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The BACK RIVER PROJECT

Final Environmental Impact Statement

Volume 5: Terrestrial Environment

November 2015

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Back River Project Fact Sheet

November 2015

Location

- Located in the western Kitikmeot Region of Nunavut at approximately 65° north latitude and 106° west longitude. About 400 km south of Cambridge Bay and 525 km northeast Yellowknife.
- Primary communities: Kugluktuk, Cambridge Bay, Gjoa Haven, Kugaaruk, and Taloyoak.
- The closest community areas to the Project are Kingaok, located approximately 160 km north of the Goose Property, and Omingmaktok, located approximately 250 km northeast of the Goose Property.

Reserves

- Four mining areas within the Goose Property: Umwelt, Llama, Goose Main, and Echo.

Mobilization and Construction Phase

- The project could commence as early as 2016 and take four years to mobilize and construct.
- Up to a $695 M initial capital investment.

Operational Phase

- Open pit and underground mines at each of the four Goose deposits.

Production

- Ore production: 19.8 million tonnes of mill feed over the life of mine.
- Projected annual 350,000 ounces of gold for about up to 10 years.

Processing

- Processing plant throughput of 6,000 tonnes per day.
- Standard gravity separation and cyanide leaching circuit.
- Tailings storage facilities in Goose Potential Development Area but purpose-built TSF on Crown land.

Transport

- Gold doré bars shipped out by aircraft.

Access Roads

- All-weather roads within Goose and MLA properties.
- Winter ice road between Goose and MLA properties.
- Winter ice road connection to George Exploration Camp.

Re-supply

- Marine supply via open water seasonal shipping (approximately 3 to 5 vessels per year).
- Year-round by aircraft.
- Winter ice road to connect the Goose and MLA properties.

Environment

- Extensive baseline studies including terrestrial environment, wildlife (particularly caribou), marine environment, freshwater environment, air quality, human environment, and resource utilization.
- Traditional knowledge (TK) information collected and analyzed through an Inuit-owned major study – *Naonaiyaotit Traditional Knowledge Project*.
- Baseline and TK information will form the foundation of Environmental Impact Statement and provide information for development of mitigation and management plans.

Employment

- Fly-in/fly-out operation.
- Direct construction employment up to 1,500 person-years over a four year period.
- Direct operations employment up to 6,970 person-years over a 10 year period.

Social and Economic Benefits

- Inuit Impact Benefits Agreement to be finalized with the Kitikmeot Inuit Association.
- Employment opportunities at the site.
- Opportunities for local businesses.
- Royalties and taxes to governments.

Closure and Post-closure Phase

- Closure will ensure that the former operational footprint is both physically and chemically stable in the long term for protection of people and the natural environment.
- Post-closure environmental monitoring will continue until it has been verified that reclamation has successfully met closure and reclamation objectives.

BACK RIVER PROJECT

FINAL ENVIRONMENTAL IMPACT STATEMENT
Supporting Volume 5:
Terrestrial Environment

November 2015
Project #0238709-0002

Citation:
Sabina. 2015. *Back River Project: Final Environmental Impact Statement Supporting Volume 5: Terrestrial Environment*. Prepared by Sabina Gold & Silver Corp.

Prepared by:

Sabina Gold & Silver Corp.

Volume 5: Revisions Log

Chapter	Section	Subject	Description (Major Revisions Only)
Chapter 1	1.1.2.5	George Geology	Removed George Geology.
	1.1.2.4	Goose Geology	Added Echo details.
Chapter 2	All sections	Permafrost characterization and delineation	Increase in site instrumentation employed to characterize the subsurface permafrost environment and thermal regime.
	All sections	Talik extent estimation	Comprehensive 2D analysis completed.
Chapter 3	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted by GIS to show new project footprints and Sub-area boundaries.
Chapter 4	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted by GIS to show new project footprints and Sub-area boundaries.
Chapter 5	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	5.1	FEIS Commitments	Update of baseline information on caribou in response to information requested by FEIS commitments.
	5.5.2, 5.5.4, 5.6.2, 5.6.4	George	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance following removal of George from the Back River Project and insertion of George as a future project for cumulative effects.
	5.5.2, 5.5.4, 5.6.2, 5.6.4	FEIS Project Design	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance using FEIS Project Layout.
	5.5.2	FEIS Commitments	Update of effects assessment of habitat loss and disturbance using updated caribou range data, in response to information requested by FEIS commitments.
	5.5.2, 5.5.4	FEIS Commitments	Update of assessments of direct mortality and injury, indirect mortality, exposure to contaminants and reduction and reproductive productivity in response to information requested by FEIS commitments.
	5.5.3, 5.8, 5.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including caribou) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.
Chapter 6	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	6.1	FEIS Commitments	Update of baseline information on grizzly bear in response to information requested by FEIS commitments.

Chapter	Section	Subject	Description (Major Revisions Only)
Chapter 6 *(cont'd)*	6.5.2, 6.5.4, 6.6.2, 6.6.4	George	Update of EA habitat loss and disturbance, and Cumulative habitat loss and disturbance following removal of George from the Back River Project and insertion of George as a future project for Cumulative Effects.
	6.5.2, 6.5.4, 6.6.2, 6.6.4	FEIS Project Design	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance using FEIS Project Layout.
	6.5.2, 6.5.4	FEIS Commitments	Update of effects assessment of habitat loss and disturbance in relation to wildlife management units for grizzly bear, in response to information requested by FEIS commitments.
	6.5.2, 6.5.4	FEIS Commitments	Update of assessments of attraction, exposure to contaminants, and reduction and reproductive productivity in response to information requested by FEIS commitments.
	6.5.3, 6.8, 6.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including grizzly bear) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.
Chapter 7	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	7.1	FEIS Commitments	Update of baseline information on muskox and validation of muskox habitat suitability model in response to information requested by FEIS commitments.
	7.5.2, 7.5.4, 7.6.2, 7.6.4	George	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance following removal of George from the Back River Project and insertion of George as a future project for cumulative effects.
	7.5.2, 7.5.4, 7.6.2, 7.6.4	FEIS Project Design	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance using FEIS Project Layout.
	7.5.2, 7.5.4	FEIS Commitments	Update of effects assessment of habitat loss and disturbance in relation to wildlife management units for muskox, in response to information requested by FEIS commitments.
	7.5.2, 7.5.4	FEIS Commitments	Update of assessments of exposure to contaminants and reduction and reproductive productivity in response to information requested by FEIS commitments.
	7.5.3, 7.8, 7.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including muskox) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.
Chapter 8	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	8.1	FEIS Commitments	Update of baseline information on wolverine and furbearers in response to information requested by FEIS commitments.
	8.5.2, 8.5.4, 8.6.2, 8.6.4	George	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance following removal of George from the Back River Project and insertion of George as a future project for cumulative effects.

Chapter	Section	Subject	Description (Major Revisions Only)
Chapter 8 *(cont'd)*	8.5.2, 8.5.4, 8.6.2, 8.6.4	FEIS Project Design	Update of effects assessment and cumulative effects assessment of habitat loss and disturbance using FEIS Project Layout.
	8.5.2, 8.5.4	FEIS Commitments	Update of effects assessment of habitat loss and disturbance in relation to wildlife management units for wolverine, in response to information requested by FEIS commitments.
	8.5.2, 8.5.4	FEIS Commitments	Update of assessments of exposure to contaminants and reduction and reproductive productivity in response to information requested by FEIS commitments.
	8.5.3, 8.8, 8.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including wolverine and furbearers) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.
Chapter 9	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	9.1	FEIS Commitments	Update of baseline information on migratory birds in response to information requested by FEIS commitments.
	9.5.2, 9.5.4, 9.6.2	George	Update of effects assessment of habitat loss and disturbance following removal of George from the Back River Project; Insertion of George as a future project for cumulative effects.
	9.5.3, 9.8, 9.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including migratory birds) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.
Chapter 10	All sections	George	Remove George as a source of ore; defer development of property.
	All sections	George	All maps were adjusted to FEIS layout and removal of George.
	10.5.2, 10.5.4, 10.6.2	George	Update of effects assessment of habitat loss and disturbance following removal of George from the Back River Project; Insertion of George as a future project for cumulative effects.
	10.5.2, 10.5.4	FEIS Commitments	Update of assessments of direct mortality and injury, attraction, exposure to contaminants, and reduction and reproductive productivity in response to information requested by FEIS commitments.
	10.5.3, 10.8, 10.9	FEIS Commitments	Update of mitigation and management actions and monitoring plans for wildlife (including raptors) following revisions made to Wildlife Mitigation and Monitoring Program in response to information requested by FEIS commitments.

Executive Summary

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Executive Summary

The Back River Project (the Project) is an exploration gold project owned by Sabina Gold & Silver Corp. (Sabina) within the Kitikmeot region of western Nunavut. The Project is composed of the Goose Property Area and a Marine Laydown Area (MLA) situated along the western shore of southern Bathurst Inlet. Sabina has prepared an Environmental Impact Statement (EIS) to identify and assess potential environmental and social effects resulting from the Project, and is consistent with the requirements outlined in the Nunavut Land Claim Agreement (NLCA) and the Nunavut Impact Review Board (NIRB) Guidelines for the Preparation of an Environmental Impact Statement for the Back River Project (NIRB File No. 12MN036; NIRB 2013). This volume of the EIS presents the assessment of potential environmental effects to the terrestrial environment associated with proposed Project activities following the application of mitigation and management measures.

The scoping of potential Valued Ecosystem Components (VECs) involved Sabina-led public consultations, the use of Traditional Knowledge (TK), regulator consultations and regulatory considerations such as conservation status of species or groups, and recommendations presented in the NIRB EIS guidelines (NIRB 2013). The *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project Report* (KIA 2012), *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014), and *Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories* were consulted extensively for TK information. Based on these sources, the following terrestrial components were selected as VECs: vegetation and special landscape features, caribou, grizzly bear, muskox, wolverine and furbearers, migratory birds, and raptors. Geology, permafrost, and landforms and soils were considered Subjects of Note and all required information noted in the EIS guidelines is included in this volume.

Potential effects on terrestrial and wildlife VECs were evaluated spatially within a Local Study Area (LSA) and a larger Regional Study Area (RSA). The terrestrial LSA covered 1,344 km^2 and included the Goose Potential Development Area (PDA), which contain all proposed Project infrastructure for the Goose Property Area, the MLA PDA, the winter roads connecting the Goose and MLA PDAs, and a buffer (1 to 1.5 km) surrounding the outer boundary of the PDAs and roads. The terrestrial RSA encompasses the LSA and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two PDAs and covers approximately 12,620 km^2. All potential Project effects were assessed during the Construction, Operations, Reclamation and Closure, and Post-closure Project phases, with a focus on a "worst-case" scenario approach whereby the phase or phases with the largest effect on the VEC are discussed. Where residual effects of the Project on a VEC were anticipated, a cumulative impact assessment was also conducted that evaluated the combined effects of the Back River Project with other existing and reasonably foreseeable industrial projects and human activities. Specific legislation was considered during the assessment, including the *Species at Risk Act* (SARA), the *Migratory Birds Convention Act*, and the *Nunavut Wildlife Act*.

The following presents summaries of the existing environment, primary Project activities that are anticipated to interact with the terrestrial VECs, mitigation measures, effects assessment, and if applicable, cumulative effects assessment for each terrestrial VEC.

Geology

The Goose PDA is located over the northeastern corner of the Slave and Churchill Geologic Provinces. The Marine Laydown Area (MLA) is underlain by Lower to Middle Proterozoic sedimentary rocks of the Kilohigok Basin, part of the Bear Geologic Province. Glacial material deposited after the Quaternary Wisconsin Glaciation covers much of the Archean Geological Provinces. Glacial deposits are predominantly comprised of moraine type deposits (glacial till), which mostly consist of sand and variable amounts of silt. The Goose Property consists of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate banded iron formation and oxide banded iron formation. The sedimentary package is cross-cut by mafic dikes, lesser volumes of felsic dikes, and volumetrically insignificant quartz veins. Gold mineralization is most often associated with sulphide minerals, particularly arsenopyrite, and visible gold is found almost exclusively in zones with abundant arsenopyrite. Other sulphide minerals (pyrite and pyrrhotite) are typically enriched in a halo in the banded iron formation and greywacke around the arsenopyrite-rich ore zones. The mafic dikes have very low sulphide contents and are largely devoid of gold mineralization.

Permafrost

The Project is located within the continuous permafrost region of western Nunavut. A seasonally thawed active layer is present immediately beneath ground surface, with a mean maximum depth of approximately 2 m and a mean annual temperature that averages -6.5°C. Subsurface temperatures are perennially below 0°C at depths up to approximately 500 m below ground surface, except beneath some surface waterbodies. At the Goose Property, open (through) taliks that connect to the deep groundwater are inferred to be present beneath waterbodies with widths greater than 200 m and water depths exceeding 1.3 m. Cryopegs are inferred to be present at the base of the permafrost and adjacent to deep taliks, as the groundwater beneath the permafrost has been shown to be hypersaline.

Landforms and Soils

The Project is located in an area dominated by gently undulating or rolling landscapes with numerous kettle lakes connected by streams. Terrain elevation ranges between 300 and 700 metres above sea level (masl) and slope gradients rarely exceed 7%. Uplands are typically covered by morainal materials (51% of the total PDA) deposited on Precambrian, sedimentary, metamorphic or intrusive rocks. Glaciofluvial (14%), organic (6.4%), marine (8.5%), and lacustrine (1.1%) deposits are less common. Exposed bedrock occurs over 2.6% of the PDA. The thickness of mineral soils overlaying bedrock (overburden) is the highest in plains and very gently sloping areas (average of 10.6 m) and decreases in rolling and undulating landscapes (average of 4.8 m).

A number of distinct landform types, including eskers, morainal rocky ridges, and boulder fields exist throughout the terrestrial RSA. Cold climate is also associated with several soil phenomena. Thermokarst typically occurs in wetlands as a system of very irregular hummocks and hollows, which form as a result of frost heaving and ice accumulation on the bottom of organic horizons. Frostboils are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heaving. The Project is located within continuous permafrost. The presence of permafrost and annual cycles of freezing and thawing results in poor development of soils. About two-thirds of the inspected soils have been classified as Static Cryosols and one-third as Turbic Cryosols.

Baseline soil samples were collected at 51 sites within the LSA and 20 sites outside of the LSA but within the RSA in 2012. Most soils have a low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%). Most soils are moderately coarse (loam, sandy loam, fine sandy loam). Mineral soils in the terrestrial RSA are predominantly acidic (median pH is 5.9, range from 4.7 to 6.8). In general soil metal concentrations in the LSA do not exceed CCME guidelines.

Vegetation and Special Landscape Features

Terrestrial ecosystem mapping (TEM) and rare plant surveys were conducted in 2012 within the 134,370 ha vegetation and terrestrial wildlife LSA. Vegetated ecosystems, constituting 73% of the LSA, are dominated by mesic tundra, dry-sparse tundra, and moist shrub-dominated tundra. The mesic tundra association, comprising nearly one-third of the LSA, is characterized by extensive areas dominated by dwarf woody shrub species, with a highly variable component of herbs, graminoids, mosses, and lichens. Sparsely vegetated ecosystems, constituting nearly 9% of the total LSA, typically occur on thin morainal veneers or exposed bedrock, windswept esker crests, blocky tundra, marine beaches and other barren sites that limit vegetation establishment. Non-vegetated ecosystems, constituting approximately 18% of the LSA, are dominated by freshwater lakes and ponds. Special landscape features, identified for their importance as wildlife habitat or potential to support rare plant species, include esker complexes, cliffs, bedrock outcrop and lichen-dominated ecosystems, riparian ecosystems, wetland ecosystems, and marine beaches and old beach heads. A total of 890 plant species identifications were made during the TEM and rare plant field surveys within the LSA and RSA. The largest species group in the identified flora is that of the vascular plants, followed by the macrolichens. Ninety rare plant species were identified and were mainly found close to the shoreline of Bathurst Inlet throughout the LSA and RSA. No invasive plant species were found in the LSA during the 2012 field surveys.

Potential Project effects on the VEC vegetation and special landscape features included the direct loss or degradation of vegetation or special landscape features. These potential effects were characterized by using the indicators diversity, productivity, and resiliency. The mitigation and management measures designed to eliminate or minimize potential Project effects on vegetation and special landscape features include: minimizing the Project footprint, using winter roads, and reducing fugitive dust where possible.

Following the application of mitigation and management measures, two residual effects were identified: vegetation loss, and special landscape feature loss. These residual effects are a result of the assumption that the entire PDAs would be lost. In reality, the area of vegetation/special landscape feature loss will be much less as it will be confined to the final footprint of the Project. The magnitude of the anticipated residual effects is expected to be low, the duration long term, the frequency is once but continuous/permanent, and the residual effects would be confined to within the Project footprint (PDA). The residual effects were assumed to be irreversible; however there may be some recovery after closure. Contingent on the implementation of mitigation measures outlined in the Air Quality Monitoring and Management Plan (Volume 10, Chapter 17) and the Site Water Monitoring and Management Plan (Volume 10, Chapter 7), the significance of residual effects for vegetation and special landscape features is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. The reasonably foreseeable George Property projects, Hackett River Project, and Bathurst Inlet Port and Road (BIPR) project would each have spatial and/or temporal overlap with the terrestrial RSA. In addition to the Project residual effect of vegetation loss within the PDAs, an estimated 556 hectares of cumulative nibbling loss within the terrestrial RSA could result from development of infrastructure and roads associated with the proposed George Property projects, Hackett River Project, and BIPR Project. The magnitude of the anticipated cumulative effect is expected to be low (less than 1% of the RSA), the duration long term, the frequency is once but continuous/permanent, and the cumulative effect would be confined to within the project footprints of each project. The significance of the residual cumulative effect (vegetation loss) for the VEC vegetation and special landscape features is predicted to be **Not Significant**. The Project residual effects and cumulative effects were confined to

the PDA and the project footprints of potential future projects within the RSA. These areas reside entirely within Nunavut, so there was no potential for transboundary effects.

Caribou

There are three barren-ground caribou herds whose ranges interact with parts of the wildlife RSA. Satellite collaring data indicate that the Bathurst herd, the Beverly and Ahiak herds (considered together in this assessment) and the Dolphin and Union herd are found in the terrestrial RSA during portions of the year.

The Bathurst caribou herd calves between the Hood and Burnside Rivers, approximately 240 km northwest of the Project site. Following calving, the Bathurst caribou travel in large groups south-east passing 30 to 60 km to the west of the Project site (their closest approach), on their way to their summer range surrounding Contwoyto and Nose Lakes, 60 to 100 km south-west of the Project site. This herd winters south of the treeline.

The Beverly and Ahiak caribou herds calve and spend their post-calving period in the Queen Maude Gulf area on the coast, 300 to 550 km northeast of the Project site. During the summer, this herd spreads south and west, with some caribou found on site during late summer and fall. The Beverly and Ahiak herd generally winters to the east of the Bathurst herd, both below treeline and as far north on the tundra as Bathurst Inlet.

The Dolphin and Union herd, also known as island caribou, calve and spend the summer on Victoria Island and winter on the mainland, likely overlaping the marine RSA during the winter. The Dolphin and Union herd is SARA-listed as a species of special concern while the Bathurst herd and the Beverly/Ahiak herd have not been assessed by COSEWIC.

Baseline studies conducted between 2001 and 2014 agreed with collar information. Five years of aerial surveys and three years of studies using motion-triggered cameras did not record caribou calving in the RSA (June 5 to 15) in any year. During the post-calving period (June 16 to July 20), large groups of caribou were observed to the west of the RSA: which were identified as Bathurst caribou. Small groups were sometimes observed in the RSA during the late summer and fall (mid-August to September): which were identified as Beverly and Ahiak herds. TK and motion-triggered cameras confirmed that Dolphin and Union caribou occur along the shores of Bathurst Inlet during winter, and at the marine PDA, but at extremely low numbers.

Within the RSA, TK identified several important areas for caribou. Motion-triggered cameras were used to monitor these sites, including the river crossing at the east end of Beechey Lake that is used by large groups (100 to 200) of caribou during the summer and fall (Beverly and Ahiak caribou). Within the larger cumulative effects assessment areas, TK identified Contwoyto and Nose lakes (60 to 100 km southwest of the RSA) as important summer range for caribou. GPS collar data indicates that the Bathurst caribou congregate at these lakes during summer. A resource selection function, which evaluates which habitat collared animals use more frequently and then makes a map of those preferred habitats identified that Bathurst caribou selected for highly productive areas and tall shrub areas focused around Contwoyto Lake.

Potential Project-related effects on the VEC caribou were evaluated included: habitat loss, disturbance, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) describes the measures that will minimize or eliminate effects on wildlife, including minimizing the Project footprint, noise control, speed limits of 50 km/h on roads,

the use of winter roads to supply the Project, helicopter management, waste management and camp hardening to avoid attracting wildlife, and safe chemical handling to eliminate exposure to contaminants. The Wildlife Mitigation and Monitoring Plan also includes regional and on-site monitoring programs for caribou, as well as a program for staged reductions in project activities whenever caribou are observed on site, and an activity shutdown procedure should caribou ever choose to use the Project area during the sensitive calving and post-calving periods.

Following the application of mitigation and management measures, three residual effects were identified: habitat loss, disturbance due to noise, and reduction in reproductive productivity. The magnitude of all three of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. With the mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for caribou is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted (habitat loss, disturbance, reduction in reproductive productivity). The geographical boundary used for the potential cumulative effects assessment was based on the post-calving and summer seasonal ranges of the Bathurst herd and the summer and winter ranges of the Beverly herd, and included areas within Nunavut and the Northwest Territories. As outlined in the EIS guidelines (NIRB 2013a), the Minister of Aboriginal Affairs and Northern Development Canada highlighted the importance of the Bathurst herd caribou in the region and identified the need to conduct a cumulative effects assessment for this herd (letter dated December 17, 2012). There were ten possible projects (including four potential future projects) that could act cumulatively with Project residual effects within the Bathurst herd cumulative assessment area, and five possible projects (including three potential future projects) that could act cumulatively with Project residual effects within the Beverly herd cumulative assessment area.

In order to support the potential cumulative effects assessment for caribou, a broad-scale Resource Selection Function model was developed for the Bathurst caribou herd on their post-calving and summer ranges. Results of this model were used to determine where caribou are typically found in their ranges, and what types of habitat they use while on these ranges. The model was also used to derive habitat quality ratings for vegetation to determine the extent of cumulative habitat loss and disturbance to Bathurst caribou on their foraging ranges. The magnitude of all three of the residual cumulative effects on both caribou herds is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprint, sporadic in nature, confined to local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual cumulative effects are also anticipated to be reversible with the possible exception of habitat loss within specific areas of the project footprint. With the mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of residual cumulative effects for caribou is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for both the Bathurst herd and the Beverly herd. As such, the potential transboundary effects are evaluated in the cumulative effects assessment and are predicted to be **Not Significant.**

Grizzly Bears

Barren-ground populations of grizzly bears are federally listed as species of "Special Concern" (SARA; COSEWIC 2012) and are listed as Sensitive in Nunavut (CESCC 2010). Baseline studies were conducted for bears in 2012 and 2013 using hair stag stations to collect hair to estimate the regional population of bears in a 18,500 km^2 study area. Using a DNA mark-recapture analysis, the regional population of bears was calculated to be 72 females and 54 males in 2012 and 64 females and 54 males in 2013.

TK indicates that grizzly bears are found throughout the regional study area (RSA) especially in association with major river systems such as the Western River and coastal areas, including Bathurst Inlet. Baseline studies agreed with TK information; in spring, detections of grizzly bears mainly occurred in the eastern portion of the study area and along major river systems, particularly the Western River. During the summer and fall, bear detections were evenly distributed throughout the study area. Four grizzly bear dens were recorded in the terrestrial wildlife RSA between 2007 and 2012 – two located along the Western River corridor in sandy glacial fluvial habitat and two located in moderately sloped, heath tundra habitat. Habitat suitability modeling in the RSA indicates that there is between 57% and 76% high-quality habitat within the RSA during spring, summer and fall seasons, but less than 2% of high-quality denning habitat, which is largely confined to eskers. The average distance travelled by these bears between May and August was 25.7 km for female bears (max 65 km), 42.5 km for male bears (max 138 km) and 32.6 km for bears travelling in family units (max 84.8 km).

Potential Project-related effects on the VEC grizzly bear were evaluated, including: habitat loss, disturbance due to noise (e.g., displacement from areas of habitat), disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Winter roads were excluded from the assessment as grizzly bears are hibernating when these roads are constructed and used. The primary mitigation and management measures that will minimize the potential effects are a strong waste management and camp hardening Plan to avoid attracting bears to site. Other mitigation includes: minimization of Project footprint, noise abatement measures, speed control measures, use of winter roads to supply the Project, and chemical handling to eliminate exposure to contaminants. A Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes both regional monitoring in collaboration with the Government of Nunavut and on-site monitoring of the camp no attractants are available and for grizzly bears.

Following the application of mitigation and management measures, four residual effects were identified: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity. The magnitude of all four of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss which will be long term within specific areas of the Project footprint, sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, and the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. With mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for grizzly bear is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on a buffer around Project infrastructure using the diameter of the largest area within which a typical grizzly bear can range and still interact with the Back River Project. There are eleven potential projects (including four potential future projects) that could act cumulatively with Project residual effects within the cumulative assessment area. The magnitude of all four residual Project effects on grizzly bears in the cumulative effects boundary is low, the duration medium term (confined to the life

of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to the local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the possible exception of habitat loss within specific areas of the project footprints. With mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for grizzly bear is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for grizzly bears and is anticipated to be the largest area that any one grizzly bear may be able to interact with the Project. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Muskox

Muskox are occur at moderate to low densities across the Canadian Arctic and are valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. TK indicated that muskox populations have been undergoing a long-term recovery from previously low numbers and occur throughout and surrounding the RSA at low densities, with concentrations at Bathurst Inlet and Bathurst Lake in the RSA and around Contwoyto Lake and Nose Lake outside the RSA. Aerial baseline surveys conducted between 2001 and 2010 agreed with TK information with repeated observations of a herd of muskox on the low to the west of Bathurst Inlet and surrounding Bathurst Lake, and approximately two other herds in the south of the RSA. Habitat suitability modeling in the RSA indicates that roughly one-third of the RSA is high-quality foraging habitat for muskox during both the foraging (summer and fall) and winter (winter and early spring) seasons.

Potential Project-related effects were evaluated for the VEC muskox, including: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will eliminate or minimize the potential effects include: minimization of Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife to waste and avoid exposure to contaminants. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes both regional monitoring of muskox in collaboration with the GN and local, on-site monitoring.

Following the application of mitigation and management measures, three residual effects were identified: habitat loss, disturbance due to noise, and reduction in reproductive productivity. The magnitude of all three of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. With mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for muskox is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted for muskox because three residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on a diameter around the Project using the longest straight line distance travelled by a radio-collared muskox in the west Kitikmeot region. There were 12 possible projects (including five potential future projects) that could act cumulatively with Project residual effects

within the muskox cumulative effects assessment area. The magnitude of all three of the residual effects on muskox is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to local areas for habitat loss and noise disturbance, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the project footprints. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for muskox is predicted to be **Not Significant**.

The cumulative effects assessment spatial boundary included a portion of the Northwest Territories for muskox and is anticipated to include the largest straight line distance that a muskox may be able to interact with the Project. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Wolverine and Furbearers

Wolverines and grey wolves were selected as representative VEC furbearer species. Wolverines and wolves in Nunavut are both ranked as "Secure" (CESCC 2010), but wolverines are federally listed as a species of "Special Concern" (COSEWIC 2003). Baseline studies estimated the local population of wolverines using hair snag stations and a DNA mark-recapture analysis. During 2012, a 1,692 km^2 study area was used surrounding the Goose PDA, where 12 wolverine were identified. During 2013, a second 1,800 km^2 study area was added surrounding the Marine Laydown Area, with 19 wolverine identified in the two study areas. Wolverines ranged over an average area of 162 km^2, with similar ranges for male (166 km^2) and famales (157 km^2). Habitat suitability modeling for wolverine indicates that there is approximately 44.7% high-quality habitat within the wildlife RSA.

TK identified eskers as the primary denning habitat for wolves, which habitat suitability modelling calculated covers approximately 1% of the RSA. Denning surveys conducted for grey wolf between 2007 and 2013 supported TK information with eight dens identified in the RSA on eskers, of which five dens produced pups.

Potential Project-related effects on the VEC wolverine and furbearers were evaluated, including: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. The primary mitigation and management measures that will minimize the potential effects are a strong waste management and camp hardening program to avoid attracting wolverine to site. Other mitigation includes: minimization of Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, and chemical handling measures to eliminate exposure to contaminants. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes monitoring for both the regional population of wolverine with the GN and local monitoring on the Project site.

Following the application of mitigation and management measures, four residual effects were identified for wolverine: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity, and two residual effects were identified for wolves: habitat loss and disturbance. The magnitude of all of the residual effects for both wolverine and wolves is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the Project footprint which would be long term. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, the LSA for noise disturbance, and potentially the RSA for reduction in reproductive productivity. The residual effects are also anticipated to be reversible with the possible exception of habitat loss within specific

areas of the Project footprint. With mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for wolverine and furbearers is predicted to be **Not Significant**.

A potential cumulative effects assessment was conducted because residual Project effects were predicted. The geographical boundary used for the potential cumulative effects assessment was based on the movement distances defined for wolverine and wolves that interact with the Project. For wolverine this area is the RSA. For wolves, this area represents the summer ranges of the Bathurst and Beverly caribou herds as wolves follow caribou for prey when they occur within range of the Project. There were three possible projects (including two potential future projects) that could act cumulatively with Project residual effects within the wolverine cumulative effects assessment area, and fifteen possible projects (including six potential future projects) that could act cumulatively with Project residual effects within the wolf cumulative effects assessment area. The magnitude of all residual effects on wolverine and furbearers is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss within specific areas of the project footprints, sporadic in nature, and confined to local areas for habitat loss, disturbance, and attraction, and potentially the cumulative study area for reduction in reproductive productivity. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the project footprints. With mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) and assuming similar measures for future projects, the significance of cumulative effects for wolverine and furbearers is predicted to be **Not Significant**.

Wolverine that may interact with the Project are not anticipated to travel into the Northwest Territories, thus transboundary effects for wolverine are not anticipated. The cumulative effects assessment spatial boundary for wolves included a portion of the Northwest Territories. As such, the potential transboundary effects are accounted for in the cumulative effects assessment and are predicted to be **Not Significant**.

Migratory Birds

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994) and the *Nunavut Wildlife Act* (2003), which prohibit destruction of bird nests when these are being used by birds, and prohibits disturbance to flocks of migratory birds. No species of migratory bird occurring in the RSA is listed as a species of conservation concern under the federal *Species at Risk Act* (SARA 2002). However, three waterbird and ten upland bird species occurring in the RSA are listed as 'Sensitive' under the CESCC designations for Nunavut (CESCC 2010). Aerial surveys for waterbirds conducted between 2007 and 2013 indicate that Canada geese accounted for 80% to 90% of all detections of waterbird species. Several large wetlands, particularly in the southeast portion of the RSA are used by geese as a migration corridor, and as moulting areas. Additionally, a key staging site was identified on the western side of the RSA where large flocks of geese and ducks were consistently observed during both spring and fall staging surveys. Ground-based surveys for upland birds indicated that counts of upland birds (species and individuals) were highest in survey plots along the shoreline of Bathurst Inlet, relative to elsewhere in the RSA. A density estimate of 133 ± 9.8 upland bird pairs per km^2 was recorded in moist to wet lowland habitat, and 94 ± 6.8 upland bird pairs was recorded in dry upland habitat.

Potential Project-related effects on the VEC migratory birds were evaluated, including: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimizing the Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste and chemical handling measures to avoid attracting wildlife to wastes

and contaminants. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes both regional monitoring for migratory bird populations and on-site monitoring to reduce the chance of birds interacting with the Project.

