12 Summary of Existing Environment Terrestrial Wildlife and Habitat

The following is a summary of baseline information for the Key Indicator species assessed for potential environmental Project effects. A more comprehensive description of baseline information is presented in Tier 3, Volume 6, Technical Appendix 6C, Terrestrial Wildlife Baseline.

12.1 Caribou

The barren-ground caribou is listed as secure in Nunavut (CESCC 2011) and, with the exception of two subspecies, is not listed federally under the SARA or by COSEWIC. The two listed subspecies, the Dolphin and Union population (ssp. *groenlandicus*; COSEWIC Special Concern) and the Peary caribou (ssp. *pearyi;* COSEWIC 'Endangered' and SARA Schedule 1 Endangered'), do not occur in the Project area.

As reported through IQ studies and in the literature, recent population declines in several caribou herds may be part of a downward trend in a population cycle that can last from 20 to 60 years. Elders have said that *caribou move from time to time and that number estimates by the government are faulty because they do not take into account that animals do not always consistently occupy one area, and that populations generally return* (IQ-McDonald et al. 1997). A hunter shared how *he was told to cache many caribou as it was predicted caribou would be scarce — it happened and he was thankful for IQ and guidance* (EN-BL EL Sept 2013). Another Elder *remembers how he moved into Chesterfield in 1949 due to starvation on the land and there were no caribou in Chesterfield Inlet at that time* (IQ-CI06 2009). Available population data from 1970 onwards does indicate that most northern caribou herds have increased from lows around 1975 to a peak around 1995, followed by a decline (Gunn et al. 2011), but few studies have been able to document cycles across multiple caribou herds in the north.

Knowledge of seasonal occurrence of caribou herds in the RAA is based on local knowledge, regional surveys conducted since the late 1940s, land use studies, data from caribou collaring programs, and Project-specific surveys conducted in 1979 and 1980, and as part of the current baseline program beginning in 2007 (Tier 3, Volume 6, Appendix 6C). The five caribou herds identified in Nunavut's mainland region are the Beverly, Ahiak, Wager Bay, Lorillard, and Qamanirjuaq herds. All of these herds are known to occur within the Kiggavik RAA, although at different frequencies and seasons depending on their herd ranges. The analysis of the telemetry data used to delineate ranges assigned each collared animal to a herd based on the calving area it returns to on a yearly basis. Nagy et al. (2011) and Campbell et al (2012) consider the Ahiak, Wager Bay, and Lorillard herds as part of a tundra-wintering barren-ground caribou herd.

The Beverly herd was recently documented as substantially declining since population surveys conducted in 1994. Although historically the Kiggavik RAA was identified as a post-calving area for Beverly caribou, current use during the post-calving season appears to be limited. The Qamanirjuaq herd was not traditionally identified as using the Kiggavik RAA during any season; however, observations in 2009 and 2010 and collaring data found that most caribou occurring within the Kiggavik RAA during late July and early August were from the Qamanirjuaq herd. Collaring data on the northeast mainland herds has supported the view that most caribou occurring in the Kiggavik RAA in the winter are individuals from the Wager Bay and Lorillard herds.

All caribou herds near the Kiggavik RAA show variation in movements and habitat use among years. Mapping of caribou movement to their calving and wintering grounds during the migratory seasons incorporated government data, Project data, and current and older sources of IQ. The resulting maps showed that caribou movement in the region is well documented (Figure 12.6-1 and Figure 12.6-2). The information sources are complementary as government information describes herd-level caribou movement (based on collar locations), IQ describes regional caribou movement that covers close to 40 years and likely represents a much longer period, and baseline data collected by AREVA describes local water crossings and local movements at the Project-scale. Information from IQ studies supports the view that caribou change their migration patterns every few years. The mapped IQ highlights the variation in caribou movement, as much of the older IQ describes caribou movement in areas where the recent government data is absent. Generally, 'resident' animals are from the tundra-wintering herd(s) and present during the winter months, but summer and calve north and east of the RAA. During the spring migration, individuals of the Beverly/Ahiak and resident herds may be present, but herd numbers are generally low. In summer, very few caribou are present within the RAA and calving has not been documented. The analysis identifying regional calving areas integrated baseline information from a variety of sources into one map (Figure 12.6-3). The map shows relatively strong agreement between IQ and scientific knowledge. During the post-calving period and summer dispersal period, moderate numbers of Qamanirjuaq and possibly Beverly/Ahiak animals move through the area on their way to wintering areas. Later in the fall, caribou from the tundra winter herds return to the Kiggavik RAA and broader surrounding area.

Although the annual life cycle of barren-ground caribou has been described according to six seasons, for the purposes of this assessment, habitat use during spring and summer (i.e., growing season) and fall and winter (i.e., winter season) is described. Caribou are most sensitive to disturbances that alter their use of habitat during the late-winter, calving and post-calving periods. Winter, particularly late-winter, is the time of the year when populations of caribou are most limited by habitat and may be subject to forage limitations with factors such as snow condition and lichen availability affecting habitat selection. Lichen is the most important source of winter food for caribou because it is relatively high in energy and easily digestible compared to other sources of food. Late winter is even more critical for cows because they are using more energy during the late stages of gestation. During the spring, energy requirements of female caribou increase because of late-gestation and the start of lactation; therefore, they are more sensitive to disturbances during this period compared to other times of the year.

Caribou need extensive space to undertake traditional movements, presumably, as a strategy to minimize predation, exploit seasonal habitats and avoid deep snow. The RAA was divided into ELC units that are recognizably different in vegetation content and geographic features. Caribou generally feed on lichen during winters, and fresh shrubs (leaves and stems) and graminoids during the growing season; therefore, habitat that contains these features is of higher value to caribou in the appropriate season.

During the growing season, there is a roughly equal amount of High, Moderate and Low quality habitat distributed throughout the RAA. Most of the High quality habitat in the growing season is found in southern portions of the Kiggavik RAA, corresponding with the distribution of post-calving aggregations of caribou in 2009 and 2010. In winter, the distribution of most moderate quality habitat corresponds with the distribution of collared caribou in the northwestern portion of the Kiggavik RAA in the winters of 2009 and 2010.

Based on previous land use studies summarized in the baseline report, most of the Kiggavik RAA was identified as a hunting area in the past. More recent harvest location statistics collected as part of the Nunavut Wildlife Harvest (NWMB 2005) and the ongoing AREVA/AEM Hunter Harvest Study (HHS) indicate that relatively few caribou have been harvested west of the Thelon River in the last decade.

12.2 Muskox

Muskox is listed as 'Secure' in Nunavut (CESCC 2006) and is not listed federally under the SARA or by COSEWIC. In the mid-1900s, with concerns about declining populations, the territorial government banned all muskox harvest. Only in recent years has hunting again been permitted on a license basis. To this day, elders and hunters in Baker Lake talk about these restrictions and how the restrictions affected their current hunting patterns. Recently, muskox have begun to re-establish populations in many parts of Nunavut. Inuit have suggested that the animals may have moved into the area from the Thelon Wildlife Sanctuary.

Muskox were regularly observed during most wildlife survey programs, including the aerial surveys flown in 2007 and 2008. Although muskox were found throughout the RAA, the highest number of sightings was in the southeastern portion of the study area just west of the Kazan River, which is consistent with comments by Baker Lake residents, IQ and government data (Figure 12.6-4). The largest cow-calf group reported numbered 80 individuals, of which a third were likely calves. Overall ratio of calves to cows appears to be in the 30% to 50% range. Most bulls observed were single or in small groups. Muskox feed on willow and sedges in the summer and primarily willow, birch and other shrubs in the winter.

12.3 Wolf

The Arctic wolf is listed as 'Secure' in Nunavut (Canadian Endangered Species Conservation Council 2010), and has not been identified as a species at risk or of concern by COSEWIC or SARA. Based on available information, wolves appear to be widespread and range across the entire RAA. No particular area, other than possible den sites, appears to be of critical importance to these species. A wolf den identified from IQ is found north of Pitz Lake. Habitat suitability for wolf denning is discussed in more detail in the Wildlife Baseline Report (Tier 3, Volume 6, Appendix 6C). The presence of wolf in the Project area was confirmed by both IQ and engagement data. Some areas noted for wolves included Anigguq Lake and Qallihaaq (near Thom Lake). Wolves were also observed in the area of Qikiqqtarjualik (Sissons) Lake. A large wolf winter hunting area was identified around Aberdeen and Schultz Lake. Hunting around Siamese and Skinny Lakes was also noted (Wildlife Baseline, Tier 3, Vol. 6, Appendix 6C). Wolves were the most frequently observed large predator within the Kiggavik Mine LAA and RSA. Wolves were seen during all RSA aerial surveys from 2007 to 2009, but not during LSA surveys. Incidental ground observations of wolves throughout the RSA were recorded in 2007, including in the Mine LSA. At least one pack appears to use the RSA for denning east of Skinny Lake, identified during 2008 aerial surveys.

In the Thelon River area, caribou was the main prey species in the spring, summer and winter (Kuyt 1972). Other prey items (i.e., muskox, ermine, wolverine, wolf, fox, Arctic hare, Arctic ground squirrel, lemmings, voles, geese, ptarmigan, fish, and insects) were taken only rarely during that period (Kuyt 1972).

Wolf populations are likely stable or increasing within their Nunavut range, but regional population trends remain poorly understood. Very little demographic information is available for wolf, although they are more common and generally seen singly or in small packs ranging from three to seven animals.

12.4 Raptors

Eight raptor species were observed in the Kiggavik RAA to date: peregrine falcon, gyrfalcon, rough-legged hawk, northern harrier, bald eagle, golden eagle, short-eared owl and snowy owl. The tundrius subspecies of peregrine falcon, the subspecies that breeds north of the tree line, is listed as 'Secure' in Nunavut (CESCC 2006), Special Concern by COSEWIC, and is on Schedule 3 of the SARA. Short-eared Owl is considered to be 'Sensitive' in Nunavut (CESCC 2006), Special Concern by COSEWIC, and is also on Schedule 3. The only other raptor species considered to be 'Sensitive' in Nunavut is the golden eagle, which is not listed by either COSEWIC or the SARA. Raptor species documented in IQ and engagement studies included eagles, peregrines, and snowy owls.

Peregrine falcons and rough-legged hawks were the most common raptor species encountered during field programs. Nesting birds were closely associated with steep terrain including cliffs and rock outcrops. Most suitable peregrine falcon habitats within the Mine and All-Season Road LAA were occupied by nesting birds suggesting that cliff-nesting habitat in the Kiggavik area may be saturated with nesting pairs. Sightings of bald eagle and northern harrier in the Kiggavik RAA are unexpected and may be part of a current range expansion.

Peregrine falcon was used as the indicator species for the raptor group because it is the most abundant breeding raptor in the area and it is a federally listed species. Suitable nesting habitat is primarily steep rocky areas and cliffs although nesting has been reported on large rocks. Foraging habitat is determined by the density of available prey, which are primarily birds. The most common prey items are passerines (i.e., snow bunting, lapland longspurs, horned lark, and American pipit), but lemmings, shorebirds, and sik sik are also taken.

12.5 Migratory Birds

Fifty-six bird species were observed at the Kiggavik site since 1979. Birds use all habitats within the study area from wetlands (i.e., waterbirds) to upland heath communities (i.e., upland breeding birds).

Upland Breeding Birds — Of the 56 bird species observed at the Project site since 1979, 15 species are upland breeding birds (includes passerines and ptarmigan). Of these, American tree sparrow, snow bunting, and white-crowned sparrow are considered to be 'Sensitive' in Nunavut (CESCC 2006). No upland bird species observed to date is listed federally in the SARA or by COSEWIC and no other listed species are expected to occur. In IQ studies (historical and current), the only upland bird that was reported to be regularly harvested was ptarmigan, which was also one of the most frequently observed upland birds in most baseline field surveys.

Population and distribution data on upland breeding birds were collected from a number of field surveys. The most common and widespread species was Lapland Longspur, which was found in all terrestrial habitat types. Four other common species or species groups, in descending order of abundance, were savannah sparrow, redpoll, ptarmigan and horned lark. Given the abundance of Lapland Longspurs in the study area and the diversity of habitats used, they were selected as the indicator species for upland breeding birds in this assessment. Foraging habitats for longspurs are most often wet tundra meadows that are relatively flat; however, they will also use drier vegetated slopes. Nesting habitat is usually well-vegetated meadows.

Waterbirds — Of the 56 bird species observed at the Kiggavik site since 1979, 41 species are waterbirds (i.e., ducks, geese, shorebirds, gulls, terns, jaegers and cranes). Of these, American golden-plover, king eider, ruddy turnstone, semipalmated sandpiper, and Wilson's snipe are considered to be 'Sensitive' in Nunavut (CESCC 2006). No waterbird species observed to date is listed federally in the SARA or by COSEWIC and no other listed species are expected to occur.

Some waterbirds and eggs are harvested by local communities, particularly geese (Canada goose, snow goose) and some ducks. Elders and hunters interviewed for IQ studies confirmed that geese were a food source historically, and are still used today.

Population and distribution data on waterbirds were collected from a number of field surveys. The most common and widespread breeding species were Canada goose, sandhill crane, long-tailed duck, semipalmated sandpiper, American golden-plover and herring gull. Snow goose, a migratory species, was seen very commonly in late August and September in some years. Long-tailed Duck was used as the indicator species for the waterbird group because they are one of the most common waterbird species in the area during the growing season, and most wetland habitats are occupied. Long-tailed ducks select nesting sites that are relatively close to waterbodies, with nests frequently located on islands or within 100 m of shorelines. Long-tailed Ducks forage almost exclusively on or at the edge of waterbodies where they consume primarily aquatic insects, crustaceans, fish roe and vegetation.

Shorebirds — Shorebirds are a category of waterbird that are highly dependent on the upland/water interface. They are used as another indicator species for waterbirds because of their specific habitat requirements. Information on shorebirds was collected during several surveys, but specifically using PRISM (Program for Regional and International Shorebird Monitoring) plots and wetland shoreline surveys. Some of the more commonly observed shorebirds in the Project area included semipalmated sandpiper, dunlin, and red-necked phalarope. Other species included American golden plover, least sandpiper, pectoral sandpiper, semipalmated plover, and stilt sandpiper. Eskimo curlew (*Numenius borealis*) is an endangered shorebird species that may have migrated through the area historically, but has not been observed anywhere in decades and is likely extinct.

12.6 Species at Risk

The only species at risk recorded within the Kiggavik study area to date include peregrine falcon, short-eared owl, wolverine and grizzly bear. A brief summary of abundance and distribution of the latter three species is provided below.

Short-eared Owl — The short-eared owl is listed as Special Concern by COSEWIC and is on Schedule 3 of the SARA. Short-eared owls were rarely observed during the field surveys, but nesting was suspected. Graminoid, Shrub and Heath Tundra habitats, which are widespread and readily available within the RAA, provide good nesting habitat for Short-eared Owls. Key prey items for Short-eared Owls are small mammals including lemmings and red-backed vole.

