to mesic moisture regimes.

Heath Upland (HU)

The Heath Upland class may occur on a variety of substrate types, but is often associated with rocky soils (sand, gravel, boulders). Field studies indicate variable slope positioning (top of slope, midslope and tableland) with shallow to moderate soil depth and a dry to mesic moisture regime. The Heath Upland community is similar to Heath Tundra but occurs in drier upland areas.

Heath Upland/Rock Complex (HR)

Very similar to Heath Upland, the Heath Upland/Rock Complex class has strong associations with significant rock cover (boulders). Field observations indicated that slope position was typically midslope, while soil depths were shallow with a dry moisture regime.

Lichen Tundra (LT)
While some cover from all vegetation functional groups may be present in the Lichen Tundra community, lichens dominate this land class. This community is found in dry, rocky and upland areas, typically in midslope areas, has very shallow to moderate soil depths, and a dry to mesic moisture regime.

Lichen/Rock Complex (LR)
The Lichen/Rock Complex land class is prominent within the study areas and is found on well-drained sites where rocky substrates are combined with significant cover from large rocky elements (boulders). Slope position is variable (top of slope, tableland or midslope), soil depths are very shallow, and moisture regime is typically dry.

Sand (SA)
Rare on the landscape, the Sand land class occurs along ridges such as eskers and in riverine and lacustrine areas. Soils are shallow and have a dry moisture regime.

Boulder/Gravel (BG)
The Boulder/Gravel land classification applies to areas dominated by boulders, stones, cobble and gravel. Soil depth is very shallow with a dry moisture regime. Exposed substrate material was observed to typically have significant percent cover from rock-affiliate lichens.

Disturbance (DI)
The Disturbance land class applies to anthropogenic disturbances. In disturbed areas, native soils are typically removed and replaced with thick layers of crushed rock to facilitate the construction of buildings.

Water (WA)
Water covers a large portion of the RSA and LSA.

Shadow (SD)
The Shadow classification represents a data gap in the GIS analysis caused by clouds and/or shadows in the LIDAR imagery and thus is not associated with any particular soil type.

3. VEGETATION

3.1. INTRODUCTION

Plants and plant communities were investigated in the LSA and RSA in order to fulfill a number of requirements for this project:

1. Develop a baseline list of plant species present across the study area;
2. Compare plants found to plants with potential to occur in the study area;
3. Determine typical plant associations for each ELC unit in the LSA and RSA; and
4. Confirm the accuracy of the ELC mapping provided for this project by the GN.

This section describes the methods and findings of the 2014 field surveys. Due to the condensed nature of this project, data from the Meadowbank baseline data collection work (1999 to 2005) have been included in the discussion sections for potential species (Section 3.3.4.2), and rare plants and communities (Section 3.3.4.3)

3.2. METHODS

3.2.1. LITERATURE REVIEW

The following publications were used to research the flora of the LSA and RSA, identify plants collected in the field, and subsequently confirm identification in an in-house herbarium:

- **Aiken, S.G., et al. 2007.** Flora of the Canadian Arctic Archipelago;
- **Argus, G.W. 1973.** The Genus *Salix* in Alaska and the Yukon;
- **Argus, G.W., Pryer, K.M. 1990.** Rare Vascular Plants in Canada Our Natural Heritage;
- **Brodo, I.M. et al. 2001.** Lichens of North America;
- **Brouillet, L. et al. 2014**. VASCAN, the Database of Vascular Plants of Canada;
- **Cody, W.J. 1979.** Vascular Plants of Restricted Range in the Continental Northwest Territories, Canada;
- **Cody, W.J. et al. 1989.** Vascular Plant Flora of the Wager Bay Region, District of Keewatin, Northwest Territories;
- **Conard, H.S. 1979.** How to Know the Mosses and Liverworts;
- **Hulten, E. 1968.** Flora of Alaska and Neighboring Territories: A Manual of the Vascular Plants;
- **Larsen, J.A., 1972.** The vegetation of Northern Keewatin. Canadian Field-Naturalist 86:45-72;
- **McJannet, C.L., et al. 1993.** Rare Vascular Plants in the Canadian Arctic; and
- **Porslid, A.E., Cody, W.J. 1980.** Vascular Plants of Continental Northwest Territories, Canada.

Full citations for these publications are available in Section 7, References. The taxonomy for all plants collected in this study was checked online using two major authorities; the PLANTS Database (USDA, NRCS, 2014) and the Database of Canadian Vascular Plants (Brouillet et al, 2014).

3.2.2. ECOLOGICAL LAND CLASSIFICATION (ELC) MAPPING

The GN's Department of Environment (DoE) conducted a multi-year program to develop ELC for the Kivalliq region based on classification of Landsat imagery. This mapping facilitates the identification of ecological land classes, and ultimately the identification of important vegetation communities, which is critical to the sustainable management of the Kivalliq's ecological communities and the wildlife species utilizing these habitats.

For the Amaruq exploration road baseline data collection, the GN's ELC mapping for the RSA and LSA was provided by Caslys Consulting in ArcGIS Shapefile format. A thorough ELC of the Kivalliq Region of Nunavut was completed by Caslys Consulting in 2012 on behalf of the GN in collaboration with data provided by AEM (from the Meadowbank baseline studies) to the GN. Image classification is a statistical process that groups together pixels that have similar spectral characteristics. There are two methods of image classification: unsupervised and supervised. For this project, an unsupervised classification was performed. In an unsupervised classification, ArcGIS looks at spectral reflectance characteristics and assigns every pixel into a class. This is useful when there is no prior knowledge of the classes in a landscape.

Both Landsat 5 TM (Thematic Mapper) and Landsat 7 ETM (Enhanced TM) satellite sensors were considered, with dates ranging from August 2000 to August 2009. A preliminary classification was then completed to identify distinct ecological areas within each scene. These results were used to delineate sample sites, stratified across each distinct area. The preliminary classification provided information to formulate draft class breakdowns, understand broad class distributions across the landscape, and to plan field program logistics.

The field program carried out by the GN was designed to optimize quality and quantity of data, to guide the ELC mapping process, and to visit pre-defined sample site locations. Data and knowledge acquired during the field program were the basis for the final class descriptions. The imagery and sample data were analyzed to generate refined classes based on multiple factors. The image classifications were run a second time using the updated class definitions to achieve the greatest possible accuracy when compared to the actual sample locations. Numerical information in the image's spectral bands defined the spectral 'signature' of each class. Once the spectral signatures were determined, every pixel was compared to the signatures and labelled as the class to which it was mathematically closest. In addition to specifying the classes, two other parameters determined how close pixels' digital numbers must be to be considered in the same class. The supervised classification was an iterative process where classes were combined and/or excluded based on the results in the classification report.

The ELC Units for the Amaruq RSA are:

- Lichen/Rock Complex;
- Heath Upland;
- Heath Tundra;
- Boulder/Gravel;
- Lichen Tundra;
- Graminoid Tundra;
- Shrub/Heath Tundra;
- Graminoid/Shrub Tundra;
- Heath Upland/Rock Complex;
- Cloud/Shadow;
- Shrub Tundra;
- Wet Graminoid;
- Sand;
- Disturbance; and
- Water.

3.2.3. BASELINE VEGETATION FIELD SURVEYS

3.2.3.1. SITE SELECTION

The GN has developed 25 x 25m grid square ELC data for the Kivalliq region of Nunavut. This mapping was completed through Landsat 7 imagery analysis as described in Section 3.2.2. Twenty vegetation communities are mapped within the LSA and RSA, along with non-vegetated areas such as water, ice, anthropogenic disturbed areas, and areas of cloud or shadow that were present within the Landsat images.

3.2.3.2. PLOT SAMPLING

From August 28th to September 3rd, 2014, field investigations were undertaken along the proposed road alignment to the Amaruq exploration site. Surveys involved botanical inventories and classifications within 5 x 5m plots. In order to encompass and examine the diversity of ELC communities within the study area, plots were established as informed by the site selection process (Section 3.2.3.1 above) and conditions in the field.

During each sampling day, field ecologists traveled to and from pre-arranged drop-off points along the proposed Amaruq road alignment by helicopter. Once on the ground, a Trimble GeoExplorer 6000 Series GeoXH high-accuracy GPS unit was used to access ELC mapping and pre-defined plot location targets. Staff hiked to select plot coordinates and determined whether the remote sensing mapping [GN 2012] accurately reflected on-the-ground conditions.

Upon reaching plot coordinates, one of several decisions was made:

1) If the plot was located within a target ELC community and that ELC community was correctly identified by remote sensing data, a plot would be established;
2) If the plot was located within a target ELC community but the ELC community was not correctly identified by remote sensing data, a plot would be established and notes would be taken concerning updates to the remote sensing mapping;
3) If the plot was located within a non-target ELC community and the mapping was not correctly identified by remote sensing data, no plot would be established; and
4) If a target ELC community was discovered on-the-ground, which had not been previously identified during the site selection phase, a new plot would be created using the *Trimble GeoXH*.

Under the conditions for plot establishment, as described above, 52, 5 x 5 m square plots were established and surveyed. Each plot was measured using a tape measure and wire flags were temporarily installed at the corners. Once established, parameters that were recorded included:

- Date, Observers, and Plot Number;
- Quadrat Location (Lat/Long), using the *Trimble GeoXH*;
- ELC Type;
- General plot site information (slope percent, aspect, shape and position as well moisture regime and rooting depth);

- Plot substrate information (percent bedrock, boulder, stone, gravel, bare soil, water and vegetation);
- Vegetation cover percentages (tall shrubs, low shrubs, herbs, graminoids, mosses, lichen and other);
- Summary of species dominance;
- Flora species list with layers, cover, and sample information; and
- Fauna and general observations.

3.3. RESULTS

3.4. OVERVIEW

Limited information is available in the general literature on the species types and distribution of plants in the Kivalliq Region. Academic studies available for this region began in the 1960s and include Hulten (1968), Cody et al (1979), and McJannet (1993, 1995). Field work carried out for the Meadowbank project in 1999, 2002, and 2003 provides the most in-depth and up-to-date information available on the vascular and non-vascular plants in the vicinity of the Amaruq project. In addition, the Map Atlas provides a list of the plants most commonly found in each of the ELC communities in the Kivalliq region.

3.4.1. ELC UNITS

Following are descriptions of the ELC communities present in the Amaruq exploration road RSA.

Wet Graminoid (WG)
The Wet Graminoid vegetation community is found in poorly drained areas where standing water is present, is often associated with lake and watercourse edges, and typically occurs on a graminoid/peat substrate. Plots within the study area had moderate to deep soils with a wet moisture regime. The dominant species were Russet Sedge (*Carex saxatilis*), Water Sedge (*Carex aquatilis*), Capitate Sedge (*Carex capitata*), and Dwarf Willow (*Salix herbacea*). Within the Kivalliq region, this vegetation community type represents approximately 4.7% of total cover (19,360 km^2), whereas within the RSA and LSA, it represents 0.5% (23.17 km^2) and 0.4% (0.77 km^2), respectively.

Graminoid Tundra (GT)
Dryer than the Wet Graminoid land class, Graminoid Tundra represents graminoid-dominated communities in imperfect drainage, often on bottomlands. Found on graminoid/peat substrates, soil depth was observed to be moderate to deep and moisture regime was identified as mesic to wet. Tussock Cottongrass (*Eriophorum vaginatum*), with Cordlike Sedge (*Carex chordorrhiza*), Capitate Sedge, and Sphagnum Moss (*Sphagnum* sp), form the basis of this community with moderately low percent associations of shrubs and lichens. Within the Kivalliq region this vegetation community type represents approximately 3.1% of total cover (12,800 km^2), while within the RSA and LSA, it represents 2.08% (95.34 km^2) and 1.66% (3.13 km^2) cover, respectively.

Graminoid/Shrub Tundra (GS)
This class represents a transition in cover from graminoids towards shrubs. Observations from the field indicated that this land class was often associated with bottomlands. Graminoid and moss/peat substrates were moderate to deep and a mesic moisture regime was typically observed. Dominant

species were Short-anther Cottongrass (*Eriophorum brachyantherum*), Bog Blueberry (*Vaccinium uliginosum*), Northern Labrador Tea (*Vaccinium uliginosum*), and Dwarf Birch (*Betula nana*). Within the Kivalliq region, this vegetation community type represents approximately 1.5% of total cover (6,000 km^2), while within the RSA and LSA, it represents 1.51% (69.22 km^2) and 1.61% (3.05 km^2) cover, respectively.

Shrub Tundra (ST)

Erect shrubs account for the main functional component of vegetation in the Shrub Tundra land class. Typically occurring on moss/peat substrates, field data indicate a typical soil depth of moderate to deep and moisture regime of mesic. Dominant species include Dwarf Birch, Bog Blueberry, and Northern Labrador Tea as well as significant cover of mosses, graminoids and various other shrubs. Within the Kivalliq region, this vegetation community type represents approximately 4.5% of total cover (18,560 km^2), while within the RSA and LSA it represents 0.98% (45.20 km^2) and 0.74% (1.40 km^2) of cover, respectively.

Shrub/Heath Tundra (SH)

Occurring in areas with well to moderately well drained soils, Shrub/Heath Tundra is a transitional community containing elements of Shrub Tundra and Heath Tundra. Slope position was often midslope or on tablelands and the moderate to deep rooting depth into moss/peat soils typically had a mesic moisture regime. Dominant plant species included Dwarf Birch, Bog Blueberry, Arctic White Heather (*Cassiope tetragona*), and Northern Labrador Tea with a greater prominence of ericaceous shrubs than observed in Shrub Tundra plots. Within the Kivalliq region, this vegetation community type represents approximately 5.6% of total cover (23,100 km^2), compared to 1.7% (78 km^2) and 1.82% (3.44 km^2) of the RSA and LSA, respectively.