Following the application of mitigation and management measures, two residual effects were identified for migratory birds: habitat loss, and disturbance. The magnitude of both of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) for disturbance and long term for habitat loss within specific areas of the Project footprint. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss, and to the LSA for disturbance. The residual effects are anticipated to be reversible with the exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for migratory birds is predicted to be **Not Significant**.

A potential cumulative effects assessment was not conducted for migratory birds as the zone of influence of Project-related effects on migratory birds in expected to be limited to within the Project PDAs. No additional projects fall inside of the Project PDAs, thus no cumulative effects on migratory birds are anticipated to occur. Similarly, no transboundary effects are expected, as the Project PDAs fall entirely within Nunavut.

Raptors

Raptors, or birds of prey, were chosen as a wildlife VEC because five of the eight raptors species occurring in the wildlife RSA are species of conservation concern. The cliff-nesting peregrine falcon and the ground-nesting short-eared owl are listed as species of Special Concern on Schedule 1 of the federal *Species at Risk Act* (Government of Canada 2013). Three additional cliff-nesting species – the golden eagle, gyrfalcon, and rough-legged hawk – are listed as "Sensitive" in Nunavut by the Canadian Endangered Species Conservation Council SARA (CESCC 2010). Ground-based surveys for upland birds confirmed that ground-nesting raptors occur relatively rarely within the wildlife RSA. Thus, baseline studies for raptors were focused on mapping the location of cliff-nesting raptor nests, and measuring the productivity of breeding pairs. Aerial surveys of cliffs were conducted between 2002 and 2013 over approximately 80% of the wildlife RSA. A total of 147 raptor nest sites were mapped; nests of the peregrine falcon were the most abundant of all raptor species. Two nest sites occur within the PDAs, and an additional seven raptor nest sites occur within a 12 km radius of the PDAs.

Potential Project-related effects on the VEC raptors were evaluated, including: habitat loss, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, attraction, exposure to contaminants, and reduction in reproductive productivity. Mitigation and management measures that will be in place to eliminate or minimize the potential effects include minimizing the Project footprint, noise abatement measures, speed control measures, the use of winter access roads only, waste management and chemical handling measures to avoid attracting wildlife. The Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) includes both regional monitoring for raptor species and on-site monitoring.

Following the application of mitigation and management measures, five residual effects were identified: habitat loss, disturbance, direct mortality and injury, attraction, and reduction in reproductive productivity. The magnitude of all five of the residual effects is expected to be low, the duration medium term (confined to the life of the Project) with the exception of habitat loss which would be long term within specific areas of the Project footprint. The effects would be sporadic in nature, and confined to within the Project footprint for habitat loss and attraction, and the LSA for disturbance, direct mortality and injury, and reduction in reproductive productivity. The residual effects are also

anticipated to be reversible or reversible with effort for attraction, with the possible exception of habitat loss within specific areas of the Project footprint. Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20), the significance of residual effects for raptors is predicted to be **Not Significant**.

A potential cumulative effects assessment was not conducted for raptors as the zone of influence of Project-related residual effects on raptors in expected to be limited to within a 12 km radius from the Project infrastructure which corresponds to the maximum expected home range of breeding raptors. No additional projects fall within 12 km of the Project PDAs, thus no cumulative effects of the Project on raptors are anticipated to occur. Similarly, no transboundary effects are expected, as the Project PDAs fall entirely within Nunavut.

ᓄᓇᖅᑐ ᐊᕐᑎᐱᓄᑦ ᓇᐃᓚᒋᔭᐊᖏᑦᑐᒍ ᐅᓂᒃᑲᖅ

ᓴᓪᓂᓂᒋᑦᑕᐅᑦ ᑯᖅᓯᓂ ᓴᓇᓕᐅᔨᓕᒥ (ᓴᓇᓕᐅᔨᖅᓯᖅ) ᐅᔨᕋᓪᓂᕆᐊᖏᑦ ᖃᓄᖅᓭᓂᒃ ᓴᓕᕋᔨᒃᓴᓂᒃ ᑯᓇᕋᐅᑎᔨᐅᔨᓂᒃ ᓄᓇᕗᑦᑎᓕᖅᑐᑦ ᐊᓯᓇᓕᖅᑐᑦ (ᓴᐃᓇ) ᑕᒪᑐᒪᓂ ᖃᑎᖏᑦᒥᐅᓂ ᓄᓇᕗᒥᐅᑦ ᐅᐊᓕᓂᖅᓱᓚᓂ.ᓴᓇᓕᑎᔨᖓᓕ ᐱᖓᓱᖏᓪᓕᑦ ᓄᓇᕐᕋᕋᓕᖅᖏᓪᓕᑦ ᓄᓇᒥ: ᑯᐃᒥ ᓴᓇᓕᐅᔨᖅᓯᖅ, ᔨᐊᔭᒥ ᓴᓇᓕᐅᔨᖅᓯᖅ, ᐊᒻᒪᓗ ᓂᐃᒥ ᑐᓐᔭᒥ ᑕᓐᓂᖅᓯᖅ ᓂᕆᔭᕐᓂᖅ (MLA) ᒋᐟᓇᓪᓂ ᐅᐊᓕᓂᖅᓱᓚᖅᑕᑦᑐᖅ ᖃᖓᓐᓄᑦᒥᐅᑦ ᑲᖏᖅᓯᖅ.ᓴᐱᓇᓂᖅ ᐊᒻᒪᓗ ᐊᑐᖅᑕᐃᓕᓴᕐᓂᖅ ᑐᓴᕐᓯᓂᖅ ᑐᓴᕐᓯᓂᖅᑐᑦ ᐊᑐᖅᓯᓂᖅ ᐊᑐᖅᑕᐃᓕᓴᕐᓂᖅ ᐊᑐᖅᓯᓂᖅ (EIS) ᐃᓚᐅᐃᓕᔭᐃᑦᓚᑎᓂᖅ ᓴᓇᓕᐅᔨᖅᓯᖅ ᑕᒪᐅᖓᓕᓂᕆᓂᖅᑐᑦ ᐊᒻᒪᓗ ᐊᖅᑯᓂᖅᑕᐅᓂᕆᖅᑐᑦ ᐊᑐᖅᓯᓂᖅ ᐊᑐᖅᑕᐃᓕᓴᕐᓂᖅ ᐊᒻᒪᓗ ᓴᓇᓕᐅᔨᖅᓯᖅ ᑕᒪᐃᓂᖅᑐᑦ ᐃᓕᓴᕐᓂ

ᑕᒪᐃᓐᓂᕆᔨᖅ LSA ᐊᒻᒪᓗ ᐃᓕᓴᐃᒍ 35-ᑭᓕᒥᑐᒥᐅᑦ ᐊᑯᐊᖅᑎᑦ ᓗᓂ ᐊᕐᑎᑕᖅᑕᒃ ᓯᓚᑦᓂᓂ ᓴᖅᑭᐅᓂᐊᖅᑐᑦ ᐊᖅᑯᓂᕐᓂᖅ ᐊᖅᑯᑎᓕᐅᑦᓯᒪᓕᕆᓂᖅ ᑕᓂᐊᖅᑐᑦ ᐊᖅᑯᓂᖅᓯᒪᔪᓐᓇᖅ ᑲᑎᑎᓂᖅ ᐃᓚᖓᓂᑦ ᐃᓐᓇᑦᑎᓂᒃ 12,620-ᑭᓚᒥᑐ ᓯᓂᑭᒥᑦᓂ. ᑕᒪᐃᑐᑦ ᓴᓇᓕᕆᔨᓂᑦ ᐃᓂᒪᓐᓇᓂᑦ ᓴᖅᑭᑎᓂᐊᖅᑐᑦ ᐅᑭᐅᖅᑯᓂᑦ ᓄᓇᕗᑦ ᐸᑦᓇᐃᓕᓐᓂᒥᐅᑎᓂᒃ ᑕᒪᓂ ᓴᓇᓕᖅᑎᑦᓂᒃ ᓄᓇᕗᓂᖅᓴᖅᑎᓂᒃ, ᓴᓇᖅᑯᑎᒍᑎᓂᒃ ᐅᑎᖅᑕᐅᓂᐊᖅᑐᑦ, ᑭᖑᓂᖓᓯᑦᓗ ᐅᑎᖅᑕᐅᓂᐊᖅᑐᑦᓂᒃᓴᑕ ᑲᒪᑎᐅᕐᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᑭᖑᓂᖓᓯᑦᓗ ᐊᑐᓚᐃᓕᓐᓂᐊᖅᑐᑦᓂᒃ, ᓄᓇᕗᑦ "ᐱᐅᖏᓂᖅᓴᖅᓯᐅᓇᖅᑐᑦ" ᐃᓱᒪᑎᑐᓂᑦ ᑕᒪᒃ ᑯᐊᐅᓄᓇᕗᑦ ᒪᓕᒃᑐᓂᑦ ᐃᓐᓇᑦᑎᓂᒃ VEC-ᓂ ᐅᖅᑲᓱᐅᔨᓂᑦ. ᑕᐃᒪᓗᖅᑲᐃ ᐄᓴᓗᓀᒃᑐᒃ ᐱᓕᕆᔨᓂᑦ ᐊᐅᑐᖅᑯᐊᓱᒪᓂᑦ ᑕᒪᐅᐅᓇ ᐱᐅᓂᑦᑎᓐᓄᑦ ᑕᒪᐅᓇᖅᑐᑦ, ᐊᐅᑐᐃᓐᓇᓄᑦ ᓴᐅᔨᓴᖅᑕᐅᓱᒪᓂᑦᓴᑲ ᐅᓇᓗ ᓇᓗᓇᐃᖅᑯᓂᑦ ᑎᑭᐅᓂᖅᓴᖅᑎᓂᒃ ᐊᐅᑐᖅᑕᓂᒃ ᓴᓐᓂᒃᑯᑦ ᓴᓐᓂᒃᑯᑦ ᐊᓯᖏᓐᓂᒃ ᐱᓕᕆᔨᓂᑦ ᐅᖅᓯᒪᐃᑦᑐᓂᑦ ᓴᖅᑭᑎᓂᐊᖅᑐᑦᓂᒃᓴᑕ ᐱᓇᓕᕆᓂᖅᓴᖅᑎᓂᒃᐊᒻᒪᓗ ᐱᐅᓂᑦᑎᓐᓄᑦ ᐅᖃᐅᓯᒪᓂᖅ ᐊᑐᖅᑯᐊᓱᒪᓂᑦ ᐊᑐᖅᑯᓂᖅᓴᖅᑎᓂᒃ ᐊᒻᒪᓗ ᐱᐅᓂᑦᑎᓐᓄᑦ ᓴᖅᑭᑎᓂᐊᖅᑐᑦ (SARA), ᐊᐅᓚᑦ ᑲᓂ ᑕᒪᐅᖏᓪᓗᑕᒃᑯᑦ ᑎᖏᑎᑦ ᐊᒻᒪᓗ ᓄᓇᕗᑦ ᓴᖅᑭᑎᓂᐊᖅᑐᑦ.

ᐅᑯᐊ ᑕᕐᖓ ᓇᐃᓗᓕᕆᔨᓂᑦ ᐅᓂᒃᑳᓕᕆᔨᓴᕆᔨᓂᑦ ᐊᖏᑎᖏᓐᓂᑦ, ᓴᖅᑮᓕᖅᑐᒥ ᓴᓇᐅᔨᓂᐊᖅᑐᑦ ᕿᓚᒻᒥᐊᖅᑐᑦᓗ ᐃᒃᐱᓇᓱᐊᖅᑐᑦ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ ᐅᓇᓗ ᓇᓗᓇᐃᖅᑯᓂᑦ VECs, ᐊᒃᓴᓂᐊᖅᑐᕈᑕᓂᑯᓘᑦ ᓄᓇᕗᑦ ᐃᓕᓴᕐᕕᖏᓐᓂᒃ ᐃᓐᓇᑦᑎᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ, ᐊᒻᒪᓗ ᐱᔪᓐᓇᖅᑐᑦ ᐃᓐᓇᑦᑎᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ ᐊᒻᒪᓗ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ ᐊᑐᖅᑯᐊᓱᒪᓂᑦ ᓇᓗᓇᐃᖅᑯᓂᑦ ᑕᒪᓐᓇ ᐅᓇᓗ VEC-ᓂ.

<u>ᐅᓴᕆᖏᑦ</u>

ᔪᓯᒥ ᓴᐊᔨᒥᓗ ᐅᓴᕆᖏᓐᓂᒃ ᓄᓇᕗᑦ, ᐱᐅᓂᑦ PDAs ᐅᑯᐊᐱᓴᓯᑦ ᓇᓗᖏᓂ ᑲᓇᖅᑲᖏᓂ ᐅᖅᑯᑯᓱᐱᓂᒃᓂ ᐃᓯᐊᓂ ᓯᓚᖅᑯᑦᓂᒃ ᓯᓚᑦᓯᑯᑦᓂᒃ (Slave Churchill Geologic Provinces) ᐅᓴᕆᖅᓂᐊᕐᒥᒋᑦᓴᖅᓴᓯᓂ ᓇᓗᓇᐃᖅ. ᓯᑲᓴᒥ ᑐᓕᑦ ᑕᕐᕆᔨᓂᖅ ᓂᐅᕆᐊᕐᓇᖅᑐᓂᒃᑎᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦᓂᒃ ᑐᓕᑦ ᕿᓚᒻᒥᐊᖅᑐᑦᓂᒃᓴᓕᓚᒻᒥᐊᖅᑐᑦ (MLA) ᐃᓗᐊᓂᑲᓪᓚᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦ ᐊᑐᖅᑯᓂᖅᓴᖅᑎᓂᒃ ᓴᖅᑭᐅᓂᐊᖅᑐᑦᓂᒃ ᐊᖅᑯᓂᖅᓴᖅᑎᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦᓂᒃ ᓄᓇᕗᑦ ᐊᖅᑯᓂᖅᓴᖅᑎᓂᒃ ᓴᓇᖅᑭᑎᓂᐊᖅᑐᑦᓂᒃ ᐅᓇᓗ

ᔨᓱᒥ ᓴᐊᔨᒥᓗ ᓴᓇᕕᐊᓴᓂ ᐱᐅ ᑯᒥᑎᓴᐅᓴᓂᓗ PDA-ᓂ ᐊᒻᒪᓗᑦ ᑕᐅᐅ ᓱᐢᒥᐊᓗᑦ ᐊᐅᐅ ᓱᓱᒥᓴᐅᓄᑐᓂ ᐃᑎᓂᓗᓂᓗᓂ ᐃᑎᓂᓗᓂᓗᓂ ᐃᑎᓂᓗᓂᓗ

ᐃᒪᖏᐅᖅᓂᖅᓴᓂ ᑕᓯᖏᐅᖅᓂᖅᓴᓂ ᐊᑦᒪᓗ ᑕᓯᑯᓗᖏᐅᖅᓂᖅᓴᓂ. ᐃᑦᒥᐅᒃ ᑯᖕᒪᔪᑦ ᓄᓇᐃᑦ ᑲᔪᓐᓇᖅᐳᖅ ᐊᓗᓇᐃᖅᑕᐅᓕᐅᖅᓯᒥᔪᑦ ᐊᑐᖅᓂᖅᓂᖅᓴᒻᒥᓄᑦ ᐅᓕᔪᓄᑦ ᓇᔪᓚᖏᐅᓕᓐᓂᐅᒃ ᐅᖃᓖᔪᓐᓇᖅ ᐱᕐᖅᑐᓄᑦ ᑕᒋᓂᖅᓯᒥᓄᑦ ᐊᑦᔨᐅᖅᓴᑐᓄᑦ ᐱᓕᕐᓂᐊᕐᓂᓗᐊᒃᑐᒃ ᓚᑯᐊ ᑐᐊᕐᓗᐃᑦ ᐱᖓᐃᑦ, ᖃᐃᖅᓯᓱᓂᑦ, ᐅᓴᖅᓯᓱᐃᑦ ᓄᓇᒥ ᑕᑯᐅᖅᓱᐊᕐᓂ ᐊᑦᒪᓗ ᑐᐅᑐᐅᖅ ᖃᐅᔨᓴᖅᑐᑦ ᐅᓄᖅᓴᓂᐅᓕᐅᑦᑐᑦ ᓄᓇᖕᒪᓂ ᑯᑯᓚᓂᑦ, ᓚᖅᓴᐃᑦ, ᐊᑦᒪᓗ ᐃᑭᖕᒪᓂ ᓄᑯᓂ ᐱᖓᐃᑦᓗ. ᑲᑎᓴᑦᑐᒃ 890-ᖏᓐ ᓂᑦᑐᓂᐅᒃ ᐊᑦᔨᑎᖏᑦ ᑐᐅᑐᒃ ᓄᓇᕆᓂᒃ ᓇᓗᓇᐃᖅᓯᓕᐅᖅᑐᑦ ᑕᒪᑐᓗᒥ TEM-ᑯᑦ ᓴᓇᔪᑦ ᐊᐅᓕᑕᐅᔪᓕᐅᖅᑐᖅᑐᑦ ᑕᑯᐃᑐᖅᑐᑦᓴᑎᒃ ᑕᑯᐃᑦᓴᐅᓕᑦᑐᒃᓴᑦ ᑐᑭᓯᑕᐅᓕᓕᐅᑦᑎᔪᑦ ᐅᖃᓖᑦᓴᐅᓕᑦᑐᒃᓴᑦ ᐃᓕᓴᕐᓂᐊᕐᓂᖅ SLA-ᓂ ᐊᑦᒪᓗ RSA-ᓂᓗ. ᐅᓄᖅᓂᖅᓯᖓᔪᓕᓕᐅᖅᑐᑦ ᑕᖅᑲᓕᑦ ᐅᖅᑲᐅᔭᐃᑦ, ᑭᒃᑯᐊᑎᑦᑐᒃ ᑕᑯᐃᑦᓴᐅᓕᑦᑐᒃᓴᑦ ᐊᓗᓇᐃᖅᓯᓕᐅᖅᑐᑦ ᑭᓂᖅᑕᐅᓕᓕᐅᑦᑎᔪᑦ ᐱᓕᕐᓂᐊᕐᓂᖅ ᑭᓯᑕᐅᓕᓕᐅᑦᑎᔪᑦ ᐊᓗᓇᐃᖅᓯᓕᐅᖅᑐᑦ ᐊᑦᒪᓗ ᐊᐅᓚᑦᑎᓕᐅᖅᑐᑦ ᐱᓕᕐᓂᐊᕐᓂᖅ

ᑐᑲᑐᓂ

ᑕᐃᒪᓗ ᐱᖓᓱᖏᒪᑕ ᓄᓇᒥ ᑐᑲᑐᐃᓂ ᑕᓯᐅᖅᑎᑕᑦ ᑕᖅᑐᑦ ᐃᓕᓴᕐᕕᖏᓂ ᑭᓯᐊᓂᖅᑎᓂᖅ ᓄᓇᕗᑦ ᐅᖃᓕᒫᖅᑎᑦ ᓄᓇᕗᒻᒥᐅ ᑐᑲᑐᐃᓂ ᓄᓇᖓᓂᒃ. ᖃᖓᑦᓯ ᑕᖅᑎᑕᐅᓯᒪᔪᖅᑐᑦ ᑯᓘᓐ ᑕᐅᔪᓂᒃ ᓴᖅᑭᑎᒃᓴᖅᑭᒃᑐᑦ ᑲᒪᒋᔭᖅᑐᒃ ᑲᑎᒪᔨᓂᖓᓂ ᑲᑎᒪᔨᓂᖓᓂ (ᑕᓪᓕᐊᔪᖓᑕᓪᓕᐊᑎᑦᑐᖅ ᐊᑕᐅᔪᓂᒃ ᐃᓕᓴᕐᕕᖏᓂ ᑐᑲᑐᐃᓂ) ᐊᒻᒪᓗ ᐃᑉᐱᒃ ᑐᑲᑐᐃᓂ ᐅᖃᐅᓯᖅᑕᐅᔪᓂᒃ ᑕᐃᒃᑯᑦ ᓄᓇᖓᓂᒃ ᐃᓕᓴᕐᕕᖏᓂ ᑐᑲᑐᐃᓂ ᐊᒻᒪᓗ ᐊᕿᐃᐊᓂᒃ ᑐᑲᑐᐃᓂ ᐃᓕᓴᕐᕕᖏᓂ ᑐᑲᑐᐃᓂ ᐊᒻᒪᓗ ᐊᕿᐃᐊᓂᒃ ᑐᑲᑐᐃᓂ ᑐᑲᑐᐃᓂ ᐅᑉᐱᐅᓯᖅᑕᐅᔪ

ᑭᐸ ᑯᑎᐱᑦ ᓄᓇᖅ ᖃᐅᔨᓴᕆᔨᑦᑕᐅᔪᓂᒃ ᐃᓕᓴᕐᓂᒃ ᓇᓗᓇᐃᖅᑯᓯᓪᓚᑦ ᑭᐸ ᑯᑎ ᖃᖓᓐᓂᐸ ᑐᓴ ᑐᖓᔪᓕᐸᖅᑕᐅᔪᓯᓪᓚᑦ ᐊᓐᓇᕐᓂᖅ ᖃᑐᓂᖅᓴᖅᑐᑦ ᐊᐅᑦᓯᑎᑐᑦ ᑭᓚᐅᑎᓪᓗᑎᒃ ᐱᖓᓱᒃᑐᒥᒃ.

ᐱᓕᓚᐊᖅᓯᓂᑦ ᐊᖅ ᑐᖅᑕᐅᔪᓚᕆᖅᑐᑦ ᑕᐃᓂᓕ ᐱᖅ ᑯᒋᒥᑎᓴᐅᔨᓯᑦ ᓂᕆᔨᑎᓄᑦ ᐊᖏᑎᓕᐃᖏᓐᓂᒃ ᓄᑕ ᑕᒪᑐᒍᓐᓇ ᑐᐃᓐᓇᖅᑐᑎᓄᑦ ᑐᑭᓯᐅᑎᓪᓗᑎᒃ ᐃᒪᓐᓇᐅᔪᓂᒃ ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ : ᐃᓂᖏᓐᓄᑦ ᓄᖅᑕᐅᓕᓂᕆᖏᓐᓂᒃ ᓄᓇ , ᐸᑲ ᓚᕋᖅ ᑕᐅᔪᓂᖏᓐᓂᒃ ᓄᓇ , ᐸᑲ ᓚᕋᖅ ᑕᐅᔪᓂᖏᓐᓂᒃ ᓄᓇ ᓄᐱ ᑕᕐᓂᖏᓐᓂᒃ , ᑐᐱ ᑕᕐᓂᓕᕆᓚᓄᑦ ᐊᒪᓂ ᓄᓕ ᐋᖅᓂᖏᓐᓂᒃᑕᐅᔪᓂᖏᓐᓂᒃ ᑕᖏᑐᑦ , ᓄᕐᓂᐅᕐᓄᑦᓴᖅᑕᐅᑦ ᑕᐃᓂᓕ ᑐᓂᓯᒪᓂᖅ ᐊᖅᑯᓂᖅᑐᑦ , ᐅᓪᓗᕆᐊᖃᖅᑐᑦ ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ , ᑕᑯᔨᐅᔪᓚᐃᒍᑦ , ᐅᓪᓚᔪᑎᓕᑦᑐᑦ ᓄᓇᕗᑦ , ᐊᒪᓂ ᐅᓄᖅᑕᐅᔪᓂᒃ ᓄᓇᕗᑦ . ᓂᕆᔨᑎᓄᑦ ᐊᖅ ᑐᖅᑕᐅᔪᓚᐃᒪᓕᕆᓂᑎᓄᑦ ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ ᒥᓂᖅᑐᑦ (ᐃᓕᓴᕐᓂᖅ 10, ᐃᓕᓐᓂᑌ 20) ᓇᓗᓇᐃᔨᓂᑦ ᑎᐊᖅᓯᓚᕆᔨᑦ ᐊᑐᖅᑕᐅᔪᓚᕆᖅᑐᑦ ᐊᖅ ᑐᖅᑕᐅᔪᓗᐊᖅᓯᓂᖅ ᑐᓴᕐᓂᖅᑐᑎᓪᓗᑎᒃ ᐅᓄᕐᓄᑦᓴᖅᑕᒫᒃ ᓚᐅᑦ ᐅᓴᓂᔪᓂᕐᒥᒃ ᓄᓇᕗᑦ , ᑕᒪᐃᓐᓇᖅᑐᑎᓪᓗᑎᒃ ᐊᖅᑯᓂᖅᑐᑦ ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ ᓄᓇᕗᑦ , ᑕᑯᔨᐅᔪᓚᐃᒪᓕᕆᓂᑎᓄᑦ ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ ᓄᓇᕗᑦ , ᐊᒪᓂᖅᑐᑎᓪᓗᑎᒃ ᓄᓇᕗᑦ

ᐃᑲᔪᖅ ᓂᐊᖅ ᓄᓇᕗᑦ ᐊᒃ ᑐᐃᖏᕐᓇᖅᑎᖅᓯᓐᓂᒃ ᖃᐅᔨᓴᖅᑕᐅᓚᑐᑎᒃ ᑐᒃ ᑐᐃᑦ, ᐊᖏᕐᕿᖅᑎᓂᓕᒫ ᓄᓇᖏᓐᓂᖅ ᐃᑲᔪᑎᒃ ᓴᓂᒃ ᓂᕈᐊᖅᓯᒪᔪᓂᒃ ᐊᑐᐊᓕᒫᓂ ᖃᓄᐃᖅ ᑲᑎᕐᓯᒪᔪᓂᒃ ᐊᑐᐊᓕᒫᓂ ᐊᑐᖅᑕᐅᑐᐃᓐᓇᖅᑐᒥ ᐊᑐᖅᑕᐅᓚᑐᑎᒃ ᐊᑐᐊᓕᒫᓂ ᐊᑐᖅᑕᐅᓚᑐᑎᒃ ᐊᑐᖅᑕᐅᓚᑐᑎᒃ ᐃᓕᓴᐅᔪᓂᒃ ᐊᑐᖅᑕᐅᓚᑐᑎᒃ ᐊᑐᖅᑕᐅᓚᑐᑎᒃ ᐊᑐᖅᑕᐅᓚᑐᑎ

ᐃᒃ ᐱᖓᓱᓂ ᓂᕆᔨᒃ ᓂᐊᕐᓇᓯᕐᒥᔪᐃᓕᓂᖅ ᓴᓇᖏᑦᓂᕐᒧᑦ ᑕᒪᖓᓄᑦ ᐅᓂᒃ VEC-ᒥ ᐊᒃ ᓱᓄᑦ ᓴᓇᔨᓂᑦ ᓄᓇᕗᑦᐃᖅᓯᒪᔪᖅᑐᑦ ᖃᐅᔨᓴᓕᖅᑎᑦᓄᓐᓂᒃ: ᓄᔨᖅᑎᑦ ᑕᖅᑕᖓᓂ ᐱᓕᕆᓂᐊᕐᓕᒪᑦ ᐊᓯᐅᓕᖅᑎᓯᒪᔨᑦ, ᐸᑲ ᐃᓴᖅᑎᑕᐅᔨᔪᖅ ᓄᓇᕗᑦᐃᖅᓯᓐᓄᑦ ᐱᖓᓱᓯᖏᓪᓗ ᓄᓇᖃᐅᑎᓄᑦ (ᐃᓄᖏᖅᑐᑕᐅᒃ ᐸᑦ ᓄᓇᕗᑎᑦᑎᑦᑕᖅᑐᑦ), ᐃᖏᕐᓂᕆᔪᖅᑎᑦ ᑕᖅᑕᖓᓂᓗ ᐊᓯᔾᔨᑐᑎᓄᑦ ᓄᓇᖃᐅᑎᓄᑦ, ᑐᑭᓯᐅᑎᓂᒃ ᐊᔪᕐᓇᖅᑐᑦ ᐃᓄᐃᑦ ᐃᓄᐃᑦ ᐊᑐᖅᑐᑦ ᐊᑐᖅᑐᑦ ᐊᑐᖅᑐ

ᑭᐅᓯᔪᑕᐅᑎᐊᖅᓴᓪ ᑲᑎᓪᓗᑎᓪ ᐃᒃ ᐱᖓᓐᓄᑦ ᓂᖅᐊᓂᒃᑐᓄᑦ ᖃᐅᔨᒃᑯᓯᒪᖓᓕᒃ ᐅᒃ ᑐᕆᖅᑕᐅᓄᓯᐊᖅᓯᑎᑦ ᓄᓇᕗᒻᒥ ᐅᓂᒃᑕᐅᔪᓐᓇᖅᑐᑦ **ᐊᒃ ᓯᓗᐊᖏᓐ ᓂᐊᕆ ᓂᕆᖅᑕᐅᔨᓪ ᓗᑎᒃ .`**

ᐅᒥᖏᒪᐃᓪ

ᐅᒥᖏᒪᐃᓪ ᐊᖏᕐᓂᖅᓴᕐᖏᖓᒪᑕ ᓄᓇᕆᓂᒃ ᓂᕿᑭᖅᑕᐅᑐᓂ ᑕᒪᓂ ᐃᓕᖏᓐ ᓂ ᐅᓄᖏᓯᑎᒃ ᐃᓕᖏᓐ ᓂᓗ ᐅᓄᖏᓂᒃ ᑎᓇᑕᐅᔨᓪ ᐅᑭᐅᓂᖅᑕᐅᑐᓂᒻᒪᑦᑐᖓᓕᒃ ᑲᒪᒋᓗ ᐱᓕᒃ ᐱᓕᕐᓂᑎᒃ , ᓄᑖᔨᖏᓐ ᓗ, ᐊᒪᒋᓗ ᒥᖅᑯᖏᓐ , ᐊᒪᒋᓗ ᓂᐅᕐᐳᓕᐅᓕᖅᑎᑦ ᑕᒪᓂᒋᒥᐅᓄᓂᒃ ᓂᐅᖅᓂᓐ . ᐃᓄᐃᑦ ᖃᐅᔨᒋᔭᐅᑎᖏᓐᓂ ᑎᒍᑦ ᓇᓗᓇᐃᖅᓯᒪᔨᖅ ᐅᑯᐊ ᐅᒥᖏᓕᒃ ᐅᓄᖏᓂᒃ ᐃᓕᖏᓐ ᐅᓄᖏᓂᒃ ᐅᓄᓯᖅᓯᓐᓂᒃ ᐅᓄᖅᓯᐊᓂᒃᑐᓄᑦ ᑕᐃᒪᓕᖅᓴᓂ ᐅᓄᓘᒃᑐᓂᒃ ᐊᒪᓂᒃᑐᓄᑦ ᐊᒡᓗᐊᓂᓗ ᐊᒪᓂᒃᑐᓄᑦ ᖃᑎᖅᑎᒥᓂ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ , ᑕᒪᓐᓇᐅᑉ ᐳᓚᕆᐊᖅᑐᓂᒃ ᐊᒪᓂᒃᑐᓄᑦ ᖃᑎᖅᑎᒥᓂ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ ᖃᑎᖅᑎᒥᓂ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ ᓄᓇᕗᒻᒥ ᓄᓇᕗᒻᒥ ᐊᒪᓂᒃᑐᓄᑦ ᓄᓇᕗᒻᒥ ᓄᓇᕗᒻᒥ ᐃᓕᓴᕐᓂᐅᓕᖅᓯᒪᓂᒃ

ᐊᑯᓂᐅᖅᑐᑦ ᑐᒥᒃ ᐱᑕᖃᑎᒋᑐᓂᒃ (ᐃᓕᓴᕐᓯᒪᓂᑦ ᓴᓇᙳᐅᔪᓂᑦ) ᐊᓴᐊᔪᑦ ᐊᓴᐅᓵᓂᐊᕐᑎᓂᖅᑕᑦ ᓇᔪᓴᖃᑎᒌᑦᑕᑦ ᑕᒥᑎᒋᔭᐅᓂᖅ ᐃᓕᓐᓂᐊᕐᓂᖅ, ᐃᓕᓴᕐᓂᓕᐅᔪᓴᐅᑉ ᑯᑦ ᐱᖓᑯᓂᖃᖅᓯᒪᓂ ᑕᐃᒪᐃᓕᐅᔪᓴᐅᖓᒪᑕ, ᐊᒻᒪ ᓗᓐ ᑕᕐᓂᐊᑐᐊᖅ ᑭᓴᑕᒥᐊᖅᑕᑦ ᐊᓴᐅᓵᓂᐊᖅ ᓄᓇᖕᓂᖅ ᐊᒻᒪ ᓗᓐ ᐸᑎ ᓴᙵᕆᖃᑕᐅᓂᖅ ᓂᐸᖅᓴᓄᑦ, ᐊᒻᒪ ᓗᓐ ᑲᑎᑦᑕᑐᑦ ᐅᓄᖅᓯᑐᑦ ᐅᓄᖅᓴᓂᖅᑐᑦ ᑲᑎᒪᔨᖃᑎᒌᖅᓯᒪᓂ ᐊᓴᐅᓵᓂᐊᖅᑐᑦ ᐃᓄᐃᑦ ᓴᙵᕆᖃᑕᐅᓂᖅᑐᑦ ᐃᓄᐃᑦ ᐊᓴᐅᓵᓂᐊ

ᐸᑦ ᓂᐊᐅᑕᐅᔨᐟᐢᓇᓵᑦ ᐊᐢ ᓱᓗᐊᕈᐢᓄᑕᐅᔭᓗᑎᓗ, ᓴᓇᓂᐅᔨᓂ ᐊᖏᑕᓗᐊᖅᑕᑕᐃᓕᒥᔨᑕᐅᔭᓗᑎᐢ , ᓂᐸᕆᔨᓂᐢ ᐊᐢ ᓱᓗᐊᕈᐢᓄᑕᐅᔭᓗᑎᐢ ᑎᖅᑕᑦ ᑕᖏ ᓗᑎᐢ , ᓱᐢ ᐢᑕᓗᐊᖅᑕᐃᓕᒥᒪᑦ ᑎᖅᑕᑦ ᑕᖏ ᓗᑎᐢ ᓄᓇᐢ ᑯᐊᕈᑎᐢ , ᐊᐢ ᑕᖏ ᓗᑯᐃᓪ ᓗ ᐊᐅᑕᒥᑕᐅᔭᑎᑦ ᑎᐊᖅᑯᑎᑦ ᑕᖏ ᓗᑎᐢ , ᓴᓇᖅᑯᑎᓄᑦ ᐅᐊᕈᑎᑦ ᐊᑐᖅᑕᐅᔭᓱᖏᑦ ᐊᑐᐊᓴᖅᑎᑕᐅᔭᓗᑎᐢ ᓂᖏᔨᑎᓄᑦ ᐱᐢ ᑯᒥᑦᓴᐅᔭᓂᐢ ᐱᑕᖅᐅᓪᓚᒥᔨᑦ ᑐᖏᖅᓄᑦ ᐅᐸᐅᓪᓚᑦ ᐅᓪᓚᑦ, ᐊᐢ ᒪᓕ ᑲᔨᓂᐢᓄᑎᐢ ᐅᒪᔨᓪᓚᑎᓂᐢ ᐊᐢ ᓱᓗᐊᕈᐢᓄᑕᐅᔭᓗᑎᐢ (ᐃᐢ ᔨᔨᖅ 10, ᐃᓕᖏᓗ 20-ᒥ).