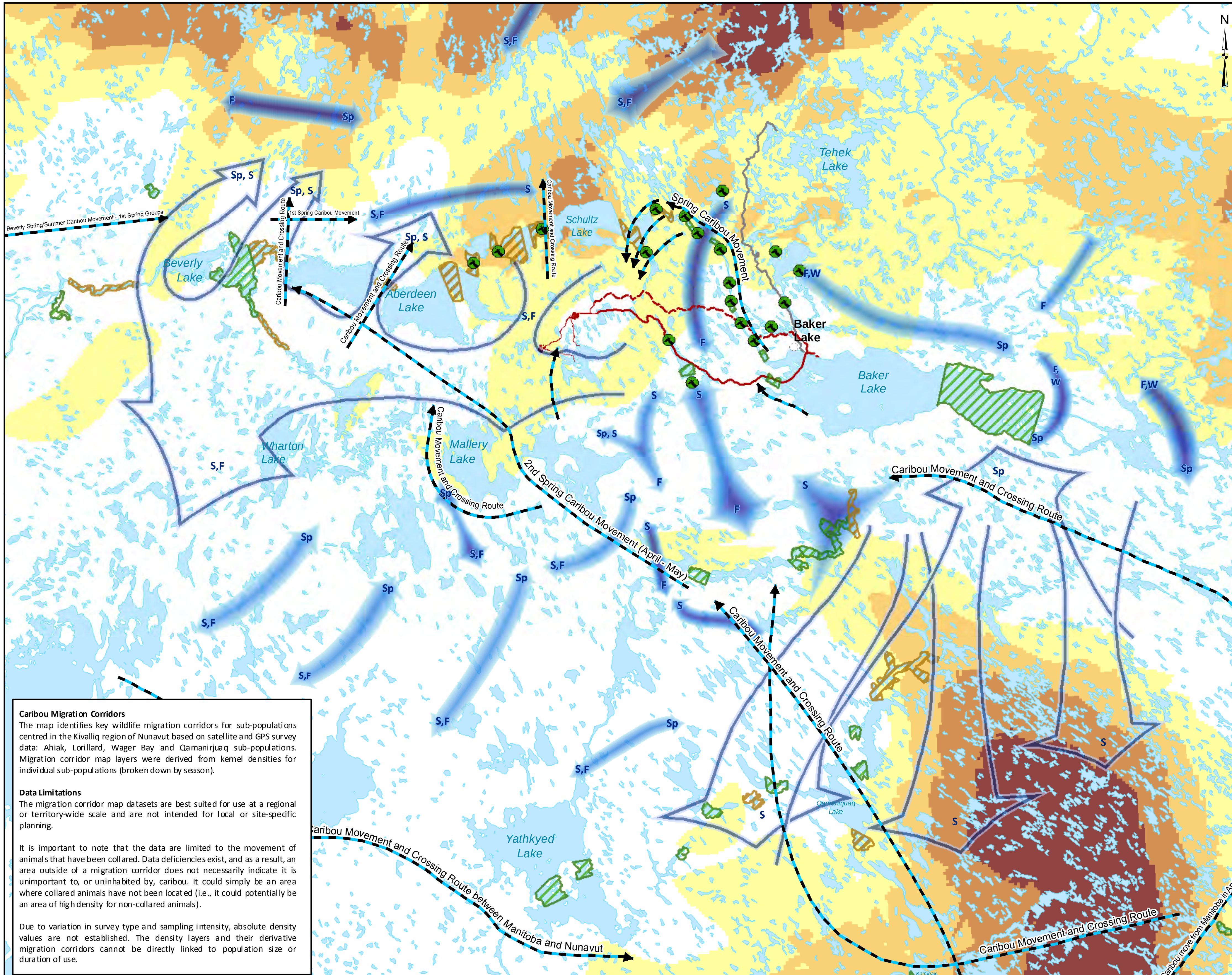
Wolverine — Wolverine is listed as ‘Secure’ in Nunavut (CESCC 2006) and as a species of Special Concern by COSEWIC, but is not listed under the SARA. The presence of wolverine in the Kiggavik RAA was confirmed during IQ studies, although low populations were noted. Some Elders commented that wolverine is one of the few targeted species that is not often found close to Baker

Lake. Wolverine is an important furbearing species for residents of Baker Lake, and the maintenance of a healthy population is important for local trappers.

Very little demographic information is available for wolverine largely because of their solitary nature and dispersion across the landscape. Wolverines were only occasionally recorded during field surveys in the Kiggavik RAA and appeared to be distributed across the entire Kiggavik RAA. No particular area, other than possible den sites, appears to be of critical importance.

Grizzly Bear — Grizzly bear is listed as 'Sensitive' in Nunavut (CESCC 2006) and is federally listed as Special Concern by COSEWIC, but is not listed under the SARA. The presence of grizzly bear in the Kiggavik RAA was confirmed during IQ studies, although comments noted that populations were low. According to Baker Lake community members, numbers of grizzly bears, and the number being killed each year, have been increasing steadily over the last few years. Previous IQ studies have also indicated that the number of harvested grizzly bears in the area has increased. The increase in grizzly bear populations and an apparent eastward range expansion were also documented in the literature.

Minimal abundance or distribution information is available for grizzly bear in the region largely because regional studies have not been conducted. Additionally, bears are solitary animals and widely dispersed on the landscape making standard aerial surveys methods unreliable for documenting bear distribution. The GN-DoE produced a grizzly bear sensitivity map. The identified areas are presumably where bears are relatively more abundant and exposed to some type of risk from humans. Grizzly bear were occasionally recorded during field surveys in the Kiggavik RAA and appeared to be distributed across the entire RAA. No particular area, other than possible den sites, appears to be of critical importance. During IQ studies, interviewees noted that grizzly bears have been observed in the area of Qikiqqtarjualik (Judge Sissons) Lake, near Shultz Lake and north of Baker Lake. The integration of the limited data show that the government sensitivity data, Project data and IQ are generally discordant (Figure 12.6-5), reflecting the lack of information on grizzly bears distribution.



Caribou Migration Corridors
The map identifies key wildlife migration corridors for sub-populations centred in the Kivalliq region of Nunavut based on satellite and GPS survey data: Ahiak, Lorillard, Wager Bay and Qamanirjuaq sub-populations. Migration corridor map layers were derived from kernel densities for individual sub-populations (broken down by season).

Data Limitations
The migration corridor map datasets are best suited for use at a regional or territory-wide scale and are not intended for local or site-specific planning.

It is important to note that the data are limited to the movement of animals that have been collared. Data deficiencies exist, and as a result, an area outside of a migration corridor does not necessarily indicate it is unimportant to, or uninhabited by, caribou. It could simply be an area where collared animals have not been located (i.e., it could potentially be an area of high density for non-collared animals).

Due to variation in survey type and sampling intensity, absolute density values are not established. The density layers and their derivative migration corridors cannot be directly linked to population size or duration of use.

Western Science Legend

Caribou Migration

Spring Migration Corridor (April - June), Campbell et al. 2012*

Increasing Use

Caribou Water Crossings

Caribou Water Crossings, GN 1978~

IQ Legend

Caribou Migration

Migration Routes, IAND 1978~

Migration Routes, IAND~(Sp = Spring, S = Summer, F = Fall, W = Winter)

Caribou Movement

Local Caribou Movements, AREVA 2014>

Caribou Water Crossings

Caribou Water Crossings, Riewe 1992<

Caribou Water Crossing, AREVA 2014>

Mine Site Legend

Proposed Kiggavik Site

Proposed Winter Road (Preferred)

Proposed All-Season Road (Option)

Meadowbank All-Season Road (Existing)

References

*Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective.Government of Nunavut, Department of Environment. Technical Report Series #1-2012. 274 pp.

<Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB.Art design Printing Inc.

>AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation.

~Department of Indian Affairs and Northern Development. 1978. Effects of Exploration and Development in Baker Lake Area Volume 1-Study Report & Volume 2-Map Supplement. Prepared by Interdisciplinary Systems Ltd. Winnipeg, MB.

Nunavut

GN Caribou data collected and analysed by: Mitch Campbell - Government of Nunavut, Department of Environment, Wildlife Division
Background: Collar locations collected between 1993 and 2012.

This map is not intended to be a complete representation of what is known

Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date: 06/02/2014 Scale: 1:1,500,000
Data Sources: Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., IAND, Baker Lake Hunter Focus Group, Baker Lake Hunters and Elders 2014, Gebauer & Associates.

FIGURE 12.6-1
REGIONAL CARIBOU MIGRATION, LOCAL MOVEMENT AND CROSSING INFORMATION - SPRING

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

30 0 30
Kilometers

KIGGAVIK PROJECT

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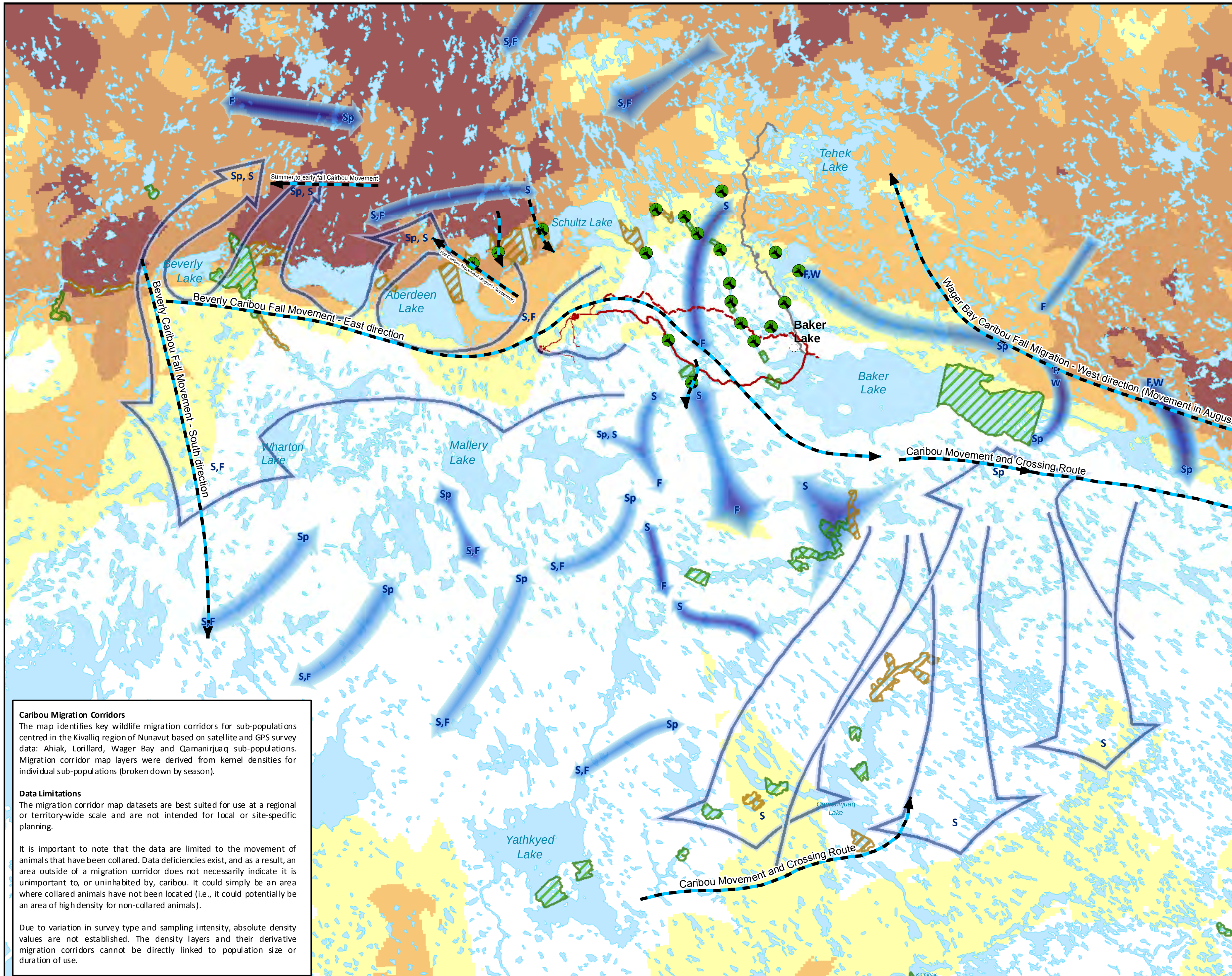

Caribou Migration Corridors
The map identifies key wildlife migration corridors for sub-populations centred in the Kivalliq region of Nunavut based on satellite and GPS survey data: Ahiak, Lorillard, Wager Bay and Qamanirjuaq sub-populations. Migration corridor map layers were derived from kernel densities for individual sub-populations (broken down by season).

Data Limitations
The migration corridor map datasets are best suited for use at a regional or territory-wide scale and are not intended for local or site-specific planning.

It is important to note that the data are limited to the movement of animals that have been collared. Data deficiencies exist, and as a result, an area outside of a migration corridor does not necessarily indicate it is unimportant to, or uninhabited by, caribou. It could simply be an area where collared animals have not been located (i.e., it could potentially be an area of high density for non-collared animals).

Due to variation in survey type and sampling intensity, absolute density values are not established. The density layers and their derivative migration corridors cannot be directly linked to population size or duration of use.

Western Science Legend

Caribou Migration

Fall Migration Corridor (Sepember - November), Campbell et al. 2012*

Increasing Use

Caribou Water Crossings

Caribou Water Crossings, GN 1978~

IQ Legend

Caribou Migration

Migration Routes, IAND 1978~

Migration Routes, IAND~(Sp = Spring, S = Summer, F = Fall, W = Winter)

Caribou Movement

Local Caribou Movements, AREVA 2014>

Caribou Water Crossings

Caribou Water Crossings, Riewe 1992<

Caribou Water Crossing, AREVA 2014>

Mine Site Legend

Proposed Kiggavik Site

Proposed Winter Road (Preferred)

Proposed All-Season Road (Option)

Meadowbank All-Season Road (Existing)

References

*Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective.Government of Nunavut, Department of Environment. Technical Report Series #1-2012. 274 pp.

<Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut. Edmonton, AB.Art design Printing Inc.

>AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation.

~Department of Indian Affairs and Northern Development. 1978. Effects of Exploration and Development in Baker Lake Area Volume 1-Study Report & Volume 2-Map Supplement. Prepared by Interdisciplinary Systems Ltd. Winnipeg, MB.

Nunavut

GN Caribou data collected and analysed by: Mitch Campbell - Government of Nunavut, Department of Environment, Wildlife Division
Background: Collar locations collected between 1993 and 2012.

This map is not intended to be a complete representation of what is known

Projection: NAD 1983 UTM Zone 14N
Compiled:TL
Date: 06/02/2014 Scale: 1:1,500,000
Data Sources: Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., IAND, Baker Lake Hunter Focus Group, Baker Lake Hunters and Elders 2014, Gebauer & Associates.

FIGURE 12.6-2
REGIONAL CARIBOU MIGRATION, LOCAL MOVEMENT AND CROSSING INFORMATION - FALL

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

30 0 30
Kilometers

KIGGAVIK PROJECT

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Western Science Legend

1	Beverly South Calving Area*
2	Lorillard Calving Area*
3	Qamanirjuaq Calving Area*
4	Caribou Calving Grounds - BQCMB
5	Proposed Protection Area Boundaries^

Increasing use

^Density values include survey data and telemetry data collected up to 2010.

IQ Legend

- Caribou Calving Area - IAND Interviews~
- Caribou Calving Area - IAND Biology~
- Caribou Calving Area>
- Caribou Calving Area<

Mine Site Legend

- Proposed Kiggavik Site
- Proposed Winter Road (Preferred)
- Proposed All-Season Road (Option)
- Meadowbank All-Season Road (Existing)

References

^Mychasiw.L. NWT Wildlife Service.1984. Five Year Review of the Beverly and Kaminuriak Caribou Protection Measures. File Report No.42

*Nagy, John A., Deborah L. Johnson, Nicholas C. Larter, Mitch W. Campbell, Andrew E. DerocherAllicia Kelly, Mathieu Dumond,Danny Allaire, and Bruno Croft. 2011. Subpopulation structure of caribou (Rangifer tarandus L.) in arctic and subarctic Canada. Ecological Applications 21:2334–2348. http://dx.doi.org/10.1890/10-1410.1

^Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective.Government of Nunavut, Department of Environment. Technical Report Series # 1-2012. 274 pp.