Heath Tundra (HT)

The prominent Heath Tundra land class occurs in areas with a variety of substrates including moss/peat, clay/silt, sand/gravel, and boulders. Slope position was variable (tablelands, bottomlands, and midslope), soil depths were shallow to moderate, and moisture regime was dry to mesic. Dominant species within this ubiquitous land class included a full suite of ericaceous shrubs such as Mountain Avens (*Dryas integrifolia*), Crowberry (*Empetrum nigrum*), Bearberry (*Arctous alpina*), Arctic White Heather, and Lingonberry (*Vaccinium vitis-idaea*). Within the Kivalliq region, this vegetation community type represents approximately 9.5% of total cover (39,200 km^2), while in the RSA and LSA it covers 11.73% (538.79 km^2) and 12.05% (22.80 km^2), respectively.

Heath Upland (HU)

Similar to Heath Tundra, but occurring in drier upland areas, Heath Upland was an important land class within the study area. This class may occur on a variety of substrate types, but is often associated with rocky soils (sand, gravel, boulders). Field studies indicate variable slope positioning (top of slope, midslope, and tableland) with shallow to moderate soil depth and a dry to mesic moisture regime. Dominant species were ericaceous shrubs such as Northern Labrador Tea, Bearberry, and Crowberry. Lapland Rosebay (*Rhododendron lapponicum*) was found to be exclusively associated with Heath Upland and Health Upland/Rock Complex areas. Lichens, such as *Flavocetraria* spp., *Cladonia* spp. and *Alectoria* spp., were also important components of this class. Within the Kivalliq region, this vegetation community type represents approximately 9.8% of total cover (40,600 km^2), compared to 16.1% (739.26 km^2) and 19.86% (37.55 km^2) of the RSA and LSA, respectively.

Heath Upland/Rock Complex (HR)
Very similar to Heath Upland, the Heath Upland/Rock Complex land class has strong associations with significant rock cover (boulders). Field observations indicated that slope position was typically midslope, while soil depths were shallow with a dry moisture regime. Dominant plant species were the lichen, *Flavocetraria* spp., Arctic White Heather, Northern Labrador Tea, and Alpine Holygrass (*Hierchloe alpine*). Within the Kivalliq region, this vegetation community type represents approximately 8.4% of total cover (34,800 km^2), while in the RSA and LSA, it represents 1.46% (67.16 km^2) and 1.33% (2.52 km^2), respectively.

Lichen Tundra (LT)
While some cover from all vegetation functional groups may be present, lichens dominate the Lichen Tundra land class, which is found in dry, rocky, and upland areas. Slope position was typically midslope, soil depths were shallow to moderate, and moistur regime was dry to mesic. Dominant species were lichens; most notably *Cladonia* spp., *Flavocetraria* spp., *Stereocaulon* spp., *Thamnolia vermicularis,* and *Dactylina arctica*. Within the Kivalliq region, this vegetation community type represents approximately 2.3% of total cover (9,600 km^2), compared to 4.21% (193.44 km^2) and 4.61% (8.72 km^2) of the RSA and LSA, respectively.

Lichen/Rock Complex (LR)
The Lichen/Rock Complex land class is prominent within the study areas and is found on well-drained sites where rocky substrates are combined with significant cover from large rocky elements (boulders). Slope position was variable (on top of slope, tableland, or midslope), soil depths were very shallow, and moisture regime was typically dry. Dominant species in this class included a wide diversity of lichens. Rock-associated lichens such as *Ophioparma lapponica*, *Arctoparmelia centrifuga*, and *Umbillicaria mammulata* were prominent alongside *Flavocetraria* spp., *Cladonia* spp., and *Alectoria* spp. lichens. Within the Kivalliq region, this vegetation community type represents approximately 7.3% of total cover (30,200 km^2), while in the RSA and LSA it represents 23.04% (1058.12 km^2) and 27.19% (51.42 km^2), respectively.

Sand (SA)
Rare on the landscape, the Sand land class occurs in midslope areas along ridges such as eskers, and in riverine and lacustrine areas. Soils were found to be shallow with a dry moisture regime. Apart from non-vegetated sandy substrate, the dominant functional vegetation cover for sand came from ericaceous shrubs and lichens. Within the Kivalliq region, this community type represents approximately 0.3% of total cover (1,410 km^2), while in the RSA and LSA it represents 0.44% (19.98 km^2) and 0.47% (0.9 km^2), respectively. Furthermore, this land class was the least reliably identified by remote sensing data; three of the four plots established within areas mapped remotely as Sand were reassigned to a different land class based on field observations.

Boulder/Gravel (BG)
The Boulder/Gravel land class applies to areas dominated by boulders, stones, cobble and gravel. Soil depth in these areas was very shallow with a dry moisture regime. Dominant plant species included the lichens *Umbillicaria mammulata*, *Arctoparmelia centrifuga*, and willows (*Salix* spp.). No plots were established within this land class. Within the Kivalliq region, this community type represents

approximately 6.8% of total cover (28,200 km^2), while in the RSA and LSA it represents 9.13% (419.26 km^2) and 6.67% (12.62 km^2), respectively.

Disturbance (DI)

The Disturbance land class applies to anthropogenic disturbances. Examples of disturbance include residential, commercial, industrial, and resource extraction land uses. No plots were established within this land class. Within the Kivalliq region, this community type represents approximately 0.1% of total cover (38 km^2). Within the RSA and LSA, Disturbance represents 0.17% (7.62 km^2) and 0% (0 km^2), respectively.

Water (WA)

The Water class is the single most common land class in the study area. Specifically, any water body larger than 0.75 ha or watercourse wider than 75 m is distinguishable within the Landsat base data. No plots were established within this land class. Within the Kivalliq region, this class represents approximately 24% of total cover (100,000 km^2), while within the RSA and LSA it represents 25.59% (1175.22 km^2) and 21.58% (40.81 km^2), respectively.

Shadow (SD)

The Shadow class applies to areas covered by clouds or their associated shadows within the source Landsat data. No plots were established within this land class. Within the Kivalliq region, Shadow represents approximately 3.2% of total cover (13,150 km^2). Within the RSA and LSA, it represents 1.36% (62.46 km^2) and 0% (0 km^2), respectively.

Table 3. Total Area and Percent Cover of ELC Units within the RSA & LSA

ELC CLASS	RSA		LSA	
	Area	Percentage	Area	Percentage
Lichen/Rock Complex	105,812.39	23.04%	5,141.90	27.19%
Heath Upland	73,925.98	16.10%	3,755.32	19.86%
Heath Tundra	53,878.64	11.73%	2,279.67	12.05%
Boulder/Gravel	41,925.72	9.13%	1,261.93	6.67%
Lichen Tundra	19,343.85	4.21%	872.25	4.61%
Graminoid Tundra	9,534.37	2.08%	313.16	1.66%
Shrub/Heath Tundra	7,799.75	1.70%	344.23	1.82%
Graminoid/Shrub Tundra	6,922.04	1.51%	304.84	1.61%
Heath Upland/Rock Complex	6,715.82	1.46%	252.08	1.33%
Cloud/Shadow	6,245.72	1.36%	0.00	0.00%
Shrub Tundra	4,519.92	0.98%	139.69	0.74%
Wet Graminoid	2,316.98	0.50%	76.54	0.40%
Sand	1,997.87	0.44%	89.55	0.47%
Disturbance	761.59	0.17%	0.00	0.00%
Water	117,522.20	25.59%	4,081.33	21.58%
	459,222.84	**100.00%**	**18,912.49**	**100.00%**

See Figure 3 for an illustration of where these ELC communities are located in relation to the LSA and RSA.

3.4.2. DISTRIBUTION OF ELC UNITS IN STUDY AREAS

Broad-scale patterns are visible for the ELC types present within the study areas. Most prominently, dozens of lakes of varying sizes are present throughout the RSA and LSA. The proposed road alignment traverses along a very large lake for its first ~20 km northwest of the Meadowbank mine. After approximately the 32nd km of the alignment, the lakes are for the most part much smaller. Overall, these lakes contribute to more than one quarter (25.6%) of the RSA and more than one fifth (21.6%) of the LSA.

From approximately the 19th km of the proposed alignment onwards, a broad swath of rocky lands crosses the study area roughly perpendicular to the road direction. These rock-associated land class types include Lichen/Rock Complex and Boulder/Gravel, which are two contributors to land cover in the RSA and LSA. This rocky landscape is associated with dry moisture regimes and a predominance of lichen species. Throughout the study area, rockier lands were often present on rises in the topography while the intervening valleys and tablelands were dominated by heath-affiliated land classes. Heath Upland and Heath Tundra, the third and fourth most prominent land cover types within the study areas, form broad stretches along the study areas, particularly along the first (southerly) 17 km and the last (northerly) 8 km of the proposed road alignment. Heath lands have a more mesic moisture regime than the rocky lands described above and are dominated by the *Ericaceae* (heath family) of low shrubs such as Bearberry, Arctic White Heather, Dwarf Labrador Tea, and Crowberry.

The top five most prominent ELC types (i.e., Water, Lichen/Rock Complex, Heath Upland, Heath Tundra, and Boulder/Gravel) comprise 85.59% of the RSA and 87.35% of the LSA. Conversely the remaining ten ELC units account for only 14.41% of the RSA and 12.64% of the LSA. Furthermore, these less common land classes do not occur in broad geographic areas, but rather are associated with specialized conditions. Lichen Tundra, accounting just under 5% of the study areas, occurs in transitional terrain between lands dominated by rock and lands dominated by heath elements. As implied by its title, Lichen Tundra forms diverse lichen communities often with an abundance of *Flavocetraria* spp., *Cladonia* spp., and *Bryoria* spp. Graminoid Tundra (2.08% of RSA and 1.66% of the LSA) forms in areas with greater moisture (imperfect drainage), such as along lakeshores, and is dominated by cottongrasses (*Eriophorum* sp) and sedges (*Carex* sp). In areas of even poorer drainage, Graminoid Tundra transitions to Wet Graminoid (0.5% of RSA and 0.4% of LSA). Wet Graminoid is dominated by sedges, which are often in standing water in riverine and lacustrine areas.

Three transitional land classes (i.e., Shrub/Heath Tundra, Graminoid/Shrub Tundra, and Heath Upland/Rock Complex) were found scattered throughout the study areas. These land classes represent intermediate conditions between more commonly occurring land types (e.g., Graminoid/Shrub Tundra has intermediate drainage and vegetation cover conditions between Graminoid Tundra and Shrub Tundra; described in detail in Section 3.4.1). These three classes combined form less than 5% of the study areas and are found in conjunction with their associated land types. Shrub Tundra (0.98% of RSA and 0.74% of LSA) is quite rare in the study areas; however, small notable concentrations are present at approximately 7.7 km, 39.1 km, and 58.8 km (northerly) along the proposed road alignment. This land class is dominated by the low-lying deciduous Dwarf Birch.

Sand is described in detail in the preceding section (Section 3.4.1) and occurs on just less than half of one percent of the study areas. The Sand class is associated with lacustrine areas as well as esker slopes. Furthermore, field surveys indicated that Sand was unreliably identified by the Landsat source imagery. Cloud/Shadow is present randomly in areas where cloud cover obscured the Landsat imagery sourced to create this mapping (i.e., 1.36% of RSA and 0% of LSA). Disturbance, accounting for just 0.17% of the RSA (0% of the LSA) represents anthropogenic disturbances to the landscape and, in this context, applies only to the Meadowbank mine and road.

3.4.3. FIELD VARIATION OF ELC UNITS SURVEYED

During the 2014 field surveys, not every plot that was surveyed accurately portrayed the ELC community to which it was assigned via the Landsat imagery analysis. The accuracy of the Ecological Land Classification model was tested using Cohen's Kappa (Cohen 1960).

Table 4. Confusion Matrix to Test Accuracy of ELC Community Model

Row Labels	Boulder/Gravel	Graminoid Tundra	Graminoid/Shrub Tundra	Heath Tundra	Heath Upland	Heath Upland/Rock Complex	Lichen Tundra	Lichen/Rock Complex	Sand	Shrub Tundra	Shrub/Heath Tundra	Wet Graminoid	Grand Total	Row Probability	Correctly Assigned	Incorrectly Assigned	Assignment Accuracy
Boulder/Gravel	3												3	0.058	3	0	1
Graminoid Tundra		2											2	0.038	2	0	1
Graminoid / Shrub Tundra			3										3	0.058	3	0	1
Heath Tundra				4			1						5	0.096	4	1	0.8
Heath Upland				1	4		1						6	0.115	4	2	0.67
Heath Upland / Rock Complex						3							3	0.058	3	0	1
Lichen Tundra							2						2	0.038	2	0	1
Lichen/Rock Complex							1	5					6	0.115	5	1	0.83
Sand			1	1	1		1						4	0.077	0	4	0
Shrub Tundra										7			7	0.135	7	0	1
Shrub/Heath Tundra		2							1		3		6	0.115	3	3	0.5
Wet Graminoid												5	5	0.096	5	0	1
Grand Total	3	4	4	6	3	3	6	5	1	7	3	5	52				
Column Probability	0.058	0.077	0.077	0.115	0.058	0.058	0.115	0.096	0.019	0.135	0.058	0.096					

Cohen's Kappa is a measure of prediction accuracy, corrected for chance agreement. The statistic varies from -1 to +1, where values of less than 0 indicate a predictive model that is no better than chance, and +1 indicates perfect agreement (Allouche et al., 2006); Kappa values of 0.7 or more are typically indicative of models with a high degree prediction accuracy (Landis and Koch, 1977). The predicted and observed ELC types for 52 sample locations were organized into a confusion matrix. The confusion matrix provides a summary of locations that were correctly predicted (i.e., the diagonals of the matrix), versus those that were incorrectly predicted (i.e., off-diagonals). Cohen's Kappa is calculated from the confusion matrix using the accuracy measure and the chance agreement measure, where:

$$kappa = \frac{accuracy - chance\ agreement}{1 - chance\ agreement}$$

Overall, the results suggest the ELC model has a high degree of prediction accuracy (kappa = 0.70). The metric however, is on what is typically considered the threshold for a model that is moderately versus highly predictive. In part, this results from some inaccuracies in the ELC model for specific ELC types. For example Sand ELC types had the worst prediction accuracy (none were correctly identified). Similarly Heath Upland and Shrub/Heath Tundra had low prediction accuracies (67 and 50%, respectively). The remaining ELC types had relatively high prediction accuracies (all above 80%).