ᐅᑯᐊ ᑕᕐᖓ ᐊᑐᓕᖅᑎᑕᐅᓂᐊᖅᑐᑦ ᐊᐢ ᓱᓗᐊᓕᓴᐃᐢ ᑯᑯᑎᑕᐅᔨᑦᓗᓗ ᓴᓇᓂᐅᔨᓂ, ᓱᑕᒪᓂᐢ ᐊᒥᐊᐢ ᑯᑎᐢᓄᑦ ᐱᐢᑐᖅᑕᐅᔭᓗᑎᐢ ᐊᐢ ᓱᓗᐊᕈᐢᓄ

ᑕᐃᒪᐃᓐᓂᑦ, ᐃᓅᓪ ᐱᓐᓇᓕᕆᓂᖅᓯᒪᓕᒃ ᐊᓯᖏᓐᓂ ᓄᓇᕗᑦ ᓄᓇᕗᒻᒥᐅᑦ ᑲᑎᑦᑕᐅᔪᓐᓇᖅᑐᑦ ᐊᑐᐃᓐᓇᖅᑐᑦ ᐃᓅᓪᓗᒍ ᐊᑐᐊᓘᓐᓃᑦ ᐊᑐᐃᓐᓇᖅᑐᑦ ᐊᑐᐊᓘᓐᓃ

ᑲᑎᖏᓯᐅᑦ ᓄᑕᖅᑭᑦ ᐃᓕᓴᐃᓐᓇᖅᑐᖅ ᓄᑕᖅᑭᑦ ᐊᑐᖅᑐᑦ ᑲᑎᖏᓯᐅᑦ ᐊᑐᖅᑐᑦ ᓄᑕᖅᑭᑦ ᐊᑐᖅᑐᑦ ᐊᑐᖅᑐᑦ ᐊᑐᖅᑐ

10, ᐃᓕᓴᐃ 20-ᒥ), ᐊᐅ ᑐᐊᓂᑌᓇᔭᖅᑕᓴᓐ ᐊᒥᐊᐅ ᑯᑎᐅᓕᐅᑦ ᑐᓂᐅᑦ ᐃᐅ ᐱᓕᓴᐃ ᓂᐊᖅᑐᓂ ᓂᐊᖅᑐᑦ ᑐᑭᓯᐅᑦ ᑐᑭᓯᐅᑦᑐᑦ ᐊᐅᑦ ᑐᑭᓯᐅᑦᑐᑦ ᐃᓐᓇᐃᓐᓇᖅᑐᑦ ᐊᐅ ᑐᑭᓯᐅᑦᑐᑦ ᐃᓐᓇᐃᓐᓇᖅᑐᑦ **ᐊᐅ ᓱᑐᐊᐅᖏᓐᓄᓐᓂ ᓂᕆᖅᑕᐅᓯᓐᓂ ᑐᑎᐅᓐ .**

ᐅᑎᖅᓯᖅᑐᑎᓐᓂ ᐃᐅ ᐱᓕᓴᐃ ᓂᕆᔨᕐᓴᖅᑕᓴᓐᓂ ᐅᐊᖅᑐᑎᓐᓂ ᓴᐃᑐᖅᑕᐅᓯᐅᓴᓐᓂ ᒪᑕ ᖁᔨᓄᑦ ᓴᐃᑐᖅᑕᐅᓯᐅᓴᓐᓂ ᐃᑐᓕᓐᓂᑐᓂ ᑭᓯᐅᓂᐊᕐᓂᖅ ᐊᐅᓕᑦ ᐱᑎᓕᐅᑦ ᐱᐊᓐᓂᖅ ᐊᒥᐊᐅ ᐱᓕᓴᐃ ᓂᕆᔨᕐᓴᖅᑕᓴᓐᓂ ᐃᓐᓇᐃᓐᓇᖅᑐᑦ

Ataniuyunut Nainaqhimayuq

Tamna Haningayuq Kuugaq Havanga (tamna Havanguyuq) havikhaqhiuqtun guulit havanguyuq nanminigiyan Sabina Guulit Silverlu Kuapurisan (Sabina-kut) tahamani Kitikmeotni nigingani Nunavut. Tamna Havanguyuq ilalik Goose Havakvia, tamnalu Tagiumi Iliuqaqvik Nuna (MLA-nga) inilik tahamani nigingani hinaani kanangnata Kingaok. Sabina-kut hanaiyaqhimayan Avatiliqutit Aktuanit Uqauhiit (EIS-ngi) naunaigahuaqhugin nainaqnitlu pilaqniyt avatiliqutinut inuliqutitlu aktuani piplugit taphumanga Havanguyuq, ilagiplugitlu tapkuat piyaqaqnit titigaqhimayut tapkunani Nunavutagauyuq Angigutit (Nunavutagutit) tapkuatlu Nunavut Avatiligiyit Katimayit (NIRB-kut) Naunaipkutat Hannaiyaqninut tapkuat Avatoiqutinut Aktuanit Uqauhiit taphumunga Hanningayuq Kuugaq Havanguyuq (NIRB Titigaqqutat Nappaa 12MN036; NIRB 2013). Una taiguaq tapkununga EIS-ngi hatqigutauyut naunaiyaqnit pilat avatiliqutit aktuanit nunaliqutinut avatigiyai piqatai uuktugutauyumun Havanguyuq huliniit tukhigautaulgaqtitlugu ihuaqhigiagutit aulatauninutlu piyaunit.

Tapkuat pinahuaqtai pilat Pinnagiyauni Uumatyutin Ilagiyait (VECs-ngi) pipkaqtai Sabina-kut hivuliqtai inungnut uqaqatigiknit, atuqni Ilitquhit Ilihimani (TK-ngi), maligaligiyin uqaqatiginit maligaligiyinlu ihumagiqahiutini tahapkuatut nunguttailinit qanugitni allatqit uumayut ilagitluniit, atugahuaquinitlu hatqiqtitai talvani NIRB-kut EIS-ngi naunaipkutat (NIRB 2013). Tapkuat *Inuit Ilitquhit Ilihimani tapkuat Sabina-kut Guulit Silverlu Kuapurisan, Hanningayuq Kuugaq (Hannigayok) Havanga, Naonaiyaotit Ilitquhit Ilihimanit Havanguyuq Tuhagakhaliat* (KIA 2012), *Naonaiyaotit Inuit Ilitquhiit Ilihimayangit Havaariyauyum - Hannigayok (Sabina Kulu & Havigalit Kuapuriisan Havaariyauyum Hanningayum Kugaa). Ilittuqhiyangit Naunaiyaqtut Ilihautiyut, Nunguanit Unipkaangitn (Juun 2014)* (KIA 2014), unalu *Hanningayum Kugaa Havaariyauyum: Atuqtangit Kitunuliqaak Piyumayangit ukunani Inuit Ilitquhiit Ilihimayangit Tikkuaqtauhimayut Nunaqaqaaqhimayunut Ilauqatauyut iluani Nunatsiarmi ihumagiyauyut akhut tapkununga TK-ngi tuhagakhat*. Piplugit tahapkuat piqaqnit, tahapkuat nunaliqutit ilagiyai tikkuaqtauyut tapkuangunit VECs-ngi: nauhimayut taihimayutlu nunap qanugitnit, tuktut, akhait, umingmait, qalviit mitqulgitlu, tikitpaktut tingmiat, kilgaviitlu. Nunaliqutit, qiqumainaqniq, nunaplu qanugitnia nunatlu ihumagiyauyut Pityutaunit Titigaqni tamaitalu piyalgit ilaliutini uumani taiguani.

Pilat aktuanit nunaliqutitt angutikhatlu VECs-ngi naunaiyaqtauyut akuttuyumik tahamani Nunalikni Naunaiyaqtat Nunat (LSA-nga) attaqtuniqpamiklu Nunaliit Avikhimaniani Naunaiyaqtat Nuna (RSA-nga). Tamna nunaliqutit LSA-nga pihimaya 1,344 kilaamitat kikagiktumik ilagiplugit Goose Pivaliatitni Nunat (PDAs-ngi), tapkuat ilalgit tamaita uuktugauyut Havanguyuq havagutai taphumunga Goose Havakviit Nunat, tukligikninut, tamna MLA-nga PDA-nga, tapkuat ukiumi apqutit atatyutai tapkuat Goose, tamnalu MLA-nga PDAs-ngi, tamnalu uigutyuta (1 tikitlugu 5 kilaamitat) avataani tahamna hilataani kikligiya tapkuat PDAs-ngi apqutitlu. Tapkuat nunaliqutit RSA-ngi ilalgit tapkuat LSA-ngi, tamnalu 35 kilaamitat uigutyuta naliakni haniani tamaita uuktugauyuq Havanguyuq havagutai ukiumilu apqut aulagiangi akungani tapkuak malruk PDAs-ngi piplugitlu mikhaani 12,620 kilaamitat kikagiktumik. Tamaita aktuanit naunaiyaqtauyut atuqtitlugu Havakvik Hannaiyaqnia, Hanayaunia, Aulani, Halumaqtigaunia Umiknialu, Umikhimaliqaqtitlugulu Havanguyuq tukligiknit, pinahuaqhugin “ihuinaqpallaat-piplugin” atulaqnit piyautyuhit tahapkuat tukligikhat pihimanit anginiqpamik aktuanit tapkununga VEC-ngi uqauhiuyut. Humiliqaak amiakkuutit aktuqhimayauyut Havaariyauyukhanut uumani VEC naaguhiiyaugumi, hamna angiklirningit aktuqtaunianit qauyihaiyangit havaktauhimagaluaqtut qimilruqtauvluni atauttimut aktuqtauningit Hanningayum Kugaa Havaariyauyukhanut aahiit tautungnaqtumik havaktauhimayut havaangit inuup aktuqhimayangillu. Taihimayut piquyaqnittut ihumagiyauyut atquniani naunaiyainiq, ilautitlugit tapkuat *Uumayut Allatqit Nungunahuquqnit Piquyat* (SARA-ngi), tapkuat *Tikitpaktut Tingmiat Maligait Piquyat*, tapkuatlu *Nunavut Angutikhat Piquyat*.

Tahapkuat hatqiqtauyut nainaqhimanit atuqtunut avatiliqutit, atuqniqhat Havanguyuq huliniit piniagahugiyauyut piqatainut tahapkuat nunaliqutit VECs-ngi, ihuaqhigiagutit piyaunit, aktuanit naunaiyaqni, atuqqatalu, katihimanit aktuanit naunaiyaqni atuqni nunaliqutit VEC-ngi.

Uyagaliqutit

Tamna Goose PDAs-ngi iniqaqtuq tahamani ungalata pingangnani tiqitquani taphuma Slave tamnalu Churchill Uyagaliqutit Inigiyait. Tamna Tagiumi Iliuqaivia Nuna (MLA-nga) piqaqniqhaq Atpagut tahaphuma Qitiqpaqhiutit Utuqauqpiaqnit aqipyaktut uyaqattahamani Kilohigok Imaqaqniani, ilagiya taphuma Bear Uyagaliqutit Nunagiyat. Hikuqpiaqhumnit hunat iliuqaqnit kingugut taphuma Hitamauyaqhiqninut Wisconsin Hikuqpiaqhimaniat ulikpiaqhugu tahamna Archean Uyagaliqutit Nunagiyat. Hikuqpaiqhimanit ilihimani piqaqniqhauyut attaqtuyunut ihugiyai uyagainauyut pihimanit (hikuqpiaqhimanit nunan), tapkuat piqaqniqhan hiugaq allatqitlu aktilat nunat. Tamna Goose Havanguyut piqaqtuq atatyutainik allatqiknit imugaqhimuyuyaqtut ahiqukuyaqtutlu aqipyaktut uyaqat. Aqyaluyaqtut mikitqiyatlu maqlugalgit uyaqat avataaniittut akuttuyuniklu ilaliutyaqnit qaiqtuvaluknit iron piqaqnit tamnalu oxide piqaqnit iron piqaqtut. Tapkuat aqipyaktut piqaqtut akimun avguyaqnit hapuhimayauplutik, mikitqiyat ikitqiyaunit naptunit hapuhimanit, angitqitlu huvalangitni uyagainauqpiaqnit piqaqni. Guulit havikhaqaqnit piqaqniqhauyut sulphide havikhanut, piluaqtumik qakuqtanguat, takukhauyut guulit nalvagauyut ilikuqtunik nunaitni amigaiqniqhauyumik qakuqtangualikni. Ahii sulphide havikhat (guuliqpaluktut guuliuyaqtutlu) piqaniqhat tahamani nunatni iron piqaqnihaunini aqyaluknilikniluavataani tapkuat qakuqtanguaqaqpiqnit havikhaqaqnit. Tapkuat avikhimauyaqnit haputit piqaqtiangittut sulphide piqarluaqhuni guuliqangittutlu havikhaqtainik.

Qiqumainaqniq

Tamna Havanguyuq inilik tahamani qiqumainalikmi nigingani Nunavut. Ukiup ilaani auktuqnia auktuqattaqtuq qaligiknia pihimayuq atiqpiangani maniqap qanganit, atikniqhauyumik mikhaani 2 miitat tukiqaqhunilu ukiungagut niklaumanirnia uuktuutiqaqhuni -6.5°C nit. Maniqap atiqpiangani uunaqniq pihimaniaqhauyuq tungani 0°C ilutinini tikitlugu mikhaani 500 miitat ataani maniqap qanganit, kihimik ataaniungittuq ilaitnit imaqaqniuyut itininginut. Apqutigiplugit auktuqtaqnit iluvanut maniqami imaqaqniuyut pivaktut piqagutai ataani imaqaqniuyut attatunilgit avataani 200 miitat unalu imangit hitinganit tahiyaaqhuni 1.3 miittat. Qiqumaniuqattaqtut naunainilgit piqaqninut talvani ataani qiqumainaqniup nalaanilu iluvani auktuqtaqniup, piplugu maniqami imaq ataani qiqumainaqniup takukhaunia tagiuquqtugangat.

Nunat qanugitnit Nunatlu

Tamna Havanguyuq inilik tahamani nunami piqaqniqhauyumi manikniqhami pinguqyuliknik amihuqpianiklu tahivalulikni atatyutilgit kuugauyaqnik. Maniqap puqtunia allatqiktuq akungani 300 tamnalu 700 miitat qulaanit tagiup puqtunianit (masl-nga) uvinganialu avatqulluayuita 7%. Puqtuniqni qaqaqniahauvaktuq nunavaluknik hunanik (51% katitlugu PDA-nga) piqaqnia Qaiqtunik, aqilguvaluknik, qaiqtuinaqpianiklu napauqtunikluniiy uyaqanik. Hikuqpiaqhimanigaqtut (14%), naulviuhimayut (6.%), tagiuq (8.5%), tamnalu nunavalulgit (1.1%) piqaqnia piqangitniqhauyuq. Hatqiumanit qaiqtut piqaqtut tahamani (2.6%) taphuma PDA-nga). Tamna ipyunia havikhalik nuna qanganittuq qaiqtut (qaligiyat) puqtuniqhauyuq maniqami uvingaluangittuqlu nunat (atuqpakniqhaq 10.6 miitat) mikhivaliaplunilu maniktunut pinguaqyuit allatqiknit nunat qanugitni (atuqniqhat 4.8 miitat).

Qaphit nunat nunaita qanugitni, ilautitlugit qimiit, uyagainait uyagaktunit qimiit, uyagaluqaqnit tahamaniittut nunagiyata RSA-nga. Niglamaniq hila piqatigiplugu qapgit nunat piqaqnit. Uunaqattaqnit atuqpakhimayut mihalukni allatqigutauyuynut niaquptait ilutunitlu, tahapkuat pingugutauyut patukhimaniqnut ingutaqtaqnit hikuinangugutauplutiklu ataani piguqviuyuni. Patuktaqnit kaivyagikniqhauvaktut (1 tikitlugu 3 miitat akimun) quglukniuyut maqluit pinguqtauyut patuktaqnit

ingutaqninnut. Tamna Havanguyuq inilik tahamani qiqumainaqniani. Qiqumainaqniliuyuq ukiumilu atuqattaqnia qiqiqattaqnia auktuqattaqniqlu pityutauyuq nakungittumik pivaliatitnia nuna. Mikhaani malgunia-pingahuyaqninut tahamna qauyihaqtauyuq nuna taihimayuq Huniumaitniq Qiqumaniuqattaqtut atauhiqlu-pigahuyaqniani Ingutaqattaqnit-qiqumaqattaqnit.

Huniumaititlugu ilitquhia nuna naunaiyaqni katitauhimayut tapkunani 51 inaitni tahamani LSA-nga tapkuatlu 20 inait hilataani RSA-nga 2012-mi. Amihuniqhat nunat piqaqtut pukitniqhanik ilaitnik hiqumaqluktut ahiquit (tungani 30%) tapkuatlu pukittut uyagauyaqtut (tungani 15%). Amihuniqhat nunat hiqumaqluyaqtut (nunagait, nunagapyait, nunagainapyait hiugaliat). Havikhat nunait tahamani nunaliqutini RSA-nga huguilaqniqhat (akungani immap qanugitnia tamna 5.9. akutunilgit 4.7 tikitlugu 6.8). Nunat haviktait katihimanit tahamani LSA-nga avatqungittut CCME naunaipkutainik.

Nauhimayut Qanugitnilgitlu Nunat Qanugitni

Nunaliqutit uumatyutauyut nunauyaliuqni (TEM) takuttigittutlu nauhimanit naunaiyaqni havaktauyut 2012-mi tahamani 134,370 ha nauhimanini nunaliqutitlu angutikhait LSA-nga. Nauhimayulgit uumatyutauyut, ilalgit 73% tapkunani LSA-nga, piqaqniqhat natiqnainaq, paniumayut-akuttuyut natiqnait, kinipanitlu uqpigalgit natiqnait. Tahamna kinipaniq natiqnaq piqata, ilalik haniani atauhiqmik pingahuyaqnia tahaphuma LSA-nga, piqaqhuni attaqtuyunik nunat piqaqniqhat mikiyunik avalaqianik, piqaqpiaqhuni aalatqinik ilagiyainik nunagiat, ivivaluit, uqyut, ikhutitlu. Akuttuyut-nauhimanit uumatyutauyut, ilalgit haniani 9% katitlugit LSA-nga, atuqpakniqhaq pinia hattuni uyagaliat piqaqnit hatqiumaniluniit qaiqtut, anuqimit manikhiyaunit qimiit, niaquptainait natiqnait, tagiumi hinigiyait ahiilu maniqami inait nauhimalaqnilgit pihimanit. Naunhimayuilgut uumatyutit, ilalgit mikhaani 18% tahamna LSA-nga, piqaqniqhat imatqiktumik tahiit tahigaitlu. Alangayut nunat qanugitnit, naunaiqtauyut atuqpiaqninut angutikhat nayuqpaktai ikayuqhiutilatluniittakuttigittut nauhimanit allatqit, ilautitlugit qimiit pihimaqpiaqnit, imnait, qaiqtuqaqnit ikhutyaqnitlu-piqaqpiaqnit uumatyutit, manilgut uumatyutit, mihaluqaqnit uumatyutit, tagiumilu hinanittut hinaanilu tikiqiumanittuqat. Katitlugit 890 nautiat allatqit naunaiaqtauyut atuqtitlugu tamna TEM-nga takuttigitttlu naunaimaviuyut maniqat naunaiyagauyut tahamani LSA-nga tamnalu RSA-nga. Tamna anginiqpaq alatqit ilagit naunaiqtauyuni nautiaq tapkuat auliit nauhimayut, kinguanilu mikiyunnuit nunagait. Naitit takuttigittut nauhimayut allatqit naunaiqtauyut nalvagauniqhauyutlu haniani hinaanit Kingaok tahamuunalu LSA-nga tamnalu RSA-nga. Tikittayuittut nauhimayut allatqit naniyaungittut tahamani LSA-nga atuqtitlugu 2012-mi maniqami naunaiyaqnit.

Pilat Havanguyuq aktuanit tahapkununga VEC-ngi nauhimayut allanganitlu nunap qanugitni ilalgit tugaqpiaqhugit tamaini nungutpalianilu nauhimayut allanganitlu nunat qanugitni. Tahapkuat pilat aktuanit naunaipkutilgit atuqhugit naunaipkutai allatqiknit, piguqpalianit, nunguttailinitlu. Tapkuat ihuaqhigiagutit aulanilu piyauni hanatyuhikhat piiqninut mikhigiaqniluniit pilat Havanguyuq aktuanit nauhimayunut alangayutlu nunat qanugitnit ilalgit: mikhigiaqni tapkuat Havanguyup tupligaqnia, atuqni ukiumi apqutit, mikhigiaqnilu ahinuktaqni puyuit ayuqnaittagangat.

Kinguagut tamna tukhigaut ihuaqhigiagutinut aulanilu piyaunit, malguk qimaiviuninut aktuanit naunaiqtauyuk: nauhimayut tammainit, allangayut nunat qanugitnit tammainit. Tahapkuat qimaiviunit aktuani piplugit tapkuat ihumaginit tapkuat tamaita PDAs-nga tammaiyaunianinut. Atuqpiaqtut, tamna nuna nauhimayulik/allangayut nunat qanugitnit tammainit mikitqiyauniat piplugu hiamakpalaqtailini kinguliqpamik tunmigaqtaunit taphumanga Havanguyuq. Tapkuat anginit tapkuat qimaiviunit aktuanit nigiugiyauyut angilaitninik, tamna hivitunia pivikha, tamna akulaitnia atuqinaliqat/hunilaiqnia, tapkuatlu qimaiviuni aktuanit hiamalaitni tahaphumunga Havanguyumun tupligaqninut PDA-nga). Tapkuat qimaiviuni aktuanit ihumagiyauyut utilaiqninik: kihimik pilaqgunaqhiyuq utiqtitaunit umiqaqtitlugu. Atugahuquqnit tahapkuat atuqpalianit ihuaqhigiagutit piyauni titigaqhimayut tapkunani Aniqhaktauvaktup Qanugitnia Munaginia Aulataunialu Upalungaiyaqnit (Makpigaq 10, Taiguaq 17) tapkuatlu Havakvikmi Imaq

Munagiyaunia aulanilu Uplaungaiyautit (Makpigaq 10 Taiguaq 7), tapkuat angipyaktut qimaiviunit aktuanit nauhimayunut allangayutlu nunat qanugitnit nalautagauyut **Angivalangitnit**.

Pilat katittaqninut aktuanit naunaiyaqni havaktauyut piplugit qimaiviunit Havanguyuq aktuanit nalautagauyut. Tapkuat naamaktumik piniagahugiyauni George Havannguyut, Hackett Kuugaq Havanguyuq, tamnalu Kingaok Tulaktaqvik Apqutlu (BIPR-nga) havanguyuq atuni inikhaqagialgit tamnalu/tamnaluniit avatqutautilutik tahamunga nunaliqutainut RSA-nga. Ilagiplugulu taphuma Havanguytuq qimaiviunia aktuanit nauhimayunut tammainit tahamani PDAs-nga, mikhautauhimayuq 556 hectares katiqhuqhimanit tamugaluktauninut tammainit tahamani nunaliqutit RSA-nga pityutaulaq pivaliatitauniqmun havagutainut apqutitlu piqatai tapkuat uuktugutauyut Georgr Havaanguyuq,Hackett Kuugaq Havanguyuq, tamnalu BIPR-nga Havanguyuq. Tamna angininga tapkuat nigiugiyauyut katiqhuqhimanit aktuanit pukkittut (tungani 1% tapkuat RSA-nga), atuqtitlugu hivituyumik, akulaitnia atauhiqhinnaqlugu kihimik atuinaqniaq/hunnilaittumiklu, katiqhuaqhimanilu aktuanit iluaninginaqtitlugit havanguyup tupligaqtainut atuni havanguyuni. Tamna angipyaknia qimaiviunit aktuani (nauhimayut tammainit) tahamunga VEC-nga nauhimanit allanganilu nunap qanugitni nalautagauyut **Angivalangittut**. Tapkuat Havanguyut katiahuqhimanit aktuani katiqhuqhimayutlu aktuanit iluaninginaqlutik tahaphuma PDA-nga havanguyup tupligaqtanut pilatlu hivunikhami havanguyut iluani taphuma RSA-nga. Tahapkuat nunat tahamaniittut tamaita Nunavutmi, taimaittumik piittuq nunaqatigingittut aktuaninik.

Tuktut

Piqaqtuq pingahunik iluilikmiunik tuktut amihuaqyuit aulaqpaktut avatqutaqhugit nunaliqutauyut RSA. Qangattaqhimayut qunguhiaqtaliqtuqnit tuhagakhat titigaqhimayut tapkuat Kingaok amihuaqyuit, Beverly Ahiak amihuaqyuit (tamainnut atauttimi titiraqtauvlutik) unalu Tapkuat ukiumi hiamaktihimanit Dolphin Unionlu tuktut avatqutagutilat tahamunga tagiumi RSA-nga mikiyumiklu uiguplugu ukiungutitlugu.

Hamna Kingaop tuktuit amihuaqyuit nurrait uvani Hood Burnside Kugait, ungahingniat 240 km kangangnami uataa Havaariyauyum nayugaaniittut. Irniuqtut, Kingaop tuktut ingilrayuktut amihuaqhutik tunnganit kivataanit qaangiqhugit tapkuat inilgit avataani 100 kilaamitat 60 kilaamitatlu ungahiknit tahamanga 30-60 km uataanut Havaariyauyunut nayugaanut (qanilruanut ininganit), ikaarnahuaraangat auyami Tahiryuarmut Nose Tahingit, 60-100 km tunnganit- uataangat Havaariyauyunut nayugaanut. Hamna amihuaqyuit ukiivlutik hivuraanut uqyulingnit nunaanut.

Hamna Beverly Ahiak tuktut amihuaqyuit irniuliqpakhutik iluani Kiluhiktum nunangani taryum hinaani, 300-550 kilamiitat tunnganit kivataanit Havaariyauyunut nayugaanit. Auyami, amihuaqyuit hiamittivaktut hivuraanut uataanullu, ilangit tuktut naniyauvaktut nayugaanit auyarnaqhiliraangat ukiakhamilu. Hamna Beverly Ahiak amihuaqyuit ukiivakhutik kivataanit Kingaop amihuaqyuinnit, ataanit napaaqtuqarnirmi tunnganaanilu nunangani Kingaongmi.

Hamna Dolphin Union amihuaqyuit, ilittuqtauvaktut qikiqtat tuktungit, irniuqpaktut auyami ukiivaktut Kiillinirmilu ukiivaktuttauq ahiarmi, qaliriiqpakhutik taryurmit RSA ukiumi. Hamna Dolphin Union amihuaqyuit SARA-titiraqtauvlutik huraat ihumaaluutauvagaat hamnalu Kingaop amihuaqyungit unalu Beverly/Ahiak amihuaqyuit qauyihaqhimaittut COSEWIC nit.

Kiglingani qauyihaqtauhimayut uvani 2001 mi 2014 milu angiqtauvlutik qimilrurnigut naunaiyaivlutik. Tallimmanit ukiungagut qulaanngat qauyihaqhutik unalu pingahut ukiunganit qauyihaqtauvlutik ingutaaqhimavlutik piksaliuqtauvakhutik nipiliuqtauhimaittut tuktunut irniuqhutik ukunani RSA nit (Juun 5-15) ukiungani. Irniuqhutik inilguani (Juun 16 – Julai 20) amihuryuit tuktut ihivriuqtauvlutik uataanit haffmuani RSA: naunaiqhiivlutik Kingaop tuktungit. Ikittumik ilaani ihivriuqtauvaktut RSA uvani auyami ukiakhamilu (qitqani Aagasimi-Saptaippamilu): naunaiyaivlugillu Beverly Ahiak amihuaqyuit. TK

hamnalu ingilralaaqtut piksaliurutit ilittuqhiivlutik hamna Dolphin unalu Union tuktut takunnaqhutik taryumi Kingaom hinaani ukiumi, uvanilu imarmi PDA, kihimi ikivalliavluni amihuuningit.