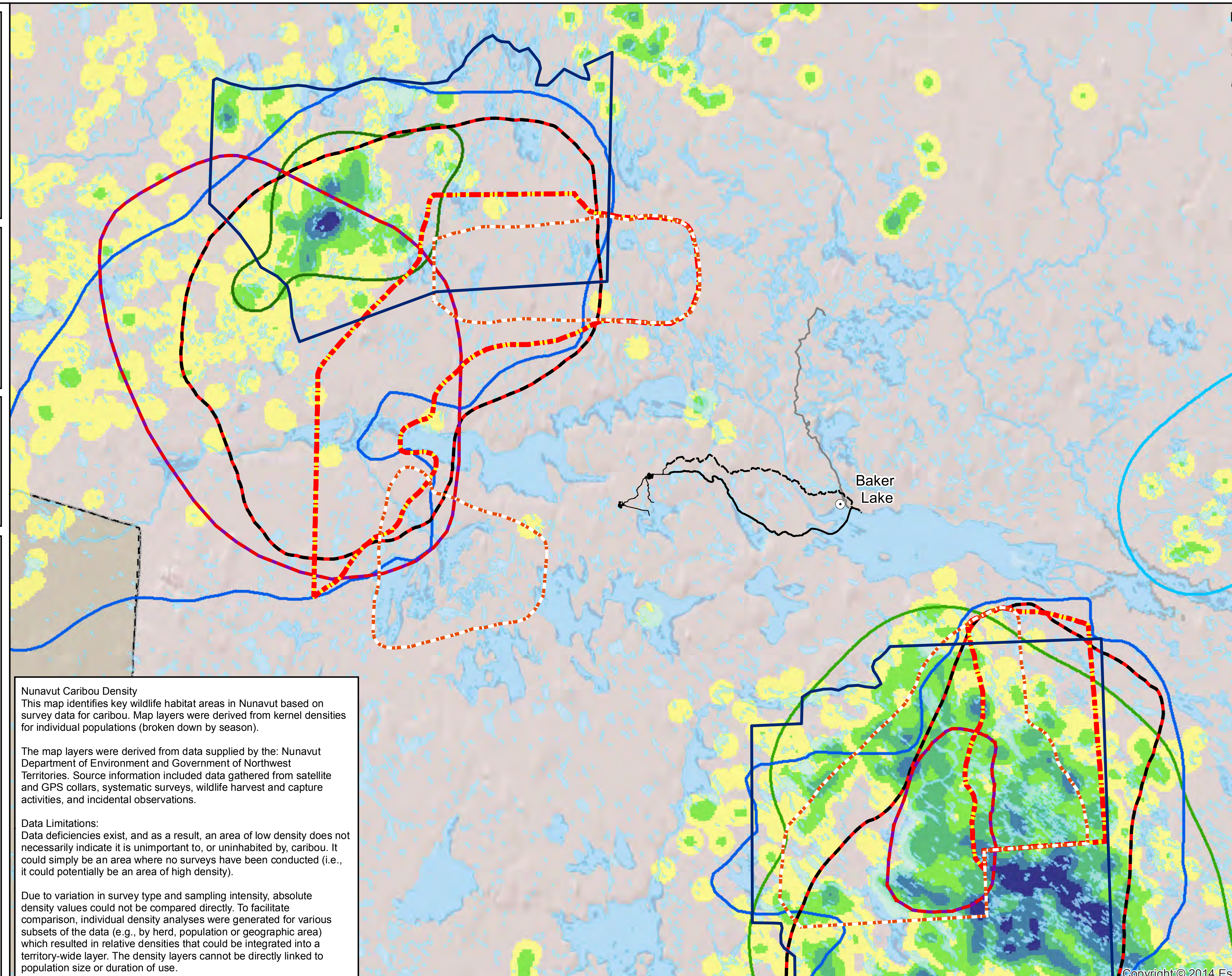
<Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut.Edmonton,AB.Art design Printing Inc.

>AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation.

~Department of Indian Affairs and Northern Development. 1978. Effects of Exploration and Development in Baker Lake Area Volume 1-Study Report & Volume 2-Map Supplement. Prepared by Interdisciplinary Systems Ltd. Winnipeg, MB.

Data Sources:
Natural Resources Canada, Caslys Consulting Ltd.
Department of Environment (Government of Nunavut)

This map is not intended to be a complete representation of what is known



Nunavut Caribou Density
This map identifies key wildlife habitat areas in Nunavut based on survey data for caribou. Map layers were derived from kernel densities for individual populations (broken down by season).

The map layers were derived from data supplied by the: Nunavut Department of Environment and Government of Northwest Territories. Source information included data gathered from satellite and GPS collars, systematic surveys, wildlife harvest and capture activities, and incidental observations.

Data Limitations:
Data deficiencies exist, and as a result, an area of low density does not necessarily indicate it is unimportant to, or uninhabited by, caribou. It could simply be an area where no surveys have been conducted (i.e., it could potentially be an area of high density).

Due to variation in survey type and sampling intensity, absolute density values could not be compared directly. To facilitate comparison, individual density analyses were generated for various subsets of the data (e.g., by herd, population or geographic area) which resulted in relative densities that could be integrated into a territory-wide layer. The density layers cannot be directly linked to population size or duration of use.

Projection: NAD 1983 UTM Zone 14
Compiled: TL Drawn: TL
Date: 9/18/2014 Scale: 1: 1,750,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.Natural Resources Canada, Caslys Consulting Ltd. Department of Environment (Government of Nunavut)*

FIGURE 12.6-3
REGIONAL CARIBOU CALVING AREAS

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

40 0 40
Kilometers

KIGGAVIK PROJECT

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File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 6 - Terrestrial Environment\Maps\Volume 6 - Tier 2\MXD\FINAL\Figure 12.6-3 Regional Caribou Calving Areas.mxd

Western Science Legend

*Muskoxen Sensitivity, Campbell et al 2012**

- Low or Data Deficient
- Moderate
- High
- Very High

IQ Legend

- Important Muskoxen Range, Riewe 1992<
- Muskoxen Range, Riewe 1992<

Muskox Range - Point Reference

1. A small resident population of muskox may be found within this unbounded area. Muskox have been observed recently near Sand and Deep Rose lakes.
2. This large area contains important range for muskox. During the spring, summer and early fall, muskox are found concentrated along the rivers, particularly the north shore of the Thelon and the region between the Tammarvi and Thelon Rivers. During the winter, muskox are more widespread in their distribution, but even then they do not appear to range very far from the Thelon or its tributaries. In fall, muskox are thought to move to the nearest satisfactory winter range, often elevated areas of windward slopes or hilltops where snow depths are at a minimum. Sometimes, during winter, they return to the forested areas along the rivers to forage. A few muskox may also be found in areas outside of the boundary of this area.
3. Within this area an estimated 150-200 muskox may be found. These animals tend to concentrate in areas adjacent to Pelly and Garry lakes along the unnamed river emptying into Upper Garry Lake and running through the central portion of the mapsheet.
4. This unbounded area which extends in all directions contains important range for small numbers of muskox. Within this area, muskox are found mainly concentrated in areas along the Bullen and, to a lesser extent, the Back rivers. A few may also be found, on occasion, outside this area.

Mine Site Legend

- Proposed Kiggavik Site
- Proposed Winter Road (Preferred)
- Proposed All-Season Road (Option)
- Meadowbank All-Season Road (Existing)

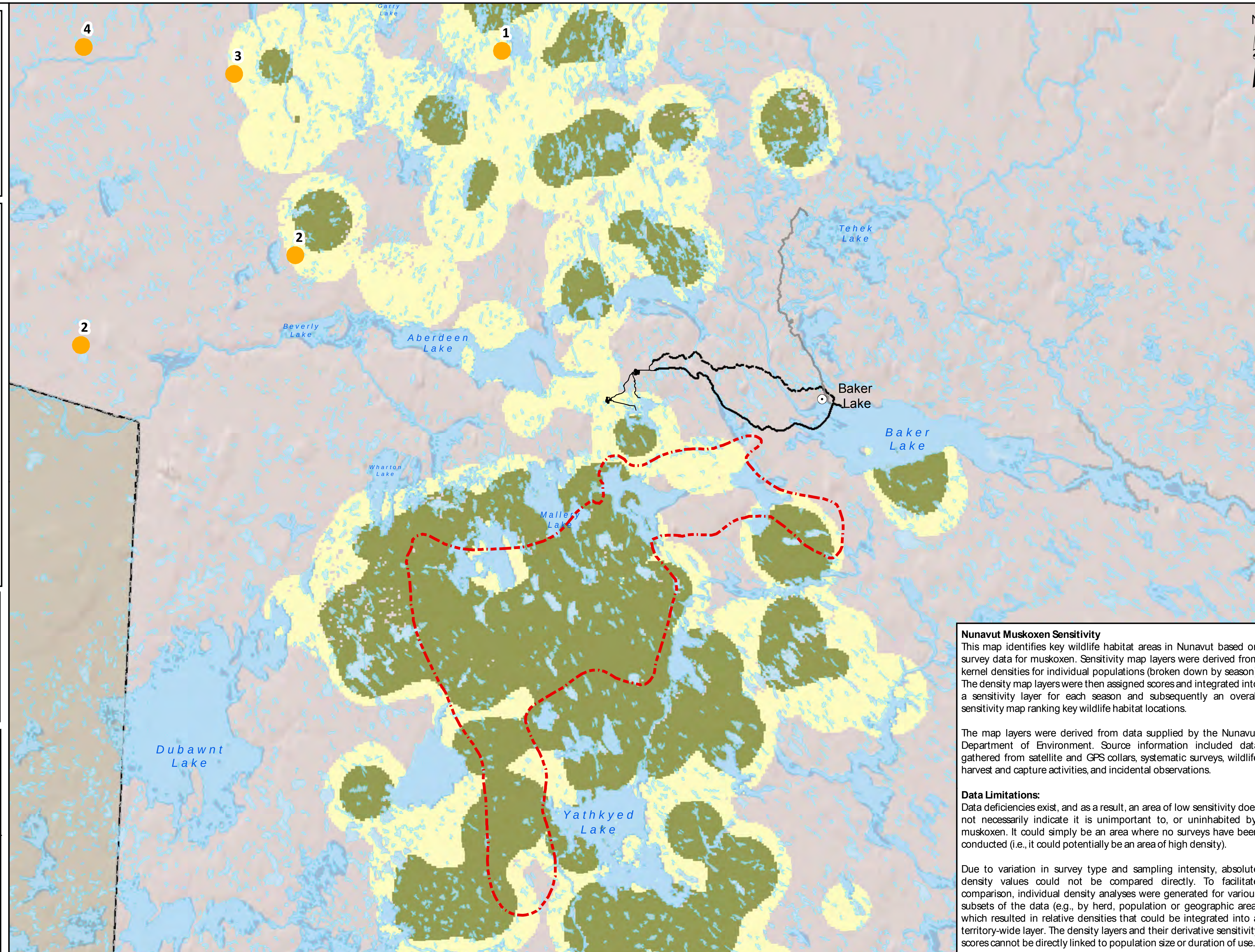
References

*Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective.Government of Nunavut, Department of Environment. Technical Report Series # 1-2012. 274 pp.

<Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut.Edmonton,AB. Art design Printing Inc.

Data Sources:
Natural Resources Canada, Caslys Consulting Ltd.
Department of Environment (Government of Nunavut)

This map is not intended to be a complete representation of what is known



Nunavut Muskoxen Sensitivity
This map identifies key wildlife habitat areas in Nunavut based on survey data for muskoxen. Sensitivity map layers were derived from kernel densities for individual populations (broken down by season). The density map layers were then assigned scores and integrated into a sensitivity layer for each season and subsequently an overall sensitivity map ranking key wildlife habitat locations.

The map layers were derived from data supplied by the Nunavut Department of Environment. Source information included data gathered from satellite and GPS collars, systematic surveys, wildlife harvest and capture activities, and incidental observations.

Data Limitations:
Data deficiencies exist, and as a result, an area of low sensitivity does not necessarily indicate it is unimportant to, or uninhabited by, muskoxen. It could simply be an area where no surveys have been conducted (i.e., it could potentially be an area of high density).

Due to variation in survey type and sampling intensity, absolute density values could not be compared directly. To facilitate comparison, individual density analyses were generated for various subsets of the data (e.g., by herd, population or geographic area) which resulted in relative densities that could be integrated into a territory-wide layer. The density layers and their derivative sensitivity scores cannot be directly linked to population size or duration of use.

Projection: NAD 1983 UTM Zone 14
Compiled: TL Drawn: TL
Date: 9/18/2014 Scale: 1: 1,750,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.Natural Resources Canada, Caslys Consulting Ltd. Department of Environment (Government of Nunavut)*

FIGURE 12.6-4
MUSKOX SENSITIVITY & HERD RANGE

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40 0 40
Kilometers

KIGGAVIK PROJECT

AREVA

Western Science Legend

Grizzly Bear Sensitivity, Campbell et al. 2012*

- Low or Data Deficient
- Moderate
- High
- Very High

AREVA Grizzly Bear Observations

- Grizzly Bear - 2007 Incidental Ground Observations
- Grizzly Bear - Winter Road South Alignment Survey

Point Reference
A. Dig
B. Standing
C. Walking
D. Inactive Den Site
E. Chew on Willow
F. Tracks

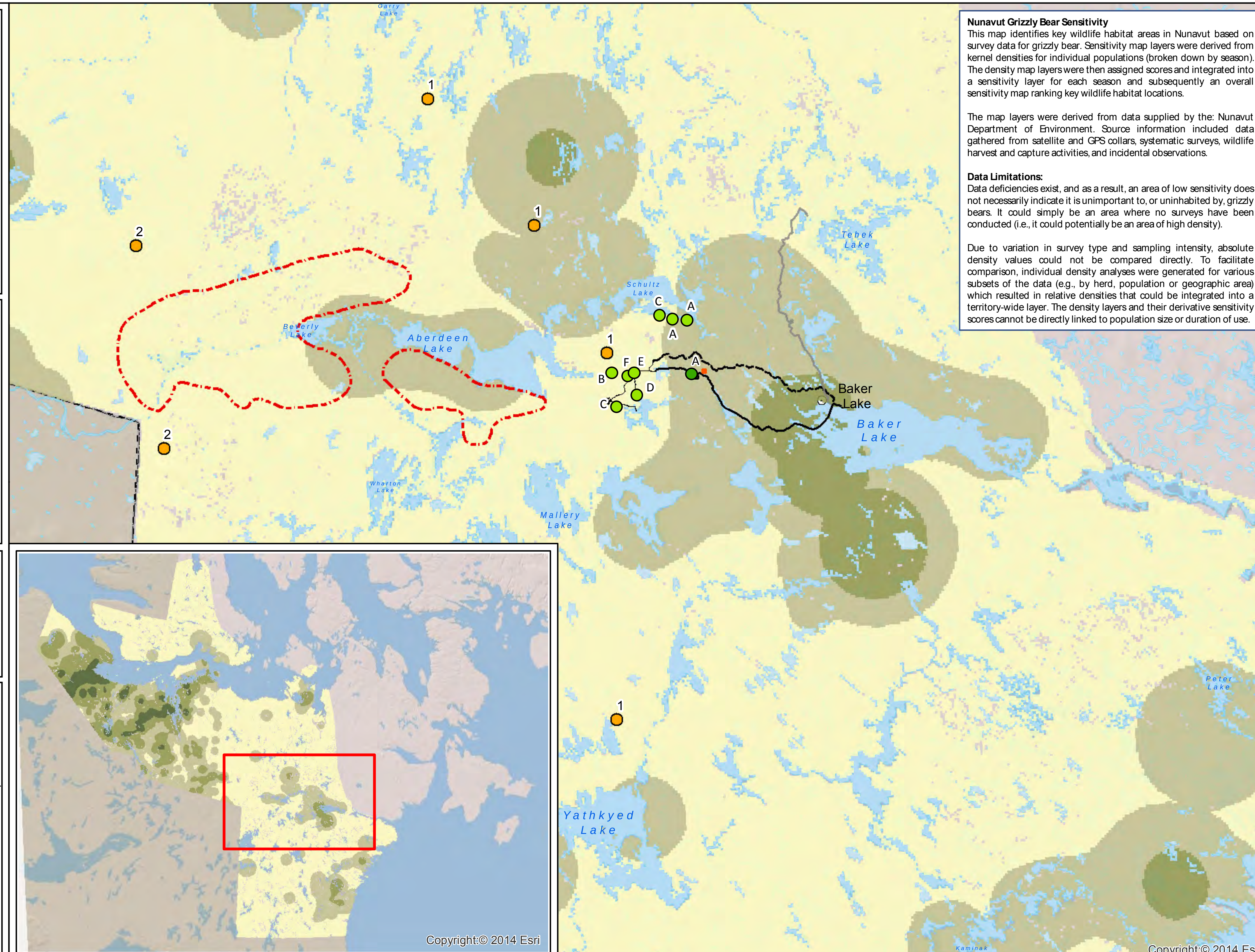
IQ Legend

- Grizzly Den, AREVA>
- Grizzly Denning Area, Riewe 1992<
- Grizzly Bear Observation, Riewe 1992<

Grizzly Bear Observations - Point Reference<
1. Barren-ground grizzly bears have been commonly observed throughout the area. There is no boundary associated with this area.
2. Barren-ground grizzly bear occur throughout this unbounded area but are most commonly observed in close proximity to the rivers, particularly the Thelon. Sandy areas adjacent to the rivers provided denning habitat.