3.4.4. PLANT SPECIES

The 2014 vegetation surveys identified 76 vascular plants in the project area, of which 60 were identified to species level and 16 were identified to genus level due to the condition and/or maturity of collected samples (see Appendix 1 for the full list of identified vascular plants). In addition, 33 non-vascular plants, primarily lichens, were identified during the same surveys (Appendix 2), 11 of which were identified to genus level only. Some vascular and non-vascular plants collected during the 2014 surveys remain unidentified.

An additional 138 vascular plant species (Appendix 3) have the potential to occur near the proposed mine development based on their inclusion in the following resources:

- **Argus, G.W., Pryer, K.M. 1990.** Rare Vascular Plants in Canada Our Natural Heritage;
- **Brouillet, L. et al. 2014**. VASCAN, the Database of Vascular Plants of Canada;
- **Cody, W.J., Scotter, G.W., Zoltai, S.C. 1989.** Vascular Plant Flora of the Wager Bay Region, District of Keewatin, Northwest Territories;
- **Cumberland Resources Ltd. 2005.** Meadowbank Gold Project Baseline Terrestrial Ecosystem Report; and
- **Larsen, J.A., 1972.** The Vegetation of Northern Keewatin. Canadian Field-Naturalist 86:45-72

Full citations for these publications are available in Section 7, References.

3.4.4.1. RARE PLANTS AND COMMUNITIES

3.4.4.1.1 *RARE PLANTS*

Plant species rarity is usually established at the federal, provincial/territorial, and local level by government agencies and/or interest groups. Due to the scarcity of available data in comparison to more southern and/or more populated regions, no territorial status lists for plant species have yet been developed. Publications available to determine what constitutes a 'rare' plant in Nunavut include:

- **Argus, G.W., Pryer, K.M. 1990.** Rare Vascular Plants in Canada; Our Natural Heritage;
- **Canadian Endangered Species Conservation Council (CESCC). 2011.** Wild Species 2010: The General Status of Species in Canada;
- **Cody, W.J. 1979.** Vascular Plants of Restricted Range in the Continental Northwest Territories, Canada; and
- **McJannet, C.L., G.W. Argus, S. Edlund, and J. Cayouette. 1993.** Rare Vascular Plants in the Canadian Arctic.

Full citations for these publications are available in Section 7, References. In addition, the Meadowbank Baseline Terrestrial Ecosystem Report (2005) and subsequent annual monitoring studies contain information on rare plants that has been used to inform this report. A full list of the rare or limited range species identified in these reports can be found in Appendix 4.

A list of species with restricted range or probable rarity was generated through comparison of the plants listed in Appendix 3, with the available publications that determine what constitutes a 'rare' plant in the Kivalliq region. The following 13 species have the potential to occur and may be considered rare in the study area:

Table 5. Plants with Restricted Range or Probable Rarity Likely to Occur in Amaruq Study Area

Botanic Name	Common Name
Antennaria alpina	Dwarf Pussytoes
Caltha palustris var. *arctica*	Marsh Marigold
Carex bicolor	Two-colour Sedge
Carex norvegica	Norway Sedge
Oxytropis bellii	Bell's Crazyweed
Phippsia algida	Icegrass
Phyllodoce coerula	Mountain Heather
Potentilla rubricaulis	Rocky Mountain Cinquefoil
Potentilla vahliana	Vahl's Cinquefoil
Sagina caespitosa	Cushion Pearlwort
Salix glauca	Greyleaf Willow
Salix glauca var. *cordifolia*	Beautiful Willow
Stellaria longipes ssp. *longipes*	Long-stalked Starwort

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has identified one species of vascular plant, Felt-leaf Willow (*Salix silicicola*) as occurring in Nunavut. This species has a rank of 'Special Concern' as of its last examination date in May 2000 (COSEWIC 2014). Felt-Leaf Willow was not recorded in any of the plant lists consulted to create Appendix 3 and thus is unlikely to occur in the vicinity of the Amaruq exploration road.

Of the species listed in Table 5, one was found during the 2014 field studies:

- Beautiful Willow (*Salix glauca* var. *cordifolia).*

This species was relatively uncommon in the 2014 field study, having been collected in two plots. In addition, Bell's Crazyweed, Greyleaf Willow, Dwarf Pussytoes, and Mountain Heather were all found during the Meadowbank field studies and thus have a higher probability of occurring in the Amaruq study area than the remaining species. The time of year in which the field work was conducted may have been a limiting factor in the observation of herbaceous plants as many non-woody plants may have already entered dormancy.

According to Wild Species 2010, the ranking of most potential 'rare' plant species is Secure, which means that the species is not of conservation concern. Bell's Crazyweed and Beautiful Willow were not assessed.

3.4.4.1.2 *RARE PLANT COMMUNITIES*

No resources have been developed to define the rare plant communities in Nunavut or the Kivalliq region; however, the GN's Map Atlas provides a summary of the percentage of ELC classes in the Wager Bay Plateau, the ecoregion in which the study site occurs. This summary is useful in understanding the more common ELC community types in the site's immediate landscape.

Table 6 compares the percentage of ELC communities found in the LSA and RSA to those in the Wager Bay Plateau as a whole (GN 2012).

Table 6. ELC Community Coverage Comparison

ELC Unit	% of RSA	% of LSA	% of ELC Classes in Wager Bay Plateau
Lichen/Rock Complex	23.04%	27.19%	15%
Heath Upland	16.10%	19.86%	9%
Heath Tundra	11.73%	12.05%	4%
Boulder/Gravel	9.13%	6.67%	13%
Lichen Tundra	4.21%	4.61%	2%
Graminoid Tundra	2.08%	1.66%	3%
Shrub/Heath Tundra	1.70%	1.82%	No data
Graminoid/Shrub Tundra	1.51%	1.61%	1%
Heath Upland/Rock Complex	1.46%	1.33%	14%

ELC Unit	% of RSA	% of LSA	% of ELC Classes in Wager Bay Plateau
Cloud/Shadow	1.36%	0.00%	4%
Shrub Tundra	0.98%	0.74%	<2%*
Wet Graminoid	0.50%	0.40%	2%
Sand	0.44%	0.47%	<2%*
Disturbance	0.17%	0.00%	<2%*
Water	25.59%	21.58%	24%
Rock	0%	0%	4%
Graminoid/Heath Tundra	0%	0%	4%
Dryas Tundra	0%	0%	1%
	100.00%	**100.00%**	**100.00%**

* 2% of region was classified as "Shrub/No Data/Sand/Shrub Tundra/Ice/Disturbance/Shrub Thicket"

Table 6 clearly shows that the proportion of ELC vegetation communities in the study area is similar to those in the Wager Bay Plateau.

The five least common species in the Wager Bay Plateau are:

- **Wet Graminoid** (2%);
- Lichen Tundra (2%);
- Dryas Tundra (1%);
- **Shrub Tundra** (<2%, lumped with Shrub, No Data, Sand, Ice, Disturbance, & Shrub Thicket); and
- **Sand** (<2%, lumped with Shrub, No Data, Shrub Tundra, Ice, Disturbance, & Shrub Thicket).

The five least common species in the LSA and RSA are:

- Shrub/Heath Tundra (1.70%, 1.82%);
- Heath Upland/Rock Complex (1.46%, 1.33%);
- **Shrub Tundra** (0.98%, 0.72%);
- **Wet Graminoid** (0.50%, 0.40%); and
- **Sand** (0.44%, 0.47%).

Communities that are uncommon in both study areas and the Wager Bay plateau are shown above in **bold.** Interestingly, one of the remaining uncommon communities in the LSA and RSA, Heath Upland/Rock Complex, is relatively common in the Wager Bay plateau, comprising 14% of the overall landscape. There are no data for the Shrub/Heath Tundra community in Wager Bay plateau; therefore, it may be encapsulated within the <2% assigned to 'Shrub/No Data/Sand/Shrub Tundra/Ice/Disturbance/Shrub Thicket'.

The following communities may, thus, be considered the most uncommon plant communities in the LSA and RSA:

- Shrub/Heath Tundra;
- Shrub Tundra;
- Wet Graminoid; and
- Sand.

However, the results of the confusion matrix presented in Table 4, Section 3.4.3 may influence these results. For Sand, Heath Upland, and Shrub/Heath Tundra, the model prediction accuracy was low (i.e., in the ground-truthing exercise, locations mapped as these communities were found to be a different community type). Conversely, for Graminoid Tundra and Lichen Tundra, other communities misinterpreted in the mapping were often found to be these communities during the field exercise.Therefore the proportion of Sand, Heath Upland, and Shrub/Heath Tundra may be overestimated in the ELC mapping for the RSA and LSA, while the proportion of Graminoid Tundra and Lichen Tundra may be underestimated.

4. WILDLIFE

4.1. INTRODUCTION

Wildlife have high ecological and cultural value in the Kivalliq region of Nunavut. Compared to more southern locales, few terrestrial vertebrates are found in the vicinity of the Amaruq LSA and RSA. The literature for this area estimates that approximately 15 mammalian species, 62 avian species, and no amphibians or reptiles are expected (Cumberland, 2005).

The wildlife data presented in this report includes data collected in 2014 and analysis of existing data from previous years (in the case of the Hunter Harvest Survey and Caribou findings). This section describes the methods used for the 2014 field surveys and the findings of this work. The wildlife data section fulfils the following requirements for this project:

1. Establish baseline presence/absence of species in the LSA and RSA based on site observations and available background information;
2. Determine predicted Caribou presence in and movement across the RSA according to collaring data;
3. Establish wildlife suitability within the RSA based on literature review investigation of preferred habitat of each of the following wildlife types:
    - Ungulates (Caribou and Muskox);
    - Predatory Mammals;
    - Small Mammals;
    - Raptors (raptors in general and Short-eared Owl;
    - Upland Breeding Birds;
    - Waterfowl; and
    - Shorebirds.

Extensive wildlife studies were carried out for the 2005 Meadowbank Baseline Terrestrial Ecosystem Report and have continued on an annual basis as a requirement of the Terrestrial Ecosystem Management Plan (TEMP). Where appropriate, this information was used to supplement the data collected during the 2014 Amaruq field studies.

4.2. METHODS

4.2.1. LITERATURE REVIEW

A variety of scientific data sources were used to characterize baseline conditions in in the Amaruq study area, including:

- **Studies Related to the Meadowbank Gold Project** — the AEM Meadowbank Gold Project provided extensive regional data. Terrestrial wildlife baseline studies were completed at Meadowbank from 1999 to 2005 (AEM 2005) and long-term monitoring studies have been conducted from 2006 to 2014 (refer to annual reports for 2006 to 2013).

- **Other Regional Studies** — regional studies included work conducted in the late 1970s on harvests and critical wildlife areas (ISL 1978*a, b*), and more recently from the Nunavut Wildlife Harvest Study (NWMB 2005). Other GN regional data included regional ecological land classification (ELC) data (provided under a data-sharing agreement with AEM), Caribou collaring data, and the Caribou atlas (Campbell et al. 2012). Any literature relevant to regional wildlife conditions is referenced in VEC-specific sections in this report.

- **Territorial and Federal Sources** — Information from territorial and federal government agencies was used to provide a regulatory context whenever necessary. In particular, databases from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014, internet site) and the *Species at Risk Act* (*SARA* 2014, internet site) were accessed regarding the status of federally-listed species in the RSA. Territorial status ranks for wildlife species are referenced to provide a more regional frame of reference on priority species (CESCC 2011, internet site).

- **Books and journal articles** – literature used to compile the Species Data Summary and to inform the wildlife habitat suitability ranking. Sources used include:

    - **Cluff, H.D. et al. 2002.** Movements and Habitat Use of Wolves Denning in the Central Arctic Northwest Territories and Nunavut, Canada.
    - **Court, G.S. et al. 1988.** Natural History of the Peregrine Falcon in the Keewatin District of the Northwest Territories.
    - **May, R.L. et al. 2012.** Habitat Characteristics Associated with Wolverine Den Sites in Norwegian Multiple-use Landscapes.
    - **McLoughlin, P.D et al. 2002.** Denning Ecology of Barren-ground Grizzly Bears in the Central Arctic.
    - **McLoughlin, P.D. et al. 2004.** Hierarchical Habitat Selection by Tundra Wolves.
    - **Mueller, F.P. 1995.** Tundra Esker Systems and Denning by Grizzly Bears, Wolves Foxes and Ground Squirrels in the Central Arctic, Northwest Territories.
    - **NWT Species at Risk. 2014.**
    - **Schaefer, J.A., F. Messier. 1995.** Habitat Selection as a Hierarchy: The Spatial Scales of Winter Foraging by Muskoxen.
    - **Williston, P. et al. 2004.** Eskers and Outwash Plains: Skeins of Connectivity in the Liard Basin

Full citations for these publications are available in Section 7, References.

4.2.2. FIELD SURVEYS

4.2.2.1. FALL 2014 FIELD WORK

The August 28th to September 3rd, 2014 field surveys along the preferred option for the proposed exploration road alignment to the Amaruq were focused on collecting vegetation data; however, all wildlife observations and signs were recorded, including individual wildlife, scat, nests, bones, and Caribou trails. All observations were recorded in field staff notebooks and point data were taken for each observation, excluding scat, using a high-accuracy Trimble GeoExplorer 6000 Series GeoXH GPS. Scat was generally excluded from point data collection due to its high presence across the landscape.