Iluani RSA, TK naunaiyaivlutik amihuuyut ihumannaqtut iningit tuktut. Ingilralaaqtut piksait aktuqhimayangit amiqhaivlutik uvani nayugaannit, ilagiyangit kuukkat ikaaliraangat kivataanit Beechey Tahianit amihuaqyuit (100-200) tuktut auyannguraangat ukiakhamilu (Beverly Ahiamlu tuktungit). Iluani angitqiyaanit angiklirningit aktuqtaunianut ihivriuqtut iniani, TK naunaiyaivlutik Tahiryuam unalu Nose tahiita (60-100 km hivuraa uataanit RSA nit) ihumagiyauyut auyami tuktunit. GPS qunguhiqtauyut naunaiyaiyut hapkuat Kingaom tuktuit atauttimut katilviuliqpakhutik uvani tahiinnit auyami. Avatingnut tikkuarniit iningit, ihivriuqtauhimayut hunali nayuqpauhingit qunguhialgit huraat atuinnaqhugit unalu nunauyait kitunuliqaak piyumavagaat nayuqpauhingit naunaiyaiyut Kingaom tuktuit naunaiqhiiyut nunaa nayuinnaqhugit takiyaaqtulingnit uqpiligyuangit haniani Tahiryuami.

Pilat Havanguyuq-tuganganit aktuanit tapkuat VEC-ngi tuktut ilalgit Havanguyuq huliniit ahiangugutaulat tahapkuat naunaipkutait: nayuqpauhiat tammaiyut, ulapiharniit nipitunirmun, ulapiharniit ingilrayarnirmun, tugaqpiaqhugit tuqutaunitaaniqnitlu, tugaqpiaqhimaittumik tuqutaunit, upagumanit, hatqiumanilu halumailgunut, ikikligiaqni nugiuqnit. Hamna Anngutikhait Ingattaqhiittailinirnut Amiqhidjutinut Parnautait (Makpirak 10, Taiguat 20) tukiliaqaqhuni uuktuutingit nailinahuaraangat aktuqtailivlugillu uumayunut, uuminngattauq nailinahuaraangat Havaariyauyunut inungnut aktuqhimayangit, kuinginnairnahuarniq, kayummaarnikkut haffumani 50 km/h apqutiit, atuqhugit ukiungat apqutit agyaqhiinahuaqhutik Havaariyauyunut, halikaapta amiqhainirnut, halumaittunit amiqhainirnit unalu nayugaat tupligaqtainni pittailinahuaqhugit huraanut, qayangnaittunit amiqhaiyangit hiamipkaqtailivlutik halumaittunit. Hamna Huraat Ingattaqhiittailiyangit Amiqhidjutauyunit Parnautaa ilagiyauvlunilu aviktuqhimayumit nayugaanillu amiqhainirnut piliriakhait, uuminngattauq piliriakhanut nailinahuaqhugit havaariyauyukhanut hulidjuhiit tuktut ihivriuqhiyaugaangat havagviup haniani, haffumanilu hulidjuhiit nutqaqtaunahuaraangat tuktut ikaarnahuaraangat Havaariyauyumi nunaanit irniurnahuaraangat nurrait pamiqtaugaangat.

Kinguagut taphuma tukhigaut ihuaqhigiagutinut aulanilu ingattaqhiittailinianut, pingahut qimaiviuyut aktuanit naunaiqtauyut: nayuqtauvaktut tamainnit, ulapiharnit piplugit nipituniq, ikiklivalirniq nuqhiurniit. Taapkuat anginiqhainiit tamaita pingahut qimaiviunit aktuanit niriugiyauyut huvallaannginnit, akuniutiginni akunngani hivitunit (kiklilgit piplugit atukharnia Havaanguyuq) niriugiyauyut nayuqtauvaktut tamainnit tahamani taihimayuni nunani Havaanguyup tupliraqtainnut taapkuat hivituyulaat. Tapkuat aktuanit akuttullat pihimani, tahamaninginaqlutiklu Havanguyup tupligaqtaini nayuqtauvaktut tammaiyauninut, tamna LSA-nga nipituniup ulappihaqninut, pilaqnitlu tapkuat RSA-nga ikiligianinut nugiuqnit. Tapkuat qimaiviuni aktuanit nigiugiyaukmiyut utiqtilaiqnit kihimiuyuq nayuqtauvaktut tammaini tahamani taihimayut nunait Havanguyup tupligaqnit. Atugahuquqnit atuqpaliani ihuaqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munagiyaunilu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyakni qimaiviuyut aktuanit tutunut nalautagauyut **Angivalangittut**.

Pillat katiqhurninut aktuanit naunaiyarniit havaktauyut piplugit qimaiviunit Havaanguyuq aktuanit nalauttaagauyut (nayuqtauvaktut tamainnit, ulapiharnit, ikikligiarni nuqhiurniit). Taapkuat nunaliqutauyut kikligiyai atuqtauyut pillarninut katiqhurlugit aktuanit naunaiyaqni piplugit nugiuqaqtitlugit auyamilu aulaqvigivaktai tapkuat Kingaok amihuaqyuit auyamilu ukiumilu aulaqvigivaktai tapkuat Beverly amihuaqyuit, ilautitlugit nunat tahamani Nunavutmi Nunatsiaqmilu. Titigaqhimanitigut tapkunani EIS-ngi naunaipkutat (NIRB 2013a), tamna Minihitauyuq Nunaqaqaqtunut Ukiuqtaqtumilu Pivaliayuliginiq Kanatami uqauhigiyai atuqpiaqnit tapkuat Kingaok amihuaqyuit tuktut tahamani nunaliit avikhimaniani naunaiqnilu piyaaqaqnit havagini katiqhuqhimani aktuanit naunaiyaqni ukununga amihuaqyuit (titigaqhimayuq upluliqhimayuq Tisaipa 17, 2012). Piqaqtuq 10 pilaqnit havanguyut (ilautitlugit 4 pilaqnit hivunikhami havanguyut) aktiqhugutaulat tapkununga Havanguyuq

qimaiviunit aktuanit tahamani Kingaok amihuaqyuit katiqhuqnit naunaiyaqni nuna, tapkuatlu 5 pilat havanguyut (ilautitlugit 3 atulat hivunikhami havanguyut) katiqhugutaulat taphumunga Havanguyuq qimaiviuni aktuanit tapkunani Beverly amihuaqyuit katiqhuqhugit naunaiyaqni nunat.

Ikayuqhiutinahuaqhugit pillarniit katiqhuqhugit aktuanit naunaiyaqni tuktut, attaqtuyumiklu Piqaqnit Tikuaqtauni Havangit uuktugautit pivaliatitauni tapkununga Kingaok tuktut amihuaqyuit nugiuqaqtitlugit auyami aulaqvigivaktai. Qanugitni ukuat uuktugautit atuqtauyut naunaigahuaqhugit humut tuktut nalvagauvaknit aulaqpaktaini, qanugittutlu nayuqpaktai atuqpaknit tahapkunani aulaqpaktaini. Tapkuat uuktugautit atuqtaukmiyut naunaiqninut nayuqpaknit qanugitni uuktugautai nauhimayunut naunaigahuaqhugit qanuqtut katiqhuqnit nayuqtauvaktut tammainit ulapihaqnilu Kingaok tuktuit niginiaqninut aulaqpakvit nunat, naliat tahapkuat atatyutai ukiuqhivigiyainut nugait uumaninut. Tapkuat anginit tamaita pingahut qimaiviuni aktuanit tamatkiknut tuktut amihuaqyuit nigiugiyauyut huvalangitni, akuniuni akulliqhiutauyut (tahamaninginaqnit atuqnianut taphuma Havanguyuq) kihimik tahapkuat nayuqtauvaknit tammaini tahamani taihimayumi nunat havanguyup tupligaqnit, akuttuyumik ilitquhit, tahamaninaqlu nunalit nunagiyaini nayuqtauvaktut tammainit nipitunitlu ulapihaqni, atulaqnilu tapkuat katiqhuqnit naunaiyaqni nuna ikikligiaqninut nugiuqnit. Tapkuat qimaiviuni katiqhuqhugit aktuanit nigiugiyaukmiyut utiqtitaulaitnit kihimikluniit nayuqtauvaktut tammainit tahamani taihimayumi nunat havanguyup tupligaqnit. Piplugit atuqpalianit ihuaqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munagiyaunilu Upalungaiyautit (Makpigaq 10, Taiguaq 20) piniagahuginilu ayyikkutapyainik piyauni hivunikhami havanguyut, tapkuat angipyakni qimaiviuni aktuanit tuktut nalautagauyut **Angivallaanngittut**.

Tapkuat katiqhurnit aktuani naunaiyarnit akuttuyumik kiklikhait ilalgit ilagiyainik tapkuat Nunatsiaqmi tamatkirnut Kingaok amihuaqyuit tapkuatlu Beverly amihuaqyuit. Taimaittumik, pilaqnit nunaqatigingittut aktuanit pioyauyut tapkuat katiqhuqninut aktuanit naunaiyaqni nalautagauyut **Angivallaanngittut**.

Akhait

Iluilikmi amigaitnit akhait kavamatuqatkutnit titigaqhimayut uumayut “Taihimanit Ihumalugiyauyut” (SARA; COSEWIC 2012) tapkuatlu titigaqhimayut Qanugililat Nunavutmi (CESCC 2010). Kiglingani naunaiyaiyut akhanut uvani 2012 mi 2013 milu mitquitigut piplugit kititiqhutik naunaiyaqpagait amihuugumik akhait iluani 18,500 km^2 manirarmi nunaani. Naunaiqhiivakhutik titiraqhugit ihivriuqtangit, uvani avikturnia amihuuningit akhait kititiqtauvlutik 72 nit kulavait 54 nit anguhalluit 2012 mi uvanittauq 64 kulavait 54 anguhalluit 2013 mi.

TK naunaiyainiit haffumani akhait naniyauvagaat tamainnut aviktuqhimayumi nunangani naunaiyairaangamik (RSA) naunaiqhiivaktangit kuukkainnarni naniyauvaktut uumanilu Kuukami Uataani hinaanilu, Kingaongmilu. Nayuqpaktaat piyuminarnikhat uukturauvangni naunaiyaiyut; upinngaami, akhait naunaiyaiyut takunnaqhutik iluani kivataanit tungaani hitiqarnirmi kuukkam hinaani, uvani Uataani Kuukkami. Auyami ukiakhamilu, akhait naunaiyaiyangit tungaani nayuqtauvangnia. Hitamanit akhait hitingit naunaiqtauhimayut tahamani nunaliqutait RSA-mit akunngani 2007 mi 2012 milu- malruk inait tahamani Uataani Kuugarmi aulagianga hiuralingnit hikuqpiaqhimania nunagiyaani nayuqtauvaktut malruk inilgit uvinganirmi, ikhugiaktumi manirarmi. Nayuqpaktaat piyuminarniqhat uuktugauvakni tahamani RSA-nga naunaiqhimayut piqaqtut akungani 57% tamnalu 76% nayuqtauyuminaqniqpat tahamani RSA-nga upingami, auyami ukiakhamilu, kihimik tungani 2% hitiqaguminaqnia nayuqtauvaknia. Hamna unganingningat ingilraliraangat akhait akunngani Maimi Aagasimilu 25.7 km kulavait akhait (ungahingnia 65 km), 42.5 kmanguhallut akhait (ungahingnia 138 km) unalu 32.6 km akhait ingilraraangat nuatqatiqaqhutik ilalingnit (ungahingnia 84.8 km).

Pillat Havaannguyuq-turaangani aktuanit tahamunga VEC-nga akhait ilalgit Havaanguyuq hulini ahiangugutaullat tahapkununga naunairutainut: nayuqtauvaktut tamainnit, ulapiharniq piplugit

nipitunit (naunaipkutariplugit, ahittirnit nunanit nayuqtauvaktunit), ulapiharnit ingilrayunut, turaaqpiaqhugit tuqunnit aanirniitlu, turaaqpiaqhimaittumik tuqunit, upakhigauninut, hatqiumanit halumailgunut, ikiklivalirnia piagaliurnit. Ukiumi apqutit ilaunngittut tahapkunannga naunaiyarninit piplugit akhait hitimiinngninmata tahapkuat apqutit hanayautitlugit atuqtitlugitlu. Ihuaqhigiarutit aulanitlu piyauni aturniat piirninut mikhigiarnilu pillat aktaunit ilalgit mikhigiangani Havaanguyup tupligarnit, nipittuqpallaaqtailiniq piyaungani, kayumakpallaaqtailiniq piyaungani, aturni ukiumi tikittarvit apqutit kihimik, iqakut aulanit avugiyauvaktutlu tiguttaqnit piyauni upaktauyumattailiplugit angutikhanit iqakunut hatqiumattailinilu halumailgut, atuqpaliani tapkuat Angutikhat Ihuaqhigiaqni Munagininutlu Upalungaiyautit (Makpigaq 10, Taiguaq 20) ilagiyangit nunangani amiqhautjutit ilagivlugulu Nunavut Kavamangit nayuqpauhianinilu amiqhaiyunit nayugaannit kinaliqaak naimayakhait piqannginnamik uuminngalu akhainillu.

Kinguagut tapkuat tukhirautit ihuaqhigiarni ingattaqhittailinirnut aulanilu piyaunit, hitamat qimmaiviuni aktuanit naunaiqtauyut: nayuqtauvaktut tamainnit, ulapiharniq piplugit nipitunit, upaktauyumanit, ikikligiarni piagaliurnit. Tapkuat angiqpiaqnit tamaita hitamat tapkuat qimaiviuni aktuanit nigiugiyauyut huvalangitninut, tamna hivitunia akulliqhiuqtuq pivikha (tahamaninaq atuqniani taphuma Havanguyup) kihimiungittuq nayuqtauvaktut tamainnit tapkuat hivituniat tahamani taihimayumi nunani Havaanguyumi tupliraqtainnit, akuttuyut ilitquhit, tahamaninginaqni Havaanguyup tupligaqtaini nayuqtauvaktut tamainnit upaktauyumanitlu, tapkuatlu LSA-nga nipituvangnirnut, pillarnilu RSA-nga ikiligiaqni piagaliuqparnit. Taapkuat qimmaiviuni aktuanit niriugiyaungmiyuttauq utiqtitaulainnit kihimik taapkuat nayuqtauvaktut tamainnit taihimayuni nunani Havaanguyumi tupliraqtainnut. Turaahuqurnit atuqpaliani tapkuat ihuaqhigiagutiti piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigaiqnit Munagiyauninutlu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyaknit qimmaiviuni aktuanit akhaqnut nalautagauyut **Angivalangittut**.

Umingmait

Umingmait anginiqhat nunatuqtiuyut tahamanittut amigaitpalangittumik ikittupyaktut humiliqak tahamani Kanatamiuni Ukiuqtaqtuani pinnagiyauyutlu Inuit piqaqnit niqikhanut, nagyuit, qiviungilu, tahapkualuttauq niuvgutaunit aulaqtitaqni niqit. Tingmitikkut huniumaititlugit ilitquhit naunaiyaqni havaktauyut akungani 2001 tamnalu 2010 titiqhimayut tapkuat umingmait pivakni ikittupyauyut tahamani RSA-nga. Umingmait takuyauttaqtut ikittut, pinguaqyukni, tahamani nigingani Kingaok malguknilu ahiini amihuaqyuit pilat haniani Havanguyup, atauhiq kanangnata pingangnani taphuma George Havanguyuq Nuna aipaalu haniani Goose Haavnguyuq Nunani. Nayuqtauvaktut naamaktut uuktugaqninut tahamani RSA-nga naunaiqhimayut immaqak atauhiq-pingahuyaqniani tahaphuma RSA-nga nakuqpiaqtuq nayuqpaktat umingmait atuqtitlugit tamatkikni niginiaqviuyuni (auyami ukiakhamilu) ukiumilu (ukiuq upingalihaqtitlugulu) ukiup ilaini.

Pilat Havanguyuq-tuganagyut aktuanit tahamunga VEC-nga umingmait ilalgit Havanguyuq huliniit ahiangugutaulat tahapkununga naunaipkutaqnut: Nayuqtauvaktut tammainit, ulapihaqni piplugu nipitunit, ulapihaqni ingilganiqmut, tugaqpiaqhugit tuqutauni, upaktauhiqnit, hatqiumani halumailgunut, ikikligiaqni umingmaliuqnit. Ihuaqhigiaqni aulanilu piyauni atuqtauniat piiqninut mikhigiaqniluniit pilat aktuanit ilalgit mikhigiaqni Havanguyuq tupligaqni, nipittuqpalaqtailini piyauni, kayumaqpalaqtailini piyauni, atqunilu ukiumi tikittaqni apqutit kihimik, iqakut aulanit avugiyauvaktutlu tiguttaqnit upaktauyumattaqlininut angutikhat iqakunut hatqiumattailinilu halumailgunut, atuqpalianilu tapkuat Angutikhat Ihuaqhigaiqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20).

Kingaugut tukhigaqni ihuaqhigaigutit aulanilu piyauni, pingahut qimaiviuni aktuanit naunaiqtauyut: nayuqtauvaktut tammaini, ulapihaqni umingmaliuqninut. Tapkuat angiqpiaqnit tamaita pingahut qimaiviunit aktuani nigiugiyauyut huvalangitnit, tapkuat akuniutigini akuniqhiuqtut hivituni (tahamaninaq atqutauniani tamna Havanguyuq) kihimiungittuq nayuqtauvaktut tammainit tahamani

taihimayumi nunat Havanguyuq tupligaqninut tapkuat hivitulat. Tapkuat aktuanit akuttulat ilitquhit, tahamaninaqlu Havanguyup tupligaqniani nayuqtauvaktut tammaininut, tamna LSA-nga nipituniqnut ulapihaqnit, pilaqnilu tapkuat RSA-nga ikikligiaqnit umingmaliuqnit. Tapkuat qimaiviuni aktuanit nigiugiyaukmiyuttauq utiqtitaulaitnit kihimiutitlugu nayuqtauvaktut tammainit tahamani taihimayuni nunat Havanguyup tupligaqtaini. Atugahuquqnit atuqpaliani ihuaqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigaiqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyaknit qimaiviuni aktuanit umingmaknut nalautagauyut **Angivalangittut**.

Pilaq katiqhuqninut aktuanit naunaiyaqni havaktauyut umingmaknut piplugit pingahut qimaiviunit Havanguyuq aktuanit nalautagauyut. Tapkuat nunaliqutinut kikligiyai atuqtauyut pilaqninut katiqhuqhugit aktuanit naunaiyaqni pihimayut tapkuat attaqtunianut avataani taphuma HAvanguyup atuqhugit takiniqpaq akimuinaq ungahiknia aulaqhugu tapkunanga qunguhiaqtauhiqhimayut umingmak tahamani nigingani Kitikmeotni. Piqaqtut 12 pilaqnit havanguyut (ilautitlugit tallimat pilaqnit hivunikhami havanguyut) katiqhuqviulat taphumunga Havnguyumun qimaiviunit aktuanit tahamani umingmait katiqhuqhugit aktuani naunaiyaqni nunat. Tapkuat anguiiqpiaqnit tamaita pingahut tapkuat qimaiviuni aktuani umingmaknut nigiugiyauyut huvalangitnit, tapkuat akuniuni akuniqhiuqtut hivitunia (tahamaninaq atqutauniani tamna Havanguyuq) kihimiungittuq nayuqtauvaktut tammainit tahamani taihimayumi nunat Havanguyuq tupligaqninut tapkuat hivitulat. Tapkuat aktuanit akuttulat ilitquhit, tahamaninaqlu Havanguyup tupligaqniani nayuqtauvaktut tammaininut, nipituniqnut ulapihaqnit, pilaqnilu katiqhuqhugit naunaiyaqnianut ikikligiaqnit umingmaliuqnit. Tapkuat qimaiviuni aktuanit nigiugiyauyut utiqtitaulaitninut kihimiuyuq tapkuat nayuqtauvaktut tammainit tahamani taihimayumi nunat havanguyup tupligaqninut. Atugahuquqnit atuqpaliani ihauqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20) piniagahuginilu ayyikkutapyai katiqhuaqnit aktuani umingmait nalautagauyut **Angivalangittut**.

Akuakaiqhuqniaktani naunyaqnit atuninu kikliyat ilit lagiya tahamna Nunatsiaq maknu ngigiyauyuq ilaqania anginiqpamik akimuinaq nahinia kamngmait takuttaaulqni taphumunga Havanguyuq. Taimaittumik, apkuatpilaqnit nunagiyauyumun akutuanit pihimayut katiqhuqninut aktuani naunaiyaqnit nalautagauyut **Angivalangittut**.

Qalviit Mitqulgitlu

Qalviit aqyalktutlu amaqut kuaqauyut ptyutaninut mitqulgit uumayut allatqit tapkununga DEIS-ngi. Qalviit amaqutlu Nunavutmi tamatkiknik taiyauyut “Naamaktut” (CESCC 2010), kihimik qalviit kavamatuqatkutni titigaqtauyut uumayut allatqit “Ihumalugiyauyut” (COSEWIC 2003). Titiqtauyut-piyautqikni DNA huniumaititlugit ilitquhit naunaiyaqni havaktauyut qalviit 2012-mi naunaiqtauyut katitlugit 12 qalviit tahamani 1,692 kilaamitat kikagiktumik nuna akungani taphuma Goose tamnalu George Havalviit. Mikiniqhamik titigaqtauyut nunat mikhautnit ilikkut qalviit aulaqpaknit talvanga 89 kilaamitat kikagiktumik tamnalu 264 kilaamitat kikagiktumik, atqupakniqhaupluni nuna 162 kilaamitat kikagiktumik. Anguhalluit qalviit pihimatqiyaunuaqtut anginiqhamik nunat atuqtai aqnalluniunganit (166 kilaamitat kikagiktumik aipalu 157 kilaamitat kikagiktumik). Nayuqpaktai naamaknit uuktugaqtauni qalviit naunaiqhimayut mikhaanittut 44.7% nakuuniqpamik nayuqpaktai tahamanni angutikhat RSA-nga. Aqyaluktut amaqut, tingmitikkut hitiqaqvit naunaiyaqni havaktauyut akungani 2007 tamnalu 2013 naunaiqtai aitnguyut atuqtut amaqut hitai inilgit tahamani angutikhat RSA-nga, tapkunanga tallimat nakuuyumik amaguaqaqtut. Nayuqtauvaktut naamaknit mikhaani 1% nakuuqpiaqtut hitiqaqnit nayuqtauvaktut tahamani RSA-nga.

Pilat Havanguyuq-tugangani aktuanit tapkununga VEC-ngi qalviit mitqulgitlu ilalgit Havanguyuq huliniit ahiangugutaulat tahakununga naunaipkutainut: nayuqtauvaktut tammainit, ulapiohaqni nipituyunut, ulapihaqni ingilgayunut, tugaqpiaqhugit tuqutaunit aaniaqnilu, tugaqpiaqngitlugit tuqutaunit, upakhiqni, hatqiumani halumailgunut, ikiklivaliqni amagualiuqnit. Ihuaqhigiaqgutit aulanilu piyauni

atuqniat piiqninut mikhigiaqniluniit pilat aktuanit ilalgit mikhigiaqni Havanguyuq tupligaqni, nipittuqpalaqtailiniq piyauni, kayumaqpalaqtailini piyauni, atuqni ukiumi tikittaqninut apqutit kihimik, iqakut aulanitavugiyauvaktutlu tiguttaqnit piyauni upaktauhiqtailiplugit angutikhanit iqakut pittailinilu hatqiumani halumailgunut, atuqpalianilu tapkuat Angutikhat Ihuaqhigiaqni Munagiyaunilu Upalungaiyautit (Makpigaq 10, Taiguaq 20).

Kinguagut tapkuat tukhigaqni ihuaqhigiagutit aulanilu piyauni, hitamat qimaiviuni aktuanit naunaiqtauyut qalviknut: nayuqtauvaktut tammainit, ulapihaqni piplugit nipitunit, upakhigaunit, ikilivaliqnilu amagualiuqnit, malguklu qimaiviunit aktuanit naunaiqtauyut amaqunut: nayuqtauvaktut tammainitulapihaqnilu. Tapkuat anginiqpamik tamaita qimaiviunit aktuanit tamatkiknut qalviit amaqutlu nigiugiyauyut huvalangitnit, tapkuat hivituni akuniqhiuqtut hivitunigiyai (tahamaninaq atqutauniani tamna Havanguyuq) kihimiutitlugu nayuqtauvaktut tammainit tahamani taihimayumi nunat Havanguyumut tupligaqnit tapkuat akuniulat. Tapkuat aktuanit akutulat ilitquhit, tahamaniitlugit Havanguyuq tupligaqnit nayuqtauvaktut tammainit upaktauhiqnilu, tamna LSA-nga nipituvalaqtailiniq, pilaqnilu RSA-nga ikikligiaqnit qalvailiuqni amagualiuqnilu. Tapkuat qimaiviuni aktuanit nigiugiyaukmiyut utiqtitaulaitnit kihimiulaqtitlugu nayuqtauvaktut tammainit tahamani taihimayumi nunat Havanguyup tupligaqninut. Atugahuquqnit atuqpalianinut ihuaqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munagiyaunilu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyaknit qimaiviuni aktuanit qalviknut mituqlgitlu nalautagauyut **Angivalangittut**.

Pilaqnit katiqhuqlugit aktuanit naunaiyaqni havaktauyut piplugit qimaiviuni aktuanit nalautagauninut. Tapkuatr nunaliqutit kikligiyai atuqtauyut pilaqgahuquqninut katiqhuqhugit aktuanit naunaiyaqni piplugit aulaqpakninut ungahiknit taihimani qalviknut takuyauvaknit Havanguyumit. Tapkuat qalviit uumani nunami ayyikkutagiyai taphuma RSA-nga, kihimik ilalgit uiguyaunit avataani TCWR-nga atatyutai. Amaqunut, una nuna pihimayuq auyami aulaqpaknit tapkuat Kingaok Beverlylu tuktut amihuaqyuit amaqunit maliktauvakni tuktut angunahuaqtauni hanianittagangata Havanguyuq. Piqaqtuq pingahunik pilaqnit havanguyut (ilautitlugu malguk pilak hivunikhami havanguyuk) katiqhuqviulat Havanguyumut qimaiviuni aktuanit tahamani qalviit katiqhuqhugit aktuanit naunaiyaqni nuna, fiftinlu pilat havanguyut (ilautitlugit siksit pilat hivunikhami havanguyut) katiqhuqviulat havanguyumut qimaiviuni aktuani tahamani amaqut katiqhuqhugit aktuanit naunaiyaqni nuna. Tapkuat angiqpiaqtumik tamaita qimaiviuni aktuanit qalviit mitqulgit nigiugiyauyut ikitnit, hivituni akuniqhiuqtut hivituni (tahamaninaq atqutauniani tamna Havanguyuq) kihimiutitlugu nayuqtauvaknit tammainit taihimayumi nunat havanguyup tupligaqnit, akuttuyut ilitquhit, tahamnaititlugit nunalit nunat ikikligiaqni piagaliuqnit. Tapkuat qimaiviuni aktuanit nigiugiyauyut utiqtitaulaitnit kihimiutitllugu nayuqtauvaktut tammainit, ulapihaqni, upaktauhiqnit, pilaqni katiqhuqhugu naunaiyaqni nuna ikikligiaqni piagaliuqninut. Tapkuat qimaiviunit aktuani nigiugiyauyut utiqtitaulainahugiyauyut kihimiutitlugu nayuqtauvaktut tammainit tahamani taihimayuni nunat havanguyup tupligaqnaini. Piplugit atuqpalianit ihuaqhigiagutit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munagiyaunilu Upalungaiyautit (Makpigaq 10, Taiguaq 20) piplugitlu ayyikkutapyai piyauni hivunikhami havanguyut, angipyaktumik katiqhuqnit aktuani qalviit mitqulgitlu nalautagauyut **Angivalangittut**.

Qalviit takuqattagaulat Havanguyumi nigiugiyaungittut aulaqnit Nunatsiaqmun, taimaitytumik nunaqatigingittut aktuanit qalviknut nigiugiyaungittut. Tapkuat katiqhuqhugit aktuanit naunaiyaqni akuttuyumik kikligiyai amaqut ilalgit ilagiyainut Nunatsiaq. Taimaittumik, pilaqnit nunaqatigingittut aktuanit piyauyut katiqhuqninut aktuanit naunaiyaqni nalautagauyut **Angivalangittut**.

<u>Tikitpaktut Tingmiat</u>

Tikitpaktut tingmiat uplugiyailu hapuhimayauyut kavamatuqatkutnit *Tikitpaktut Tingmiat Maligait Piquyat*(1994) tapkuatlu *Nunavut ANgutikhat Piquyat* (2003), tapkuat pittailiyai ahiguqtiqnit tingmiat upluit tahapkuat atuqtautitlugit tingmianit, pittailini ulapihaqnit tingmianguqatigit tikitpaktut

tingmiat. Piittuq uumayut allatqit tikitpaktut tingmiat tahamani RSA-nga titigaqhimayut uumayut nunguttailinit ihumalugiyauni malikhugit kavamatuqatkut *Uumayut Allatqit Nungitnahuquqnit Piquyat* (SARA 2002). Kihimik, pingahut imaqmiutat tingmiat qullitlu nunainaqmiutat tingmiat uumayut allatqit tahamani RSA-nga titigaqhimayut 'Qanugililat' malikhugit tapkuat CESCC taihimanit Nunavutmun (CESCC 2010). Tingmitikkut naunaiyaqni imaqmiutat tingmiat havaktauyut akungani 2007 tamnalu 2013 titigaqtai Kanatami ulluut pihimayut 80% tikitlugu 90% tamaitni naunaiqninut imaqmiutat tingmiat allatqit. Qaphit angitqiyat mihaluqaqniqmi, piluaqtumik kanangnata pinganani ilangani RSA-nga atuqtauyut ulluunit tikitpaktut aulagianginut, ihaviuyunutlu. Ilagiplugu, atuqniqhat nutqangaviunit inigiyai anunaiqtauyut itkalguni tahiqni hilatinuangani George Havakvik PDA-nga tahapkuat amigaittut ulluut mitqitlu takuqattagauyut tamatkikni upingami ukiakhamilu nutqangavigiyai naunaiyaqnit. Maniqakut naunaiyaqni nunainaqmittut tingmiat pityutai qaphiunit nunainaqmittut tingmiat (uumayut allatqit ilikkuqtutlu) amigaitniqhauyut naunaiyaqninut tahamuna hinaatigut Kingaok, pitqiyauyut ahiinit RSA-ngani. Amigaitnit mikhautauyut 133 ± 9.8 nuainaqmittut tingmiat aqnallugit atuni kilaamitat kikagiktumik titigaqtauyut mihaluqaqniqni natiqnani nayuqtauvaktuni, tamnalu 94 ± 6.8 nunainaqmi tingmiat aqnallugit titigaqtauyut paniumaniqni nunainaqni nayuqpaktai.

Ilat Havanguyuq-tugangani aktuanit VEC-ngi tikitpaktut tingmiat ilalgit Havanguyuq huliniit ahiangugutaulat tahapkununga naunaipkutai: nayuqtauvaktut tammainit, ulapihaqni piplugit nipitunit, ulapihaqni ingilgayunut, tugaqpiaqhugit tuqutaunit aaniaqnilu, tugaqpiaqhimaittumik tuqutaunit, upakhiqninut, hatqiumanit halumailgunut, ikikligiaqnilu piagaliuqnit. Ihuaqhigaiqni aulanilu piyaunit atuqtauniat piiqninut mikhigiaqnilu pilat aktuanit ilalgit mikhigiaqni Havanguyuq tupligaqnit, nipituqpalaqtailinit piyauni, kayumaqpalaqtailini piyauni, atqunit ukiumi tikittaqninut apqutit kihimik, iqakut avugiyauvaktutlu tiguttaqnit piyauni upakhigauttailininut angutikhat iqakunut halumailgutlu, atuqpalianilu tapkuat Angutikhat Ihuaqhigaiqni Munagininutlu Upalungaiyautit (Makpigaq 10, Taiguaq 20).