Mine Site Legend

- Proposed Kiggavik Site
- Proposed Winter Road (Preferred)
- Proposed All-Season Road (Option)
- Meadowbank All-Season Road (Existing)



Nunavut Grizzly Bear Sensitivity
This map identifies key wildlife habitat areas in Nunavut based on survey data for grizzly bear. Sensitivity map layers were derived from kernel densities for individual populations (broken down by season). The density map layers were then assigned scores and integrated into a sensitivity layer for each season and subsequently an overall sensitivity map ranking key wildlife habitat locations.

The map layers were derived from data supplied by the: Nunavut Department of Environment. Source information included data gathered from satellite and GPS collars, systematic surveys, wildlife harvest and capture activities, and incidental observations.

Data Limitations:
Data deficiencies exist, and as a result, an area of low sensitivity does not necessarily indicate it is unimportant to, or uninhabited by, grizzly bears. It could simply be an area where no surveys have been conducted (i.e., it could potentially be an area of high density).

Due to variation in survey type and sampling intensity, absolute density values could not be compared directly. To facilitate comparison, individual density analyses were generated for various subsets of the data (e.g., by herd, population or geographic area) which resulted in relative densities that could be integrated into a territory-wide layer. The density layers and their derivative sensitivity scores cannot be directly linked to population size or duration of use.

References

*Campbell, M. W., J.G. Shaw, C.A. Blyth. 2012. Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective.Government of Nunavut, Department of Environment. Technical Report Series # 1-2012. 274 pp.

<Riewe, Rick (Editor). 1992. Nunavut Atlas. Canadian Circumpolar Institute and the Tungavik Federation of Nunavut.Edmonton,AB. Art design Printing Inc.

>AREVA 2014. Kiggavik Environmental Impact Statement. Tier 3, Technical Appendix 3B: IQ Documentation.

Data Sources:
Natural Resources Canada, Caslys Consulting Ltd.
Department of Environment (Government of Nunavut)

This map is not intended to be a complete representation of what is known

Projection: NAD 1983 UTM Zone 14
Compiled: TL Drawn: TL
Date: 9/19/2014 Scale: 1: 1,750,000
Data Sources: *Natural Resources Canada, Geobase®, Nation Topographic Database, AREVA Resources Canada Inc.Natural Resources Canada, Caslys Consulting Ltd. Department of Environment (Government of Nunavut)*

FIGURE 12.6-5
GRIZZLY BEAR SENISITIVITY & OBSERVATIONS

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

KIGGAVIK PROJECT

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

File:Q:\SHEQ\GIS\KIGGAVIK\2014\EIS\Volume 6 - Terrestrial Environment\Maps\Volume 6 - Tier 2\MXD\FINAL\12.6-5 Grizzly Bear Sensitivity and Observations.mxd

13 Effects Assessment for Caribou and Muskox

13.1 Scope of the Assessment for Caribou and Muskox

13.1.1 Project-Caribou/Muskox Interactions and Effects

Project activities have the potential to affect the abundance, distribution, movement and health of caribou and muskox within the Kiggavik RAA. A summary of relevant Project activities and a description of the associated environmental interactions were included in Table 11.4-1. The most substantive and temporally relevant effect of the Project to wildlife is the land clearing required for construction of the mine site and, if implemented, the development of the All-Season Road option, and those parts of the Project are the focus of the assessment. Reclamation will return land to a more natural state, but will not return the area to baseline conditions. Key issues related to potential effects on caribou and muskox are summarized in Table 13.1-1 and include:

- Increased mortality risk from wildlife-vehicle collisions or indirectly by increased harvest (improved access);
- Reduced habitat availability from the Project footprint that results in a direct loss of foraging habitat;
- Reduced habitat effectiveness due to sensory disturbances;
- Creating semi-permeable or permanent barriers to migratory and localized movements because of sensory disturbance or physical barriers created by mine infrastructure, and
- Change in population health

Table 13.1-1 Project-Environment Interactions and Potential Effects on Caribou and Muskox

Project Component	Project Activities	Environmental Effect			
		Change in Mortality	Change in Habitat	Change in Movement	Change in Health
Construction					
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing)		2	2	
Supporting Activities	Transport fuel and construction materials	2		2	
	Air transport of personnel and supplies		2	2	
	Explosives storage and use		2	2	

Table 13.1-1 Project-Environment Interactions and Potential Effects on Caribou and Muskox

Project Component	Project Activities	Environmental Effect			
		Change in Mortality	Change in Habitat	Change in Movement	Change in Health
Operation					
Mining	Mining ore (blasting, loading, hauling)		2	2	2
	Mining clean waste (blasting, loading, hauling)		2		2
Milling	Crushing and grinding		2		2
Transportation	Truck transportation	2		2	
	General traffic (Project-related)	2	2	2	
	Controlled public traffic	2		2	
	Air transportation of personnel, goods and supplies		2	2	
Ongoing exploration	Aerial surveys			2	
	Ground surveys			2	
Final Closure					
On-land Decommissioning	Revegetation		2		
NOTES: Only Project interactions ranked as 2 in Table 11.4-1 are carried forward to this table. A 2 indicates an activity with the potential to contribute to an effect.					

13.1.2 Residual Environmental Effects Criteria for Caribou and Muskox

Residual effects on caribou and muskox were characterized quantitatively and qualitatively using direction, magnitude, geographic extent, frequency, duration and reversibility — the definitions are summarized in Table 13.1-2.

Table 13.1-2 Residual Environmental Effects Criteria for Caribou and Muskox

Attribute	Description	Rating	Definition
Direction	The ultimate long-term trend of the environmental effect	Positive	Reduced mortality risk, reduced barriers to movement, increased habitat availability, or improvements in animal health relative to baseline conditions
		Neutral	No change in mortality risk, habitat, movement or animal health
		Adverse	Increased mortality risk, increased barrier to movement, decreased habitat availability, or decrease in animal health relative to baseline conditions
Magnitude	Amount of change in a measurable parameter relative to baseline conditions; for health, defined by potential for exposure compared to a toxicity benchmark	Negligible	No anticipated effect on wildlife species
		Low	Observable effect on wildlife species but not likely to affect species' sustainability in the LAA
		Moderate	Observable effect on wildlife species but not likely to affect the species' sustainability in the RAA
		High	Measurable effect on wildlife species that will likely affect the species' sustainability in the RAA
Geographic Extent	The geographic area within which an environmental effect occurs	Local	Effect confined to the LAA
		Regional	Effect extends beyond the LAA but within the RAA
		Territorial	Effect extends beyond the RAA but within Nunavut
		National	Effect extends beyond Nunavut but within Canada
Frequency	Number of times that an effect may occur over the life of the Project	Once	Effect occurs once throughout the Project
		Sporadically	Effect occurs occasionally but not consistently throughout the life of the Project
		Regularly	Effect occurs repeatedly at regular intervals throughout the life of the Project
		Continuous	Effect occurs continuously throughout the Project
Duration	Length of time over which the effect is measurable	Short term	Less than one year
		Medium term	More than one year, but not beyond the end of the Project.
		Long term	Beyond the life of the Project
Reversibility	Likelihood that a measurable parameter for a VEC will recover from an environmental effect to baseline conditions	Reversible	Will likely recover to baseline conditions after or before the end of the Project.
		Irreversible	Unlikely to recover to baseline conditions after the end of the Project.

13.1.3 Standards or Thresholds for Determining Significance

As described in Section 11.7.3 — Technical Boundaries, no standards or thresholds exist for determining the significance of Project effects on caribou and muskox. The Project is not located within any known caribou calving grounds and there are no protected water crossing areas located within 10 km of the Project. In the absence of legislated or otherwise identified thresholds, the significance of effects are determined based largely on experience, and precedence or lessons learned from other project environmental assessments. The authors and their qualifications that determined the significance thresholds are identified in FEIS Tier 2, Volume 6, Terrestrial Environment, page i. Determination of whether the Project's residual effects on caribou and muskox are considered significant is based on whether the effect influences the long-term viability of a population or delays its recovery. A residual effect is considered not significant if the effect causes a change in the condition of an individual or population (or their habitat) that is within the range of natural variability or does not affect the integrity of a population in a measurable way. Potential changes in a measurable parameter or VEC resulting from Project or cumulative effects were evaluated against these standards or thresholds, and were rated as either significant or not significant.

The assessment of Project effects on caribou and other wildlife species is divided into two components: the effects on the viability of the caribou populations (biophysical effects) and the effects on those who harvest caribou (socio-economic effects). The biophysical effects are associated with the sustainability of caribou herds — Will the herds be able to survive given the construction, operation, and final closure of the mine? The socio-economic effects are associated with hunting caribou — Will the communities still be able to harvest caribou in the numbers required to meet their needs? In the FEIS, Volume 6, Terrestrial Environment, the Project effects on caribou, a Valued Environmental Component (VEC) as identified in the NIRB guidelines and during community meetings are assessed. In the FEIS, Volume 9, Part 1, Socio-Economic Environment, the effects of the Project on caribou harvesting are assessed. The definition of the significance of the effects is different for each case. The two cases are connected in that if we maintain the long-term viability of caribou populations, future generations of local harvesters should be able to continue with their traditional hunting practices.

Mortality — Increased mortality risk could be significant if caribou or muskox herd-specific mortality is increased beyond a level of sustainable harvest (e.g., Total Allowable Harvest [TAH], or greater than 5% mortality for overall harvest of the "standing stock" of a given caribou herd); identified by the Kivalliq Regional Biologist (Campbell et al. 2010). Standing stock is defined as 75% of a total herd estimate. We assume the same TAH calculation for muskox herds. The context for the assessment of Project effects on caribou mortality is the sustainability of the Kivalliq caribou herds that interact with the Project. To adopt a more conservative approach, the management threshold for caribou and muskox mortality is one Project-related mortality per year of operation, which is much less than the accepted TAH threshold.

Habitat — There are no known or definitive habitat loss or disturbance thresholds specific to barren-ground caribou. The concepts and evidence of critical habitat thresholds are debated in the literature (e.g. Swift and Hannon 2010). A scientific review of empirical evidence suggested habitat disturbance thresholds for boreal caribou up to 35% within individual ranges (e.g., Environment Canada 2011, Environment Canada 2012). Outside of the literature, other northern mining project environmental assessments have used criteria for habitat disturbance ranging from 10 to 40% in seasonal range as a measure of a significance (e.g., Meadowbank — Cumberland Resources Ltd. 2005; High Lake — Wolfden Resources Inc. 2006; Gacho Kué — De Beers Canada Inc. 2010). Based on current literature and precedents set in previous projects, a habitat disturbance threshold of 10% within seasonal range or population unit is very conservative. There was no available IQ that suggested thresholds about habitat effects.

Movement — There are no prescribed thresholds for evaluating Project effects on movement. Changes in caribou movement are difficult to define or assess discretely because responses to disturbance may vary from none, to minor or delayed movement, to deflected movement. Predicting those behavioural responses is challenged by a lack of empirical or conclusive behavioural data on animal responses to various disturbances and how that may affect individual or population-level movement. There was no available IQ that suggested thresholds about movement effects.

Possible Project effects on migratory and localized movement are characterized quantitatively (for caribou) with encounter and residency rates as descriptive statistics characterizing movement. That quantitative evaluation reveals the likely proportion of time that caribou from the various herds interact with the Project during migratory and less migratory periods. The overall Project effect on movement is addressed qualitatively by reviewing the location of the Project in respect to major migratory pathways and known and protected water crossing areas. We also review the Project location relative to distinct seasonal areas such as calving and post-calving grounds. Finally, we consider the effects of the project on localized movements that are not necessarily migratory when considering sensory disturbances during periods when caribou may be more sedentary within the zone of influence (ZOI). Regardless of the number of ways of characterizing movement, there are no effective thresholds known to the authors of determining significance of effects on movement per se. Rather, those effects are encompassed within predicted reduced habitat effectiveness (Habitat Availability), or within measures of possible Project effects on caribou energetics and likely population projections (combined Project effects).

Health — For this assessment, the estimated exposure to COPC (Constituents of Potential Concern) by wildlife and birds is compared to values that are set to be protective of health. If the exposure is lower than this value then no adverse effects are expected. The estimated dose received by the biota from exposure to radioactivity, considering both baseline and Project emissions, is compared to a level that is protective of mammals.

13.1.4 Technical Limitations of the Assessment for Caribou and Muskox

Section 11.7.3 describes the general technical and/or scientific limitations that introduce uncertainty to the assessment of Project effects to wildlife. Information, data and knowledge gap limitations that are relevant to the effects assessment on caribou and muskox are described below.

Caribou — Despite being the most well-studied species in the Kivalliq region, gaps remain in the ecology of barren-ground caribou. The available information demonstrates many consistencies between Inuit Qaujimajatuqangit (IQ), local knowledge, scientific literature, and unpublished government reports. However, there are also discrepancies that arise, introducing uncertainty into the assessment on caribou.

Caribou and the habitats they use are always changing over time, and as a result, herd designations often change and have resulted in some debate about the behaviour and distribution of certain populations. For example, the population decline and calving distribution change of the Beverly herd is a debated topic and not agreed upon by all parties. The observed population decline in the Beverly herd may have been less drastic, a result of a gradual switch in calving grounds. This argument suggests the possibility of two distinct calving areas for Beverly animals in the past. However, an alternative explanation may be that the observed population decreases were evidence of a severe decline that forced a shift to different calving areas for the Beverly, and the move to the Queen Maud Gulf (Ahiak) calving area (Gunn et al. 2011). Although not fully understood or agreed upon, it is clear that the connection between the two herds make it difficult to fully explain population changes with certainty.