Particular attention was paid to collecting wildlife data on the eskers, as background research has shown that eskers are a preferred location for mammal denning and potentially suitable for raptor nesting. In order to identify potential locations for raptor nests, each day to and from the vegetation plot surveys, the helicopter was flown low along the eskers, and these features were scanned with binoculars to look for birds, 'white-wash' (feces), and cliff features. Any raptors or suitable nesting locations were recorded by GPS. Where vegetation plot surveys coincided with one of the eskers, field staff scanned the eskers for nests and suitable nesting locations.

In addition to the field observations collected at the end of August and early September, a helicopter reconnaissance was conducted by a qualified biologist on 18 October 2014 to evaluate large mammal occurrences along the proposed exploration road alignment. Conditions were cool (-5^{0}C), windy, and overcast, with light snow flurries toward the end of the survey. All significant habitat features, potential den sites, and wildlife observations were recorded along with their UTM coordinates. A brief ground reconnaissance of a cliff-dominated area with high suitability for peregrine falcon nesting habitat was also conducted.

4.2.2.2. HUNTER HARVEST SURVEY

As a condition of the Nunavut Impact Review Board (NIRB) certificate for the Meadowbank Gold Project, in March 2007 a harvest study was initiated by AEM in association with the Baker Lake Hunters and Trappers Organization (HTO) to monitor and document the spatial distribution, seasonal patterns, and harvest rates of hunter kills and angler catches before and after construction of the Meadowbank All-Weather Access Road (AWAR). The study is similar to the Nunavut Wildlife Harvest Study (NWMB 2005) and the Inuvialuit Harvest Study conducted between 1988 and 1997 (The Joint Secretariat 2003); however, it is limited to one community (Baker Lake) and focuses on four Meadowbank Mine VEC species (Muskox, Caribou, Wolverine and fish) relevant to Inuit and northern culture.

The primary objectives of the Meadowbank Harvest Study are to:

1. Gather information on Caribou, Muskox, and Wolverine harvest (i.e., animals retrieved) rates and Inuit-use patterns in the Baker Lake area;
2. Support creel surveys by gathering information on Arctic Char (*Salvelinus alpinus*), Lake Trout (*Salvelinus namaycush*), Lake Whitefish (*Coregonus clupeaformis*) and Arctic Grayling (*Thymallus arcticus*) catch rates and Inuit-use patterns in the Baker Lake area;
3. Understand regional distribution of hunting and fishing activity;
4. Investigate seasonal timing of hunting and fishing activity;
5. Determine whether increased harvest and catch rates are associated with the Baker Lake to Meadowbank mine AWAR;
6. Assess overall impacts of project-related facilities on Caribou, Muskox, Wolverine, and fish populations; and
7. Help make informed decisions regarding fish and wildlife management in the Baker Lake area to verify that the key species are adequately protected.

The HHS is promoted within the community, and participation is encouraged through the use of raffles and prizes. Hunter harvest data are collected using a harvest calendar, which is handed out at the beginning of the year. Participating households use the harvest calendar to record harvest details for each hunting date, including number and type of animals, sex and age, and harvest location based on a reference map. Hunter interviews are typically conducted four times each year by the hunter administrator to ensure completeness of harvest data, and maintain a personal and respectful relationship with the hunters. The harvest study administrator also conducts radio addresses, and posts promotional material around the Hamlet of Baker Lake during the quarterly visits. Participation has continued to increase steadily since 2007 and the dataset is becoming increasingly robust with increasing participation.

4.2.2.3. WILDLIFE LOG SHEET

A log sheet for recording wildlife observations was posted at the Amaruq exploration camp. Workers who saw wildlife while on site were encouraged to log their observations. The log sheet included the following information:

- Date;
- Time (night/day),
- Species;
- Number of individuals;
- Place;
- Behavior;
- Observer name; and
- Action taken.

4.2.2.4. CARIBOU COLLARING DATA

Agnico Eagle Mines has a long-term Memorandum of Understanding for the Caribou Monitoring and Management studies led by the GN DoE and includes the GN DoE-led Caribou satellite-collaring program. Collaring data to support the evaluation of impact predictions is collected on an annual basis within the Meadowbank RSA. The joint satellite-collaring program was developed to provide information on the distribution of Caribou occurring within the Meadowbank RSA and contribute data to other ongoing satellite-collaring programs for the Beverly, Qamanirjuaq, and other herds to assist the GN in caribou management. The satellite-collaring program has become increasingly important as a monitoring and management tool in recent years. The satellite-collaring program, along with GN DoE regional data, is also serving to provide a regional perspective on Caribou activity near Meadowbank operations and natural changes in Caribou populations in the region.

Four deployments, consisting of a total of 58 collars, have been completed in the Baker Lake area since AEM became involved in the collaring program, with the following number of collars successfully deployed: May 2008 (9 collars); November 2009 (21); April 2011 (13); and April 2013 (15). Most collars were deployed west of Baker Lake, south of Aberdeen and Schultz lakes, and north of Baker Lake within the Meadowbank area. Collars deployed for this program in the Baker Lake area have been assigned by the GN to one of the five major sub-populations or herds that reside in the area: Ahiak, Beverly, Lorillard, Qamanirjuaq, and Wager Bay. Collars deployed up to the end of 2012 were included in a population distribution analysis performed for the GN (Nagy et al. 2011). Collar locations from 2010 to 2014 were used to generate figures for this report.

4.2.3. SPECIES DATA SUMMARY – TERRESTRIAL MAMMALS AND BIRDS

Observations of wildlife and wildlife sign were recorded in the field as described above (Section 4.2.2.1) and then displayed in ArcGIS using the best available coordinate locations for each observation (Figure 5). Overall species lists for the study areas encompass all of the aforementioned direct and sign observations from the 2014 field program in conjunction with incidental observations from AEM staff (Section 4.3.2.3). Using COSEWIC and Wild Species data and the Meadowbank Baseline and Impact Assessment reports (AEM, 2005a and 2005b), wildlife sensitivity and Species-at-Risk statuses have been assigned where applicable. The wildlife list from the 2014 field program is displayed in Appendix 6.

4.2.4. WILDLIFE HABITAT SUITABILITY

Wildlife habitat suitability rankings identify the importance of habitat types to wildlife. Habitat use is based primarily on the availability of food, which is considered the most limiting factor for wildlife in the study area. Other variables which have been incorporated into habitat suitability evaluation include preferred nesting/denning habitat, staging areas, and known movement corridors. To rank habitat suitability, ELC units were first developed to quantify the availability of various habitat types within the RSA and LSAs (see Section 3.4.2 and Figure 3), followed by the ranking of these habitat types for different terrestrial wildlife.

The ELC units were ranked according to their seasonal suitability for each wildlife species or group (i.e., High, Moderate, Low, and Nil) (see Table 7 for definitions). This approach, adapted from British Columbia standards (RIC 1999), is also used by the GN DoE to assess habitat value or suitability for a species over a large regional area without ground-truthing the entire area. The approach is scientifically defensible, efficient, and compatible with regional programs. Habitat suitability rankings for each VEC were developed based largely on relevant literature on VEC habitat use and requirements, field data, professional experience and judgment, and discussions with wildlife biologists with experience in the Arctic.

Table 7. Wildlife Habitat Suitability Rating Scheme

Forage Habitat Quality Relative to "Best in Territory" (%)[a]	4-class – Intermediate Knowledge of Habitat Use	
	Rating	Code
100–76%	Moderately High to High	H
26–75%	Moderate	M
1–25%	Low	L
0%	Nil	Nil

Source: RIC 1999

(a) 'Best in Territory' is the territorial benchmark habitat for a species against which all other habitats for that species are rated.

4.2.4.1. CARIBOU HABITAT SUITABILITY

Due to their high cultural importance, development of the caribou habitat suitability rankings is presented in more detail than the other VECs.

4.2.4.1.1 *OVERVIEW*

Caribou use of habitat is dynamic with suitable habitat not always used even if available, which makes delineating habitats in a specific area difficult. The reasons for suitable habitat remaining unused could be cyclical habitat use by a herd, abundance of other higher quality habitat, or random patterns of suitable quality habitat. Lack of use of suitable habitat during one year does not necessarily mean the habitat will remain unused in subsequent years.

Given the uncertainty and unpredictability of habitat use by Caribou, literature was reviewed to determine habitat and food preferred by Caribou. This information was used to rate the suitability of different ELC habitat units available to Barren-ground Caribou in the RSA, and to identify and quantify the habitat that might be important to Caribou during important seasons of their annual life cycle.

Although the annual life cycle of Barren-ground Caribou has been described according to six seasons (see Table 8) for the purposes of this baseline, habitat use during spring and summer (i.e., growing season) and fall and winter (i.e., winter season) was described since most of habitat selection modeling approximately follows these seasons and habitats are seasonally important for Caribou (i.e., important winter habitat is not necessarily important growing season habitat). A detailed discussion of habitat selection during these primary seasons is provided below.

4.2.4.1.2 *FALL AND WINTER (WINTER SEASON)*

September to December is the period of the year when barren-ground Caribou start their migration south and shift to a predominantly lichen-based diet (Boertje 1984). Winter is the time of the year when populations of Caribou are most limited by habitat and may be subject to density-dependent forage availability (Tyler et al. 2008). The two factors that most affect habitat selection by Caribou during winter are snow condition and lichen availability. Snow depth and hardness are the limiting climatic conditions during winter making food acquisition more energetically costly because Caribou spend an increasing amount of their energy cratering for food and moving through deep snow (Adamczewski et al. 1988; Tucker et al. 1990; Turney and Heard 1991).

Lichen, which is the most important source of winter food for Caribou because it is relatively high in energy and highly digestible compared to other sources of food (Storeheier et al. 2002), comprises a large portion (greater than half) of a Caribou's winter food intake (Thompson and McCourt 1981; Boertje 1984; Storeheier et al. 2002). The most heavily used winter vegetation communities in order of preference are lichen steppes, lichen heath tundra, dwarf shrub-lichen tundra, and dwarf shrub-sedge tundra (Thompson et al. 1978).

4.2.4.1.3 *SPRING AND SUMMER (GROWING SEASON)*

During the spring, energy requirements of female Caribou increase because of late-gestation and the start of lactation (Adamczewski et al. 1993). Female barren-ground Caribou are more sensitive to disturbances during this period (Reimers and Colman 2006). Barren-ground Caribou migrate north from winter range in April and May and congregate in relatively small discrete areas to calve. Calving is a critical time of the year for Caribou because calving cows require high quality food for production of milk. The timing of calving has evolved to coincide with the start of the growing season because newer growth provides the higher quality nourishment that calving and post-calving Caribou need to recover from the winter and feed their new calves (Post and Forchhammer 2008; Sharma et al. 2009).

Caribou select for habitats that have an earlier start of the growing season (Sharma et al. 2009). Habitats that contain open shrub, grasslands with sparse shrubs, and lichen veneer are preferred, while riparian shrub areas and treed habitat are avoided (Johnson et al. 2005; Sharma et al. 2009). Food is abundant during the summer season, so Caribou can feed on high quality vegetation and restore fat reserves required to survive the coming winter (Ouellet et al. 1997). Females in particular need to gain enough weight during the summer to be able to reproduce. In summer through to late fall Caribou feed on shrubs, grasses, lichens and mushrooms (Boertje 1984).

4.2.4.1.4 *CARIBOU HABITAT SUITABILITY APPROACH*

The RSA was divided into ELC units that are recognizably different in vegetation content and geographic features (see Section 3.4.1 and Figure 3). As discussed above, Caribou generally feed on lichen during winters, and fresh shrubs (leaves and stems) and graminoids during the growing season (Adamczewski et al. 1988); therefore, habitat that contains these features will be of higher value to Caribou in the appropriate season.

The relative importance of each ELC unit for Caribou in the growing and winter seasons was rated as High, Moderate, or Low based on the ELC unit's maximum importance during the season in question (see Table 8). For example, Lichen Tundra is particularly important in late winter, but the value of this habitat unit was rated as High for the entire winter season, and Graminoid Tundra is important early in the growing season when vegetation quality is greatest, but is rated as High for the entire growing season.

The habitat suitability rankings for this project for each ELC unit are presented in Table 8. Rankings are provided for the growing season (defined as June 1 to September 30), and for the winter season (defined as October 1 to May 31). These rankings were then used to develop habitat suitability maps and to estimate the areas of study areas important to Caribou in the winter and growing season (see Section 4.4, Discussion).