Kinguagut tukhigautit ihuaqhigaiqni aulanilu piyaunit, malguk qimaiviuni aktuanit naunaiqtauyut tikitpaktunut tingmiat: nayuqtauvaktut tammainit, ulapihaqnilu. Tapkuat angiqpiaqnit tamatkiknut qimaiviunit aktuanit nigiugiyauyut huvalangitnit, tapkuat akuniunit akuniqhiuqtut hivituni (tahamaninaq atqutauniani tamna Havanguyuq) ulapihaqninut hivituyumutlu nayuqtauvaktut tammainit tahamani taihimayumi nunat Havanguyuq tupligaqnit. Tapkuat aktuanit akuttuniat ilitquhit, tahamaninaqlu Havanguyuq tupligaqniani nayuqtauvaktut tammainit, tapkuatlu LSA-nga ulapihaqninut. Tapkuat qimaiviuni aktuanit nigiugiyauyut utiqtitaulaitnit kihimiuyuq nayuqtauvaktut tammainit tahamani taihimayumi nunat Havanguyup tupligaqnini. Piplugit atuqpalianit ihuaqhigiaqnit tituigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyaknit qimaiviuni aktuanit tikitpaktut tingmiat nalautagauyut **Angivalangittut**.

Pilaqnit katiqhuqhugit aktuanit naunaiyaqni havaktaungittut tikitpaktunut tingmiat pihimanit qanugitnit Havanguyuq-tugangani aktuanit tikitpaktut tingmiat nigiugiyauyut kikliqaqnit tahamunga Havanguyuq PDAs-nga, taimaittumik katiqhuhimayut aktuangitnit tikitpaktut tingmiat nigiugiyaungittut pininik. Taimattauq, nunaqatigingittut aktuanit nigiugiyaungittut, piplugu Havanguyuq PDAs-nga tahamaniittuq tamaat Nunavutmi.

Kaayuat

Tallimat tapkunani aitnit kaayuat allatqiknit atuqtitlugu angutikhat RSA-nga uumayut allatqit nunguttailininut ihumalugiyauyut. Tapkuat imnait-upluqaqvit kaayuat maniqamilu-uplulgit naittumik hiutilgit ukpiit titigaqhimayut uumayut allatqit Taihimayut Ihumaluginit tapkunani Atugakhaliat 1 tapkunani kavamatuqatkut *Uumayut Allatqit Piquyat* (Government of Canada 2013). Pingahut ilaliutihimanit imnait-upluqaqvit uumayut – tapkuat naktugalik, kilgaviit, kaayuatlu – titigaqhimayut "Qanugililat" Nunavutmi tapkunanga Kanatamiuni Nungunahuquqtut Uumayut Nunguttailinit Katimayit SARA (CESCC 2010). Maniqami naunaiyainit nunainaqmi tingmiat naunaiqtauyut tapkuat maniqami-

uplulgit kaayuat pivaktut akuttuyumik tapkunani angutikhat RSA-nga. Taimaittumik, huniumaititlugit ilitquhit kaayuat piyaunahuat nunauyaliuqnit inigiyai imnait-upluqaqnit kaayuat uplui, uuktugaqnilu piagaliuqnit piagaliuqtut aqnallugit. Tingmitikkut naunaiyaqni imnait havaktauyut akungani 2002 tamnalu 2013 mikhaani 80% tahamani angutikhat RSA-nga. Katitlugu 147 kaayuat upluit inai piyut tahamani PDAs-nga, ilaliutiplugitlu saivat kaayuat uplut inait piyut tahamani 12 kilaamitat avataani taphuma PDAs-nga.

Pilat Havanguyuq-tugangani aktaunit tapkununga VEC-ngi kaayuat ilalgit Havanguyuq huliniit ahiangugutaulat tahapkununga naunaipkutai: nayuqtauvaktut tammainit, ulapihaqni piplugit nipitunit, ulapihaqni ingilgani, tugaqpiaqhugit tuqutauni, upakhiqnit, hatqiumani halumailgunut, ikiklivaliqni piagaliuqnit. Ihuaqhigiaqni aulanilu piyauni atuqtauniat piiqninut mikhigaiqniluniit pilaqnit aktuanit ilautitlugit mikhigiaqni Havanguyup tupligaqnit, nipittuqpalaqtailinit piyauni, kayumaqpalaqtailini piyauni, atquni ukiumi tikittaqninut apqutit kihimik, iqakut aulanit avugiyauvaktutlu tiguttaqnit piyauni pittailininut upaktagaunit angutikhat, atuqpalianilu Angutikhat Ihuaqhigaiqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20).

Kinguagut tapkuat tukhigautit ihuaqhigiaqniqmut aulanilu piyauni, tallimat qimaivaiuni aktuanit naunaiqtauyut: Nayuqtauvaktut tammainit, ulapihaqni, tugaqpiaqhugit tuqutauni aaniaqnilu, upaktaunit, ikikligiaqnilu piagaliuqnit. Tapkuat angiqpiaqnit tamaita tallimat QImaiviuni aktuanit nigiugiyauyut huvalangitnit, atuqtitlugu akuliqhiuqnit hivituni (tahamaninaq atqutauniani tamna Havanguyuq) kihimiutitlugu tapkuat nayuqtauvaknit tammainit tapkuat hivitulat tahamani taihimayumi nunat Havanguyuq tupligaqnini. Tapkuat aktuanit akuttuyumik ilitquhilgit, tahamaninginaqlutiklu Havanguyup tupligaqnini nayuqtauvaktut tammainit upaktauhiqnilu, tapkuatlu LSA-nga ulapihaqni, tugaqpiaqhugit tuqutaunit aaniaqnilu, ikikligiaqnilu piagaliuqnit. Tapkuat qimaiviuni aktuanit nigiugiyaukiyut utiqtitaulaitnit utiqtitaulatluniit upaktaqhiqninut, piplugit kihimiungittuq nayuqtauvaknit tammainit tahamani taihimayut nunat Havanguyup tupligaqnit. Atugahuquqnit atuqpalianinut ihaqhigaiqnit piyauni titigaqhimayut tapkunani Angutikhat Ihuaqhigiaqni Munaginilu Upalungaiyautit (Makpigaq 10, Taiguaq 20), tapkuat angipyaknit qimaiviuni aktuanit kaayuat nalautagauyut **Angivalangittut**.

Pilat katiqhuqhugit aktuanit anunaiyaqni havaktaungittut kaayuanut nunagiyani aktuqtauninut Havanguyuq-tugangani qimaiviunit aktuaqtaunit kaayuaqnut nigiugiyauyuni kiklilgit iluani 12 kilaamitat avataani talvanga Havanguyuq havagutauyut piplugit piqatai anginiqpamik nigiugini angilgagiyauyut tikitpaktai piagaliuqtut kaayuat. Ilahimaittut havanguyut tahamanitni 12 kilaamitat Havanguyuq PDAs-nga, taimaittumik katiqhuqhimaittut aktuanit Havanguyuq kaayuanut nigiugiyaungittut piyauni. Taimattauq, nunaqatigingittut aktuanit nigiugiyaungittut, piplugu Havanguyuq PDAs-nga tahamaniitnit tamaat Nunavutmi.

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Sabina
GOLD & SILVER CORP.

BACK RIVER PROJECT
FINAL ENVIRONMENTAL IMPACT STATEMENT
Supporting Volume 5:
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Appendix V5-5A. 2013 Wildlife Habitat Suitability Baseline

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Appendix V5-6A. Back River Project: Grizzly Bear and Wolverine DNA Report, 2012

Appendix V5-6B. Back River Project: Grizzly Bear and Wolverine DNA Report, 2013

Acronyms and Abbreviations

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Acronyms and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

AAFC	Agriculture and Agri-Food Canada
AANDC	Aboriginal Affairs and Northern Development Canada
BIF	Banded Iron Formation
BIPR	Bathurst Inlet Port and Road
CCME	Canadian Council of Ministers of the Environment
CESCC	Canadian Endangered Species Conservation Council
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
EIS	Environmental Impact Statement
FID	Flight Initiation Distance
GN DOE	Government of Nunavut Department of Environment
KIA	Kitikmeot Inuit Association
LSA	Local Study Area
m	Metre(s)
masl	Metres above mean sea level
mbsl	Metres below mean sea level
mbg	Metres below grade
mg/L	Milligrams per litre
MLA	Marine Laydown Area
mm	Millimetre
mol/kg	Molality (moles per kilogram)
NAD 83	North American Datum 1983
TEM	Terrestrial Ecosystem Mapping
NIRB	Nunavut Impact Review Board
NRCan	Natural Resources Canada
NWA	Nunavut *Wildlife Act* (2003)

NWT	Northwest Territories
NTU	Nephelometric turbidity units
NU	Nunavut
PDA	Proposed Development Area
pH	The pH is a measure of the hydrogen ion (H+) content of the soil. Term commonly used to describe soil reaction.
psi	Pounds per square inch
ppb	Parts per billions
PRISM	Program for Regional and International Shorebird Monitoring
Project, the	The Back River Project
RSA	Regional Study Area
RST	RST Instruments Ltd.
R-XRD	Rietveld X-ray Diffraction
SARA	*Species at Risk Act* (2002)
TDS	Total dissolved solids
TIA	Tailings Impoundment Area
TK	Traditional Knowledge
µS	Micro Siemens
US EPA	United States Environment Protection Agency
US OAQ	United States Office of Air Quality
UTM	Universal Transverse Mercator coordinate system
VEC	Valuable Environmental Component
VSEC	Valued Socio-economic Component
VTS	Volcanic-Turbidite Series rocks
VWP	Vibrating wire piezometer
WCED	World Commission of Environment and Development
WEMP	Wildlife Effects Monitoring Program
WHO	World Health Organization
WKSS	West Kitikmeot / Slave Study
WMMP	Wildlife Mitigation and Monitoring Program
WWF	World Wildlife Fund

1. Geology

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1. Geology

1.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

1.1.1 Regional Setting

1.1.1.1 Bedrock Geology

The Back River Project (the Project) is located at the intersection of three geological provinces in the West Kitikmeot Region of Nunavut (Figure 1.1-1). The majority of the Project area (the Goose Property and most of the George Property) extends over the northeastern corner of the Slave Geologic Province dominated by Precambrian clastic metasediments of the Yellowknife Supergroup. East of the Project area is the Churchill Geologic Province, which is characterized by Precambrian intrusive granitoid rocks and metamorphic gneiss. The Marine Laydown Area (MLA) and northern most portion of the George Property are underlain by the Bear Geologic Province sedimentary rocks.

The most widespread and abundant supracrustal units in the Slave Province consist of volcanic-turbidite series (VTS) rocks, which are dominated by large areas of turbidites that are flanked by narrow volcanic belts and include distinct volcanic complexes (Figures 1.1-1 and 1.1-2). Two "types" of volcanic rocks in the Project area have been identified (Cater 2011):

- Hackett River-type volcanic rocks which are comprised of felsic to intermediate composition and calc-alkaline affinity; and
- Yellowknife-type volcanic rocks which are comprised of intermediate to mafic composition and displaying tholeiitic differentiation trends.

Within the Hackett River geological area, the Yellowknife Supergroup has been divided into the Hackett River, Beechey Lake, and Back Groups. The intimate interbedding of the Hackett River and Back Group volcanic rocks with the Beechey Lake Group sedimentary rocks has led to an evolutionary model consisting of volcanism punctuated by erosion and periods of fluvial fan deposition.

Iron formations are locally abundant in VTS rocks of the Slave Province with turbidite-hosted banded iron formations (BIFs) hosting most of the stratiform and stratabound gold prospects in the northeastern Slave Province (Cater 2011).

The Bear Geological Province is part of the Canadian Shield and represents material that was added to the Archean Slave Geologic Province during the Proterozoic Eon. The MLA is underlain by sedimentary rocks of the Kilohigok Basin. The sedimentary rocks are comprised of conglomerates, sandstones, siltstones, breccias, and minor quantities of carbonates (Hoffmann and Hall 1993). The region is interpreted to represent a basin adjacent to the continental margin and contains material of similar age and depositional environment as the Thelon Basin.

1.1.1.2 Quaternary Geology

The last major advance of the North American Laurentide ice sheet over the Kitikmeot Region of Nunavut occurred during the Wisconsin Glaciation. The maximum extent of the continental glacier occurred approximately 21,000 years ago and began withdrawing from the Kitikmeot Region approximately 10,000 years ago (NRCAN 2013). Typical glacial material deposited in the Kitikmeot Region includes ground moraines, terminal moraines, drumlins, eskers, and kames.

1.1.2 Local Setting

1.1.2.1 Lithological Units

The Project, located in the northeastern corner of the Hackett River Geological Area, is comprised of rocks belonging to the Beechey Lake Group turbidites, which host oxide and silicate BIFs. The iron formations in the Beechey Lake Group exhibit similarities in stratigraphic setting and mineralogy to the Sequence C iron formations of the Back River Volcanic Complex (Cater 2011).

Table 1.1-1 summarizes generalized impressions of the different lithological units based on all available drill logs, experience of Rescan personnel at the Goose and George properties, and discussions with Sabina geology personnel.

1.1.2.2 Structural Geology

During the Archean Eon, three periods of deformation occurred in the north east portion of the Slave Geologic Province (Cater 2011):

- D1 - large scale folding and down-warping of volcanic margins;
- D2 - foliation development caused by uplift when peak regional thermal metamorphism was occurring; and
- D3 - sub-vertical foliation formation. Metamorphic grades ranged from greenschist to upper amphibolite facies.

1.1.2.3 Quaternary Geology

The quaternary geology at the Project is predominantly comprised of moraine type deposits (glacial till), which mostly consist of sand and variable amounts of silt. There is a large glacial moraine in the south-eastern portion of the Project area, which is approximately 200 km long and extends in the north-east direction. Other glacial materials in the area include coarse-grained glaciofluvial and fine-grained glaciolacustrine deposits. Glaciofluvial deposits in the area include eskers that are approximately 100 m wide and several kilometres in length. Drumlins and kettle lakes are also a common feature within the Project area (Rescan 2012). The glacial overburden deposits are commonly found in valleys and are on average 10 m thick, although some glacial deposits are up to 42 m thick (Cater 2011).

1.1.2.4 Goose Property Geology

The Goose Property is underlain by folded turbiditic meta-sediments of the Beechey Lake Group, including silicate and oxide BIFs (Figure 1.1-2). This sequence is cut by felsic dykes and gabbroic dykes. From oldest to youngest, the sequence is composed of lower greywacke, deep iron formation, lower iron formation, middle mudstone, upper iron formation, upper greywacke, and phyllite in some locations. Gold mineralization tends to be hosted in the lower iron formation unit. A narrow (3 to 5 m) felsic dyke is located along the axial plane of the major antiform at the Goose Main Deposit. Multiple thin (0.5 to 5 m) felsic dykes trend nearly parallel to the synform/antiform structures at Llama and Umwelt deposits. At Echo, a single felsic dyke cross-cuts the mineralization. All units are cross cut by gabbro dykes. A summary of each lithological unit is presented in Table 1.1-1.

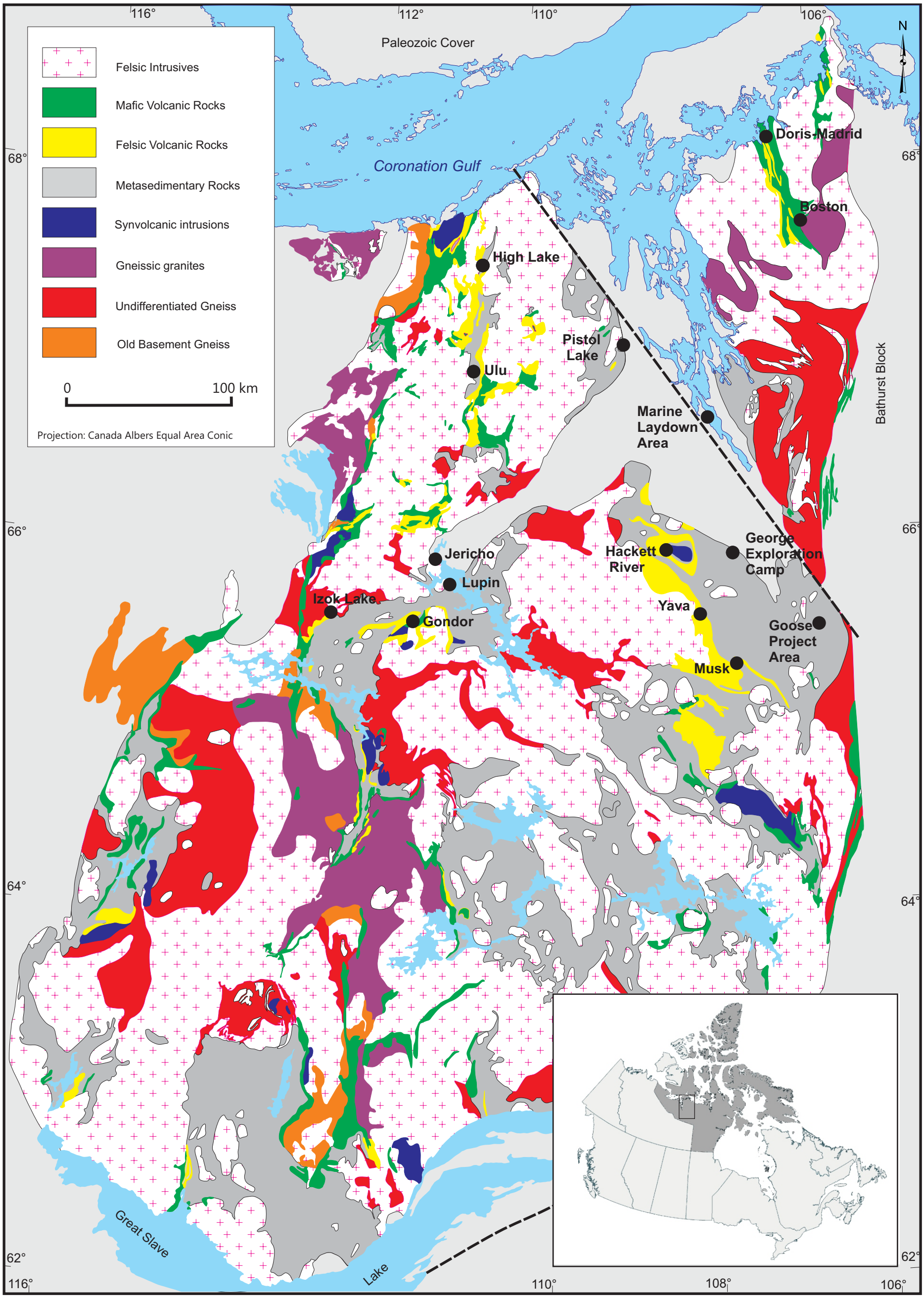

Figure 1.1-1

Regional Geology Bedrock Map

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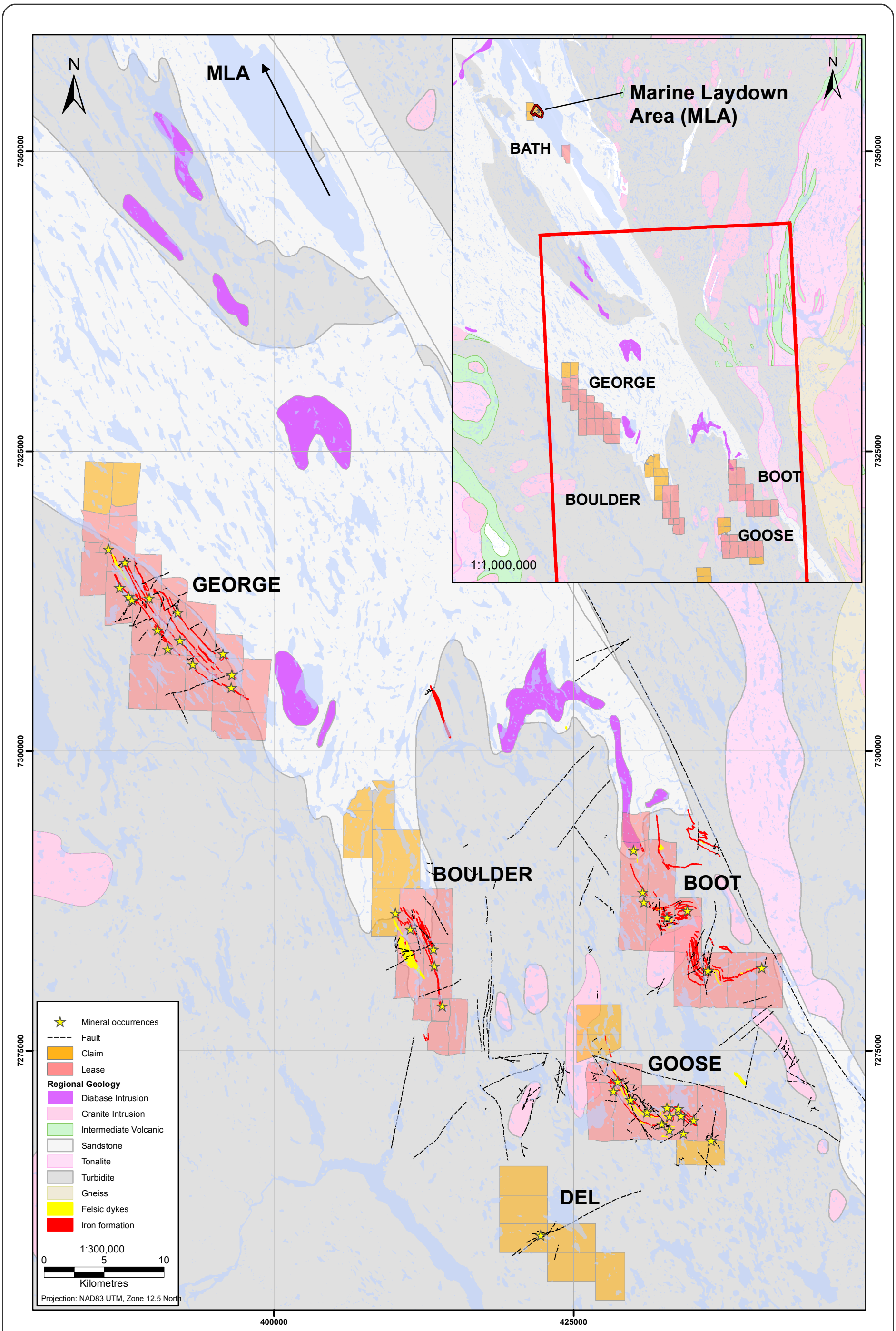

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Figure 1.1-2

Back River Property Geology

Table 1.1-1. Geological Units and Lithology codes for the Back River Project

Unit	Subunit	Major R-XRD Mineral Phases†	Description
(1) Greywacke		Quartz, clinochlore, and muscovite	
	(1a) Thickly bedded greywacke		• Frequently interbedded with minor mudstone units; • Fine to medium grained, usually chlorite altered; • Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and • Occasional carbonate veins.
	(1b) Siliceous greywacke		• Rare.
	(1c) Thinly bedded greywacke		• Interbedded at millimetre to centimetre scale with mudstone units to a much greater degree than 1a; • Chlorite and amphibole alteration was noted; • Trace amounts of sulphide minerals, mostly pyrite and pyrrhotite; and • Occasional carbonate veins.
(2) Banded Iron Formation		quartz, muscovite, and clinochlore	
	(2c) Oxide BIF		• "Zebra core" with alternating bands of magnetite, amphibole and chert, the unit had a characteristic feel when running a magnet over the core that results from the alternating bands of magnetite; • Chlorite and grunerite alteration is common; • Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite and more than 10% magnetite; • Carbonate veinlets were reported; and • Rare graphitic patches occur, typically associated with slickenlines.
	(2ca) Sulphide-bearing oxide BIF		• As 2c but with more than 2% sulphide minerals; and • Visible gold was very rarely reported, common in high grade gold zones.
(2) Banded Iron Formation (cont'd)	(2d) Silicate BIF		• Alternating bands of iron silicates and chert; • There was less than 10% magnetite; • Chlorite and grunerite alteration is common; • Sulphide minerals can make up to 2% of the core and consist of pyrite, pyrrhotite, and arsenopyrite; and • Carbonate veinlets were reported.
	(2da) Sulphide-bearing silicate BIF		• As 2d but with more than 2% sulphide minerals; and • Visible gold was very rarely reported.
	(2dc) Magnetite-bearing silicate BIF		• As 2d but with 2-10% magnetite.
	(2dca) Sulphide-bearing magnetite silicate BIF		• Rare unit as 2dc but with more than 2% sulphides.

(continued)

Table 1.1-1. Geological units and Lithology codes for the Back River Project (completed)

Unit	Subunit	Major R-XRD Mineral Phases	Description
(3) Mudstone		quartz, clinochlore, muscovite, and actinolite	
	(3a) Phyllitic mudstone		• Typically sheared or foliated and very fine grained; and • Rare sulphides and carbonate were reported.
	(3b) Chloritic mudstone		• Rarely reported, notable feature was the pervasive chlorite alteration resulting in a distinctly dark green, fine grained unit.
	(3c) Argillitic mudstone		• Typically more massive than 3a.
(4) Dykes and volcanic rocks		quartz, plagioclase, and muscovite	
	(4a) Felsic dykes		• Quartz and feldspar dominated mineralogy; • Arsenopyrite was the commonly reported sulphide phase; and • Carbonate minerals rarely reported.
	(4b) Intermediate dykes		• feldspar dominated with biotite, amphibole, chlorite, sericite, and minor carbonate.
	(4c) Mafic dykes		• Very rare; and • Probably normally reported as 8.
	(4v) Volcanic/ volcaniclastic rocks		• Very rare; and • Distinguished from 4a, 4b, and 4c through blue quartz eyes.
(5) Veins		quartz	
	(5a) Sulphide-bearing quartz veins		• Arsenopyrite with pyrrhotite and pyrite is the main reported sulphide mineral; and • Carbonates were reported in chlorite rich areas.
	(5b) Carbonate-bearing quartz veins		• Minor.
(7) Proterozoic sedimentary rocks			• Goulburn Group sedimentary rocks were occasionally encountered at the George and Boulder Properties; and • Not reported at Goose Property.
(8) Gabbro		kaolinite, actinolite, clinochlore, and quartz	• Units varied from sub-metre to greater than 10 m in thickness, thicker units frequently had chilled margins; • Chlorite alteration was not specifically noted, but many units have a green colour; • Disseminated magnetite and carbonate veinlets were identified frequently; and • Sulphide minerals of pyrrhotite and chalcopyrite were rare.
(9) Overburden		quartz, plagioclase, and muscovite	• Infrequently recovered; • Overburden typically consisted of granitic boulders or greywacke; and • Organics and sandy till were reported in the 2011 overburden drill holes.

† (Rescan 2013; Appendix 11-2A; Back River Project: 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Report)

Numerous structural studies have been conducted on the Goose Property. The structural history can be summarized in two major phases (Cater 2011):

- D1 - regional northwest trending asymmetrical tight to isoclinal folds; and
- D2 - superimposed on the previous deformation events and is represented by megascopic structures that consist of open to locally tight cross-folds that trend north to northwest.

The emplacement of the quartz veins was promoted by the deformation of the BIF units, which were later fractured and acted as conduits for gold rich fluids.

The metamorphic grade of the Goose Property is upper greenschist to upper amphibolite facies. The metamorphic grade increases to garnet-amphibolite facies to the west of the Llama Deposit (proximal to the quartz-muscovite intrusion and adjacent to the granodiorite intrusion to the southeast of the property) (Cater 2011). Figure 1.1-3 presents the results of airborne magnetic surveys for the Goose Property with an emphasis on the BIF units and the gold-rich zones projected to surface. Figure 1.1-4 is a stylized geologic cross-section based on a typical west-east Llama Deposit cross-section.

Mineralization Characteristics of the Llama, Umwelt, Goose Main, and Echo Deposits

Most of the known or observed gold mineralization identified at the Goose Property is structurally controlled with associated quartz veining, zones of shearing, and silicified BIFs. Gold mineralization predominantly occurs within silicified and variably sulphidized BIFs and, to a lesser extent, mixed iron formation and meta sedimentary units located in the underlying greywacke. The main observed sulphide minerals include pyrite, arsenopyrite, and pyrrhotite. Accessory chlorite, carbonate, hornblende, and grunerite may be associated with sulphide gold mineralization. Visible gold is locally present, especially when sulphides are greater than 10% and when coarse-grained arsenopyrite is present (Cater 2011).

The Goose Property deposit mineralogy is dominated by quartz (SiO_2), plagioclase feldspar ($NaAlSi_3O_8$ - $CaAl_2Si_2O_8$), muscovite ($KAl_2(AlSi_3O_{10})(OH)_2$), and clinochlore ($(Mg,Fe^{2+})_5Al(Si_3Al)O_{10}(OH)_8$). Calcite ($CaCO_3$), dolomite ($CaMg(CO_3)_2$), and siderite ($FeCO_3$) carbonate minerals were detected in abundances lower than 3%. Pyrite (FeS_2), pyrrhotite ($Fe_{1-x}S$), arsenopyrite (FeAsS), sphalerite ((Zn,Fe)S), and marcasite (FeS_2) sulphide minerals were noted. No sulphate minerals were detected in any of the samples. The Rietveld X-ray Diffraction (R-XRD) results for deposit samples collected for the geochemistry baseline program can be found in Rescan 2013 (Appendix V11-2A: The Back River Project: 2007 to 2012 Metal Leaching/Acid Rock Drainage Baseline Study).

The gold mineralization at the Goose Main Deposit is structurally controlled and is predominantly stratabound. The deposit is located within the Goose Antiform structure, which is part of a zone of normal faults (north to northeast trending and southeast dipping). The normal faults are widely spaced within a 500 m wide zone and have up to 30 m of left-lateral displacement and a down dropping of individual fault blocks of up to 75 m. The gold mineralization is controlled by a series of northwest oriented structures that are axial planar to the Goose Antiform and sub-parallel to the strike of the felsic dykes. These structures are interpreted to cut all sedimentary units within the antiform. Approximately 60% of the gold mineralization occurs within the lower iron formation (sulphidized oxide BIF), and the remaining 40% occurs in the core of the underlying greywacke. Visible gold is common and is associated with pyrrhotite and/or pyrite in the presence of arsenopyrite. The key gold mineralizing event appears to be late D2 deformation where existing partially or wholly discordant quartz veins act as fluid pathways. Areas of brittle deformation exhibit higher grades of gold mineralization (Cater 2011).

The Llama Deposit is hosted by a turbidite sedimentary sequence of locally sulphidized silicate and oxide BIF. This turbidite sequence is interbedded with greywacke, siltstone, and mudstone which contain varying amounts of minor gold mineralization. The host stratigraphy is a BIF and clastic sediment sequence that occurs within a southeast plunging fold. Late stage felsic and gabbroic dykes have intruded the plunging fold. The main host for the Llama Gold Zone is interpreted to be a major deformation corridor that transects a portion of the fold and is semi-concordant to the western limb (Cater 2011). Figure 1.1-4 is a stylized geologic cross-section for the Llama Deposit. The complexity of the structural history of the Llama Deposit has been supported by recent drilling. It has yet to be confirmed if the gold mineralization is related to the pre-existing structural conduits in which the gabbro and porphyritic felsic dykes intruded the clastic and chemical sediments (Cater 2011). Gold mineralization in the Llama Deposit is recognized to be hosted in both chemical and clastic sedimentary lithologies as well as quartz veins within quartz ± feldspar porphyry dykes. The majority of the gold mineralization is hosted by the lower iron formation, an oxide BIF, consisting of chert + grunerite + magnetite.

The Umwelt Deposit is underlain by similar geology to that of the Main and Llama deposits with felsic and gabbroic dykes cross cutting sulphidized oxide and silicate BIFs. Airborne and ground magnetic survey results suggest that the BIFs are strongly folded. The gold mineralization occurs within quartz ± carbonate veins and sulphidized BIF lithologies most often associated with arsenopyrite ± pyrite ± pyrrhotite. Pyrite and pyrrhotite are the most common sulphides in the Umwelt Deposit with pyrrhotite becoming significantly more prominent as the gold mineralized zone becomes deeper to the south. Arsenopyrite is the most common sulphide associated with gold and occurs as euhedral individual crystals (fine to coarse grained), vein halos, and masses of crystals occasionally located preferentially along bedding planes or trailing along fractures. Magnetite appears to be replaced by pyrrhotite. The pyrrhotite is present in beds with or without magnetite and is associated with veins and fractures. Gold mineralized zones are characterized by sulphide and silica alteration accompanied by shearing and veining (Cater 2011).