Similarly, when the DEIS was submitted, the resident tundra wintering caribou were identified as the Baker Lake herd (or “resident herd”), the Lorillard herd, and Wager Bay herd. Recently, the Government of Nunavut published the *Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective* (hereafter referred to as the Atlas; Campbell et al. 2012), which provides updated herd designations. Further to that, the Government of Nunavut’s Department of Environment identified Qamanirjuaq, Beverly, Ahiak, Lorillard and Wager Bay as barren ground caribou herds in the mainland Kivalliq region (Government of Nunavut Department of Environment 2013), with no reference to a Baker Lake or “resident” herd. According to the Atlas, the former “resident herd” referred to in the DEIS is actually part of the much larger Ahiak herd. While it is acknowledged that the interpretations presented in the Atlas will continue to be updated as additional information is gathered, we believe the data and interpretations presented represent some of the best available information upon which to base the FEIS assessment. The Atlas will continue to change over time as caribou distribution and our understanding of the dynamics of caribou range use changes, resulting in much uncertainty.

During the technical review period (DEIS revision), many interveners commented on the limitations of caribou collar data for the assessment of potential Project effects. Collar data illustrates caribou distribution in the RAA, including when, where, and what proportion of a herd may be in the area. Many attributes of caribou herds are identified by the distribution and behaviour of collared female caribou; for example, herds are defined by calving grounds often identified from a combination of survey and collar data, modeling of habitat selection by caribou describes only female habitat use, and migratory paths. Female caribou are the focus of collaring programs because their behaviour and survival have larger demographic consequences for herds. The general assumption is that the difference between male and female caribou distribution and behaviour is insignificant at the scales of these programs.

Nonetheless, collar data generally represents only a small proportion of caribou in a herd, which introduces uncertainty regarding the magnitude of effects to caribou. Effects to caribou are considered at the herd or population scale, thus effects determination depends on the proportion of individuals from a population that could be affected by a Project disturbance. For the assessment of Project effects on caribou, the consideration of collar data was based on a small proportion of female collared caribou, over a relatively short time period (20 years or less), and with an uneven distribution of collars over the years (Table 13.1-3). Although this information provides insight into individual behaviour of collared caribou, it was not the only type of information used in the assessment of effects to caribou.

Another area that introduces uncertainty into the assessment is the lack of information regarding natural mortality rates and harvest patterns. Not only is there an overall lack of information on harvest, but the rate and distribution of harvest changes over time, depending on a number of factors. In terms of Project-related mortality (i.e., vehicle collisions, tangling in Project infrastructure), uncertainties are addressed by examining lessons learned from other mining projects in the north. These technical limitations are noted in the assessment. The dynamic and fluctuating nature of mortality trends is noted. To partly compensate for the missing information we incorporate conservative estimates of Project-related mortality and cumulative harvest in the assessment of mortality risk.

All available information sources (collared caribou, aerial surveys, IQ and engagement, baseline studies, hunter harvest surveys, other published information, etc.) were used to determine when and where caribou may be affected by the Project and to assess potential Project and cumulative effects on caribou and caribou harvesters. The information in the Atlas, combined with IQ and other data sources comprises the best available information to assess potential Project effects to caribou. This information will continue to change over time, which, as described in detail above, introduces uncertainty in the assessment. To address this uncertainty, conservative estimates of the magnitude of effects were made and a continual improvement and adaptive management approach (Tier 3, Appendix 2T) is employed to minimize future Project effects on caribou. This approach will be informed by monitoring and revising over time to minimize effects.

Muskox — The technical limitations for muskox are similar to those for caribou; however, as a species, muskox are perhaps, less understood than caribou. Information regarding the populations and distribution of muskox in the Kivalliq region are very limited, which ultimately translates into uncertainty in the magnitude of potential Project and cumulative effects to muskox.

Table 13.1-3 Caribou collar datasets used in the assessment

Dataset	Herd	Number of collared animals	Average frequency of transmission (fixes)	Maximum timeframe*
GN Baker Lake 2008–2013	Ahiak	22	1 per day	May 15, 2008 to Feb. 18, 2013
	Lorillard	9	1 per day	Apr. 24, 2011 to Feb. 18, 2013
	Wager Bay	2	1 per day	Nov. 18, 2009 to Feb. 16, 2013
GN 1999–2006	Lorillard	15	1 every 5 days	Apr. 26 1999 to Aug. 12, 2006
	Wager Bay	2	1 every 5 days	Apr. 26 1999 to Nov. 17, 2004
GN 2000–2006	Lorillard	2	1 every 5 days	Apr. 19 2000 to Apr. 5, 2005
	Wager Bay	12	1 every 5 days	April 19, 2000 to Dec 31, 2006
GN 1993–2013	Qamanirjuaq	89	1 per day	April 1, 1993 to to Feb. 18, 2013
	Lorillard	2	1 every 5 days	Mar. 30, 1998 to Jul. 27, 2000
GNWT 2001–2009	Ahiak	1	1 every 3 days	Mar. 26, 2005 to Mar. 23, 2009
	Beverly	5	1 every 3 days	Mar. 27, 2001 to March 24, 2009
GNWT satellite 1996–2010	Ahiak	1	1 every 3 days	Mar. 26, 2005 to Mar. 23, 2009
	Beverly	5	1 every 3 days	Apr. 11, 1996 to Dec. 29, 2010
	Qamanirjuaq	1	1 every 6 days	Mar. 27, 2001 to Jul. 14, 2005
GNWT 2006–2012	Ahiak	7	1 per day	Mar. 9, 2006 to Dec. 30, 2012
	Beverly	55	1 per day	Mar. 8, 2006 to Dec. 30, 2012
	Qamanirjuaq	3	1 per day	Mar. 10, 2006 to Dec. 30, 2012

*Due to natural death, predation, and hunting, not all animals survive the entire timeframe listed.

13.2 Effects Assessment for Caribou and Muskox

13.2.1 Assessment of Change in Mortality

Caribou and muskox mortality can be affected by human developments through direct mortality from collisions with vehicles or entanglement with Project infrastructure (i.e., fencing) and indirect mortality from changes to activity budgets potentially increasing individual energetic demands leading to reduced survival (Bradshaw et al. 1998). Direct mortality from collisions with vehicles is quantifiable. Changes to activity budgets and resulting effects on energy balance is addressed within the caribou energetics model (Tier 3, Volume 6, Attachment A). The effect of potential increased harvest on changes to mortality risk for caribou and muskox is addressed as a cumulative effect in Section 13.3.3.

13.2.1.1 Analytical Methods for Change in Mortality

The Project's effect on direct caribou mortality was assessed qualitatively as the probability of increased risk of activities that could kill caribou, primarily the direct mortality of caribou from vehicle collisions on the access road options. Mortality resulting from interactions with other Project infrastructure was also considered. The assessment involved reviewing literature and evaluating the various factors that can influence the risk of collisions (e.g., traffic volumes, embankment characteristics, roadside attractants, speed limits, areas of the road close to migration corridors or water crossings), as well as experience and lessons learned at other northern mine sites that interact with caribou.

13.2.1.2 Baseline Conditions for Change in Mortality

Starvation, predation, and disease are mortality factors for caribou. There is no available information on trends or proportions of mortality from natural causes. An overview of current knowledge of these factors is provided in Campbell et al. (2010). However, there were no issues identified in that review that are known to interact with Project activities. For the purposes of this assessment, mortality due to these natural causes are presumed to be constant, not influenced by the Project, and are not discussed further.

Lessons learned from other Projects in the north can help to characterize Project effects to caribou mortality. At the nearby Meadowbank Mine, caribou were killed in vehicle collisions in 2007 (3), 2008 (2), 2010 (1), 2012 (1), and 2013 (5) totaling 12 caribou in seven years of road operation (Agnico Eagle Mine Limited 2008, 2010, 2012, 2013). Other mining Projects with roads, including Diavik, Ekati, Baffinland, Red Dog, and Snap Lake have reported no caribou-vehicle collisions; however, some instances of having to deter caribou from airstrips has occurred. Fencing also may interact negatively with caribou. At the Ekati mine in NWT, four caribou became entangled in airport fencing and died, leading to changes in fencing design and strategies to deter caribou from the airstrip (BHP Billiton Canada Inc. 2012).

To determine the Project's potential for increased risk of caribou mortality, an understanding of the seasonal distribution of caribou herds within the RAA is necessary (see the wildlife baseline report, Tier 3, Volume 6, Appendix 6C). Only summary information is provided in this section. This information is suitable for determination of potential effects of vehicle-caribou collisions. Encounters and residency times of each herd was determined by evaluating caribou collar data and is described fully in Section 13.2.3, Assessment of Change in Movement. Section 13.2.3 also provides information from IQ and the Atlas that describes seasonal movements of each herd. Table 13.2-1 summarizes female collared caribou use in relation to the two road LAAs.

This summary is limited in that it uses only one data source (collar data limitations are described in Section 13.1.4); however, it provides a generalized overview of herd use throughout the season. Based on this summary and information from IQ, it is a conservative assumption that caribou will likely interact with the roads and mine throughout the year. Caribou movements can also be unpredictable: *the elders say caribou have always changed their migration routes* (EN-BL OH Oct 2012), so some years there may be very few caribou near the road, and in other years, large groups of caribou may migrate across the road.

Table 13.2-1 Summarized herd interactions with Project road LAAs

Herd	All-Season Road LAA	Winter Road LAA
Ahiak	3/30 collars from 2005–2013 intersected the LAA Present during spring, fall and rut, and early and late winter	2/30 collars from 2005–2013 intersected the LAA Present during spring and early and late winter
Qamanirjuaq	5/93 collars from 1993–2012 intersected the LAA Most interaction during post-calving, but also during summer, early, and late winter	5/93 collars from 1993–2012 intersected the LAA Most interaction during post-calving, but also during summer, early, and late winter
Beverly	No collared caribou have interacted with the LAA during any season from 1996–2012	No collared caribou have interacted the LAA during any season from 1996–2012
Lorillard	5/28 collars from 1998–2013 (excluding 2007–2010) intersected the LAA Present during summer and early and late winter	1/28 collars from 1998–2013 (excluding 2007–2010) intersected the LAA Present during early and late winter
Wager Bay	1/28 collars from 1999–2013 (excluding 2007–2008) intersected the LAA Present during early and late winter	No collars from 1999–2013 (excluding 2007–2008) intersected the LAA

13.2.1.3 Effect Mechanisms and Linkages for Change in Mortality

Project-related activities could directly cause mortality events through vehicle collisions or entanglement with other Project infrastructure (e.g., fencing), resulting in reduced wildlife abundance within the RAA.

The risk of mortality from vehicle collisions is greatest in the winter months when there is decreased light and visibility for drivers, caribou are using the road for easier travel, or they are concentrated in groups on the road (Klein 1971, van der Grift 2001). Similarly, collisions with moose tend to increase with increasing snow depth and colder ambient temperatures (Gundersen et al.1998). In years with poor snow conditions (e.g., deep snow and fall icing), caribou may use the road (this likely only applies to the Winter Road) as a travel corridor to decrease energy costs, especially if they are already in poor physical condition (Klein1971), potentially increasing the risk of vehicle collisions. Current snow conditions in winter are hard-packed and allow for relatively easy movement across the landscape.

Caribou entanglement has occurred at the Ekati Diamond Mine in NWT (BHP Billiton Canada Inc. 2012). Caribou have died after getting stuck in sediment ponds, entangled in fencing, and have been injured after becoming tangled in communication tower support guy wires (BHP Billiton Canada Inc. 2012). One caribou had to be killed after it would not leave the airstrip and was creating a threat to aircraft and human safety (BHP Billiton Canada Inc. 2012). The main entanglement issues were related to the electric fencing at the airstrip, which was replaced with a Construction and Safety Barrier Fence after the issue with caribou was identified (BHP Billiton Canada Inc. 2012).

13.2.1.4 Mitigation Measures and Project Design for Change in Mortality

More detail on mitigation and monitoring for caribou and muskox is available in the WMMP (Tier 3, Volume 6, Appendix 6D). Mitigation for vehicle-caribou collision mortality is the responsibility of AREVA and a number of measures exist for mitigating the Project's potential effect on caribou and muskox mortality.

AREVA will partially mitigate the risk of increased caribou and muskox mortality due to collisions with vehicles travelling the access roads by:

- Installing signage that warns drivers of known caribou crossing or foraging areas along the road;
- Reducing speed limits where caribou interact with the road during the winter;
- Enforcing road speed limits;
- Snow plowing escape routes for caribou;
- Reporting of caribou sightings along the road to a wildlife monitor;

- Ensuring radio communication among trucks to identify wildlife locations on an ongoing basis;
- Employing a seasonal wildlife monitor to coordinate implementing caribou mitigations;
- Reporting and investigating all Project-related caribou or muskox near-misses and mortalities, and
- evaluating management strategies if there is a Project-related mortality.

13.2.1.5 Residual Effects for Change in Mortality

During the previous years of exploration in the Kiggavik Project area, no caribou mortalities occurred as a result of Project activities. The Project could result in adverse effects on caribou through direct and indirect increase to caribou mortality risk. Direct mortality could result from caribou-vehicle collisions or entanglement with other Project infrastructure. In addition, slow speed limits (30 km/hr) on the Winter Road reduce the potential occurrence for vehicle-caribou collisions at time when the risk is greater (i.e., lower light conditions, potential use of road by caribou, etc.). Vehicle-caribou collisions are unlikely to occur due to the low densities of caribou with the RAA during the winter.

Entanglement in fences is also unlikely to occur as snow fences are the only fencing structures considered for the Kiggavik Project. The proposed location of these snow fences can be found in the DEIS Tier 2, Volume 2, Project Description and Assessment Basis, Section 4.4.2, Figure 4.4-1 and Section 4.4.3, Figure 4.4-3. A standard mesh barrier heavy duty snow fence, likely made from high density polyethylene that will have a mesh opening small enough to prevent entanglement (i.e., likely a 1-1/4” x 1-1/4” mesh opening), will be constructed and maintained. Lessons learned from other mines in Nunavut and NWT suggest that having a minimal amount of fencing will reduce the likelihood of injury or death from entanglement. A further description of the snow fences is provided in DEIS Tier 2, Volume 2, Project Description and Assessment Basis, Section 9.4.

Vehicle-related mortalities to caribou are expected to be few to none throughout the life of the mine. From 1997 to 2011, no vehicle-related caribou mortalities occurred at the Ekati diamond mine (BHP Billiton Canada Inc. 2012). Vehicle-related mortalities to wildlife were primarily limited to birds and small mammals, with the exception of one wolf killed in 2002 (BHP Billiton Canada Inc. 2012). Although those data are from a different setting, it demonstrates the ability of mitigation and monitoring efforts to minimize effects to caribou mortality. Project-related direct mortality on caribou is readily reduced by adjusting speed limits, seasonal traffic limits, and regular monitoring of caribou numbers and proximity to transportation corridors.

Based on the assessment of potential Project effects to caribou mortality risk, and in consideration of the proposed mitigation measures, it is expected that Project-related mortalities will not exceed identified thresholds. Nonetheless, there remains a low probability that caribou mortalities will occur as a result of the Project. A conservative estimate of Project-related mortalities is one caribou per year. If a caribou death is directly linked to the Project, adaptive management measures will be triggered, resulting in a review of practices and potential modifications to Project activities.