Table 8. Summary of Relative Value of Ecological Land Classification Units to Caribou during the Growing and Winter Periods in the Amaruq Regional Study Area

ELC Unit	Growing	Winter	Reasoning
Water	Nil	L	Water is not important Caribou habitat. Shorelines may provide some insect relief, but other habitats associated with elevation provide better relief.
Sand	M	L	Caribou select for Sand and Gravel to avoid insect harassment in the growing season (BQCMB 1999a, internet site). The value of Sand and Gravel in winter is low because the habitat contains limited food and there are no insects in winter.
Boulder/Gravel	M	L	Caribou select for Sand and Gravel to avoid insect harassment in the growing season (BQCMB 1999a, internet site). The value of Sand and Gravel in winter is low because the habitat contains limited food and there are no insects in winter.
Lichen/Rock Complex	L	L	Lichen/Rock Complex provides little usable habitat for Caribou as there is little available food.
Wet Graminoid	H	M	Wet Graminoid was categorized as high in the growing season because of high quality new growth that is high in energy content, easily digestible, and abundant. Caribou select graminoids in spring and summer; however, Caribou avoid areas containing sedges and peat bogs in fall. Nevertheless, the overall rating for the growing season is high.
Graminoid Tundra	H	M	Graminoid Tundra was categorized as high in summer because of high quality new growth that is high in energy content, easily digestible, and abundant. In winter, the quality of vegetation decreases, therefore, so does habitat value.
Graminoid/ Shrub Tundra	H	M	Graminoid/Shrub Tundra has a similar value to the Graminoid Tundra and Wet Graminoid ELC units because it contains high quality seasonal vegetation, as well as more open shrubs (compared to straight shrub habitat). It may be of higher value than Graminoid Tundra because of the diversity of food types that are selected by Caribou – shrub, lichen and graminoid.
Shrub Tundra	M	L	Shrubs (willows) form a large part of Caribou diet in the growing season and there is evidence that Caribou select riparian areas during post-calving season, but Caribou do not select this habitat type in winter.
Shrub/Heath Tundra	H	M	Shrub/Heath Tundra is considered important during the growing season because it contains willows as well as other sources of food. The value is lower in winter because Caribou focus more on areas where lichen is present.
Heath Tundra	M	H	This habitat type has all the vegetation used by Caribou in the growing season. Due to the presence of lichen the value is higher in the winter.
Heath Upland	M	H	This habitat type has all the vegetation used by Caribou in the growing season. Due to the presence of lichen the value is higher in the winter. Ridge tops my also provide areas of reduced snow depth.
Heath Upland/ Rock Complex	L	M	Relatively low value in the growing season because of the rock content, but is higher in winter because of lichen content.
Lichen Tundra	M	H	Lichen is the most important food source for Caribou in winter. In the growing season, when Caribou select for other food, lichen is still part of their diet and they still spend time in these areas, but not to the same extent.

Growing season is approximately June 1 to September 30 (four months).

Winter season is defined as approximately October 1 to May 31 (eight months).

H = High; M = Moderate; L = Low

See Table 12, Section 4.4.2 for a habitat suitability ranking table which includes all VECs.

4.3. RESULTS

4.3.1. OVERVIEW

A total of 15 mammals and 62 birds are expected to occur in the Amaruq study area based on the literature review conducted and the Meadowbank Baseline Terrestrial Ecosystem Report. Of these, 27 species (10 mammals, 17 birds) were recorded during the 2014 field work (see Appendix 6).

The majority of wildlife observations made during the 2014 field work were of Barren-ground Caribou, Snow Geese, Canada Geese, and Arctic Ground Squirrels, which is consistent with the Meadowbank baseline terrestrial surveys except that Arctic Ground Squirrels were less abundant than Muskoxen and Arctic Hare. During the 2014 field work, 11 Muskoxen, and several Arctic Hares were observed. Previous field studies conducted for the Meadowbank project included extensive wildlife surveys. Where possible, the findings from these surveys have been used to bolster the Amaruq findings, particularly for the discussion section (Section 4.4)

Results from each data source (i.e., the 2014 vegetation plot field work, annual hunter harvest surveys, wildlife log book, and data from collared Caribou) are described below in Sections 4.3.2 to 4.3.3. Section 4.4.1 contains a Wildlife Species Data Summary for the RSA and LSA that links the key characteristics of each ELC community (vegetation, soils, and terrain) with potential wildlife habitat use. Wildlife habitat suitability maps have been created based on this information and suitability rankings previously created for the Meadowbank and Kiggavik projects (Section 4.4.3).

4.3.2. FIELD SURVEYS

4.3.2.1. FALL 2014 FIELD WORK

During 2014 field studies, 27 wildlife species were detected, including 17 birds, 10 mammals and at least one unidentified species of small mammal (vole or lemming). Apart from three wide-roaming and uncommon predatory mammals, all of the species detected within the study areas were observed directly during field studies. While not observed directly during the 2014 field program, Grizzly Bear, Arctic Wolf, and Wolverine were detected within the study areas through sign observed in the field and/or incidental observations by AEM employees working in the vicinity of the Amaruq exploration camp (see section 4.3.2.3).

A total of 78 Caribou were observed during a ground-based reconnaissance of the proposed Amaruq exploration road alignment on September 2 to 3, 2014 (see Table 9 and Figure 5). During a helicopter reconnaissance on October 18, 2014, a mixed sex herd of approximately 50 animals was observed near the south end of the alignment (see Figure 5).

Table 9. Caribou Observed during the 02 to 03 September 2014 Ground Survey of the Proposed Amaruq Exploration Road.

Date (September)	Number and Sex of Caribou	Habitat Type	Behavior
02	5	Rocky ridge	Foraging and standing
02	3	Rocky heath tundra	Foraging and walking
02	1 bull	Rocky heath tundra	Foraging and walking
03	10	Heath tundra	Foraging and walking
03	12	Rocky heath tundra	Foraging, walking, and resting
03	25	On hillside	Resting, foraging, and walking
03	4	Rocky heath tundra	Standing, foraging, and walking
03	13	Rocky heath tundra	Foraging and walking
03	1 cow	Rocky heath tundra	Standing and looking
03	3	On ridge	Foraging and walking
03	1 bull	On ridge	Standing and foraging
TOTAL	**78**		

Several Caribou trails were observed during the 18 October 2014 helicopter reconnaissance. The highest number of trails was observed near the south end of the alignment between Third Portage and Pipedream lakes (see Figure 5).

4.3.2.2. HUNTER HARVEST SURVEY

Although the hunter harvest study area only extends into the southern half of the Amaruq RSA, harvest study data to date indicate a very low harvest north of Tehek Lake (see Figure 6). The primary reasons for these low harvesting rates are limited access and the long distance from the Hamlet of Baker Lake. The higher hunting pressure in the southwestern portion of the RSA is related to the ease of access for hunters along the Meadowbank AWAR (see Figure 6). The low hunting pressure north of the Meadowbank Gold Mine and in the vicinity of the Amaruq project area is also reflected in the Nunavut Wildlife Management Board harvest study (NWMB 2005) (see Figure 7).

4.3.2.3. WILDLIFE LOG BOOK

Agnico Eagle Mines provides a *Wildlife Log Book* that employees can use to track their wildlife observations. The information from this log book was provided to the study team for the Amaruq exploration camp and included wildlife records between May 13th and September 21st, 2014.

Data from this log illustrates Caribou movement through the Amaruq exploration camp and vicinity. Groups of Caribou were first noted on August 23rd (20 individuals), which increased on the 24th (70 individuals) and then peaked for nine days between August 25th and September 2nd at 100 individual Caribou per day. On September 3rd, Caribou were noted to decrease to 50 individuals, 30 the following day, and then 10 for the two days following that (September 5th and 6th, 2014). Evidence of geese migration is also present with the first flocks observed on August 21st, and increasing to a maximum of about 500/day passing by the Amaruq exploration areas on September 5th to 7th, 2014.

The Wildlife Log Book also offered two incidental observations of species, which were not observed directly during the 2014 field. Wolverine (Special Concern – COSEWIC) was observed at 3am on May 13, 2014 in the vicinity of the Amaruq exploration areas. Also, a lone Arctic Wolf was observed near the Amaruq exploration areas on September 6th, 2014 and a pack of 10 Arctic Wolves was observed near the Amaruq exploration areas on September 14th, 2014 (this observation specifically indicated that these Wolves were observed close to the esker).

Other observations from the Wildlife Log Book include sporadic lone Caribou observations throughout July, Arctic Foxes, Arctic Hares, and Arctic Ground Squirrels. As specific GPS locations were not provided for the observations in this log book, mapping of all log book observations have been assigned to a single point near the northerly end of the proposed road alignment (Figure 5) and the Wildlife Log Book records have been provided in Appendix 7.

4.3.3. CARIBOU COLLARING DATA

4.3.3.1.1 *CARIBOU HERD SEASONS*

Barren-ground Caribou herds exhibit an annual nomadic life cycle over ranges that cover thousands of square kilometers. They are found in different areas of their annual range at different times of the year based on an annual life cycle with seven generally recognized 'seasons'. Those seasons are based on distinct movements and, for the purposes of this baseline report, include spring migration, calving, post-calving aggregation, summer dispersal, rut and fall migration, and early and late winter (Table 10).

Table 10: Mainland Barren-ground Caribou 'Seasons'

Activity	Dates	Notes
Spring migration	April 1 to May 25	Males migrate to traditional calving grounds about one month (April to June) after females and yearlings. Route depends on winter distribution.
Calving	May 26 to June 25	Most calves are born June 5 to 15. Condition of cows affects timing. The same region is used annually, but specific place varies.
Post-calving aggregation	June 26 to July 31	By early July, most cows and calves have left calving grounds. Animals gather in large groups to reduce insect harassment.
Summer dispersal	August 1 to September 15	By end of July, Caribou begin moving south. Groups break up when insect harassment decreases and scatter to avoid harassment from warble and nose botflies. Begin to regroup in late August and September.
Rut and fall migration	September 16 to November 7	Southward movement influenced by snowfall and ice formation. Rut occurs in late October. Following the rut, adult males separate from other Caribou and aggregate into separate groups.
Early and late winter	November 8 to March 31	Animals generally move away from areas with deep snow. Tundra-wintering Caribou seek range where snow is relatively shallow, such as ridge tops.

4.3.3.1.2 *SEASONAL OCCURRENCE IN THE REGIONAL STUDY AREA*

Collared Ahiak and Lorillard caribou were the most frequently recorded herds in the RSA. Ahiak collared animals were most consistently observed across seasons, whereas Lorillard animals were most common during spring migration and in winter. Wager Bay animals were also present, but primarily during the spring and in winter. Only single animals from the Qamanirjuaq and Beverly herds have been recorded in the Amaruq RSA; therefore, percentage of locations is nil or very low in all seasons.

Table 11: Use of RSA by Collared Individuals during Various Portions of the Caribou Life Cycle

Caribou Seasons	% of Satellite Transmission Locations in the RSA Based on Total Number of Collared Individuals				
	Beverly [(a)]	Ahiak[(b)]	Wager Bay [(c)]	Lorillard [(d)]	Qamanir-juaq[(e)]
Spring (April 1 to May 25)	0.0%	2.0%	1.6%	5.5%	0.0%
Calving (May 26 to June 25)	0.0%	0.3%	0.0%	0.4%	0.0%
Post-calving (June 26 to July 31)	0.0%	0.5%	0.0%	0.0%	0.0%
Late Summer (August 1 to September 15)	0.2%	2.0%	0.0%	0.0%	0.0%
Fall and Rut (September 16 to November 7)	0.0%	1.7%	0.0%	0.0%	0.0%
Early and Late Winter (November 1 to March 31)	0.0%	0.3%	0.4%	1.4%	0.0%

Source: GNWT ENR, GNDoE, and AEM collars

[(a)] n = 34; [(b)] n = 29; [(c)] n = 2; [(d)] n = 13; [(e)] n = 73

The movements of collared caribou (i.e., Baker Lake collared animals since 2010) for each season are presented in Figures 8.2 to 8.7. Summary descriptions of collared caribou movements are provided below. For the purposes of this discussion, collar locations are considered generally representative of herd movements.

Spring Migration (April 1 to May 25)

Some Ahiak and Wager Bay collared animals moved through the Amaruq RSA on their way to calving grounds to the northeast (see Figure 8.2). Most Lorillard collared animals moved through the RSA in a general eastward direction from north of the Thelon River to an area between Chesterfield Inlet and Wager Bay (i.e., calving area). One Qamanirjuaq Caribou, collared south of Aberdeen Lake in April 2013, moved north through the RSA, then east, and finally south, crossing Chesterfield Inlet toward the Qamanirjuaq calving grounds. Beverly collared Caribou were not close to the RSA during the spring season.

Calving (May 26 to June 25)

Most cows arrive on their calving grounds in the last week of May or early June, and most calves are born from June 5 to 15 (BQCMB 1999, internet site). Two collared Ahiak Caribou and one collared Lorillard Caribou were still within the RSA during the early portion of the calving period; however, these animals moved rapidly to their respective calving grounds by mid-June (see Figure 8.3). The RSA is not in close proximity to any of the documented calving grounds (see Figure 8.1).

Post-Calving (June 26 to July 31)

By early July, most cows and calves have left the calving areas and begin to aggregate in larger groups that include adult males, to reduce harassment from mosquitoes and predation by wolves (BQCMB 1999, internet site). According to Figure 8.4 and existing knowledge on post-calving areas, the Amaruq RSA is not in close proximity to post-calving areas. Beverly collared animals were generally far north and west of the RSA with only one collared animal moving from north to south approximately 25 km west of the western RSA boundary. Qamanirjuaq collared animals spread out in different directions from their calving grounds but none occurred north of the Thelon River. One of the collared Ahiak animals moved into the RSA, but most were well to the north or west. Wager Bay collared animals remained near their calving grounds, and Lorillard Caribou moved north to Wager Bay and south along Chesterfield Inlet (Figure 8.4).

Summer Dispersal (August 1 to September 15)

By the end of July, Beverly and Qamanirjuaq Caribou begin moving toward the tree line, and in August, scatter to avoid harassment from warble and nose botflies. One Beverly animal moved through the RSA, but most were situated well to the west during this period (Figure 8.5). Qamanirjuaq collared animals were spread out during the summer dispersal period but none were north of Baker Lake or the Thelon River. Some Ahiak collared animals moved through the northwestern portion of the RSA, with some crossing the Aberdeen Lake system. Lorillard and Wager Bay remained well west and north, respectively, of the RSA (Figure 8.5).

Rut and Fall Migration (September 16 to November 7)

Movement towards the tree line and/or southern wintering grounds on the barren-grounds occurs between September and November. Mating (the rut) occurs in late October, and usually near the tree line for migratory herds such as the Beverly and Qamanirjuaq. Following the rut, bulls separate from other Caribou and aggregate into separate groups (BQCMB 1999, internet site). During this season, several Ahiak animals were within or moved through the Amaruq RSA (Figure 8.6). No Caribou from any of the other herds were within the RSA although Wager Bay animals were approaching from the north and Lorillard collared animals were approaching from the east. Beverly collared animals were well to the west and southwest, with the exception of one animal on the north shore of Schulz Lake, approximately 25 km from the RSA boundary (Figure 8.6).