Gold mineralization at the Echo deposit is defined within, but is not limited to, the contact of the iron formation/interbedded sediments with the regional turbiditic lithologies. Brittle deformation is prominent at the contact; there is also a moderate amount of shearing present locally. A poorly-mineralized quartz feldspar porphyry dyke intrudes proximal to the structurally-influenced contact and is interpreted to be closely related to the timing of gold mineralization. Alteration consists of varying amounts of grunerite + chlorite + quartz + calcite ± biotite. Mineralization associated with intervals returning higher gold values (up to 120 g/t gold) consists of pyrrhotite + pyrite + arsenopyrite + chalcopyrite occurring with quartz ± calcite veining, as well as replacement of the host rocks. The overall sulphide content ranges from a trace amount up to a maximum of 10% over 0.5 m.

Banded silicate iron formation consisting of actinolite + grunerite + quartz ± tremolite hosts the majority of the known gold mineralization. Oxide iron formation is similarly mineralized but forms only a minor portion of the host. Clastic sediment lithologies appear to be less favourable hosts and appear to be best mineralized within areas of deformation that occur at contacts with iron formation. Because the area is largely covered by overburden, the relationship between the Goose Main deposit and the Echo zone is not well understood. This area has potential for the development of additional gold targets (JDS 2015).

1.1.3 Summary

The Project is located near the intersection of the Slave, Churchill, and Bear Geologic provinces. Glacial material deposited after the Quaternary Wisconsin Glaciation covers much of the Archean geological provinces.

GIS # **BAC-50-021**

September 14, 2015

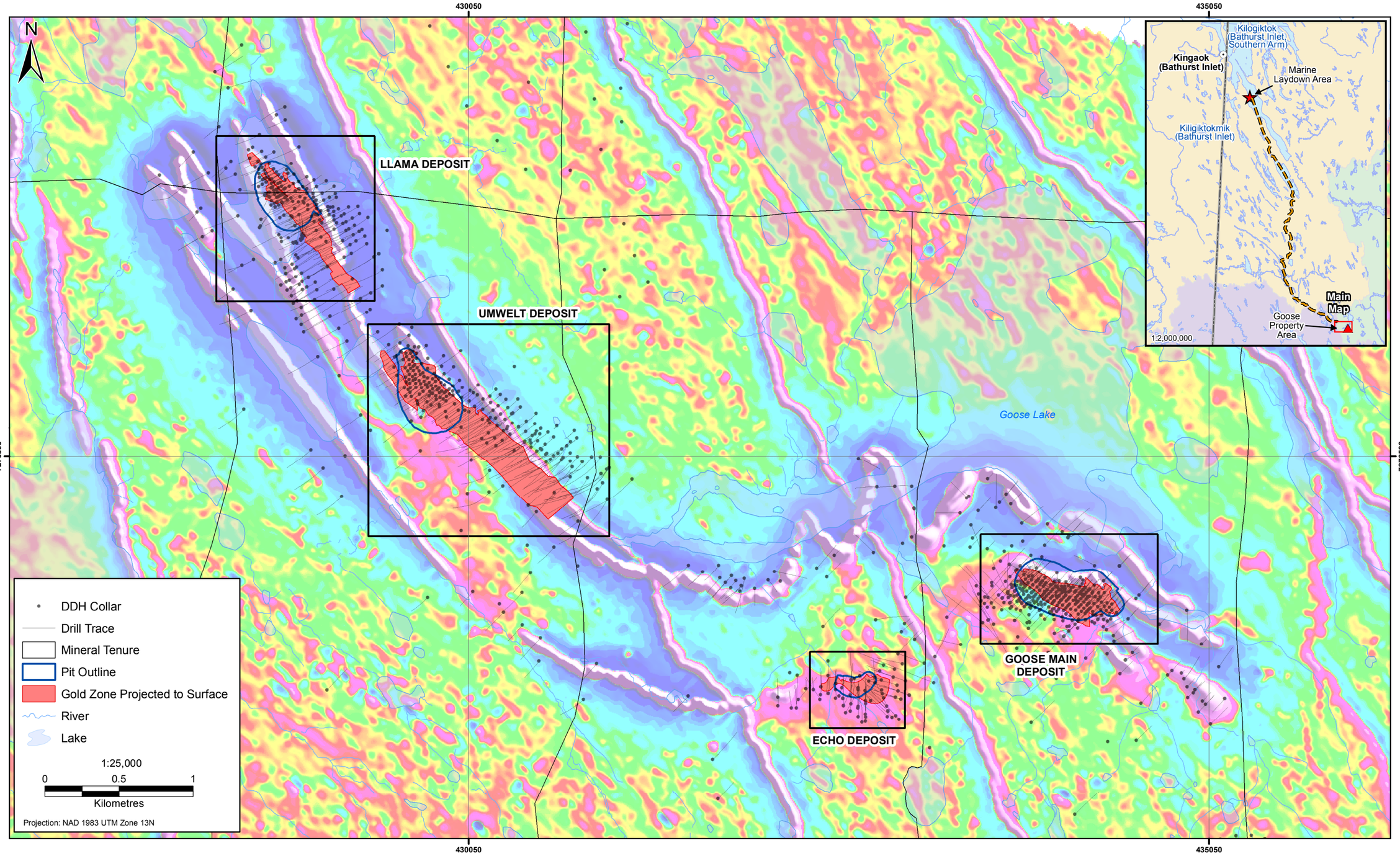

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Figure 1.1-3

Airborne Magnetic - 1VD
Goose, Llama, Umwelt and Echo

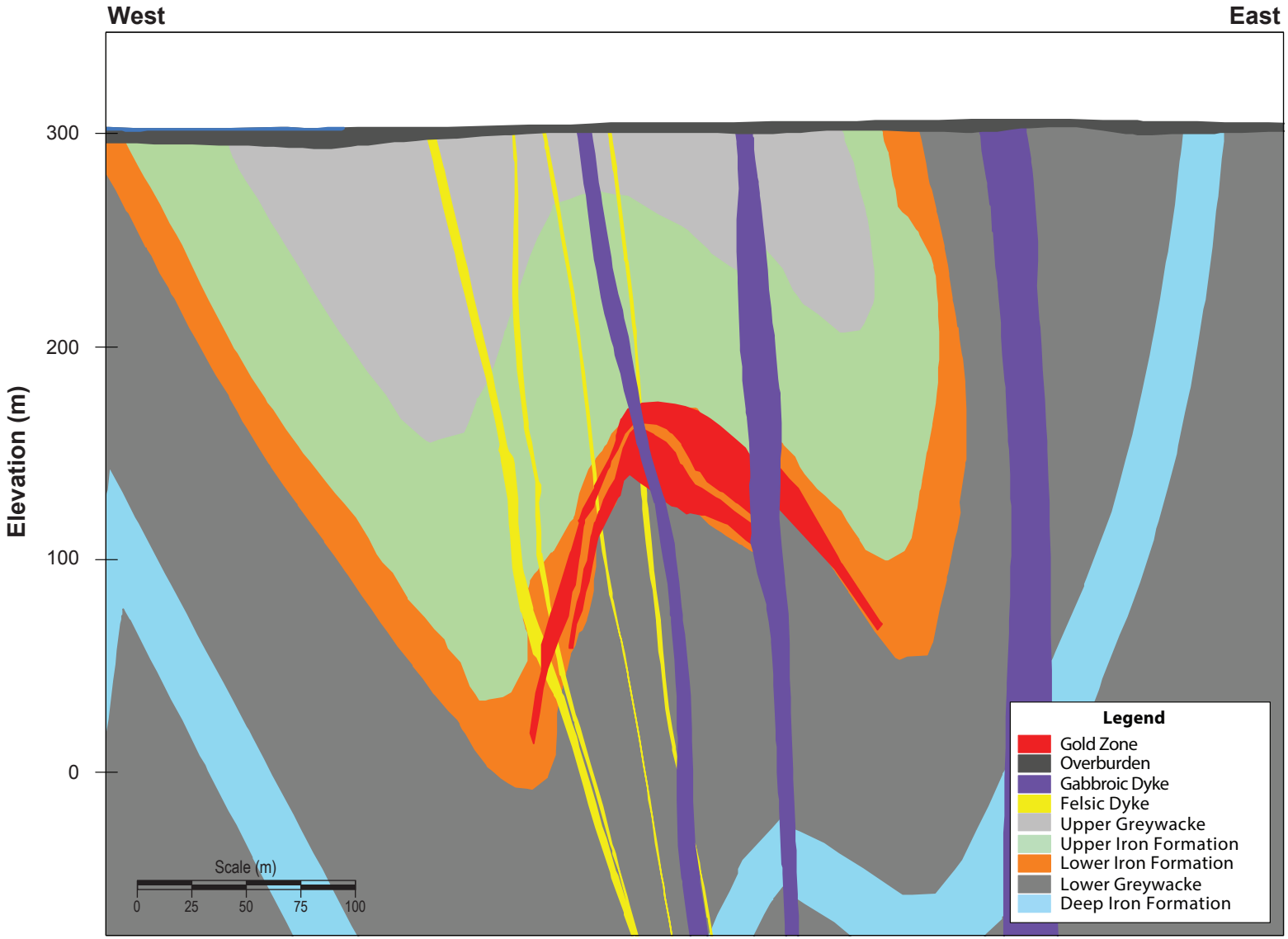

Figure 1.1-4

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Goose Property Stylized Geologic Cross-section

Figure 1.1-4

The Goose Property consists of a package of variably folded and faulted sedimentary rocks. Greywacke and subordinate mudstone surround and variably interbed with silicate banded iron formation (BIF) and oxide BIF. The sedimentary package is cross-cut by mafic dykes, lesser volumes of felsic dykes and volumetrically insignificant quartz veins. The rocks in the area have undergone prograde metamorphism up to lower amphibolite facies, resulting in abundant replacement of mafic minerals by chlorite and grunerite.

Gold mineralization is most often associated with sulphide minerals, particularly arsenopyrite, and visible gold is found almost exclusively in zones with abundant arsenopyrite. Other sulphide minerals (pyrite and pyrrhotite) are typically enriched in a halo in the BIF and greywacke around the arsenopyrite-rich ore zones. The mafic dykes have very low sulphide contents and are devoid of gold mineralization.

1.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The effects assessment relies on the information collected from Inuit-led Traditional Knowledge (TK) information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the evaluation of the potential effects of the Project on the environment. The following reports were reviewed for TK specific information related to geology:

- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014) (Appendix V3-3B of FEIS);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) (Appendix V3-3C of FEIS);
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3C of FEIS).

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

1.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available regional level TK from the Naonaiyaotit Traditional Knowledge Project (KIA 2012) and from the Results from Data Gaps Workshops, Final Report (KIA 2014) was reviewed for *geology* existing environment and baseline information. The TK collected is focused on landforms and materials, particularly eskers, cliffs, copper, carving stone, and soil for sled runners including the following comments:

> *"Black soapstone called 'okohikhaat' was used to carve the large kudlik (stone oil lamps), and for making cooking pots. Inuit looked for this stone around riverbanks or the ocean shore. Stone for making oil lamps and pots was found at a variety of places."*
>
> *"Ulu blades, arrowheads and knife blades were made from copper or silver. Copper used to be abundant along the Coppermine River but now all readily available metal has been collected. The major source of copper for Kiligiktokmiut was at Kanuyak (which means "copper"). Copper was also obtained from Egloyoalik (Cockburn Islands)."*
>
> *"Additional sources of carving stone were mapped at Buchan Bay, two areas at Kilanaktokvik (near Omingmaktok), and the northeast corner of Ekalulia Island."*

While some general locations of important eskers and cliffs were discussed, none of these areas were noted to specifically overlap with Project Development Areas (PDAs). Specific areas referenced for copper, carving stone and soil for sled runners are all well outside of the Project footprint (e.g. located on various islands in central/northern Bathurst Inlet, or on the mainland east of Bathurst Inlet)..

1.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The KIA (2012) report presents clear maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the VEC/VSEC list. There were few comments relating to geology. Geology has been included as a Subject of Note, rather than a VEC or VSEC.

1.2.3 Incorporation of TK for Spatial and Temporal Boundaries

The Project footprint did not overlap with any known occurrences of soapstone, copper, or silver (Coppermine River, Buchan Bay, Kilanaktovik, and Ekalulia Island; KIA 2012 and KIA 2014). No soapstone was noted in drill logs, during quarry sampling or in the technical assessment report (Cater 2011).

1.2.4 Incorporation of TK for Mitigation and Adaptive Management

Since it is used traditionally, if harvestable soapstone is identified in the PDA, efforts would be made to minimize the level of disturbance. Soapstone locations referenced in the NTKP and TK workshops report are well outside the Project footprint and no evidence of soapstone has been seen in the Goose Property PDA to date.

1.3 VALUED COMPONENTS

1.3.1 Potential Valued Components and Scoping

Surficial and bedrock geology were included in the scoping and refining process with all other potential VEC/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK reports (KIA 2012 and KIA 2014), consultation with regulatory agencies, and regulatory considerations geology is classified as a Subject of Note.

1.3.2 Valued Components Included in Assessment

Geology is considered a Subject of Note for the FEIS. All information requested in the NIRB-issued EIS guidelines relating to geology is included in this FEIS.

1.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

Additional information on the geology of the Project is provided in the technical report (JDS 2015) prepared as part of a Feasibility Study.

2. Permafrost

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2. Permafrost

2.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

2.1.1 Regional Setting

Permafrost extents have been characterized at a number of sites in the Canadian Arctic, including existing and prospective mine sites on mainland Nunavut (identified in Figure 2.1-1). Documentation in Environmental Impact Statement submissions to the Nunavut Impact Review Board (NIRB) has provided a publicly available database of permafrost extents at sites in similar settings as the proposed Back River Project (the Project), including the following:

- Meadowbank Gold Project (Cumberland Resources Ltd. 2005);
- Kiggavik Project (Areva Resources Canada Inc. 2011);
- High Lake Project (Wolfden Resources Inc. 2006);
- Doris North Project (SRK Consulting Inc. 2005); and
- Meliadine Gold Project (Golder Associates Ltd. 2012).

An academic research program has documented permafrost at the Lupin Mine/Exploration Site (Ruskeeniemi et al. 2002; Stotler et al. 2009). A data-sharing agreement exists with the nearby Hackett River Exploration Project under the ownership of Glencore Canada Corporation. A summary of permafrost characterization parameters available at sites located within mainland Nunavut is provided in Table 2.1-1.

All components of the Project are situated within the zone of continuous permafrost (Figure 2.1-1), as delineated in a database compiled by the Geological Survey of Canada (Government of Canada, Natural Resources Canada, and Earth Sciences Sector 2002). The Lupin, Meadowbank, Kiggavik, High Lake, Doris North, and Meliadine sites are also situated within continuous permafrost.

Basal permafrost depth has been estimated to be as shallow as 210 metres below ground surface (mbgs) at the Kiggavik site (proximal to the transition to discontinuous permafrost) and as deep as 560 m at the Doris North site. Open taliks (also called through taliks) have been estimated to exist beneath lakes with radii as small as 145 m at Kiggavik and as large as 470 m at High Lake.

Permafrost at Lupin extends to depths of 400 to 600 mbgs in the region and 541 mbgs in the mine shaft. An open talik has been identified beneath Lake Contwoyto (the lake is approximately 3 km wide by 90 km long) and is bounded vertically 30 to 60 m offshore. Talik and active layer characterization was based on the interpretation of geophysical (seismic and ground penetrating radar) surveys.

Table 2.1-1. Permafrost Characteristics Identified for Mining Projects within Mainland Nunavut

Project	Distance from Project [A]	Active Layer Thickness	Talik Characterization	Basal Permafrost Depth	References
Meadowbank	510 km East	1.3 m (overburden away from lakes), 4.0 m (adjacent to lakes), up to 6.5 m (beneath major streams)	Open taliks for lakes greater than 570 m in diameter, or long with width greater than 320 m. Talik below surface waterbodies with depth greater than 2.0 m.	450 to 550 m, related to terrain (slopes, aspect, proximity to lakes)	Cumberland Resources Ltd. 2005
Doris North	290 km North	0.5 to 2.0 m	Open taliks predicted below Doris lake ((5km long, more than 1 km wide and more than 20 m deep).	550 to 560 mbgs, as estimated by geothermal gradient. 400 m, as estimated by geothermal modelling	SRK Consulting Inc. 2005
High Lake	280 km Northeast	5 m in exposed bedrock, 2 m in soils	Open talik below lakes greater than 470 m diameter, or long with width greater than 240 m. Talik below surface waterbodies with depth greater than 2 to 2.5 m.	440 mbgs	Wolfden Resources Inc. 2006
Kiggivik	430 km East	1.0 to 5.0 m	Open talik below lakes with radius greater than 145 m, or elongated with width greater than 80 m. Talik below surface waterbodies with depth greater than 2 m.	210 to 280 mbgs	Areva Resources Canada Inc. 2011
Meliadine	800 km East	1.0 to 3.0 m	Open taliks below lakes with radius greater than 290 to 330 m, below elongated lakes with width greater than 160 to 195 m. Taliks below surface waterbodies with depth greater than 1.0 to 2.3 m.	360 to 495 m, as measured with thermistor strings. Depth to liquid water estimated at 375 m, based on sub-permafrost TDS measurements.	Golder Associates Ltd. 2012
Lupin	220 km East	1.2 to 1.8 m	Open talik below Lake Contwoyto bounded vertically 30 to 60 m offshore.	400 to 600 m regionally, 541 m locally in mine shaft.	Stotler et al. 2009; Ruskeeniemi et al. 2002
Hackett River	100 km East	1.8 to 2.4 m	Lakes with widths greater than 200 m were predicted to overlie open taliks, however warmer and deeper lakes with smaller widths may also overlie open taliks.	520 mbgs as indicated by two deep thermistor strings- basal cryopeg from 440 to 520 mbgs.	Rescan 2013b

[A] *Estimated distances from the existing Goose exploration camp*

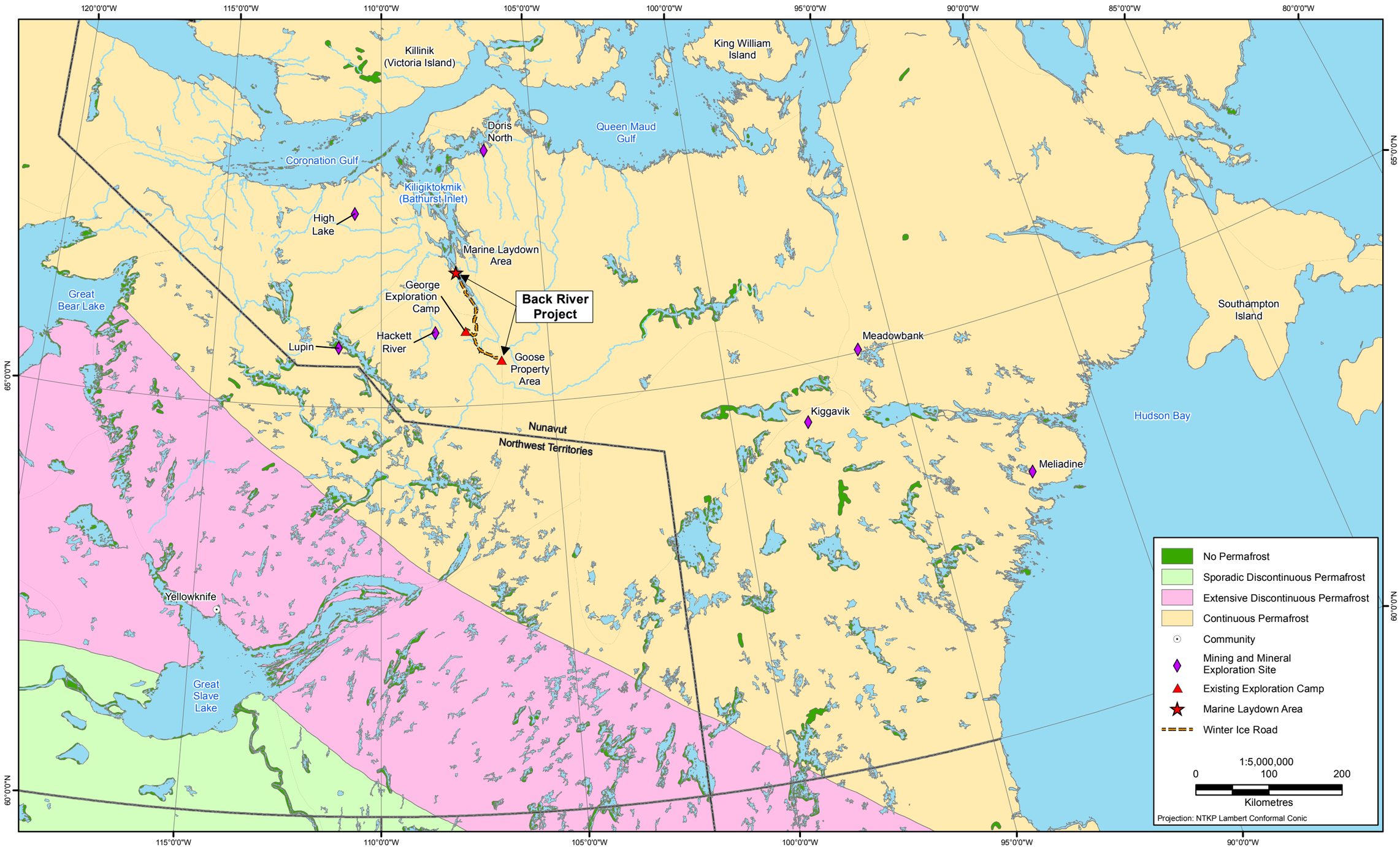

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Figure 2.1-1

Regional Permafrost Context

2.1.2 Local Setting

Site investigations as early as 2007 have provided subsurface temperature records. Existing data and analyses that have been used to characterize the permafrost environment are documented in the following sources:

- Cumulative Permafrost Baseline Data Report (2007 to May 2014) Prepared by Rescan Environmental Services Ltd. for Sabina Gold & Silver Corp. (Rescan 2010, Appendix V5-3A);
- 2015 Sub-permafrost Groundwater Quality Baseline Report Prepared by Rescan Environmental Services Ltd. for Sabina Gold & Silver Corp. (Rescan 2015, Appendix V5-2B);
- 2012 to 2013 Thermistor String Records Obtained at the Hackett River Project Prepared by Rescan Environmental Services Ltd. for Sabina Gold & Silver Corp. (Rescan 2013, Appendix V5-2C);
- Back River 2012 Geotechnical and Hydrogeological Drilling Program Factual Data Report Prepared by SRK Consulting Inc. for Sabina Gold & Silver Corp. (Appendix V6-2C);
- 2013 Geomechanical and Hydrogeological Site Investigation Prepared by Knight Piésold Consultants Inc. for Sabina Gold & Silver Corp. (Appendix V6-2D); and
- Site Wide Geotechnical Parameters Report Prepared by SRK Consulting (Canada) Inc. for Sabina Gold & Silver Corp. (Appendix V2-7C).

In relation to AANDC information request #33 and #34, not all appendices of V6-2C and V6-2D (including raw field data, drill core photos, and air photos) are included in the FES due to their significant file size. All appendices were provided during the information request phase of the DEIS and can again be provided upon request.

Field and analytical methods employed to characterize the subsurface permafrost environment and thermal regime are described in Section 2.1.2.1, followed by the results and interpretations for the Goose Property Area (Section 2.1.2.2), and Marine Laydown Area and winter ice road corridors (Section 2.1.2.3).

Permafrost has been defined by convention as the subsurface extents that remain perennially below 0°C. Cryopegs may exist within the base of permafrost where fluids are present in the fractures and pores at temperatures less than 0°C.

2.1.2.1 Field and Analytical Methods

Site Instrumentation

Borehole thermistor strings have been the principal tool used to measure subsurface temperatures, and to estimate permafrost extents. Vibrating wire piezometers (VWPs) and a Westbay system have also been used to characterize the permafrost. A summary of all deep instrument installations used to characterize the permafrost at the Goose Property are identified in Figure 2.1-2. A summary of all shallow instrument installations at Goose Property is included in Figure 2.1-3 (Appendix V2-7C). Additional information on 2015 geotechnical site investigations and instrument installation can be found in Appendix V7-2C.

Thermistor strings have been installed in 34 boreholes and 1 test pit at the Goose Property Area. Seasonal manual measurements dating back as early as 2007 exist for one 300 m long thermistor string at the Goose Property. Continuous daily temperature measurement logging began at two thermistor

strings at the Goose Property in 2011. Three thermistor strings were installed at the Goose Property in 2012 and programmed for daily data logging. 17 thermistor strings were installed at the Goose property in 2013, all programmed for daily data logging. Two thermistor strings programmed for daily data logging were installed in 2014. Ten thermistor strings without dataloggers were installed at the Goose Property along the planned TSF dam alignment and South TSF Dyke in 2015.

The depths and elevations spanned by each thermistor string across the Property vary, with the shortest string penetrating 3 mbgs) and the longest 652 mbgs. All installed thermistor strings are identified in Figure 2.1-2 and Figure 2.1-3. Construction details and available records for thermistor strings are identified in the primary documentation (Appendices V6-2C and V6-2D).

All thermistor strings were installed fixed to a PVC support pipe. Backfill materials varied, as did the manufacturers and models of thermistor strings and data loggers. Modern industrial-grade thermistors generally provide precision to the nearest 100th of a degree, and are calibrated for +/- 0.01ºC accuracy by the manufacturer. Installation methods, calibration results, and manufacturer/model information is provided in the primary sources documenting the thermistor string installations (Appendices V6-2C, V6-2D, and V2-7C).

Damage to individual thermistor nodes or wires during installation or freeze-back occurs occasionally. Thermistor nodes that were interpreted to be damaged were not included in analyses. Damage is considered to have occurred where unrealistic readings occurred. Unrealistic readings include considerable temperature variability below the depth of zero amplitude (depth below which no seasonal temperature variability is expected), and temperatures that lie considerably outside the expected trumpet-curve temperature vs. depth shape.

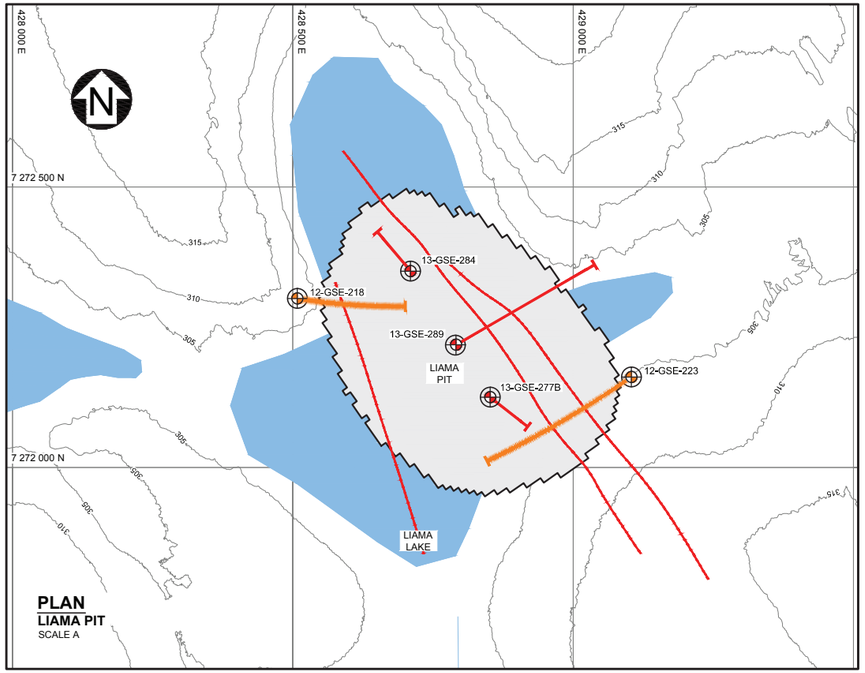
Subsurface temperatures were measured within the Westbay system casing using a thermistor installed in the sampling probe. A temperature profile was developed by taking temperature readings at a range of depths within the casing. Further information regarding methods used for data collection from the Westbay system is provided in Volume 6, Chapter 2 (Groundwater).

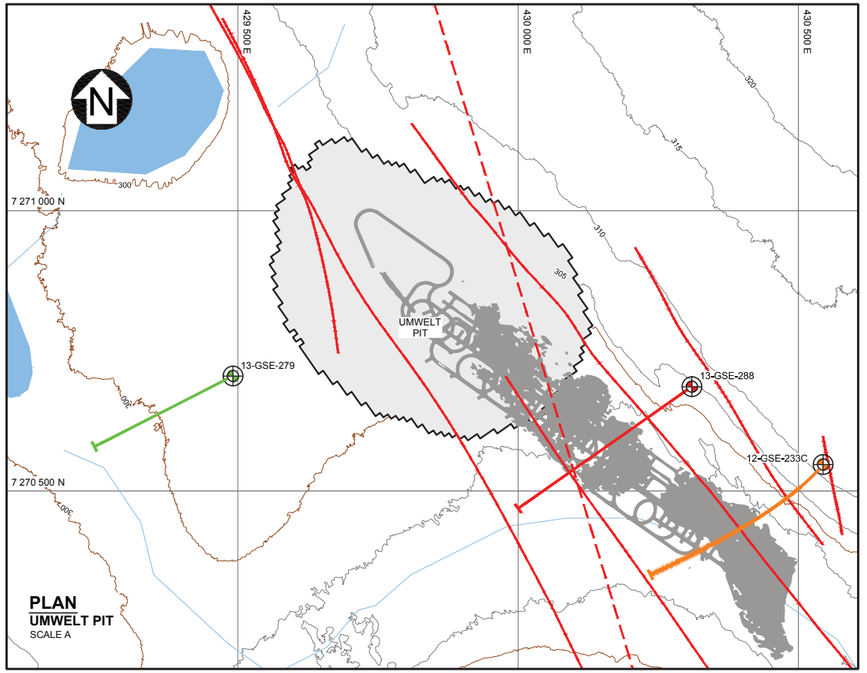
VWPs also provide temperature readings. Certain VWPs were installed within the permafrost, as indicated by a building pressure profile resulting from freeze-back. VWPs installed in the permafrost have been used to bound cryopeg extents. Further information regarding installation and data collection methods employed for vibrating wire piezometers are presented in Volume 6, Chapter 2 (Groundwater).

Permafrost Characterization and Delineation

Thermal characteristics of the subsurface were determined by inspection of the temperature vs. depth and temperature time series obtained from the thermistor strings. The depth of the active layer (surficial layer that undergoes an annual freeze/thaw cycle) was determined by interpolating between the deepest thermistor node indicating summer thaw (reaching a temperature above 0ºC) and the shallowest perennially frozen, at the time when the summer thaw attained its greatest depth of penetration (typically mid-August to mid-September).

The depth of zero amplitude was determined by interpolating between the deepest node demonstrating seasonal temperature variability (greater than 0.05ºC) and the shallowest demonstrating a static temperature year-round. The basal depth of the permafrost was determined by extrapolating along the geothermal gradient beneath the deepest node to a temperature of 0ºC, or by interpolating between nodes that straddle 0ºC at depth.