Mine and All-Season Road

Caribou-vehicle collisions may occur, but the identified mitigation will make these events unlikely. Mitigation measures are in place to stop Project traffic if large numbers of caribou are crossing certain areas of the road during migratory seasons. The magnitude of the effects regarding the interaction of the Project with the caribou herds is expected to be low. The frequency of increased mortality risk is continuous and will occur throughout the duration of the Project; however, the effects are expected to be local. The residual effects will be reversible following decommissioning of the road during the final closure phase.

Mine and Winter Road

The risk of mortality may be increased during the winter months with low light levels and the potential for caribou to be using the road as a travel corridor in poor snow conditions. Project mitigation will greatly reduce the potential for caribou-vehicle collisions, and effects at the caribou population level will be undetectable. The magnitude of potential Project effects on caribou mortality risk is expected to be negligible. The frequency of increased mortality risk is continuous and will occur throughout the duration of the Project; however, the effects are expected to be local. The residual effects will be reversible following decommissioning of the road during the final closure phase.

13.2.1.6 Determination of Significance for Change in Mortality

There is a very low potential for direct mortality risk from collisions with caribou along the access roads. Project-related mortality will be reduced by adjusting speed limits, regular monitoring, and communication of caribou in proximity to the road infrastructure. The risk of caribou being unable to move off the road when encountering vehicle traffic is considered low and mitigable because embankments and snow banks will be designed and managed to allow for wildlife movement. Residual effects of the Project on caribou mortality are not expected. Mortality, if it occurs, will be limited to individuals within the Project footprint.

The magnitude of Project effects on caribou mortality risk is predicted to be negligible. Any effect will be undetectable at the local scale, will occur continuously during mine operation, and is reversible following final closure of the Project. The effect of the Project on caribou mortality is not significant at the herd or population scale. Confidence is high in this prediction because most other mining projects in the north have been able to operate without exceeding predicted mortality thresholds. If the Meadowbank project is an example of a worst-case scenario, 12 caribou have been killed over seven years of road operation, resulting in approximately two Project-related caribou deaths per/year. With a 12 year operation life, the Kiggavik Project could result in 24 caribou deaths, which still does not exceed the 5% TAH in any herd that interacts with the Project. The likelihood of this scenario occurring is low and is mitigable.

13.2.1.7 Summary of Project Residual Environmental Effects for Change in Mortality

Project effects on increased mortality risk of caribou is expected to be not significant since the Project is not expected to contribute to caribou mortality such that numbers are detected at the population level. Table 13.2-2 summarizes the residual environmental effects of the Project for change in mortality to caribou. The Winter Road option reduces the potential for an increase in mortality risk for caribou. The All-Season Road option would slightly increase potential for an increase in caribou mortality risk, but AREVA's management actions are expected to mitigate the potential for Project related mortality. However, all road options are expected to have no significant effects on caribou herds that interact with the Project. The mitigation options available to AREVA, namely the wildlife decision matrix in Appendix 6D, and the no harvest policy, is readily implemented, monitored and enforced. Uncertainties associated with the conclusion include difficulty in predicting direct mortality events, and the unknown, but suspected low probability of caribou interaction with Project infrastructure through the year.

13.2.1.8 Compliance and Environmental Monitoring for Change in Mortality

Compliance and environmental monitoring for changes in mortality to caribou and muskox includes the following:

- continue participation in the GN-led caribou collaring program (determine seasonal distribution by herd)
- support GN-led herd deliniation and population estimate survey (determine regional herd population trends)
- report all wildlife collisions and monitor trends seasonally and annually
- continue Project-specific caribou monitoring programs (e.g., ground-based observations)

Table 13.2-2 Summary of Residual Environmental Effects for Change in Mortality to Caribou

Project Phase	Mitigation / Compensation Measures	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in Caribou Mortality Risk — All-Season Road Option												
Construction		N	N	L	MT	C	R	U	N	N/A	H	None recommended
Operation	Road closures. Private access. Multi-party management speed limits, use of convoys	N	N	L	MT	C	R	U	N	N/A	M	Road check-point monitoring, HHS
Final Closure	Road closures; private access; multi-party management	N	N	L	MT	C	R	U	N	N/A	M	Road check-point monitoring, HHS
Change in Caribou Mortality Risk—Winter Road Option												
All Project Phases		N	N	L	MT	C	R	U	N	N/A	M	Continued monitoring (collar studies) of herd distribution during winter road operation, HHS

KEY

Direction:
- P Positive
- N Negative

Magnitude:
- N Negligible: No anticipated effect on wildlife species
- L Low: Observable effect on wildlife species but not likely to affect the species' sustainability in the Project area
- M Moderate: Observable effect on wildlife species but not likely to affect the species' sustainability in the region
- H High: Measurable effect on wildlife species but that will likely affect the species' sustainability in the region

Geographic Extent:
- S Site-specific
- L Local: Effect confined to the LAA
- R Regional - Effect extends beyond the LAA but within the RAA
- T Territorial: Effect extends beyond the RAA but within Nunavut
- N National: Effect extends beyond Nunavut but within Canada

Duration:
- ST Short term: Less than one year
- MT Medium term: More than one year, but not beyond the end of Project decommissioning
- LT Long term: Beyond the life of the Project

Frequency:
- O Once: Effect occurs once
- S Sporadically: Effect occurs occasionally but not consistently throughout the life of the Project
- R Regularly: Effect occurs at regular intervals throughout the life of the Project
- C Continuous: Effect occurs continuously throughout the Project

Reversibility:
- R Reversible: Will likely recover to baseline conditions after or before the end of Project decommissioning
- I Irreversible: Unlikely to recover to baseline conditions after the end of Project decommissioning

Environmental Context:
- U Undisturbed: Area relatively or not adversely affected by human activity
- D Developed: Area has been substantially previously disturbed by human development or human development is still present

N/A Not Applicable

Significance:
- S Significant
- N Not significant

Prediction Confidence:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
- L Low level of confidence
- M Moderate level of confidence
- H High level of confidence

Likelihood of Significant Effects:

Based on professional judgment
- L Low probability of occurrence
- M Medium probability of occurrence
- H High probability of occurrence

13.2.2 Assessment of Change in Caribou and Muskox Habitat Availability

Habitat availability as a measurable parameter encompasses direct habitat loss, reduced habitat effectiveness due to sensory disturbances, and the potential for Project infrastructure to create a filter effect to movement resulting in reduced accessibility to habitat. The specific measureable parameters for habitat availability include:

1. Area of direct growing and winter season habitat loss within the Project footprint
2. Area of reduced growing and winter season habitat effectiveness within the ZOI

Habitat availability can be affected by human developments through two pathways:

- Direct habitat loss due to the Project footprint. Loss to the footprint reduces the amount of habitat available; and
- Indirect habitat loss (reduced effectiveness) from human activity associated with the Project that causes a functional loss of habitat (avoidance due to sensory disturbances such as that associated with noise and dust).

13.2.2.1 Analytical Methods for Change in Habitat Availability

Caribou and muskox baseline habitat conditions were quantified in the wildlife baseline report (Tier 3, Volume 6, Appendix 6C). The baseline growing season and winter habitat was quantified within the general wildlife RAA using a high, medium, low and nil quality habitat rating system based on the attributes of the ecological land classification (ELC) units and their likelihood of providing life requisites to caribou. A quantifiable method such as a Resource Selection Function (RSF) that correlated landscape attributes to caribou locations was not possible because AREVA did not have the rights to the collar data from the GNDoE to conduct that analyses. Further, the habitat classification was limited to the general wildlife RAA because ELC data were not available for the entire seasonal range when the analyses was conducted.

Habitat availability was quantified by calculating available Habitat Units (HUs) for the baseline and Project conditions. Habitat units were quantified by first assigning a Suitability Index (SI) to each habitat category: High (3), Medium (2), Low (1), and Nil (0). Habitat Units were then quantified by multiplying the SI by the area of the ELC polygon rated as high, medium, low, or nil. Availability of high, medium, low, and nil quality habitats are thus represented by the total Habitat Units within the general wildlife RAA for baseline and Project conditions.

Project effects on habitat availability were predicted by reducing habitat classes in areas within the Potential Disturbance Area (PDA) and ZOI. Areas within the PDA were reduced to Nil because it was presumed that habitat would be within the project footprint and no longer considered habitat. Areas within the ZOI were reduced by one or two suitability categories (to a minimum of low) depending on species' likely response to sensory disturbances. These class reductions represent habitat that may be less effective due to disturbances in the ZOI.

Change to habitat availability was calculated by subtracting the Project scenario from the baseline scenario. This calculation shows the effect within the general RAA for a detailed analyses of high, medium, low, and nil quality habitat. Habitat availability of high, medium and low quality habitats were quantified at the scale of the general wildlife Regional Assessment Area (RAA). Presuming that the proportion of high, medium and low quality habitat is proportional to that available within the broader seasonal ranges (for caribou) and MX/21 management unit (for muskox), habitat effects significance was determined by calculating the habitat effect at the scale of the seasonal range (% seasonal range effect = [Total % RAA Effect*RAA Total Area/Seasonal Range Area*100].

Change in habitat availability for caribou was assessed for the Ahiak and the Qamanirjuaq herds because those herds have the greatest interaction with the Regional Study Area (RSA) during the winter (1 October to 31 May) and growing seasons (1 June to 30 September), respectively. The remaining herds use the RSA less frequently, and Project-related effects on those herd's habitat will be less. Additional analyses on habitat effects for those herds would not inform the project effects assessment or provide additional information for habitat effects mitigation, as mitigation for habitat is the same regardless of which caribou herds interact with the Project.

The seasonal range sizes were calculated using the minimum convex polygon technique from the available collar data (Table 13.1-3). The growing season includes the period 1 June to 30 September, and the winter season includes the period 1 October to 31 May). Using a minimum convex polygon for those collar data, excluding outliers and Hudson Bay (assuming that Hudson Bay is not used by caribou due to the lack of forage), the growing season range for the Qamanirjuaq herd collared females was 394,930 km^2[197] , and the Ahiak herd's winter season range was 600,686 km^2. Although these range sizes are considered conservative, they roughly represent the potential area used by at least females of the Qamanirjuaq and Ahiak herds during the respective seasons.

Change in habitat availability for muskox was assessed at the scale of Wildlife Management Unit MX/21 as a representation of the area used by the population of muskox that interact with the Project. The total area of MX/21 is ~31,872km^2. The areas discussed above are illustrated in Figure 13.2–1.

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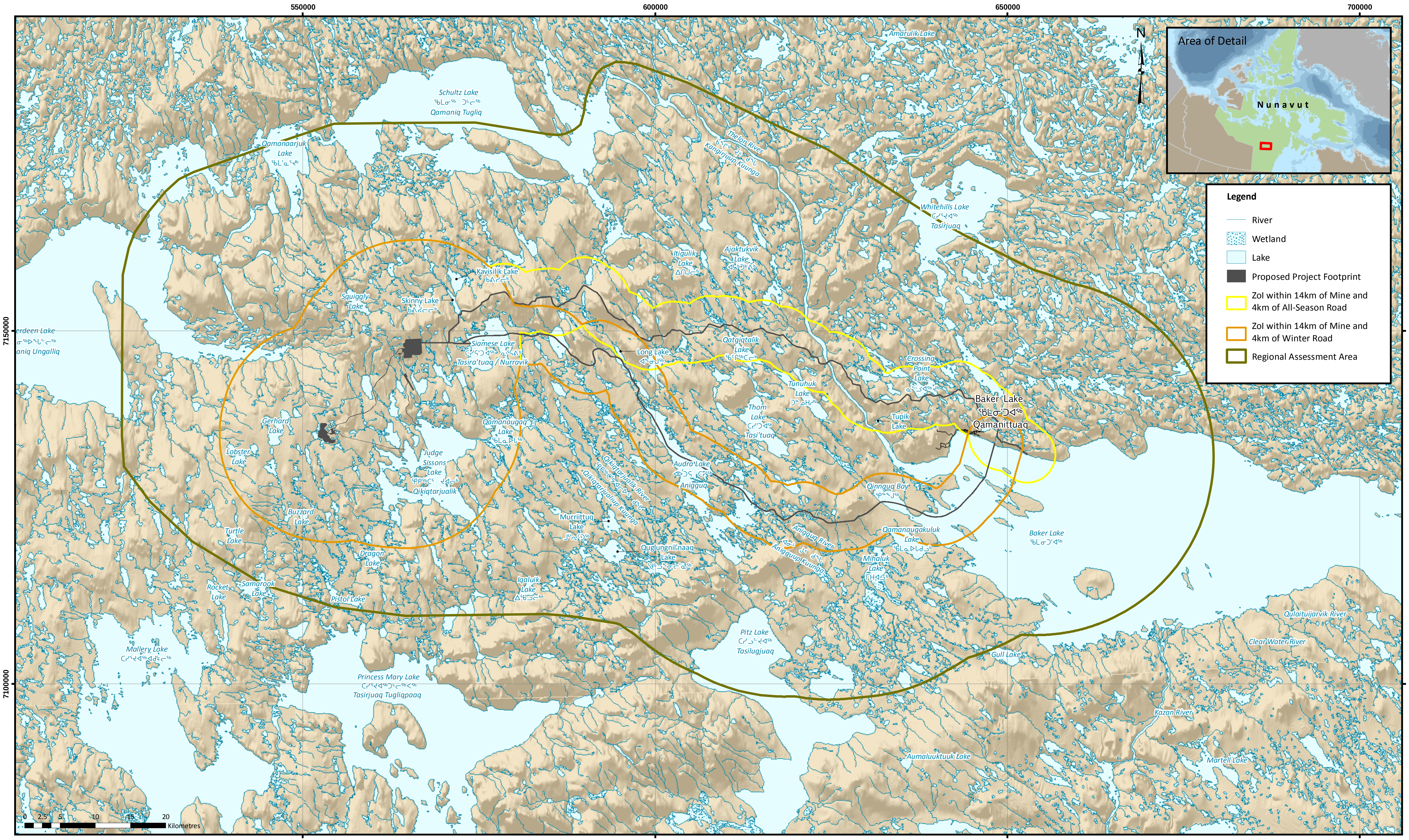
[197] Smaller MCP area than what was reported in DEIS due to collar re-assignment (i.e., what was previously considered a Qamanirjuaq collar is now assigned to Lorillard herd, and therefore excluded from MCP)



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 09/18/2014 Scale: 1:500,000
File: 13.2-1_Zones_of_Influence_for_Mine_and_Access_Roads.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., Gebauer & Associates.*

FIGURE 13.2-1

ZONES OF INFLUENCE FOR CARIBOU AND MUSKOX APPLIED TO THE PROPOSED KIGGAVIK MINE SITE AND ACCESS ROAD OPTIONS

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project

AREVA

AREVA Resources Canada Inc - P.O. Box 9204 - 817 - 45th Street West - Saskatoon, SK - S7K 3X5

Direct Habitat Loss — Direct loss of caribou and muskox habitat was assessed by identifying ELC units that will become unavailable because of the footprint of the mine site, quarries, and the access road options. The Winter Road option will remove and reduce the effectiveness of habitat in winter, but the habitat will be available again each summer when the road is decommissioned.

The Project footprint in summer (1,704 ha) was calculated using a 25 m buffer of mine site facilities (surrounding Kiggavik and Sissons mine sites/facilities/air strip/haul roads), a 12 m buffer around the all-season road alignment (24 m width), a 25 m buffer around dock options 1 and 2, and a 100 m buffer around 29 associated quarry centroids. The Project footprint in winter (1,583 ha) used the same areas for the mine sites/facilities/air strip/haul roads, but assumed a 6 m buffer (12 m width) of the winter road, and a 100 m buffer around 10 associated quarry centroids.