Early and Late Winter (November 7 to March 31)

By November, most of the migratory Beverly and Qamanirjuaq Caribou are south of the tree line. Animals may continue to move until snow depth reaches >50 cm around February or March (BQCMB 1999, internet site). Several Beverly collared animals remained on the barren-grounds well west of the RSA where they mixed with some of the Ahiak, Lorillard, and Wager Bay animals (Figure 8.7). Collared Individuals of the Ahiak, Lorillard, and Wager Bay herds were within the RSA during this period, but most were aggregated to the northeast and west (Figure 8.7).

4.3.3.2. IMPORTANT CARIBOU AREAS

4.3.3.2.1 *CALVING AREAS*

No government-designated or other formally identified calving areas are present within or close to the Amaruq RSA, and the RSA is not within Caribou protection areas identified within Territorial Land Use

Regulations (Figure 8.1). Department of Indian Affairs and Northern Development (DIAND) Caribou Protection Measures protect animals on designated calving grounds from May 15 to July 15.

4.3.3.2.2 *POST-CALVING AREAS*

Cows and calves are sensitive to disturbance and vulnerable to predation during a critical three-week period following calving. According to satellite-collaring data (see Figure 8.4), the Amaruq RSA is not important to any of the herds during the post-calving period, which is likely because all known calving grounds are a considerable distance from the RSA.

4.3.3.2.3 *WATER CROSSINGS*

Water crossings play an important role in many periods of the annual cycle for Caribou. During migration, Caribou follow natural geographic features, which cause them to concentrate at traditional water crossings (Williams and Gunn 1982). Activities within 5 km of water crossings designated by the Territorial Land Use Regulations are prohibited by the DIAND Caribou Protection Measures from May 15 to September 1. None of the water crossings identified by the DIAND (1992) are within the Amaruq RSA.

4.3.3.3. MIGRATION PATTERNS

Understanding movement patterns of migratory and tundra-wintering Caribou in and around the RSA is challenging given variability in movements between seasons, herds, and individuals. Information from various sources, including IQ and engagement studies, baseline ground and aerial surveys, and telemetry data at local and regional scales in Nunavut and the NWT, has provided some evidence on how Caribou move in and around the RSA annually (see Figure 8.8). The RSA predominantly provides a transit corridor between calving grounds and wintering grounds for the Ahiak and Lorillard herds (see Figures 8.2, 8.6, 8.9 and 8.10), and a wintering area for tundra-wintering herds such as the Ahiak, Lorillard, and Wager Bay herds (see Figure 8.7).

Spring and fall migration are major directional movements for Caribou in the region. For spring migration (April to June), areas of high use by collared Caribou are more contained (i.e., less spread out), and these corridors are quite clearly delineated on the way to and in proximity of calving grounds outside the RSA (Figures 8.2 and 8.9). Telemetry data indicate that most collared Caribou are moving in a northerly direction in the spring, but generally outside the RSA (Figure 8.2). For fall migration (September to November), as animals are migrating to wintering grounds, areas of high use by collared Caribou are more widely distributed (i.e., more spread out)(Figure 8.6). Fall migration corridors are also located closer to the Amaruq study area than spring corridors, as herds generally move in a southerly direction from calving grounds (Figure 8.10).

Within the Amaruq RSA, Caribou movements appear to be diffuse and distributed across the study area, with a potential movement corridor existing between Third Portage and Pipedream lakes (Figure 8.8). A number of Caribou trails identified in this area during the October 2014 reconnaissance supports this observation (see Figure 5).

4.4. HABITAT SUITABILITY

4.4.1. SPECIES DATA SUMMARY – TERRESTRIAL MAMMALS & BIRDS

The 2014 fall field program along the proposed road alignment, in conjunction with incidental observations by AEM staff near the Amaruq exploration camp, detected 27 terrestrial wildlife species. This species richness aligns with expected diversity for a healthy tundra ecosystem at that time of year.

Of the potential 62 bird species present within the study areas, 17 were observed during the course of the 2014 field program. This low diversity relates to the seasonal window of study, as most birds that may occur within the study areas breed on the tundra earlier in the season and migrate towards their overwintering grounds once the breeding season is complete (Pielou, 1994).

4.4.2. HABITAT SUITABILITY RANKINGS

Based on the wildlife habitat suitability rating scheme as presented in Section 4.2.5, ranks of High (H), Medium (M), or Low (L) were assigned to each ELC unit present within the LSA and RSA for each of the wildlife VECs presented in Section 1.4. An additional rating was assigned to the eskers, as they are important habitat features but are not clearly captured within the ELC community mapping.

Separate habitat suitability ratings were assigned to the growing season and the winter season for mammals but not birds, as the majority of birds are migratory and thus are not present in the study area in the winter months. The growing season is defined as approximately June 1 to September 30 (four months), and winter season is defined as approximately October 1 to May 31 (eight months).

A separate ranking was developed for predatory mammal denning, as habitat preferences for this activity is different than for non-denning individuals. Raptors has been divided into one ranking for Short-eared Owl and a separate ranking for all other raptors, as habitat preferences for Short-eared Owl differ from those of other raptors. See Table 12 for the comprehensive VEC habitat suitability rankings.

This information has been mapped as Figures 9.1 to 9.12, which show the habitat suitability rankings at a scale of 1:350,000 for each VEC in all of the ELC communities exclusive of the Eskers, as the precise extends of the eskers are have not mapped. The ELC communities comprising the eskers are variable, but commonly include Boulder/Gravel, Lichen Tundra, Lichen/Rock Complex, Upland Tundra/Rock Complex, and Upland Tundra.

Table 12a: Habitat Suitability Rankings for Wildlife VECs

ELC Unit	Ungulates				Carnivores		
	Caribou		Muskox		Predatory Mammals (except denning)		Predatory Mammals; Denning
	Growing	Winter	Growing	Winter	Growing	Winter	Jan-Sep
Water	-	L	-	L	-	L	-
Sand	M	L	L	L	L	L	H
Boulder/Gravel	M	L	L	L	M	M	H
Wet Graminoid	H	M	H	H	H	M	-
Graminoid Tundra	H	M	H	H	H	M	-
Graminoid/ Shrub Tundra	H	M	H	H	H	M	L
Shrub Tundra	M	L	M	M	M	M	M
Shrub/Heath Tundra	M	M	M	M	M	M	L
Heath Tundra	M	H	M	M	M	H	L
Heath Upland	M	H	M	M	M	H	L
Heath Upland/Rock Complex	M	H	L	L	M	H	M
Lichen Tundra	L	M	L	L	M	M	L
Lichen/Rock Complex	M	H	M	M	M	M	M
Esker	M	H	M	H	H	M	H

Table 12b: Habitat Suitability Rankings for Wildlife VECs (continued)

ELC Unit	Small Mammals	Raptors		Waterbirds	Upland Breeding Birds
		Raptors (incl. Peregrine Falcon)	Short-eared Owl		
	Year Round	Growing	Growing	Growing	Growing
Water	L	M	-	H	L
Sand	H	M	L	M	M
Boulder/Gravel	H	M	L	M	M
Wet Graminoid	M	M	M	H	H
Graminoid Tundra	M	M	H	H	H
Graminoid/ Shrub Tundra	M	M	H	M	H
Shrub Tundra	M	H	H	L	H
Shrub/Heath Tundra	M	M	H	L	H
Heath Tundra	H	H	H	L	H
Heath Upland	H	H	M	L	H
Heath Upland/Rock Complex	H	M	M	L	M
Lichen Tundra	M	M	M	L	M
Lichen/Rock Complex	H	H	M	L	M
Esker	H	M	M	M	H

4.5. DISCUSSION

The following discussion summarizes the presence, status and general habitat requirements of the wildlife VECs. Tables 13 and 14 show the area in hectares and corresponding percentages of high, medium, and low suitability habitat across the RSA for each VEC. A colour scheme has been applied to these tables to increase readability.

Table 13: Area (in hectares) of VEC Habitat Suitability in the RSA

VEC		H	M	L	Nil	ND
Ungulates	Caribou (Growing Season)	18,341.1	289,749.9	18,896.3	115,538.2	6,104.3
	Caribou (Winter)	234,795.9	44,857.6	162,128.5	743.4	6,104.3
	Muskox (Growing Season)	18,341.1	240,273.8	68,372.4	115,538.2	6,104.3
	Muskox (Winter)	18,341.1	240,273.8	183,167.1	743.4	6,104.3
Carnivores	Predatory Mammals (Growing Season)	18,341.1	306,693.5	1,952.7	115,538.2	6,104.3
	Predatory Mammals (Winter)	131,419.6	193,615.0	116,747.4	743.4	6,104.3
	Predatory Mammals (Denning)	42,916.9	114,352.3	158,139.6	127,116.6	6,104.3
Small Mammals	Small Mammals (Year Round)	277,712.8	49,274.5	114,794.7	743.4	6,104.3
Raptors	Raptors (Growing Season)	232,653.6	209,128.5	0.0	743.4	6,104.3
	Short-eared Owl (Growing Season)	80,751.9	203,318.5	42,916.9	115,538.2	6,104.3
Waterbirds	Waterfowl (Growing Season)	126,373.2	49,679.6	265,729.2	743.4	6,104.3
Upland Breeding Birds	Upland Breeding Birds (Growing Season)	155,238.6	171,748.7	114,794.7	743.4	6,104.3

Table 14: Percentage of VEC Habitat Suitability in the RSA

VEC		H	M	L	Nil	ND
Ungulates	Caribou (Growing Season)	4.1%	64.6%	4.2%	25.8%	1.4%
	Caribou (Winter)	52.3%	10.0%	36.1%	0.2%	1.4%
	Muskox (Growing Season)	4.1%	53.6%	15.2%	25.8%	1.4%
	Muskox (Winter)	4.1%	53.6%	40.8%	0.2%	1.4%
Carnivores	Predatory Mammals (Growing Season)	4.1%	68.4%	0.4%	25.8%	1.4%
	Predatory Mammals (Winter)	29.3%	43.2%	26.0%	0.2%	1.4%
	Predatory Mammals (Denning)	9.6%	25.5%	35.2%	28.3%	1.4%
Small Mammals	Small Mammals (Year Round)	61.9%	11.0%	25.6%	0.2%	1.4%
Raptors	Raptors (Growing Season)	51.9%	46.6%	0.0%	0.2%	1.4%
	Short-eared Owl (Growing Season)	18.0%	45.3%	9.6%	25.8%	1.4%
Waterbirds	Waterfowl (Growing Season)	28.2%	11.1%	59.2%	0.2%	1.4%
Upland Breeding Birds	Upland Breeding Birds (Growing Season)	34.6%	38.3%	25.6%	0.2%	1.4%

4.5.1. UNGULATES

<u>Caribou - *Rangifer tarandus groenlandicus*</u>

Status

The Barren-ground Caribou is listed as secure in Nunavut (CESCC, 2011) and is not listed federally (COSEWIC 2014); however, communities and government have expressed regarding the declining numbers and health all herds (M. Campbell, pers. comm., 2014).

Foraging Habitat and Presence within the Study Areas

Based on the relative Caribou habitat suitability ratings applied to the ELC units, habitat suitability was quantified for the RSA and LSA for the growing and winter seasons (see Table 12). During the growing season, only a small amount of High suitability habitat is available in the RSA (i.e., ~4%; Table 14). Most of the habitat is rated as being of Moderate suitability (i.e., ~65%; Table 13). Most High suitability habitat in the growing season is situated in southern portions of the RSA, while Moderate suitability habitat is distributed throughout the RSA (see Figure 9.1).

A much higher proportion of High suitability habitat is available for Caribou during the winter season (i.e., ~52%; Table 13), while the availability of Moderate suitability habitat is much lower than in the growing season (i.e., 10%, Table 13). High quality habitat is concentrated in the northwestern and eastern portions of the RSA while Moderate suitability habitat is distributed more evenly throughout the RSA (see Figure 9.2)

Table 15: Overall Area of Caribou Habitat Suitability and Percentages

Habitat Suitability	Caribou Growing		Caribou Winter	
	Area (ha)	Area (%)	Area (ha)	Area (%)
H	18341.11	4.09%	234795.89	52.34%
M	289749.87	64.59%	44857.63	10.00%
L	18896.31	4.21%	162128.49	36.14%
Nil or No Data	121642.46	27.11%	6847.74	1.53%
Total	448629.75	100.00%	448629.75	100.00%

Reproduction and Behaviour

See Section 4.2.4.1.3.

<u>Muskox – *Ovibos moschatus*</u>

Status

Muskoxen are not listed as a Species-at-Risk federally (COSEWIC, 2014) and are listed as secure in Nunavut (CESCC, 2011). Current Muskoxen populations represent a rebound from overhunting in the early 1900s.

Foraging Habitat and Presence within the Study Areas
In total, 11 Muskoxen were observed during the 2014 field program (Figure 5, Appendix 6). Additionally, evidence of Muskox foraging was observed (scat) and of Muskox predation by Wolves (damaged skull/wolf scat). Graminoids and willows form an important part of Muskoxen diet; therefore, the graminoid-affiliate land classes (i.e., Wet Graminoid, Graminoid Tundra and Graminoid/Shrub Tundra) provide the most important habitat within the study area (Figures 9.3 and 9.4) (Naughton, 2012). Muskoxen will also forage on blueberry, ground birch, and other shrubs. Similarly, preferred winter habitat is land with substantial graminoid cover (Pielou, 1994). One of the most important determinants of winter foraging areas for Muskoxen is the extent to which wind removes snow cover from browsing areas; therefore, windswept plateaus and other graminoid-rich areas with reduced snow accumulation are important throughout the winter (Naughton, 2012). Esker habitat is important as a movement corridor for Muskoxen (Figures 9.13 and 9.14) as was evidenced by the presence of a game trail and Muskox sign at the crest of the esker.