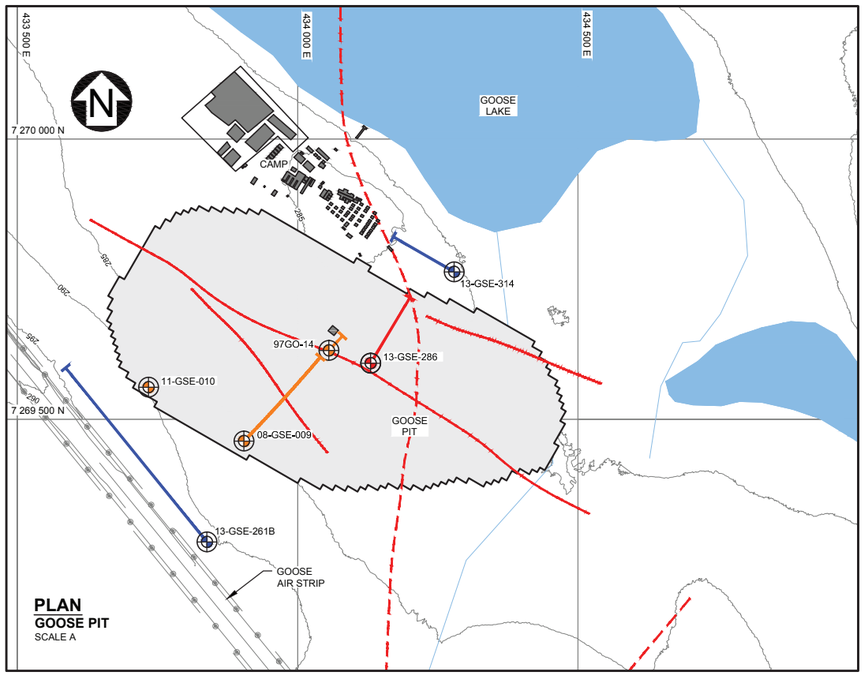


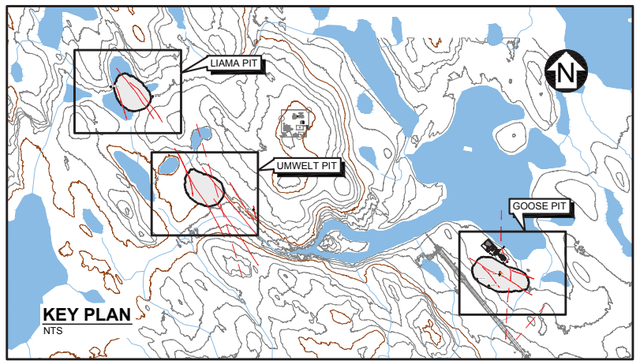
LEGEND:

- 2013 GEOMECHANICAL DRILLHOLE
- 2013 HYDROGEOLOGIAL DRILLHOLE OR EXPLORATION DRILLHOLE
- TWINNED WESTBAY ENVIRONMENTAL DRILLHOLE
- HISTORICAL GEOMECHANICAL OR EXPLORATION DRILLHOLE
- INSTRUMENTATION INSTALLED IN DRILLHOLE
- FAULT INTERSECTION WITH SURFACE
- BUILDING / STRUCTURE
- PROPOSED OPEN PIT OUTLINE
- PROPOSED UNDERGROUND MINE

NOTES:

1. COORDINATE GRID IS UTM (NAD83) ZONE 13.
2. LIDAR / TOPOGRAPHY BASED ON INFORMATION PROVIDED BY SABINA, NOVEMBER 9, 2012.
3. CONTOUR INTERVAL IS 5 METRES.
4. APPROXIMATE WATERBODIES FROM RESCAN NTS MAPPING.
5. FAULTS AND BUILDINGS BASED ON INFORMATION PROVIDED BY SABINA, RECEIVED JANUARY 28, 2013 AND MARCH 15, 2013.
6. DRILLHOLE DETAILS BASED ON SURVEY INFORMATION PROVIDED BY SABINA.
7. PROPOSED OPEN PIT SHELLS PROVIDED BY AMC, DATED MAY 8, 2013.





Installation Details and Data History

Borehole ID	Collar Location			Dip	Thermistor node elevation range (masl)	VWP elevations (masl)	Records	Reference
	Northing (m)	Easting (m)	Elevation (masl)					
Main Deposit Area								
97GO-14	7269623	434056	282	45	281 to 275	-	Five manual measurements 2007-2010	Rescan 2010
08-GSE-009	7269461	433904	286	57	286 to -14	-	continuous 17/08/2011 to 27/02/2013	Rescan 2012
11-SRK-GL-10	7269557	433734	294	90	294 to 274	-	Nine manual readings May 2008 to Sep. 2010, Continuous 17/8/2011 to 27/2/2013	Rescan 2012
13-GSE-261B	7,269,381	433,838	289	54	270 to -163	-162.6,-240.4	continuous 30/03/2013 to 23/04/2013, 27/04/2013-14/06/2013	KP 2013
13-GSE-286	7,269,612	434,066	283	47	268 to 136	135.8	continuous 08/04/2013 to 25/06/2013	KP 2013
13-GSE-314	7,269,764	434,278	280	51	263 to 123	122.7	continuous 08/05/2013 to 25/06/2013	KP 2013
Umwelt Deposit Area								
12-GSE-233C	7270547	430544	311	57	251 to -213	-246	continuous 27/08/2012 to 15/2/2013	SRK 2012
13-GSE-279	7,270,260	430,189	297	68	283 to -197	-138, -197.1	continuous 15/04/2013 to 26/05/2013	KP 2013
13-GSE-288	7,270,686	430,310	305	42	289 to -85	-76.9	continuous 09/05/2013 to 26/05/2013	KP 2013
Liama Deposit Area								
12-GSE-218	7272301	428508	307	50	280 to 89	77	continuous 12/10/2012 to 15/2/2013	SRK 2012
12-GSE-223	7272161	429104	306	42	224 to 16	12	continuous 12/10/2012 to 15/2/2013	SRK 2012
13-GSE-277B	7,272,125	428,852	303	58	288 to 169	169.0	continuous 02/04/2013 to 14/06/2013	KP 2013
13-GSE-284	7,272,370	428,710	303	57	287 to 169	169.5	continuous 12/04/2013 to 27/06/2013	KP 2013
13-GSE-289	7,272,218	428,790	303	50	295 to -77	222.4, -76.9	continuous 04/05/2013 to 27/06/2013	KP 2013

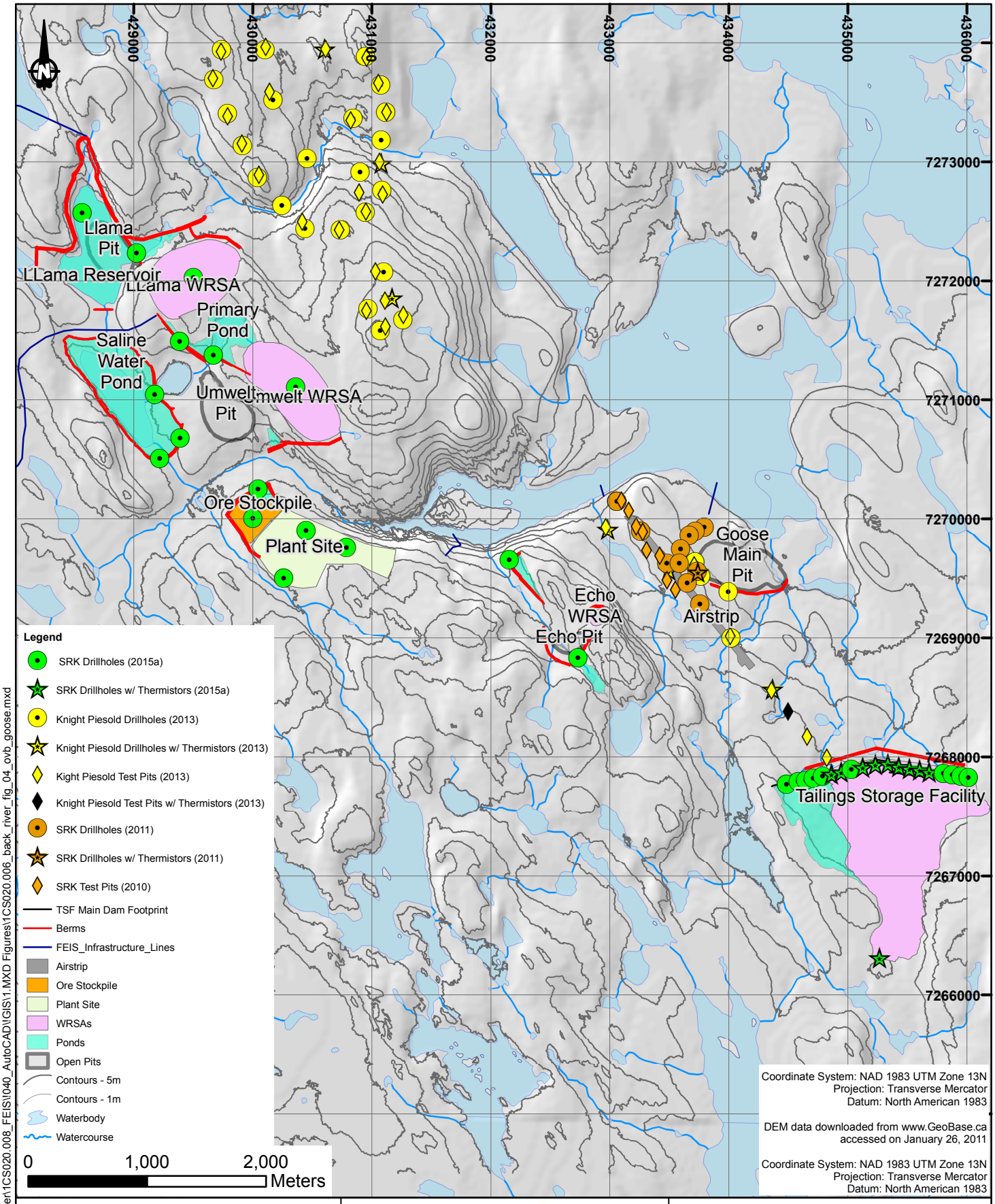
100 50 0 100 200 300 400 500 m
SCALE A

Sabina GOLD & SILVER CORP. Rescan Engineers & Scientists

Source: Knight Piésold Ltd (2013).

Figure 2.1-2

Installed Instruments Used for Characterization of the Existing Permafrost Environment at the Goose Property Area



Path: J:\01_SITES\Back River\1CS020.008_FEIS\040_AutoCAD\GIS\1.MXD Figures\1CS020.006_back_river_fig_04_ovb_goose.mxd

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GEOTECHNICAL DESIGN PARAMETERS

Overburden Investigations - Goose Property Overview

Job No: 1CS020.008

Filename: 1CS020.006_back_river_fig_04_ovb_goose

Back River

Date:	Approved:	Figure:
November 2015	EH	2.1-3

Cryopeg Extent Estimation

Cryopegs may exist in the permafrost where the salinity of the pore fluids depresses their freezing temperature. Cryopegs have been theorized to exist at the base of the permafrost and beneath lake talik where groundwater has been shown to be hyper-saline.

Groundwater samples were collected from a Westbay sub-permafrost groundwater monitoring system installed adjacent to the Umwelt Deposit, indicating hyper-saline groundwater (Refer to Volume 6, Chapter 2). The total dissolved solids (TDS) reported for the Westbay samples were used to generate a freezing temperature vs. depth profile. The freezing temperature of water may be estimated using equation 1 (adapted from Ebbing 1990).

$$T = K_f m i \qquad (1)$$

Where T = Freezing temperature of water;
K_f = Cryoscopic constant of the solvent (K_f = 1.853 K*kg/mol for water);
m = Molality of the sample solution; and
i = Van't Hoft Factor (number of ion particles per individual molecule of solute).

A TDS versus depth profile was generated by adopting a linear interpolation between measured concentrations of salts in the sub-permafrost groundwater at two different depths. A freezing temperature versus depth profile was then generated using equation 1. A Van't Hoft factor of 2.6 was used, as the groundwater is dominated by a mixture of sodium chloride (i of 2) and calcium chloride (i of 3). However varying the Van't Hoft factor between 2 and 3 had little effect on the resulting basal cryopeg thickness prediction.

Vertical extents of the basal cryopeg were determined by plotting the freezing temperature profile alongside the measured temperature profile. The intercept represents the depth above which the temperature is lower than the freezing temperature of the groundwater. The temperature versus depth profile measured at the Umwelt Westbay System was used.

A linear TDS versus depth profile may be regarded as highly conservative. Frape and Fritz (1987) and Kuchling, Chorley, and Zawadzki (2000) suggest a logarithmic relation; however, their sites are not in continuous permafrost environments and a logarithmic relationship does not fit the observations at the Umwelt Westbay system. Frozen VWPs were used to adjust the inferred basal cryopeg upper limit.

Talik Extent Estimation Using One-dimensional Steady-state Analytical Geothermal Models

The locations of open taliks are important for the understanding of groundwater flow processes. For groundwater modelling purposes, to avoid the potential influence of boundary conditions, the potential locations of open taliks at a distance of approximately 4 km from any planned Project infrastructure were mapped. Taliks were mapped by creating thermal models based on the site-wide geothermal gradient and the depth and shape of each water body in the area, as water bodies must be of sufficient size and depth in order to create enough of an insulating layer to support the presence of a talik.

Talik can generally be expected below lakes with depths greater than two thirds of the maximum thickness of ice forming annually on their surface (Mackay 1992). Ice thicknesses and bathymetry data (refer to Volume 6, Chapter 3) have been used to identify lakes which are theorized to overlie taliks. It was assumed that open taliks could only occur under lakes greater than 1.3 m in depth. Shallower waterbodies were assumed to freeze to the bottom. For more information, see Appendix V2-7A: Hydrogeological Characterization and Modeling Report.

Models documented by Mackay (1962), Smith (1976), and Burn (2002) were developed for use at study sites in the Canadian Arctic and have been used for talik characterization at other proposed mine projects located in the continuous permafrost region of mainland Nunavut, including the Meliadine (Golder Associates Ltd. 2013), Kiggavik (Areva Resources Canada Inc. 2011), High Lake (Wolfden Resources Inc. 2006), Doris North (SRK Consulting Inc. 2005), and Meadowbank (Cumberland Resources Ltd. 2005) projects.

The vertical extents of talik beneath round lakes have been modelled by Mackay (1962). The temperature profile beneath the centre of a circular lake without terraces may be modelled using equation 2.

$$T_z = T_g + \frac{z}{I} + (T_p - T_g)\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right) \qquad \text{(2; adapted from Mackay 1962)}$$

Where T_z = temperature at depth z (ºC);
T_p = average annual temperature at the bottom of the lake (ºC);
T_g = average annual ground temperature (ºC);
I= inverse of the geothermal gradient (m/ºC);
z = depth below bottom of lake (m); and
R = radius of the lake (m).

The temperature profile beneath the centre of a circular lake with terraces may be modelled using equation 3.

$$T_z = T_g + \frac{z}{I} + \left(T_p - T_g\right)\left(1 - \frac{z}{\sqrt{z^2+R_p^2}}\right) + \left(T_t - T_g\right)\left(\frac{z}{\sqrt{Z^2+R_p^2}} - \frac{z}{\sqrt{Z^2+R_{p+t}^2}}\right) \qquad \text{(3; adapted from Burn 2002)}$$

Where T_z = temperature at depth z (ºC);
T_p = average annual temperature at the bottom of the central pool (ºC);
T_t = average annual temperature at depth along the terrace (ºC);
T_g = average annual ground temperature (ºC);
I= inverse of the geothermal gradient (m/ºC);
z = depth below bottom of lake (m);
R_P = radius of the central pool (m); and
R_{P+t} = radius of the lake, including terraces (m).

Smith (1976) provides an analytical method for thermal profiling beneath elongated lakes. The temperature profile beneath the centroid of a symmetrical elongated lake (without terraces) may be estimated using equation 4.

$$T_z = T_g + \frac{z}{I} + \frac{T_p - T_g}{\pi}\left(2\tan^{-1}\frac{w}{z}\right) \qquad \text{(4; adapted from Mackay 1962)}$$

Where T_z = Temperature at depth z (ºC);
T_p = Average annual temperature at the bottom of the lake (ºC);
T_g = Average annual ground temperature (ºC);
I= inverse of the geothermal gradient (m/ºC);
z = depth below bottom of lake (m); and
w = half width of an elongated lake/pool.

Burn (2002)provides an analytical method for thermal profiling beneath elongated lakes with terraces. The temperature profiles beneath the centroid of an elongated lake with terraces may be modelled using equation 5.

$$T_z = T_g + \frac{z}{l} + \frac{T_t - T_g}{\pi}\left(2\tan^{-1}\frac{H_{p+t}}{z}\right) + \frac{T_p - T_t}{\pi}\left(2\tan^{-1}\frac{H_p}{z}\right) \qquad (5;\ \text{adapted from Burn 2002})$$

Where T_z = temperature at depth z (ºC);
T_p = average annual temperature at the bottom of the central pool (ºC);
T_t = average annual temperature at depth along the terrace (ºC);
T_g = average annual ground temperature (ºC);
l = inverse of the geothermal gradient (m/ºC);
z = depth below bottom of lake (m);
H_P = half width of the central pool (m); and
H_{P+t} = half width of the lake, including terraces (m).

Water temperatures have been derived from measurements documented in freshwater aquatic ecology baseline reports (refer to Volume 6, Chapter 3). Lake-bottom temperatures were taken to be a weighted mean (Equation 6) of winter (April) and summer (August) measurements at the deepest points available. Measurements taken in April were treated as representative of the mean temperature during months with ice cover (October through May). August temperatures were treated as the mean water temperature during ice-free months. Maximum water temperatures are typically observed during August in the Canadian Arctic (e.g., Burn 2002). Therefore the computed annual average water temperature is likely somewhat high, resulting in conservative (high) estimates of present talik extents.

$$\bar{T} = 8T_{apr} + 4T_{Aug} \qquad (6)$$

Terrace water temperatures were estimated from corresponding depths in temperature profiles obtained at survey locations, which are typically situated in deeper pools. Weighted averages were also used to determine annual average temperatures along terraces (equation 6). Where terraces freeze during the winter a temperature of 0ºC was used for the winter months.

The geothermal gradient and mean ground temperature were calculated from thermistor string records. Geothermal gradients of 0.013 to 0.014˚C/m have been adopted for the Goose Property Area.

Lake dimensions were obtained from bathymetry data (refer to Volume 6, Chapter 3).

Burn (2002) provides validation for the equations of Mackay (1962) with field data from a site in the continuous permafrost region of the Canadian Arctic. Limitations of the sub-lake temperature models that have been used must none-the-less be recognized for interpretations. The equations (equations 2, 3, 4, and 5) are one-dimensional. Local variability in the geothermal gradient arising from geologic considerations is not accounted for. For example, different rock types may possess different heat conductivity properties. Ground temperature may vary across the site due to different overburden types and variability in ambient conditions, such as snow cover and sun exposure. Ideal lake geometries are assumed, however real lakes can only be approximated as elongated or round. Steady-state conditions are assumed. Paleo-climate variability is not considered, and the temperature at depths up to 600 mbgs may be influenced by air temperatures as far into the past as 100,000 years (Lunardini 1995). A recent change in water or ground temperature or lake geometry would induce transience in the thermal regime.

A temperature envelope was developed for each sub-lake temperature profile to address uncertainty. A "cold case" sub-lake temperature profile was created by treating all lakes as round, using a geothermal gradient 10 m/°C lower, and using water and ground temperatures 0.5°C colder than the calculated annual mean values. A "warm case" profile was created treating the lake as elongated, using a geothermal gradient 10 m/°C warmer, and using water and ground temperatures 0.5°C warmer than the calculated annual mean values. The warm case results in a highly conservative estimate of present talik depth (favouring greater talik extents, and presenting a more extensive groundwater flow regime exposed to ground surface). The cold case provides a measure of confidence for open talik identification.

The thermal model results have been used to categorize the taliks beneath lakes as open taliks less than 50 m deep, open taliks 50 to 200 m deep, or open taliks. Where a open talik was predicted for all model cases (cold, base, and warm cases) the confidence in a open talik prediction was considered high. Where open talik was predicted for the base and warm cases, but not the cold case, the confidence in an identified open talik was considered moderate.

A number of lakes located within and near the potential development area were not included in the modelling exercises. Interpreted talik extents have been estimated for a number of lakes not included in the modelling exercises by comparison with lakes of similar size and shape that were included in the modelling exercises.

Input parameters adopted for each sub-lake geothermal model are listed in Table 2.1-2.

Two-dimensional thermal modeling was carried out to refine the one-dimensional analytical analysis described above, as well as to provide further definition regarding the differences between the 0°C and -2°C isotherms related to the taliks. Two-dimensional finite element steady-state thermal modeling was carried out using the finite element code SVHeat version 6.0 (SoilVision Systems 2004). The model inputs are summarized in Table 2.1-3.

2.1.2.2 Goose Property Area

Permafrost Extents

Thermistor strings installed at the Goose Property Area (Figures 2.1-2 and 2.1-3) indicate the presence of permafrost approximately 500 m thick (Table 2.1-4). The active layer has been measured to penetrate from 1.3 up to 4.3 mbgs. Depth of zero amplitude is approximately 19 mbgs. The basal permafrost depth ranges from -190 to -260 metres above sea level (masl), corresponding with 490 to 570 mbgs. For additional thermistor information used in permafrost interpretation, see Appendix V2-7A: Hydrogeological Characterization and Modeling Report.

Basal Cryopeg Extents

Hypersaline groundwater has been observed and characterized beneath the permafrost (results of the Westbay Program are described in Volume 6, Chapter 2), suggesting presence of a basal cryopeg. A linear interpolation of TDS between sampling zones 3 (620 mbgs) and 5 (515 mbgs) extrapolates to a basal cryopeg reaching as high as 300 mbgs. VWPs have frozen back at depths up to 382 mbgs. Thus, the thickness of the basal cryopeg has been estimated to be approximately 100 m (Figure 2.1-4). Fluids are inferred to exist in fracture spaces at depths exceeding approximately 400 mbgs throughout the Goose Property Area.

Table 2.1-2. Input Parameters for Sub-lake One-dimensional Analytical Geothermal Models

Lake	Water Temperatures (ºC) [A]					Radius or Half-width (m) [B]	Approximately Elongated or Circular	Terraced (Yes/No)	Central Pool Radius or Half-width (m)	Terrace-bottom Temperature [C, E]	Analytical Model [F]
	April Mean	Aug. Mean	Weighted Mean [D]	Cold Case	Warm Case						
Goose Property Area											
Big	3.9	10.8	5.3	4.8	5.8	800	Elongated	No	-	-	4
Chair	2.1	10.9	4.1	3.6	4.6	200	Elongated	No	-	-	4
Echo	0	10.4	2.6	2.1	3.1	80	Circular	No	-	-	2
Fox	3.3	12.2	5.3	4.7	5.8	210	Elongated	No	-	-	4
Gander Pond	1.9	10.5	3.9	3.4	4.4	80	Elongated	No	-	-	4
Giraffe North	2.9	12.5	5.1	4.5	5.6	230	Elongated	No	-	-	4
Giraffe South	3.7	11.2	5.3	4.7	5.8	150	Elongated	No	-	-	4
Goose (Central)	2.4	13.4	5.0	4.4	5.5	460	Elongated	No	-	-	4
Goose (Neck)	2	14.15	4.9	4.3	5.4	135	Elongated	No	-	-	4
Goose (Tail)	3.6	11.8	5.4	4.8	5.9	105	Elongated	No	-	-	4
Llama	2.7	12.3	4.9	4.3	5.4	160	Elongated	No	-	-	4
Mam	4.1	9.6	5.1	4.6	5.6	110	Circular	N/A	-	-	2
Moby	1.8	11.5	4.1	3.5	4.6	320	Circular	N/A	-	-	2
Pond 19	0	9.6	2.4	1.9	2.9	40	Elongated	N/A	-	-	4
Propeller	2.7	14.1	5.3	4.8	5.8	900	Elongated	N/A	-	-	4
Rabbit	0	10.5	2.6	2.1	3.1	150	Elongated	Yes	60	0.0	5
Rascal	1	10.5	3.3	2.8	3.8	130	Elongated	N/A	-	-	4
Umwelt	2.1	12.5	4.5	4.0	5.0	120	Elongated	No	-	-	4

Notes

[A] Estimated from deepest measurement at profiling location

[B] Measurements based on Bathymetry surveys (Appendix V6-3E). Half-width measured along secondary axis for lakes with elongated shapes.

[C] Terrace-bottom temperature estimated from corresponding depth in temperature profile obtained at survey location.

[D] Weighted Mean determined by applying April temperature for eight months of ice cover, August temperature for two months (summer), half of August temperature for two months (ice-free spring and fall).

[E] Where average terrace depth is less than 2.0 m a temperature of 0ºC is used.

[F] Equation numbers refer to those presented in the text, as adapted from McKay (1962) and Burn (2002).

Table 2.1-3. Two-Dimensional Finite Element Thermal Modeling Inputs to Refine Talik Assessment

Parameter	Value (Base Case)	Value (Sensitivity Analysis)
opp	-6°C	-5°C to -7°C
Mean Annual Lake-Bottom Temperature (Tb)	4.5°C	3.5°C to 5.5°C
Geothermal Heat Flux (G)	0.014°C/m	n/a
Water Body Half Width	5 to 150 m	n/a
Unfrozen Greywacke Thermal Conductivity	346 kJ $m^{-1}day^{-1}$ °C^{-1}	n/a
Frozen Greywacke Thermal Conductivity	350 kJ $m^{-1}day^{-1}$ °C^{-1}	n/a
Unfrozen Greywacke Volumetric Heat Capacity	2,120 kJ m^{-3} °C^{-1}	n/a
Frozen Greywacke Volumetric Heat Capacity	2,110 kJ m^{-3} °C^{-1}	n/a

Table 2.1-4. Permafrost Properties Interpreted from Subsurface Temperature Data Acquired at the Goose Property Area

Installation	Active Layer Depth (mbgs)	Basal Permafrost Depth		Zero Amplitude Depth (mbgs)
		mbgs	masl	
08-GSE-009 Thermistor String	1.25	550	-265	19
11-SRK-GL-10	1.65	na		19
13-GSE-319 Westbay Well	na	490	-195	na
13-GSE-261B	na	555	-265	na
13-GSE-279	na	550	-255	na

na = temperature measurements not available at depths necessary for corresponding interpretation

Talik Extents

Using the steady-state one-dimensional analytical geothermal models and data collected at the Property as described above, Rescan (2013a) interpreted that:

- Round ponds and lakes with widths up to 175 m are interpreted to overlie taliks up to 50 m deep;
- Elongated, narrower waterbodies up to 150 m, round water bodies with widths up to 120 m, and those with extensive shallow terraces are interpreted to overlie closed taliks ranging from 50 to 100 m deep; and,
- Larger lakes tend to have elongated shapes and have been predicted to overlie open taliks where the smaller lake width dimension exceeds 200 m.

Sub-lake temperature profiles derived from steady-state one-dimensional analytical geothermal modelling are presented in Figures 2.1-5a to 2.1-5b.

Taliks are interpreted to exist beneath numerous lakes and large ponds (water depth greater than 1.3 m) within and near the Goose Property Area (Figure 2.1-6), based on the updated two-dimensional modelling described above (SRK 2015a). The two-dimensional finite element modeling suggests that for the base case conditions presented in Table 2.1-3, the following is true:

- Open talik defined by the 0°C isotherm will develop for water bodies with half widths greater than 92 m; and,
- Open talik defined by the 2°C isotherm will develop for water bodies with half widths greater than 42 m.

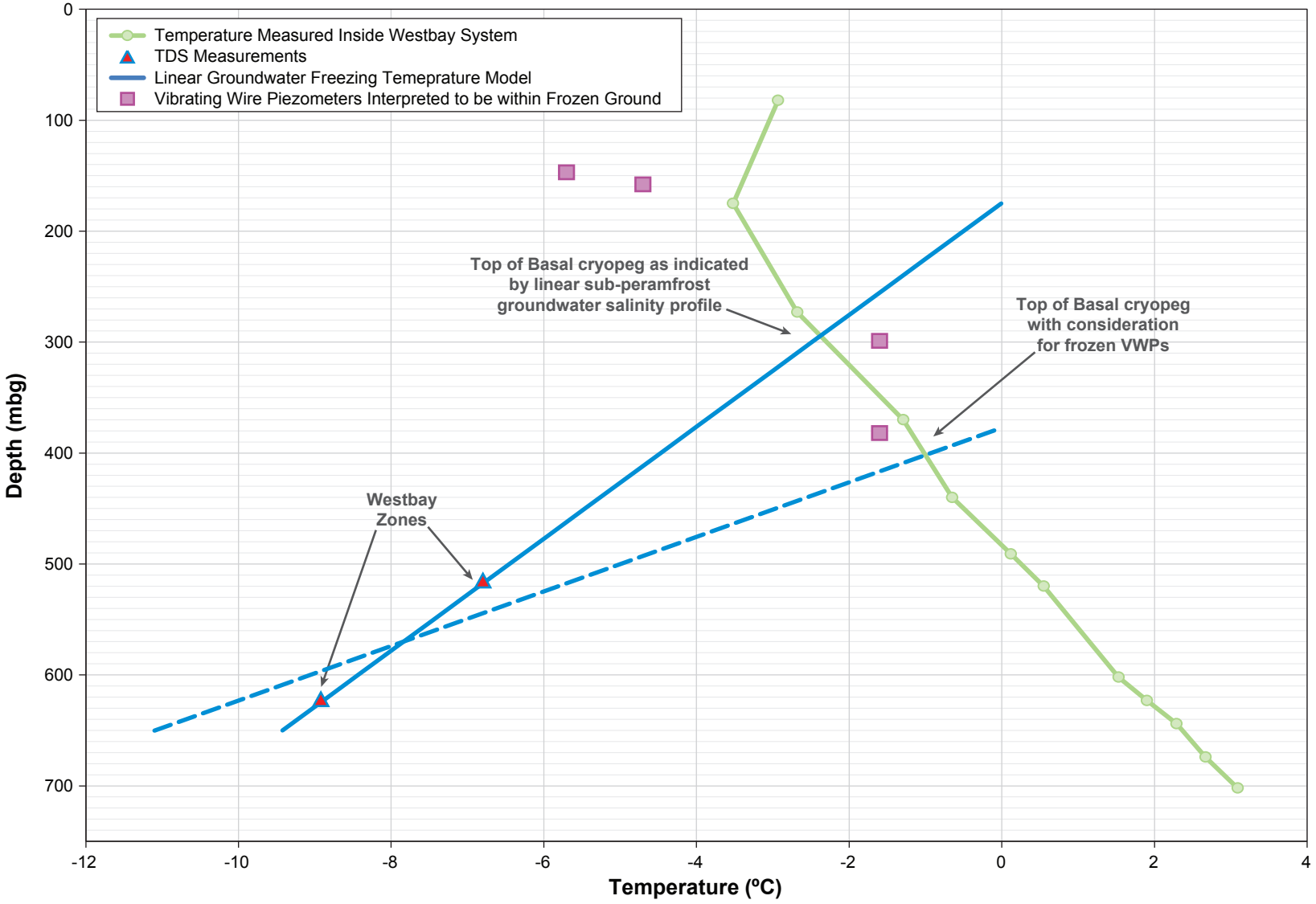


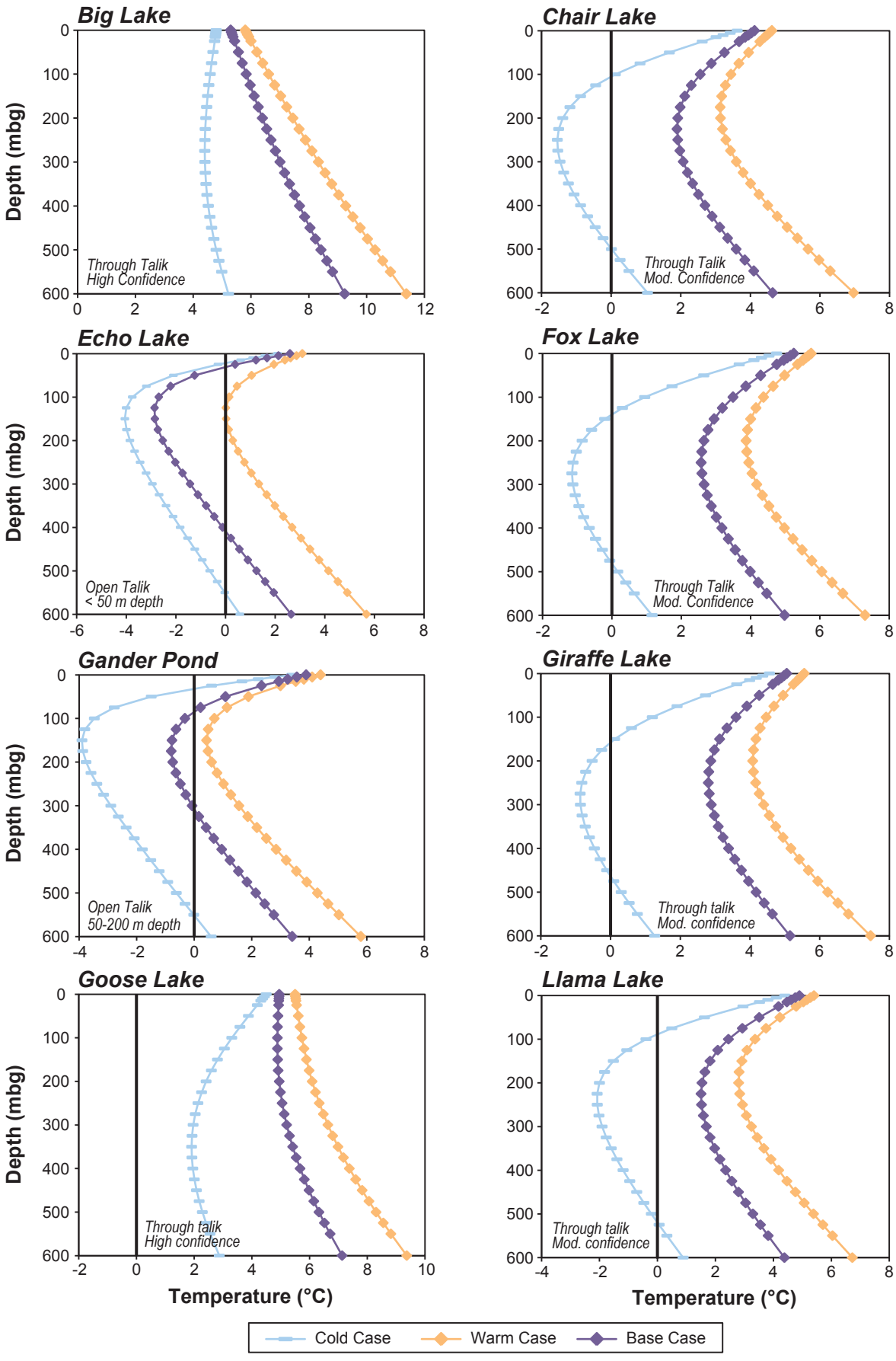
Figure 2.1-4

Sabina GOLD & SILVER CORP.