Indirect Habitat Loss — Indirect loss of habitat was assessed for growing and winter seasons within the mine site and access road options. Indirect habitat loss due to the mine site was quantified by downgrading habitat quality values (ELC unit quality) within a ZOI interpreted from results reported in Boulanger et al. (2012). This study is directly relevant to the Project as it is a study of the ZOI of three large-scale northern mining projects on the distribution of the Bathurst caribou herd. The authors document an 11 km ZOI using satellite-collar data and a 14 km ZOI using aerial survey data. There remains some uncertainty about the mechanism causing caribou responses to human disturbance, so while many other studies have documented reduced abundance at much smaller distances, we predict project effects using a precautionary approach by applying a 14 km ZOI to the mine site and assume a large effect to describe a conservative bounding scenario for the mine site. Indirect habitat loss due to the access roads was quantified by downgrading habitat values within a ZOI based on Cameron et al. (2005). This report synthesizes results from a long-term study of the effects of petroleum development on caribou distribution on calving and post-calving grounds in northern Alaska. It is the strongest evidence of a ZOI for migratory caribou around transportation infrastructure and reports a reduction in caribou occurrence within 4 km of roads.

Based on predicted caribou response to disturbances, habitat quality within the mine site ZOI was reduced by 2 classes to a minimum of low within 7 km of the mine footprint, and by 1 class to a minimum of low within 14 km of the mine footprint (Table 13.2-3). Habitat quality within each access road option ZOI was reduced by 2 classes to a minimum of low within 1 km of the access road footprints, and by 1 class to a minimum of low within 4 km of the access road footprints. The Winter Road ZOI was only applied to the winter season assessment because the road will not be present during the growing season and, consequently, disturbance along the road will also be absent during this period.

A habitat unit index was developed to assess the overall loss of caribou and muskox habitat availability within the RAA. The index is based on assigning a ranked value to each habitat class (e.g., high=3, moderate=2, low=1, nil=0), and summing the available habitat, measured in hectares, weighted by the value of each class. The difference in the weighted sum of available habitat for the baseline conditions, and the predicted direct and indirect loss of habitat indicate the expected change in caribou and muskox habitat.

Table 13.2-3 Habitat Reduction Zone of Influence by Project Area

Project area	ZOI	Habitat reduction
All	Project footprint	All habitat within the Project footprint is rated as nil
Mine site	0 – 7 km	2 class reduction to a minimum of Low
	7 – 14 km	1 class reduction to a minimum of Low
All-Season road	0 – 1 km	2 class reduction to a minimum of Low
	1 – 4 km	1 class reduction to a minimum of Low
Winter road	0 – 1 km	2 class reduction to a minimum of Low
	1 – 4 km	1 class reduction to a minimum of Low

13.2.2.2 Baseline Conditions for Change in Habitat Availability

Caribou

Caribou habitat quality within the RAA is described in the wildlife baseline report (Tier 3, Volume 6, Appendix 6C) and linked to ELC units. Caribou primarily feed on lichen during the winter period and fresh shrubs (leaves and stems) and graminoids during the growing season (Adamczewski et al. 1988). Also, *in January they try to be in rough areas when it is too cold* (EN-BL EL Oct 2012). A description of the ELC units and their value to caribou is presented in Table 13.2-4.

During the growing season, the RAA contains mostly high, moderate, and nil quality habitats (Table 13.2-5). Habitat rated as nil during the growing season is due to the abundance of water in the RAA. During the winter season, there is a roughly equal amount of high, moderate and low quality habitat distributed throughout the RAA (Table 13.2-5). Most of the high quality habitat during the growing season is located in the southern portions of the Kiggavik RAA.

Table 13.2-4 Description and Relative Value of ELC Units for Caribou during the Growing and Winter Seasons in the RAA

ELC Unit	Growing	Winter	Reasoning
Water	N	L	Water is not important caribou habitat, but can be used during the winter (ice). Shorelines may provide some insect relief, but other habitats associated with elevation provide better relief
Sand	M	L	Caribou select habitats containing predominately sand during the growing season to avoid insect harassment (BQCMB 1999). The value of sand in winter is low because the habitat contains limited food and there are no insects in winter
Gravel	M	L	Caribou select habitats containing predominately gravel during the growing season to avoid insect harassment (BQCMB 1999). The value of gravel in winter is low because the habitat contains limited food and there are no insects in winter.
Rock Association	L	L	Rock association provides little usable habitat for caribou as there is little available food.
Wet Graminoid	H	M	Wet graminoid habitat was categorized as high during the growing season due to new vegetative growth that is high in energy content, easily digestible, and abundant. Caribou select graminoids while foraging during the spring and summer periods; 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 during the growing season due to new vegetative growth that is high in energy content, easily digestible, and abundant. In winter, forage quality 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 during 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 habitat 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 during the growing season. Due to the abundance of lichen the value is higher in the winter.
Heath Upland	M	H	This habitat type has all the vegetation used by caribou during the growing season. Due to the abundance of lichen the value is higher during the winter. Ridge tops my also provide areas of reduced snow depth.
Lichen Tundra	M	H	Lichen is the most important food source for caribou in winter. During 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.

Table 13.2-4 Description and Relative Value of ELC Units for Caribou during the Growing and Winter Seasons in the RAA

ELC Unit	Growing	Winter	Reasoning
Heath Upland/ Rock Complex	L	M	Relatively low value during the growing season because of the rock content, but is higher during the winter because of lichen content.
NOTE: Growing season is defined as 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; N = Nil			

Table 13.2-5 Availability of Caribou Habitat within the RAA during Growing and Winter Seasons

ELC rating	Growing Season (%)	Winter Season (%)
High	34	29
Moderate	35	39
Low	6	32
Nil	26	0
No Rating	0	0

Muskox

Muskox habitat quality within the RAA is described in the baseline report. Muskox primarily feed on willow and sedges during the summer (Gunn and Sutherland 1997; Nellemann and Reynolds 1997). ELC units with a large willow component are Graminoid/Shrub Tundra, Shrub Tundra and Shrub/Heath Tundra. Earlier in the summer, muskox are known to feed on sedges (Gunn 1984) that are found within the Graminoid/Shrub Tundra, Shrub Tundra and Shrub/Heath Tundra ELC units (Table 13.2-6). Most of the habitat within the RAA is classified as moderate quality, and no high quality habitats for muskox are found within the RAA during the growing season (Table 13.2-7). The majority of the habitat within the RAA is classified as moderate quality for the winter period; however, there is an increase in the amount of habitat considered high and low quality (Table 13.2-7).

Table 13.2-6 Description and Relative Value of ELC Units for Muskox during the Growing and Winter Seasons in the RAA

ELC Unit	Growing Season	Winter Season	Reasoning
Water	N	L	Water is not important muskox habitat in either season, but can be travelled across during frozen periods in the winter (ice).
Sand	L	L	Sand is not important muskox habitat in either season as there is little available food.
Gravel	L	L	Gravel is not important muskox habitat in either season as there is little available food.
Rock Association	L	L	Rock association provides little usable habitat for muskox as there is little available food.
Wet Graminoid	M	M	Wet graminoid habitat was categorized as moderate for both the growing and winter seasons because of the availability of preferred foods including grasses, sedges and willows/shrubs.
Graminoid Tundra	M	M	Graminoid tundra habitat was categorized as moderate for both the growing and winter seasons because of the availability of preferred foods including grasses, sedges and willows/shrubs.
Graminoid/ Shrub Tundra	M	M	Graminoid/shrub tundra habitat was categorized as moderate for both the growing and winter seasons because of the availability of preferred foods including grasses, sedges and willows/shrubs.
Shrub Tundra	M	H	Shrubs (willows) form a large part of a muskox's diet for both the growing and winter seasons, but particularly in winter when deep snow limits access to grasses and sedges in low-lying areas.
Shrub/Heath Tundra	M	H	Shrubs (willows) form a large part of a muskox's diet during the growing and winter seasons, but particularly in winter when deep snow limits access to grasses and sedges in low-lying areas.
Heath Tundra	M	M	Heath tundra habitat has shrubs used by muskox for both the growing and winter seasons. Due to the shallower snow depths in these areas, shrubs are more accessible, although they occur at lower densities than in wetter habitats.
Heath Upland	M	M	Heath upland habitat has shrubs used by muskox for both the growing and winter seasons. Due to the shallower snow depths in these areas, shrubs are more accessible, although they occur at lower densities than in wetter habitats.
Lichen Tundra	L	L	Lichen is not an important food source for muskox in any season.
Heath Upland/ Rock Complex	L	L	Due to the high densities of rock, shrub availability is lower than in the heath upland habitat unit.

NOTE:

Growing season is defined as 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; N = Nil

Table 13.2-7 Availability of Muskox Habitat within the RAA during Growing and Winter Seasons

ELC rating	Growing Season (%)	Winter Season (%)
High	0	10
Moderate	66	56
Low	8	34
Nil	26	0
No Rating	0	0

13.2.2.3 Effect Mechanisms and Linkages for Change in Habitat Availability

The Kiggavik Project will reduce habitat availability for caribou and muskox within the RAA. Direct habitat loss from the Project footprint will likely remain unavailable as foraging habitat beyond the life of the Project. Although decommissioning includes revegetation, for the purposes of this assessment, the entire footprint is considered long-term habitat loss.

Indirect, or functional, habitat loss is a reduction of habitat effectiveness due to Project activities that cause animals to avoid habitats. Sensory disturbances are the primary cause of animals avoiding areas closer to disturbing stimuli (Stankowich 2008). For caribou, visual stimuli (as opposed to auditory stimuli,) cause a greater change in activity, possibly because barren-ground caribou tend to live in windy and, therefore, noisy environments. Olfactory and taste stimuli have not been well studied, but anecdotal information suggests that smell can elicit a flight response in the absence of visual or aural stimuli. Reimers and Colman (2006) reviewed caribou response to human activities and concluded:

- Females and calves are more sensitive to disturbances than males.
- Humans moving on foot elicit a greater response than moving vehicles. The assumption is the response has a genetic basis as caribou evolved with humans, and human sized animals as a predator. Habituation is possible.
- Off-road vehicles (ORVs) can cause increased flight responses if caribou are hunted using them. If the ORVs are seen frequently and consistently by caribou along fixed and predictable trails, caribou are able to habituate to the activity.
- Traffic activity along the transportation corridor causes the disturbance, not the infrastructure itself.

- Some degree of habituation to traffic is possible if it is not associated with direct mortality or other disturbances (e.g., harassment by humans or dogs).
- Responses to aircraft disturbance are variable. Caribou show no change in behaviour when aircraft travel at high altitudes (greater than 900 m above ground level [m agl]); however, studies of caribou responses to aircraft and helicopters at low altitudes have reported variable results. Multiple studies of fighter jets flying 30 m to 610 m above ground in caribou range resulted in small short-term changes in caribou behaviour. Caribou during the calving and post-calving seasons seem to be the most sensitive to aerial disturbances.

These responses are consistent with IQ data on indirect habitat loss: *when there was blasting at the Rankin Inlet mine, the caribou stayed away and were harder to find. The caribou returned after the blasting stopped* (IQ-ARVJ 2011). Other IQ suggests *there are often caribou around the Agnico Eagle mine (Meadowbank;* IQ-BLE 2011*).* For caribou, the extent of indirect habitat loss is at the scale of kilometres (Wolfe et al. 2000; Mayor et al. 2009). Caribou response to human disturbance varies by the ecosystems and activities to which they have adapted. Recent studies using caribou collar data have provided insight into an understanding of which habitat features caribou select and how caribou perceive their environment. Woodland caribou have been reported responding to human caused changes in habitat at distances up to 15 km (Mayor et al. 2009).

Caribou distribution in relation to oil and gas development within calving grounds in northern Alaska is a well-studied industrial interaction between caribou and humans. Caribou habitat use around oil field developments during the calving and post-calving seasons suggests there is a reduction in habitat use (measured as number of animals observed) within 1 km of industrial developments (Cameron et al. 1992) and the reduction might continue up to a distance of 4 km (Cameron et al. 2005). Decreases in caribou abundance near industrial developments are correlated with increases in habitat use beyond 4 km (Cameron et al. 2005; Joly et al. 2006; Vistnes et al. 2008).

Although the overall caribou responses to human activity along roads in previous studies are negative, caribou may seasonally choose to be near roads. First, caribou may select gravel roads as an important landscape feature during times of high insect abundance because a road tends to be elevated and exposed to greater wind speed, thus reducing insect harassment (Hanson 1981). Second, a ‘dust shadow’ effect was observed along roads in oilfield development areas of Alaska (Cronin et al. 1994 cited in Klein et al 2000). Increased dust levels from vehicle traffic may result in earlier snowmelt and vegetative growth in spring, facilitating access to higher quality vegetation prior to parturition; conversely, intense dust deposition can change the vegetation cover and reduce overall availability to forage (Klein et al. 2000), or a change in palatability (taste). Dust from mining activities could be the mechanism that reduces the abundance of caribou within the area around a mine site.

At the Ekati mine in the Northwest Territories, monitoring of caribou abundance showed that caribou were four times more likely to be found more than 14 km from mine activities than adjacent to activities (Boulanger et al. 2012). The mechanism of the change in caribou habitat use at Ekati is unclear, but hypothesized to be associated with a combination of dust deposition and other sensory disturbances. As described above, the mine site ZOI is based on Boulanger et al. (2012) and the road option ZOIs are based on Cameron et al. (2005). Each ZOI assumes that the reduction to habitat quality is inversely related to distance from the disturbance; therefore, the effectiveness of habitat near the mine site infrastructure is predicted to exhibit a greater reduction in effectiveness compared to habitat located at greater distances. During operation, disturbance at the mine site is assumed to be more intense than disturbance along the road.

Concerns were raised during the DEIS review that an increased number of aircraft flights to the Baker Lake airport may indirectly affect caribou habitat. The Baker Lake airport is a publically operated facility and operation of the airport is outside the scope of this assessment. The effects of potential increased air traffic at the Baker Lake airport from the Project are not included in this assessment. Scoping of environmental issues related to caribou is described in FEIS Tier 2, Volume 6, Terrestrial Environment, Section 11.

There is very limited information on muskox responses to industrial development and human disturbance. The lack of information is likely because few projects interact with muskox. Because they are a high arctic species, muskox were absent from much of their range during most of the last century. Compared with caribou, muskox have not been a valued species for northern communities because they are not abundant enough to support subsistence harvest. To assess Project effects on muskox habitat, we assume that the identified caribou ZOI is representative of the muskox ZOI. Comparison of similar studies of muskox and reindeer response to snowmobile disturbance suggests that these animals respond at a similar spatial scale to human disturbance. Studies have found that reindeer and muskox react to approaching snowmobiles when the machines were 534 m (Reimers et al. 2003) and 345 m (McLaren and Green 1985) away. Consequently, the caribou ZOI applied to muskox is a conservative estimate of potential muskox habitat loss.

13.2.2.4 Mitigation Measures and Project Design for Change in Habitat Availability

AREVA will partially mitigate the risk of reduced habitat availability for caribou by:

- Maintaining Project activities within the surveyed boundaries of the Project footprints will keep habitat loss within expected bounds;
- Managing road activity during important seasonal migratory seasons and during post-calving will minimize sensory disturbances during sensitive periods of caribou life history;
- Progressively reclaiming disturbed areas will advance timing of habitat recovery;
- Providing dust suppression along mine site roads during dry summer periods will reduce the sensory disturbances associated with dust;

- Eliminating dust dispersal from the tailings management facility through subaqueous deposition of tailings will eliminate the sensory disturbances associated with dust from tailings, and
- In the case of the winter road options, reducing the Project footprint will mitigate habitat loss and reduce the likelihood of the Project acting cumulatively with habitat loss other projects in the Kivalliq region.