Reproduction and Behaviour
Normally seen in herds, the solitary male Muskox observed on September 3, 2014 (Figure 5), was likely travelling in search of mating opportunities, as the timing represents the middle of the rut. Muskox reproduction, both mating and calving, is expected to occur within habitats as described above; however, to varying degrees, Muskoxen may occur in a variety of habitats.

4.5.2. CARNIVORES

Wolverine – *Gulo gulo*

Status
Wolverine is considered relatively secure in Nunavut (CESCC, 2011), but is listed as Special Concern federally (COSEWIC, 2014). Due to its scavenging feeding behaviour, Wolverine is susceptible to hunting and trapping and has been largely extirpated from the southern parts of its historic range (Naughton, 2012).

Foraging Habitat and Presence within the Study Areas
Wolverines occupy massive home ranges and are typically scarce to rare on the landscape (May et al., 2012; Naughton, 2012). An AEM employee near the Amaruq exploration area reported a single Wolverine as an incidental observation on May 13 (Appendix 7), but Wolverine sign (scat, tracks etc.) was not observed during the fall field investigations. Habitat selection of Wolverines is determined primarily by the presence of suitable prey, which includes small game, carrion, and even larger game such Caribou under ideal conditions (injured, sick or encumbered by snow). In the winter, they feed primarily on carrion and are closely linked to Caribou movement. As such, and due to their massive home ranges (400 to 1,500km^2), Wolverines utilize a wide variety of habitat types (May et al., 2012) (Naughton, 2012).

Reproduction and Behaviour
Denning occurs between February and early June, which is the period when females with kits are most vulnerable to disturbance. Wolverines have been shown to preferentially avoid human activity during denning (May et al., 2012). Denning habitat is often areas with rock matrices and deep snow (i.e., ELC

land types: Lichen/Rock Complex, Boulder/Gravel). Eskers also provide denning habitat and movement corridors for Wolverines (Williston et al., 2004).

Arctic Wolf – *Canis lupus*

Status
Grey Wolves (*Canis lupus*), referred to as Arctic Wolves in northern Canada, are considered to be secure in Nunavut (Wild Species, 2010) and are not listed as a Species-at-Risk federally (COSEWIC, 2014). The density of wolves in any given area within Kivalliq region may be very low given the immense range size that wolf packs occupy (up to 75,000km^2 annually)(Cluff et al., 2002).

Foraging Habitat and Presence within the Study Areas
Caribou form the foundation of the Arctic Wolf diet and packs migrate seasonally through their territory in order to hunt Caribou (McLoughlin et al., 2004) (Appendix 6, Figures 9.5 to 9.7). Numerous other game items will also regularly be eaten, including insects, small mammals, birds, foxes, Wolverines, and Muskoxen (Naughton, 2012). Wolf sign was observed throughout the fall field program (Figure 5), and AEM employees reported incidental observations of wolves in the Amaruq exploration area (Appendix 7). Wolves are expected to occur throughout the proposed road alignment study areas, although at a characteristically low density.

Reproduction and Behaviour
Denning for Arctic Wolves may occur within a variety of habitat types including the widespread heath-affiliate land classes (i.e., Heath Tundra, Heath Upland)(Cluff et al., 2002); however, preferred denning habitat is within sandy eskers, especially in areas with graminoid and forb cover (Mueller, 1995). Pups are typically born in April or May and remain in the den for at least four weeks, at which time they are transferred to a nearby nursery area (no longer in a den)(Naughton, 2012).

Barren-ground Grizzly Bear – *Ursus arctos*

Status
The Barren-ground Grizzly Bear is listed as Sensitive in Nunavut (CESCC, 2011) and Special Concern in Canada (COSEWIC, 2014). The primary cause of Grizzly Bear decline has been the fragmentation and destruction of their habitat, as these animals require massive territories (up to 1,000km^2)(McLoughlin et al., 2002).

Foraging Habitat and Presence within the Study Areas
Grizzly Bears were not observed directly during the field program and AEM staff did not observe any individuals. Evidence of this species in the study area came from foraging sign (i.e., digs) in a patch of *Oxytropis* spp., a known favored food item (Figure 5.2). As a highly omnivorous species, Grizzly Bears consume the roots and vegetative parts of grasses and forbs, fruits of numerous shrubs, as well as fungi. Arctic Ground Squirrels are an important part of their diet as are numerous other game including birds and ungulates (McLoughlin et al., 2002). This varied diet means that Grizzly Bears can be found in a variety of habitat types throughout the growing season. In the winter, bears hibernate in dens typically located on south-facing esker slopes and areas with rock features (Mueller, 1995).

Reproduction and Behaviour
Bear cubs are born while the female is hibernating (in January or February) and cubs emerge with their mother several months later (Naughton, 2012). Preferred denning sites are, as with winter dens, on eskers and other south-facing slopes (Mueller, 1995). Mothers with their cubs are particularly sensitive to disturbances at this time. Mother bears lactate for more than two years and remain with their cubs for a total of four years (Naughton, 2012).

4.5.3. SMALL MAMMALS

Status
In the Arctic, small mammals are a significant food resource for a variety of predatory mammals and birds. Several species including Arctic Hare, Arctic Ground Squirrel, and Northern Collared Lemming were observed during the 2014 field program. Nearctic Brown Lemming (*Lemmus trimucronatus*), Northern Red-backed Vole, and Barren Ground Shrew (*Sorex ugyunak*) may be also present within the study areas (Naughton, 2012). None of the small mammals within the study are considered Species-at-Risk (COSEWIC, 2014) and all but the Barren Ground Shrew are listed as Secure in Nunavut (CESCC, 2010). Barren Ground Shrew is a highly elusive and uncommon species that is listed as Undetermined in Nunavut (CESCC, 2010). Very little is understood about the biology of this shrew species (Naughton, 2012).

Foraging Habitat and Presence within the Study Areas
Although some variety exists within the feeding strategies of small mammals, they primarily feed on a wide range of vascular plants, fungi, and mosses (Naughton, 2012). Insect and meat consumption is typically a secondary and opportunistic feeding strategy for this group, with the exception of the Barren Ground Shrew, which likely primarily feeds on invertebrates; however, very little is known about its diet (Naughton, 2012). Some important land class types for small mammals include Heath Tundra, Heath Upland, and Lichen/Rock Complex.

Reproduction and Behaviour
Reproduction rates for small mammals are typically very high with females of several species capable of producing multiple litters per year (Naughton, 2012). Nesting can occur directly on open ground (Arctic Hare), in shallow burrows (Collared Lemming) or within extensive underground burrows (Arctic Ground Squirrel). Some species may have parturition dates early enough in the year to have pups under snow cover (Naughton, 2012). Nesting habitat for small mammals is present in most areas where suitable foraging habitat exists. Arctic Ground Squirrels are known to prefer burrow sites on sandy eskers (Mueller, 1995).

4.5.4. RAPTORS

Status
Of the 10 raptor species known to breed on mainland Nunavut (Richards et al., 2008), five species are expected to occur within the study areas: Short-eared Owl (Figure 9.10), Snowy Owl, Rough-legged Hawk, Peregrine Falcon, and Gryfalcon (Figure 9.8). Of these, Peregrine Falcon and Short-eared Owl are listed as Special Concern federally (COSEWIC, 2014) and Short-eared Owl, Rough-legged Hawk, and Gyrfalcon are considered as Sensitive in Nunavut (CESCC, 2011).

Foraging Habitat and Presence within the Study Areas
Rough-legged Hawk, Peregrine Falcon, and Gyrfalcon were observed during the 2014 field program. Although owls were not observed, suitable habitat (i.e., high suitability habitat for small mammals) is present within the study area. Rough-legged Hawk, which was observed during the field program (Figure 5), has similar foraging habitat requirements as owls and primarily hunts small mammals. Peregrine Falcon and Gyrfalcon were both observed during the field program (Figure 5). These falcons specialize in hunting birds; therefore, habitats important to ptarmigan, waterfowl, and upland birds will be used for foraging (Court et al., 1988)(NWT Species at Risk, 2014).

Reproduction and Behaviour
Raptor nesting areas can be divided into ground-nesting habitat (i.e., Snowy and Short-eared owls) and cliff-nesting habitat (i.e., Rough-legged Hawk, Peregrine Falcon, and Gyrfalcon)(Pielou, 1994)(NWT Species at Risk, 2014). Cliff-dominated areas within the study area are considered of high suitability for nesting, while eskers may also be suitable for nesting.

4.5.5. WATERFOWL

Status
Eighteen species of ducks, six species of geese, and one swan are confirmed to breed within Nunavut (Richards et al. 2008). During field surveys, four species were observed; Canada Goose, Cackling Goose (*Branta hutchinsii*), Snow Goose, and Greater White-fronted Goose (*Anser albifrons*). These geese, as well as the Long-tailed Duck were found to be the most important waterfowl species in the vicinity of the Meadowbank Mine (AEM, 2005a and 2005b). As such, descriptions of habitat use and reproduction pertain to these five species. Of the waterfowl species likely to occur within the Amaruq Exploration Road study areas, only Long-tailed Duck is listed as Sensitive in Nunavut (CESCC, 2010). No waterfowl species within the study areas is listed as a Species-at-Risk federally (COSEWIC, 2014).

Foraging Habitat and Presence within the Study Areas
The four geese species listed above feed primarily on plants such as grasses, sedges, legumes, horsetails, and various berries (Ehrlich et al, 1988). Important habitat is primarily concentrated around breeding, moulting, and staging areas (Latour et al, 2008). Graminoid-rich land classes (i.e., Wet Graminoid, Graminoid Tundra) provide staging habitat (Latour et al, 2008). Heath Tundra and Lichen/Rock Complex may also be utilized by geese as observed in the Meadowbank baseline terrestrial study (AEM, 2005a). Geese are vulnerable to predation during their summer moult due to the temporary loss of flight feathers (Ehrlich et al, 1988). Known moulting areas in the region occur west of Aberdeen Lake along the Thelon River and East of Tehek Lake along the Tehert and Quoich rivers (Latour et al, 2008). Both of these areas are outside of the study areas. Long-tailed Duck is a deep diving species, which feeds on aquatic invertebrates and fish (Ehrlich et al, 1988). Important land classes for Long-tailed Ducks include Water, Wet Graminoid, Graminoid Tundra, Heath Tundra, and other lakeside areas.

Reproduction and Behaviour
Geese within the study areas are primarily colonial or semicolonial breeders often forming associations between various goose species (Baicich and Harrison, 1997). Nesting typically begins in early June and preferred sites are often grassy areas along rivers and lakes, and especially islands (Baicich and Harrison, 1997; Latour et al, 2008). Other breeding habitat may include other land classes with low-lying

vegetation including Heath Tundra (AEM, 2005a). No evidence of geese breeding areas were observed during the 2014 field program and no Important Bird Areas (IBAs) are present within the study areas (BSC, 2014). Furthermore, Canadian Wildlife Services has identified two key habitat sites for migratory waterfowl in the region, which are both outside of the study areas; along the Thelon River west of Aberdeen Lake (breeding and moulting) and east of Tehek Lake on the Tehert and Quoich rivers (moulting) (Alexander et al, 1991). Long-tailed duck typically nests on Heath Tundra in close proximity to water bodies (often <10m)(Baicich and Harrison, 1997; Ehrlich et al, 1988).

4.5.6. UPLAND BREEDING BIRDS

Status

Various upland breeding bird species, including Horned Lark, American Pipit (*Anthus rubescens*), White-crowned Sparrow (*Zonotrichia leucophrys*), Savannah Sparrow, Lapland Longspur, Snow Bunting (*Plectrophenax nivalis*), Willow Ptarmigan (*Lagopus lagopus*), Rock Ptarmigan, Semipalmated Sandpiper, and American Golden-Plover (*Pluvialis dominica*), may be present within the study areas (Richards et al., 2008). Lapland Longspur, Snow Bunting, American Pipit, and Rock Ptarmigan were observed during the 2014 field program (Figure 5; Appendix 6). Snow Bunting, American Pipit, White-crowned Sparrow, Semipalmated Sandpiper, and American Golden-Plover are listed as Sensitive in Nunavut (CESCC, 2010). None of these upland breeding birds are listed federally (COSEWIC, 2014).

Foraging Habitat and Presence within the Study Areas

Upland breeding birds encompass a wide range of foraging guilds, including seed and insect feeding birds (e.g., Horned Lark and American Pipit), subterranean invertebrate feeders (e.g., Semipalmated Sandpiper, and more herbivorous feeders (Rock and Willow ptarmigan) (Pielou, 1994); therefore, a wide range of ELC types are used (Figure 9.9).

Land types may include Heath Upland and Heath Tundra as well as rockier land classes such as Lichen/Rock Complex and the esker (Figure 9.9).

Reproduction and Behaviour

Upland breeding birds arrive in the area between mid-April and mid-June. The period from egg-laying to fledging typically occurs between June and early August (AEM, 2005a). Nesting occurs for some species on well-drained areas with low, sparse vegetation (Pielou, 1994; Baicich and Harrison, 1997), however nesting habitat requirements are diverse for upland breeding birds in general. Upland ELC types such as Lichen/Rock Complex, Heath Tundra, and Heath Upland are some examples of suitable nesting habitat. Specific nest sites can include scrapes on the ground (which are hidden by vegetation), depressions or crevices along ridges and uplands, or within small shrubs (i.e., *Betula nana*)(Baicich and Harrison, 1997).

5. SUMMARY

The purpose of this Baseline Terrestrial Characterization Report was to collect and synthesize data on plant communities, plant species, and terrestrial wildlife in support of an application to construct a road from the existing Meadowbank mine to the Amaruq project exploration property. Field studies were conducted for this report, including vegetation and wildlife surveys, in fall 2014. Where appropriate, data collected for the Meadowbank Gold project Baseline Terrestrial Ecosystem Report as well as information from the Government of Nunavut's (GN's) Kivalliq Ecological Land Classification Map Atlas (2012) were incorporated to supplement the 2014 findings.