A more comprehensive list of mitigation actions and details are discussed in the WMMP (Tier 3, Volume 6, Appendix 6D).

AREVA has discussed dust suppression at Meadowbank with Agnico Eagle to learn of their experiences, including the use of water trucks on the Meadowbank site, supply of CaCl2 to the Hamlet for application on roads in Baker Lake, and their ongoing efforts to monitor dusting and effects from dusting on the all-season road. AREVA recognizes that the issue of dust control on roadways in Nunavut is not completely resolved and is committed to monitoring the progress made at Meadowbank with dust control, the effects dust is having on the environment, and the experiences with dust control elsewhere in the arctic. AREVA will put in place the measures for dust control at Kiggavik that are the best practices at the time.

13.2.2.5 Residual Effects for Change in Habitat Availability

Despite the implementation of mitigation measures, caribou and muskox habitat will still be lost or changed due to direct and indirect effects. Direct loss of habitat from the footprint of the Project and associated facilities is a residual effect because the habitat will not be reclaimed within a generation of caribou; however, indirect effects to habitat are reversible once the mine is closed.

Mine and Road Option Effects on Caribou Herds that Interact with Project

Overall, the mine has very little distinguishable direct habitat loss as a proportion of the ranges of caribou that interact with the Project. The difference between proportional habitat loss between the all season road and winter road is indistinguishable, ranging from a loss of 0.004%, to, at the most, 0.01% of the Lorillard range (Table 13.2-8).

Table 13.2-8 Total estimated direct habitat loss within the caribou herd ranges that interact with the Kiggavik Project road options.

Caribou herd	Total herd range size (km²)[1]	Kiggavik project ASR footprint (km²)	Kiggavik project WR footprint (km²)
Ahiak	416,796	17.8 (0.004%)	15.8 (0.004%)
Beverly	436,671	17.8 (0.004%)	15.8 (0.004%)
Lorillard	144,451	17.8 (0.01%)	15.8 (0.01%)
Qamanirjuaq	461,856	17.8 (0.004%)	15.8 (0.003%)
Wager Bay	269,209	17.8 (0.007%)	15.8 (0.006%)

Notes:

1. Total herd range size calculated using the shapefiles from Figure 2 (Barrenground caribou populations in the Kivalliq region of Nunavut) of the Statutory Report on Wildlife to the Nunavut Assembly (Government of Nunavut Department of Environment 2013)

Mine and All-Season Road

The mine site and All-Season Road option cause a direct loss of caribou and muskox habitat during both the growing and winter seasons, resulting in a loss of 1,780 ha of previously usable habitat in the RAA. This corresponds to roughly 0.18% of available habitat in the RAA.

Caribou

Caribou habitat is directly lost to the footprint and habitat effectiveness is reduced within the mine and All-Season Road ZOI. Habitat quality loss due to the footprint and ZOI is expressed as the combined effect of the direct loss and the downgrading of habitat due to the ZOI. During the growing season, the Project can cause a 24% loss of high quality habitat, 11% loss of moderate quality habitat, and a corresponding increase in low quality habitat within the RAA (Table 13.2-9, Figure 13.2-2). During the winter season, the Project can cause a 27% loss of high quality habitat, 11% loss of moderate quality habitat, and a corresponding increase in low quality habitat within the RAA (Table 13.2-9, Figure 13.2-3). This equates to a change to 11% (growing) and 10% (winter) habitat units within the RAA (Table 13.2-9). The change in the RAA equates to reduced effectiveness in 0.3% of the Qamanirjuaq growing season range and 0.2% of the Ahiak winter range (Table 13.2-9).

Table 13.2-9 Caribou Habitat Baseline and Predicted Effects for the Mine Site and All-Season Road

Season	Habitat rating		Baseline ELC	Direct loss[2]	Indirect effect[3]	RAA effect	Seasonal range effect[4]
	Class	SI[1]	ha	ha	ha	%	%
Growing (Qamanirjuaq)	High	3	333,145	-653	-78,189	-23.7	**-0.3**
	Moderate	2	339,235	-1003	-37,597	-11.4	
	Low	1	56,659	-99	115,786	204.1	
	Nil	0	251,106	-24	0	0	
	No Rating	na	2,583	0	0	0	
	Total area		982,728	-1,780			
	Habitat units[5]		1,734,565	-4,066	-193,940	**-11.4**	
Winter (Ahiak)	High	3	288,771	-928	-76,604	-26.9	**-0.2**
	Moderate	2	379,677	-737	-42,038	-11.3	
	Low	1	311,696	-116	118,642	38.0	
	Nil	0	0	0	0	0	
	No Rating		2,583	0	0		
	Total area		982,728	-1,780			
	Habitat units[5]		1,937,365	-4,372	-195,246	**-10.3**	

Notes:

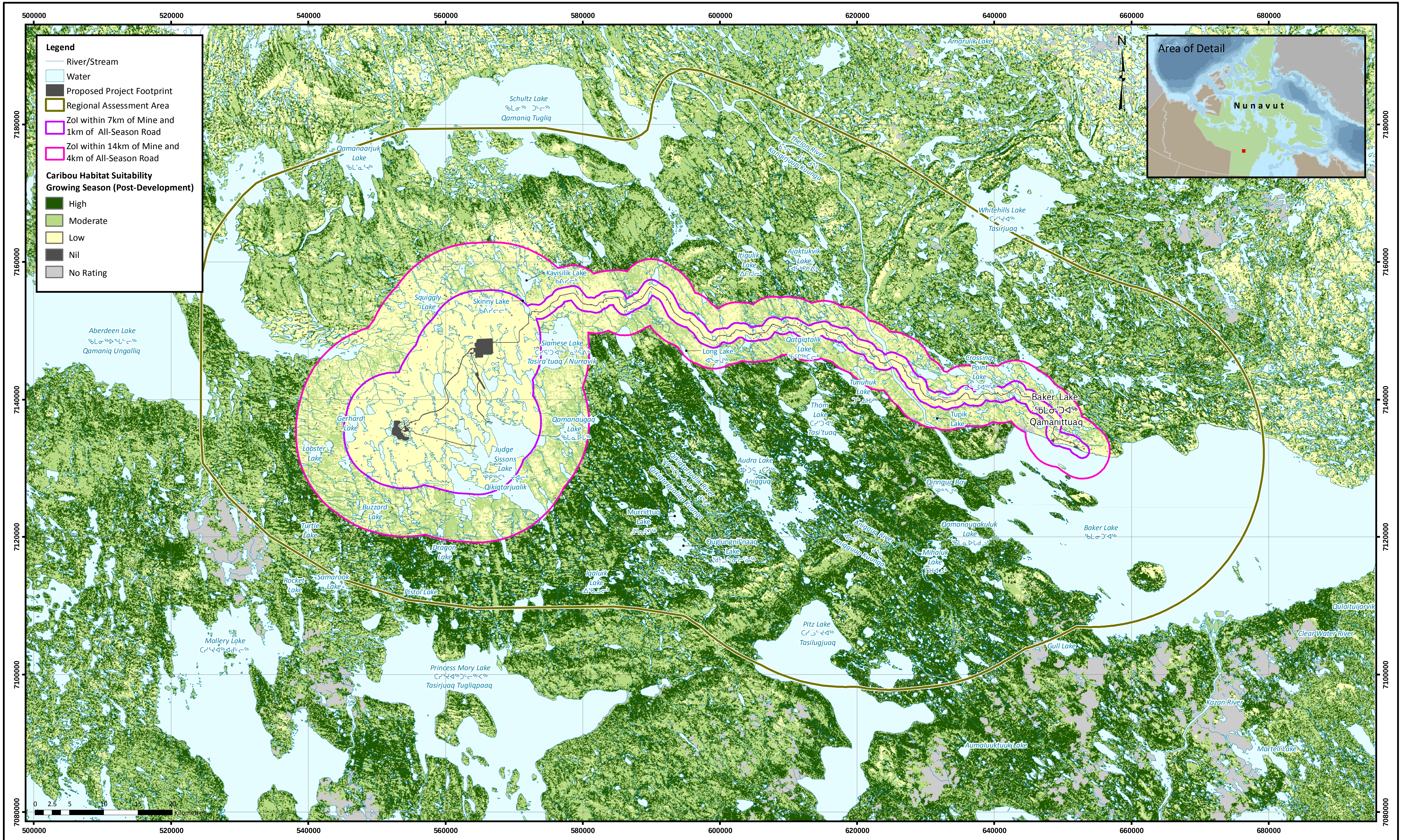
[1] SI = Suitability Index (used for weighted average calculation of Habitat Units)

[2] Direct loss is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] % seasonal range effect = [Total % RAA Effect*RAA Total Area/Seasonal Range Area (*Section 13.2.2.1*))*100]

[5] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).



Projection: NAD 1983 UTM Zone 14N
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File: 13.2-2_Habitat_Suitability_Growing_PD_Caribou.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-2
POST-DEVELOPMENT CARIBOU HABITAT SUITABILITY - GROWING SEASON
MINE AND ALL-SEASON ROAD

ENVIRONMENTAL IMPACT STATEMENT
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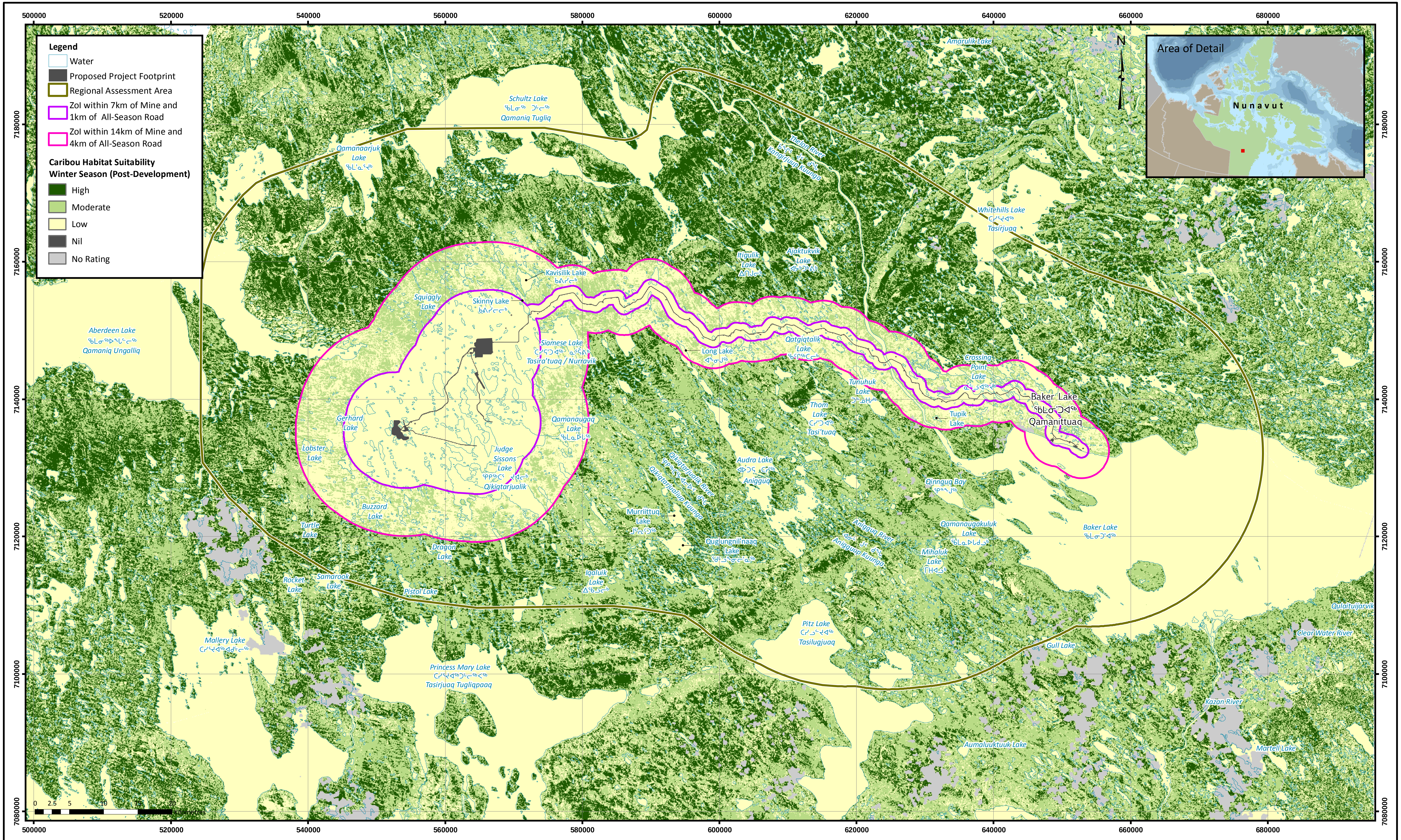

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Date: 06/02/2014 Scale: 1:500,000
File: 13.2-3_Habitat_Suitability_Winter_PD_Caribou_All-Season.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 13.2-3
POST-DEVELOPMENT CARIBOU HABITAT SUITABILITY - WINTER SEASON
MINE AND ALL-SEASON ROAD

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Muskox

Muskox habitat is directly lost to the footprint and habitat effectiveness is reduced within the mine and All-Season Road ZOI. Habitat quality loss due to the footprint and ZOI is expressed as the combined effect of the direct loss and the downgrading of habitat due to the ZOI. During the growing season, the Project can cause a 25% loss of moderate quality habitat and a corresponding increase in low quality habitat within the RAA (Table 13.2-10, Figure 13.2-4 (Figure 13.2-4). During the winter season, the Project can cause a 25% loss of moderate quality habitat, and a corresponding increase in low quality habitat within the RAA (Table 13.2-10; Figure 13.2-5). This equates to a change to 12% (growing) and 10% (winter) habitat units within the RAA (Table 13.2-10). The change in the RAA equates to reduced effectiveness in 3.7% of the Wildlife Management Unit MX/21 in summer and 3.1% in the winter (Table 13.2-10).

Table 13.2-10 Muskox Habitat Baseline and Predicted Effects for the Mine Site and All-Season Road

Season	Habitat rating		Baseline ELC	Direct loss[2]	Indirect effect[3]	RAA effect	MU effect[4]
	Class	SI[1]	ha	ha	ha	%	%
Growing	High	3	0	0	0	0.0	**-3.7**
	Moderate	2	647,733	-1,620	-161,852	-25.2	
	Low	1	81,306	-136	161,852	198.9	
	Nil	0	251,106	-24	0	0.7	
	No Rating	na	2,583	0	0	0	
	Total area		982,728	-1,780	0		
	Habitat units[5]		1,376,772	-3,376	-161,852	**-12.0**	
Winter	High	3	100,884	-207	-25,248	-25.2	**-3.1**
	Moderate	2	546,848	-1,413	-120,695	-22.3	
	Low	1	332,412	-159	145,943	43.9	
	Nil	0	0	0	0	0	
	No Rating		2,583	0	0	0	
	Total area		982,728	-1,780			
	Habitat units[5]		1,728,762	-3,607	-171,191	**-10.1**	

Notes:

[1] SI = Suitability Index (used for weighted average calculation of Habitat Units)

[2] Direct effect is the change in habitat availability due to the footprint of the project.

[3] Indirect effect is the change in habitat availability due to the zone of influence (ZOI) of the project.

[4] % MU effect = [(Total % RAA Effect*(RAA Total Area/MX 21 Area (*~31,872km²*))]*100

[5] Habitat units are the weighted sum of all available habitat (sum [ha * SI]).