Two study areas, a Regional Study Area (RSA) and a Local Study Area (LSA) were established for this project. The RSA is a 50 km corridor in width with a total area of 459,223 km^2, while the the LSA is 3 km in width with a total area of 18,912 km^2.

The overall findings of the field studies are:

- 78 vascular plants and 33 non-vascular plants were identified;
- The most common vegetated communities in the RSA and LSA are Lichen/Rock Complex, followed by Heath Upland, Heath Tundra, Boulder/Gravel, and Lichen Tundra;
- Open Water is present in high proportions across the landscape, covering 26% of the RSA and 22% of the LSA;
- In 2014, 27 terrestrial wildlife species (10 mammals, 17 birds) were recorded through direct observation or signs; and
- The most common mammal species recorded was Barren-ground Caribou (*Rangifer tarandus* ssp. *groenlandicus*) and the most common bird species was Snow Goose (*Chen caerulescens*). Other common mammal species recorded in the Meadowbank area included Muskox (*Ovibos moschatus*), Arctic Hare (*Lepus arcticus*), Arctic Ground Squirrel (*Spermophilus parryi*), and Arctic fox (*Alopex lagopus*). Common bird species included Canada Goose (*Branta canadensis*), Lapland Longspur (*Calcarius lapponicus*), Savannah Sparrow (*Passerculus sandwichensis*), and Sandhill Crane (*Grus canadensis*).

Caribou were studied in more detail than other wildlife VECs due to their cultural and ecological importance. Data on Caribou were largely synthesized from a GN-led satellite-collaring program, but also included some field observations. Following is a summary of the Caribou data analysis:

- The RSA does not contain any major calving grounds or post-calving areas;
- None of the major migratory water crossings identified by the DIAND are present within the Amaruq RSA;
- The RSA predominantly provides a transit corridor between calving grounds and wintering grounds for the Ahiak and Lorillard herds, and a wintering area for tundra-wintering herds such as the Ahiak, Lorillard, and Wager Bay herds;
- Caribou movement through the RSA occurs mainly in the spring (April to June) and fall (September to November);
- A potential movement corridor appears to exist between Third Portage and Pipedream lakes and any potential corridors prior to construction will be investigated further;

- During the growing season, the RSA contains predominantly moderate suitability habitat for Caribou, with low suitability habitat scattered throughout and high suitability habitat present in localized bands, particularly north of the Amaruq study area. High suitability habitats correspond to the locations of graminoid-dominated communities, which are relatively rare across the RSA and LSA;
- During winter, the RSA contains large amounts of high suitability habitat, corresponding to the abundance of heath and lichen communities. Low suitability habitat is also common, corresponding to Water, Sand, Boulder/Gravel, and shrub habitats. Moderate suitability habitat is relatively uncommon; and
- The habitat suitability of the esker features is moderate for Caribou during the growing season and high during the winter.

Habitat suitability for the remainder of the wildlife VECs is variable depending on species and season; however, several trends were apparent:

- ELC communities with a high graminoid content (i.e., Wet Graminoid, Graminoid Tundra, and Graminoid/Shrub Tundra) have the highest overall habitat suitability for the wildlife VECs;
- ELC communities with a high heath content (i.e., Heath Tundra, Heath Upland, and Heath Upland/Rock Complex) had high winter suitability for all mammals except for Muskox and were of moderate to high suitability for all raptors and upland breeding birds;
- Sand and boulder/gravel have low to medium suitability for all VECs in all seasons except for carnivore denning;
- Lichen Tundra and Water have the lowest overall habitat suitability for the VECs assessed; and
- Esker features have high to medium habitat suitability for all of the wildlife VECs assessed.

6. RECOMMENDATIONS

Findings of this report have been enhanced with information from the Meadowbank Baseline Terrestrial Ecosystem Report. In many cases, the GIS- based analyses have been backed up by field data; however, additional field data should be collected prior to road construction to reduce uncertainties and to ensure protection of wildlife habitat along the proposed exploration road alignment. It is recommended that:

- Field staff walk the entire length of the proposed road to substantiate the GIS findings and document wildlife occurrence, environmentally sensitive areas, and other important wildlife features such as den sites, bird breeding colonies, and Arctic Ground Squirrel colonies. The potential Caribou movement corridor between Third Portage and Pipedream lakes, and potentially other sites, will also be investigated further during this exercise;

- Faunal surveys along the eskers to better understand their use by and importance to wildlife by identifying:
    - Raptor nesting sites (actual and potential);
    - Mammal dens;
    - Movement corridors; and
    - General wildlife signs, particularly carnivores.

- Vegetation plot surveys during the flowering season to:
    - Increase the number of surveys per plot type to increase robustness of statistical analysis;
    - Collect and identify plants that were only identified to genus level in 2014.

- Additional avian surveys to supplement the Meadowbank data:
    - Breeding bird surveys during nesting season.

Any additional surveys would be documented in a similar style to this report (i.e., Methods, Findings, and Discussion, and provided as an appendix to this document) and will be conducted to align with the Meadowbank TEMP.

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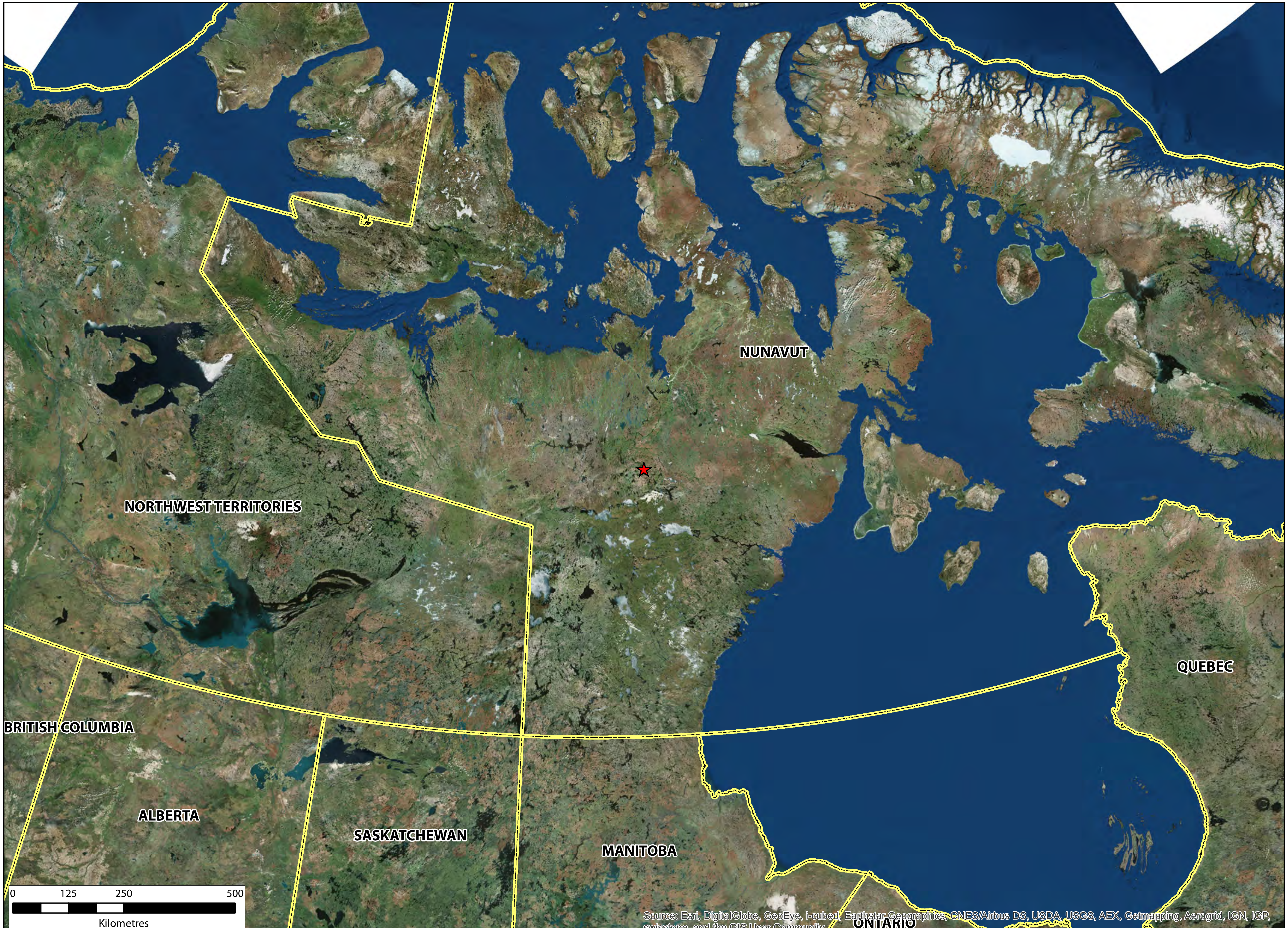
List of Figures (36 total)

List of Appendices



Legend

★ Nunavut Amaruq Mine Project Location

Amaruq Exploration Road
Project Location

DOUGAN & ASSOCIATES
ECOLOGICAL CONSULTING & DESIGN

PROJECT: DA14-053-01

CLIENT: Agnico Eagle Mines Limited

N
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S
UTM Zone 14 NAD83

DATE: DECEMBER 2014

SCALE: 1:8,000,000

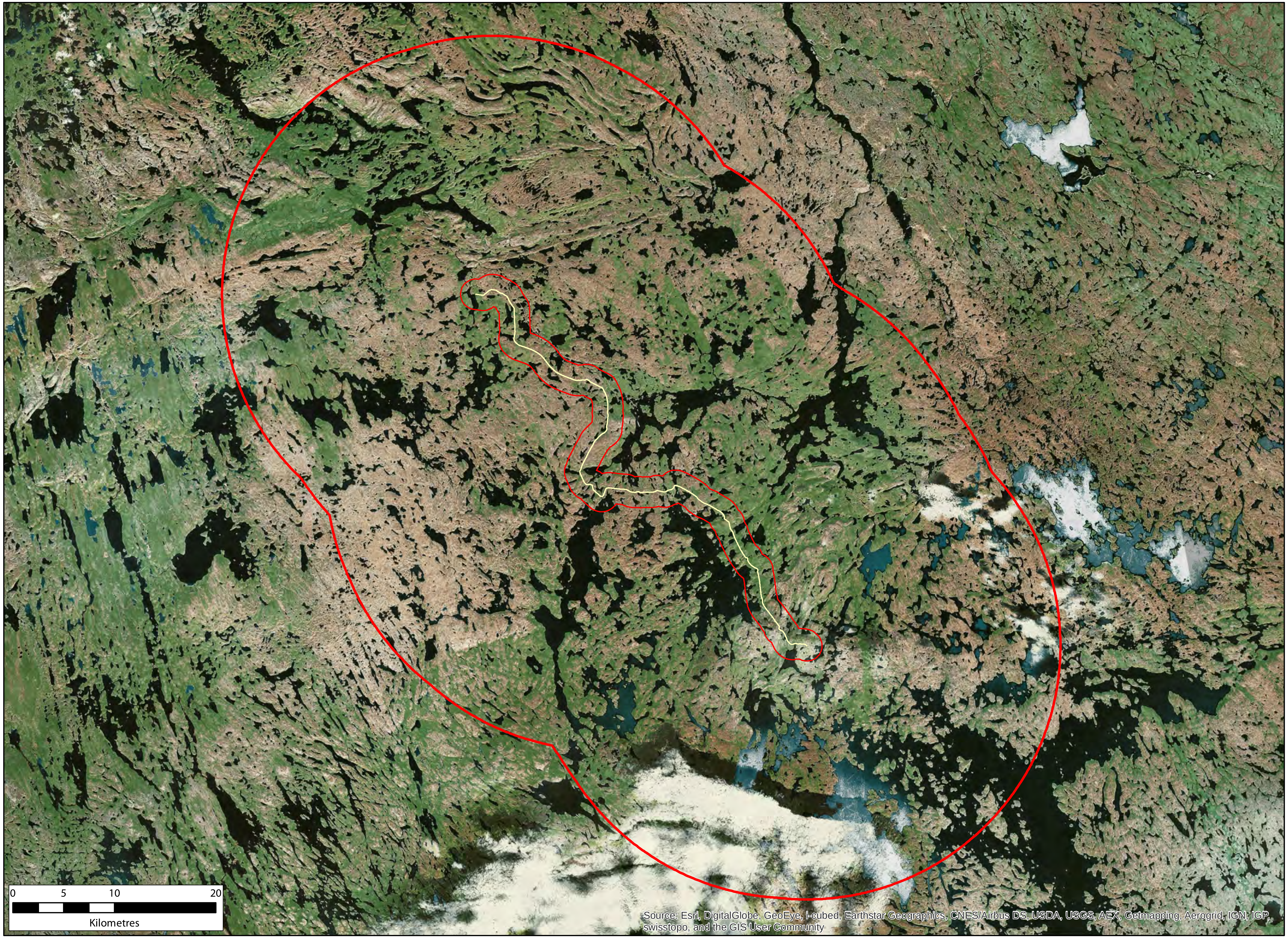
DRAWN BY: LW

CHECKED BY: MAY

Figure:

1

The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.



Legend

- Proposed Road
- LSA Boundary
- RSA Boundary

Amaruq Exploration Road
RSA and LSA Extents

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PROJECT: DA14-053-01

CLIENT: Agnico Eagle Mines Limited

N
W E
S
UTM Zone 14 NAD83

DATE: DECEMBER 2014
SCALE: 1:350,000
DRAWN BY: LW
CHECKED BY: MAY

Figure:
2