Basal Cryopeg Depth Interpretation

Figure 2.1-4

Rescan Engineers & Scientists



Sub-lake Temperature Profiles Derived from Steady-state One-dimensional Analytical Geothermal Models for the Goose Property Area

Figure 2.1-5a

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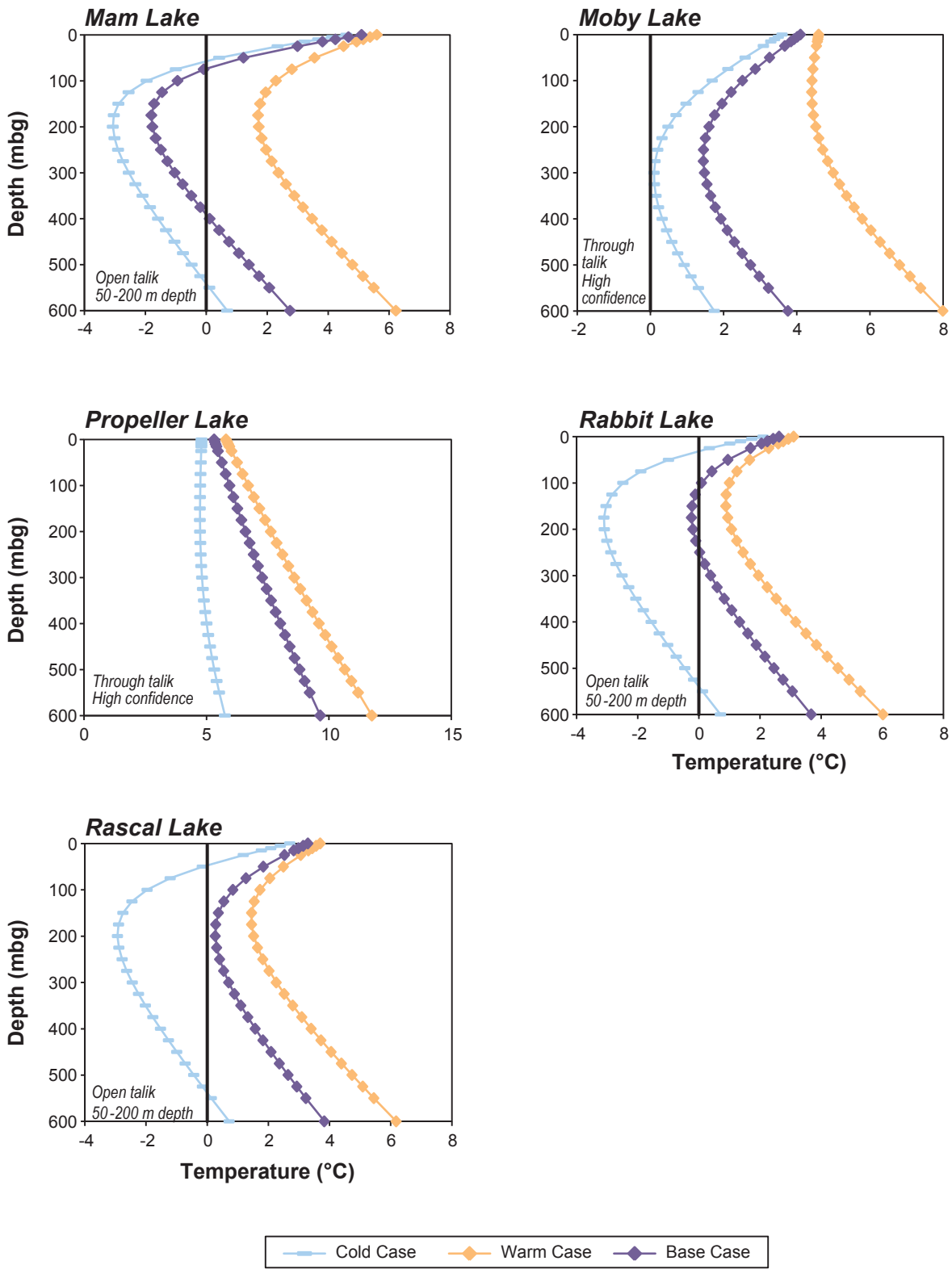
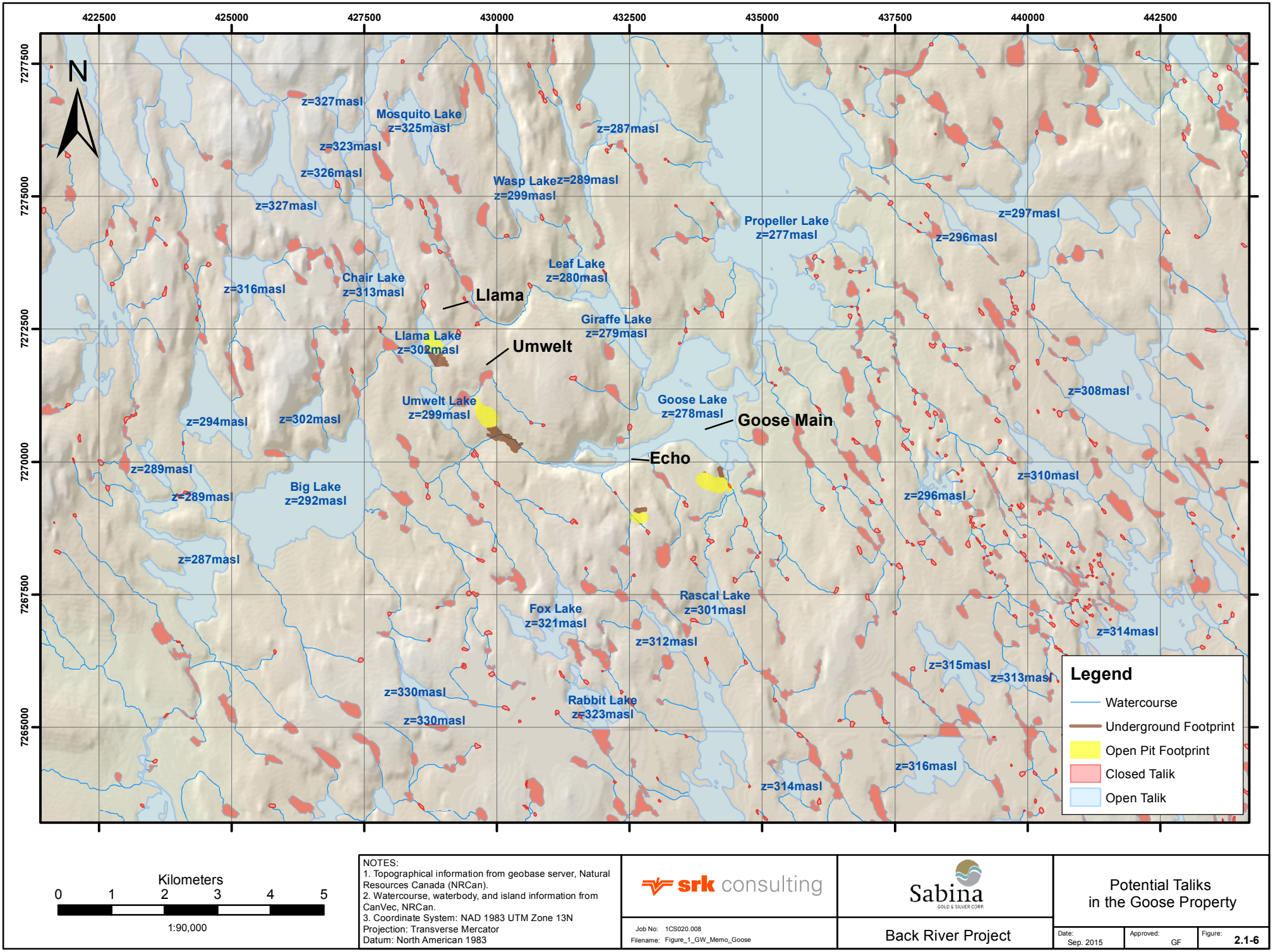


Sub-lake Temperature Profiles Derived from Steady-state One-dimensional Analytical Geothermal Models for the Goose Property Area

Figure 2.1-5b

Sabina GOLD & SILVER CORP.

Rescan Engineers & Scientists



NOTES:
1. Topographical information from geobase server, Natural Resources Canada (NRCan).
2. Watercourse, waterbody, and island information from CanVec, NRCan.
3. Coordinate System: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

srk consulting

Job No: 1CS020.008
Filename: Figure_1_GW_Memo_Goose

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Back River Project

Potential Taliks in the Goose Property

Date: Sep. 2015 | Approved: GF | Figure: 2.1-6

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The sensitivity analysis conducted demonstrated that by changing the MAGST by 1°C, the half width required to develop an open talik changes by 30 m. Changing the mean lake bottom temperature by 1°C had less of an effect, resulting in a half width change of 10 m. It should be noted that the two-dimensional modeling did not account for the thermal influence of adjacent lakes, spatial variability in ground surface temperature, or complex water bathymetry. Additionally, as mentioned above, historical changes in temperature can have effects on current permafrost temperatures (Lunardini 1995); paleo-climate variability was not considered as this data is not available for the Project area.

Instrumentation has been installed in the talik beneath Llama Lake, within and near the Llama Deposit. Records exist for functional thermistor nodes and vibrating wire piezometers (refer to Appendices V6-2C and V6-2D) at depths up to 155 m beneath the lake, and indicate the presence of talik. The recorded data appear to validate the prediction of talik up to at least 155 m beneath Llama Lake (147 masl), and appear to suggest that the actual subsurface temperatures are colder than those predicted by the base cases. The discrepancy between the measured and predicted temperatures may be a result of colder mean paleo temperatures. However, direct comparison is not possible because no temperature measurements exist beneath the deep pool of the Lake, where the model applies and mean annual water temperature is greatest. The deep pool of Llama Lake is located in its northern extremity, and reaches water depths up to 13.5 m. Thermistor strings are installed beneath extremities of the lake where the water depth does not exceed 6.5 m.

Hyper-saline groundwater has been observed in sub-lake talik at the Phase 2 Hope Bay Belt Project (Newmont 2011). As such, cryopegs are also thought to be present at the base of open taliks at the Goose Property Area. It is expected that in some cases cryopegs at the base of open taliks result in hydraulic connection between the open talik and the basal cryopeg beneath. For example, if the talik beneath Llama Lake is not in fact through, then a cryopeg is likely present beneath the talik connecting it with the sub-permafrost flow regime.

2.1.2.3 Marine Laydown Area and Winter Ice Road Corridors

Similar permafrost conditions are expected to exist along the Winter Ice Road corridors and at the Marine Laydown Area (MLA).

The MLA is approximately 130 km north of the Goose Property Area. Meteorological data collected 15 km south of the MLA indicate similar temperatures to the Goose Property, with greater rainfall. The active layer may extend deeper during the summer months due to increased rainfall, otherwise permafrost conditions would be similar to those observed at the Goose Property area. A similar permafrost thickness (around 500 m) is expected at the MLA and along the winter ice road alignments. Bathurst inlet and Bathurst Lake are expected to overlie open taliks, although there are no known observations of ground temperatures beneath Bathurst Inlet.

2.1.2.4 Impacts of Climate Change on Permafrost Conditions

Mean annual air temperatures at Goose Property Area are expected to increase about 5.3ºC over the next century. (Volume 4 Chapter 3: Climate and Meteorology). Permafrost is sensitive to climate change and an increase in air temperature is likely to cause natural permafrost degradation. Smith and Burgess (1998, 2004) assessed the sensitivity of permafrost to climate warming in Canada by categorizing the response of ground thermal conditions to climate and the effects of permafrost thaw on terrain stability. At the Back River Property, permafrost is regionally predicted to be thermally sensitive to climate change, with low physical response resulting from thaw (Smith and Burgess 2004). Permafrost, however, will be locally thaw-sensitive where ice-rich soils and massive ground ice are present. The Project is however predicted to stay within the zone of continuous permafrost (ACIASC 2005).

Widespread increases in active layer (seasonally thawed layer overlying the permafrost) depth are projected over most permafrost regions. The thin active layer of permafrost responds immediately to temperature changes, and climate change is likely to accelerate the increase in depth, due to both higher temperatures and increased evapotranspiration which makes the soil drier throughout the active layer and causes a descent of the permafrost table (ACIASC 2005).

Thaw season (summer) temperatures are most influential on active layer depth. Active layer thickness will be highly variable, and controlled by differences in soil texture, organic cover, and ground ice content, with deeper thaw penetration in coarser materials and bedrock. Details on site permafrost conditions and associated thermal modelling can be found in Appendix V2-7C and Appendix V4-3B, respectively.

2.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The effects assessment relies on the information collected from Inuit-led TK information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the evaluation of the potential effects of the Project on the environment. The following reports were reviewed for TK specific information related to permafrost:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* (KIA 2012) (Appendix V3-3A of FEIS);
- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014) (Appendix V3-3B of FEIS); and
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3C of FEIS).

2.2.1 Incorporation of TK for Existing Environment and Baseline Information

The TK makes a brief reference to effects of climate change on permafrost (KIA 2012):

> *Inuit had seen many changes in water quality over the past few decades…*
>
> *In general, these changes had lowered the quality of water. The changes were attributed to …, melting of permafrost because of global warming,…*

Additional commentary describing accelerating spring thawing and permafrost degradation is provided in KIA (2014).

The observation that permafrost degradation had occurred as a result of global warming may be attributed to a deepening of the active layer. It is likely that, as climate change progresses, the active layer will continue to penetrate deeper.

The baseline permafrost monitoring included continuous temperature measurements at borehole thermistor strings. These have allowed delineation of maximum annual active layer thickness, average ground temperature, and other permafrost and geothermal characteristics. A discussion of the impact of climate change on permafrost and the active layer is provided in Section 2.1.2.4.

2.2.2 Incorporation of TK for Spatial and Temporal Boundaries

Permafrost is not referred to as a unique or valued feature of the environment in the TK report. Spatial boundaries established for assessment of effects of the Project on surface water quality (Volume 6, Chapter 4) and quantity (Volume 6, Chapter 1) are set along watershed divides, and thus incorporate potential effects of permafrost degradation on water quality and quantity.

2.2.3 Incorporation of TK for Mitigation and Adaptive Management

There are no references to mitigation or adaptive management measures associated with permafrost or its degradation in the traditional knowledge reports.

2.3 VALUED COMPONENTS

2.3.1 Potential Valued Components and Scoping

Permafrost was included in the scoping and refining process with all other potential VECs and VSECs (Volume 9, Chapter 1). Permafrost was classified as a Subject of Note, as determined from Sabina-led public consultation, the TK report (Bianci and Spicker 2012), consultation with regulatory agencies, and regulatory considerations.

2.3.2 Valued Components Included in Assessment

Permafrost is considered a Subject of Note for the FEIS. All information requested in the NIRB-issued EIS guidelines related to Permafrost is included in this FEIS.

2.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

2.4.1 Interaction of Permafrost with the Project

The Project is expected to interact with the permafrost environment where excavations, landfilling, and changes to ground thermal conditions will occur. Infrastructure that may interact include the open pits and underground mines, tailings storage facility (TSF), waste rock storage areas (WRSAs), roads, water management infrastructure, and buildings. Numerical geothermal modelling has been conducted as a part of the Feasibility Study and FEIS. The conceptual model of changes to the permafrost environment in response to Project development as well as model predictions are described in the following paragraphs.

The proposed TSF will have an active design life of two years as a full water retaining structure and then used as a normally empty event pond for a portion of the Project life. The dam will be primarily constructed of run-of-mine (ROM) waste rock with an impermeable geosynthetic clay liner (GCL). Tailings beach development will result in the supernatant pond being located directly against the dam structure. The dam will rely on an impermeable liner incorporated into the dam fill and keyed into the permafrost foundation to achieve the required water retention properties. Therefore, in order to ensure the adequate performance of the dam, it is imperative to maintain the frozen state of the key trench. Modeling was completed to determine whether or not the proposed design was suitable given the permafrost foundation conditions. Using a conservative freezing point depression of -2^{o}C, SVHeat, a two-dimensional heat conduction model (SoilVision Systems 2011) was used to model the following two critical sections through the alignment of the dam:

- Section +0900: the highest section of the dam which will have the most water impounded against the upstream side, acting as a heat source throughout the period of operation; and

- Section +0300: the location adjacent to the TSF WRSA Pond, which will have water impounded against the dam face during both the two year TSF operation and the 16 year period where this area is used as a seasonal water management pond.

Modeling suggested that the thaw beneath the TSF based on the -2°C isotherm reaches 21 m at the end of 10 years, however this thaw does not extend into the key trench. The model shows progressive cooling within the ROM material in the dam and foundation from Years 3 to 25, after the period of TSF operation. Once the dam is breached and the facility is no longer used for water storage, permafrost will aggrade (expand upwards) into the materials being stored in the TSF.

In general, pits and underground mines are not expected to thaw permafrost during the operational phase. The local subsurface temperatures are expected to persist within underground mines. Open pits will expose deeper bedrock to ambient air temperatures, likely resulting in the development of an active layer with an annual freeze/thaw cycle.

Flooding of the pits at closure will result in the development of a talik beneath each pit. A one-dimensional analytical thermal model was used to estimate the time for open taliks to form beneath pit lakes as a function of a step change in temperature from initial conditions. The results of this modeling were also verified through 1D numerical modeling performed with SVHeat (SRK 2015a). Table 2.2-1 summarizes the estimated time for open taliks to develop beneath the proposed open pits. Existing open talik beneath Llama Lake is expected to remain, and therefore it was not included in the model.

Table 2.2-1. Summary of Estimated Open Talik Following Pit Lake Flooding

Open Pit	Timing of Open Talik (Years)	
	0°C Isotherm	2°C Isotherm
Llama Pit	Assumed open talik	
Goose Pit	252	85
Umwelt Pit	306	111
Echo Pit	541	227

Permafrost aggradation is expected to occur within and beneath earth-fill infrastructure, including the WRSAs, and the roadbeds of local site roads (SRK 2015b). Permafrost degradation will be minimized by appropriately insulating the ground with construction fill and by ensuring extra thermal protection between heat-producing structures and the ground.

3. Landforms and Soils

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3. Landforms and Soils

3.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

3.1.1 Regional Overview

The Back River Project (the Project) is located in the West Kitikmeot region of Nunavut, in the Takijuq Lake Upland Ecoregion of the Southern Arctic Ecozone (Figure 3.1-1). Temperature ranges are typical of Arctic Canada. Permafrost, which occurs throughout the Project area, contributes to the formation of landforms and topographical features characteristic of the Arctic tundra and affects development and structural integrity of soil. The region is dominated by gently undulating landscapes with numerous kettle lakes connected by streams. Several soil parent materials can be distinguished based on material texture, coarse fragment content and sequence of glacial or post-glacial deposition. Soils of the Cryosolic Order are widespread.

3.1.1.1 Topography

The topography of the region is generally characterized by low relief. The land is dominated by undulating or rolling landscapes, presented as a sequence of smooth, non-linear rises and hollows, and elongated rises and valleys that repeat in a wave-like pattern. Slopes are generally uniform and in the vicinity of the proposed Project infrastructure typically range between 0 and 5%. Slopes rarely exceed 7% and terrain elevation ranges between 300 and 700 masl (Natural Resources Canada 2013). Smoothness of the landforms reflects the influence of local hydrological patterns associated with the impermeable permafrost layer.

Uplands, which are dominant, are typically covered by veneers of morainal materials deposited on Precambrian, sedimentary, metamorphic, or intrusive rocks (Natural Resources Canada 2013). Consequently, much of the upland surface is composed of sparsely vegetated, rocky outcrops, with evidence of glacial scour along the exposed bedrock of the Bathurst fault (Zoltai S. C., Karasiuk D. J., and Scotter G. W. 1980). Wetlands occupy a relatively small portion of the area, covering only 5 to 10 % of the Takijuq Lake Upland Ecoregion (Natural Resources Canada 2013). Small- and medium-size kettle lakes formed from large blocks of melting ice left by the last retreating ice sheet (about 8,500 years ago) exist throughout region. Lakes are usually connected by a complex network of streams.

The thickness of overburden, defined as unconsolidated organic or mineral material overlaying bedrock (e.g., peat, till, sand, gravel, boulders, highly fractured bedrock), is highest in plains and very gently sloping areas (ranging from 1.0 to 37.0 m, average thickness 10.6 m). Rolling and undulating landforms are typically characterized by thinner overburden (ranging from 0.6 to 17.8 m, average thickness of 4.8 m).

A number of distinct landform types, including eskers, moraines, and boulder fields, exist throughout the region. Several large eskers occur in the region as elongated, sinuous ridges up to 100 m wide and several kilometres long. They were formed from sands, gravels, cobbles, and boulders deposited in the glacial melt water channels flowing below or within glaciers. Coarse fragment content within the top 1 m of deposit varies, in most instances, from 35 to 85%. Although not observed directly during the 2012 field program, the majority of eskers located in the Project region likely contain massive ice cores (S. R.; Dallimore and Wolfe 1988; Gowan and Dallimore 1990; S. R.; Dallimore and Davis 1992; Wolfe et al. 1997; Moorman and Michel 2003; Robinson et al. 2003; Macumber et al. 2011).

Besides being a unique geomorphological landscape feature, eskers provide several ecological functions. For example, the annual pattern of groundwater flow within the esker active soil layer governs soil moisture and nutrient regimes in lower sections of eskers and adjacent ecosystems. Also, because burrowing material is limited in the areas dominated by boulder fields and shallow morainal veneers over bedrock, the unconsolidated, coarse mineral material of eskers provides valuable denning sites for wildlife.

Moraines are rocky ridges composed of unconsolidated, unsorted mineral debris deposited at the glacier edge. A large, over 200-km long glacial moraine extends approximately 30km in the eastern direction from the Goose Property (Natural Resources Canada 2013).

Arctic boulder fields are often derived from weathered bedrock, from which finer fractions have been removed by various periglacial processes (e.g., solifluction, surface erosion; Sonesson 1985). Intense frost heaving also causes fracturing of bedrock and subsequent migration of large rock fragments to the surface. These phenomena created several boulder fields and belts in the Project region.

Repeated freezing and thawing of the soil creates unique features on the ground surface. Frostboils (also known as mud boils or mud circles) are typically circular (1 to 3 m in diameter) upwellings of mud that are created by frost heave and cryoturbation in permafrost areas. Common characteristics include an elevated centre, a formation of an organic layer on the outer edge, and resistance of the soil surface to vegetation colonization. Extensive areas of patterned ground covered by frostboils are commonly found in the region.

Thermokarst typically occurs in wetlands as a system of very irregular hummocks and hollows, which form in result of frost heaving and ice accumulation on the bottom of organic horizons. When they eventually thaw and collapse they form depressions, which further contribute to surface unevenness.

Massive ground ice of up to 10-m depth is a relict feature formed in late glacial or early postglacial times and has been reported in hummocky morainal deposits and eskers in the Contwoyto Lake and Lac de Gras areas (Wolfe 1998; Dredge, Kerr, and Wolfe 1999). Massive ice is likely present in parts of the Takijuq Lake Upland where late glacial conditions allowed rapid cover of residual forms of glacial ice and frozen melt water, especially along the west side of Bathurst Inlet (Ecological Framework for Canada 2012).

3.1.1.2 Surficial Deposits

Various surficial materials and geomorphic processes (i.e., isostatic rebound, periglacial processes, wind erosion, and mass wasting) have resulted in the present day surficial (parent) material types in the Project region. Surficial materials include bedrock; weathered bedrock; boulder field; as well as colluvial, fluvial, glaciofluvial, lacustrine, marine, morainal, and organic deposits. Hydrologic processes have played a major role in the redistribution of surficial deposits, and have contributed to considerable mixing of various deposits.

Morainal surficial materials are dominant within the area. Morainal till generally consists of well compacted, non-stratified material composed of a mixture of sand, silt, and clay, with a heterogeneous mixture of sub-rounded to angular coarse fragments of different sizes.

Organic veneers (less than 1 m in depth) are also common, resulting from the accumulation of very slowly decomposing vegetation, typically in the wet lowlands and in areas of intense seepage. Glaciofluvial materials deposited as eskers or veneers over morainal materials can also be found.

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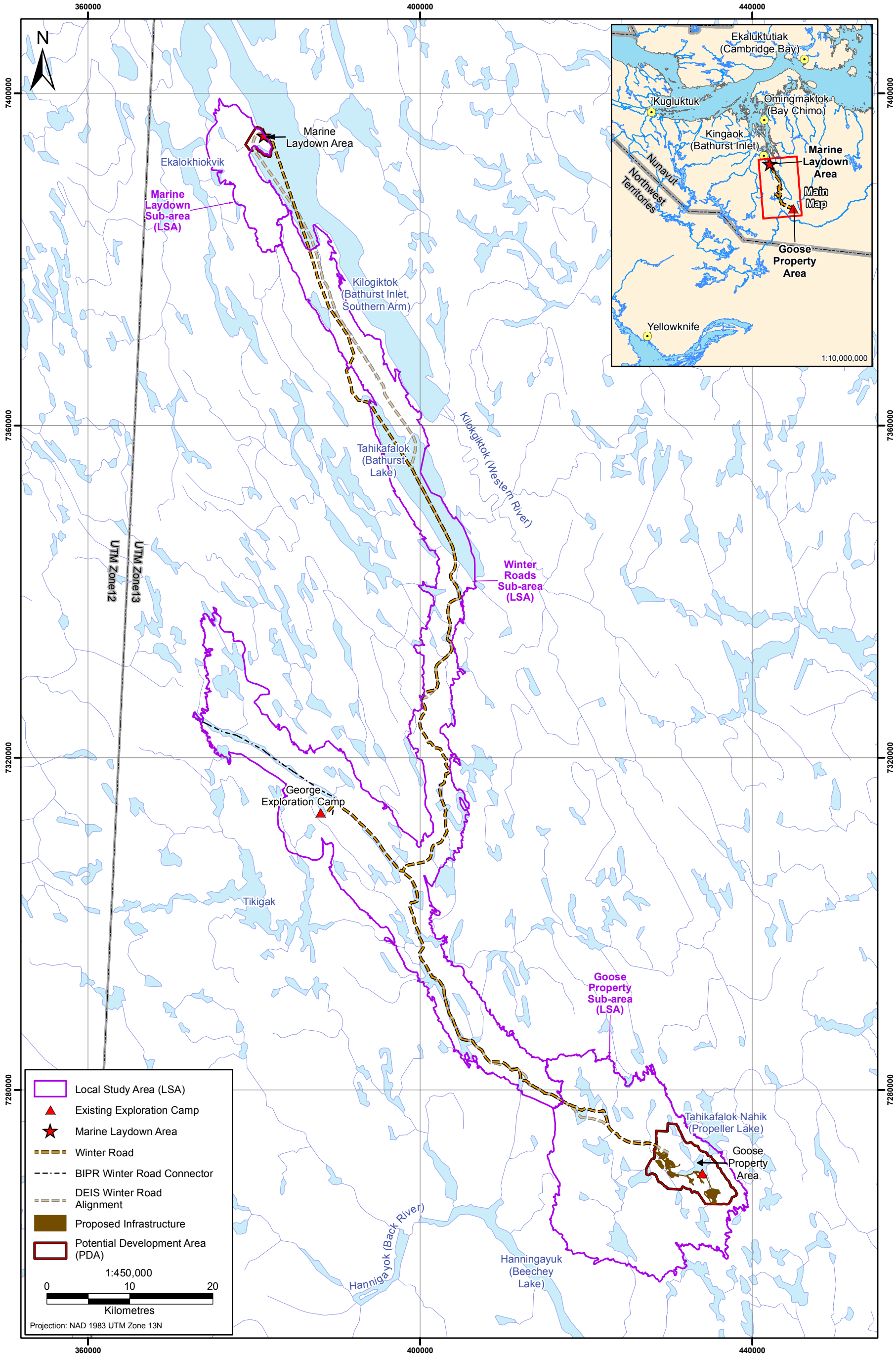

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Figure 3.1-1

Back River Project: Landforms and Soils Local Study Area

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Eolian parent materials, wind-deposited materials that consist primarily of sand or silt-sized particles, may also be present at higher elevations. Glaciolacustrine and lacustrine deposits, containing significant proportions of silt and clay, may be found in some lowlands and deltas. These are often associated with sedge-dominated wetlands. Bedrock and weathered rock are common in uplands. Colluvial materials are the products of bedrock mass-wasting typically occurring on steep slopes, and are very rare in the region.

3.1.1.3 Soils

Soil development in the Project region is influenced by the interaction of factors associated with characteristics of surficial deposits (parent material), topography, local climate, biotic influences, hydrology and permafrost, and time.

The region is underlain by continuous permafrost with sporadic occurrences of massive ground ice (Natural Resources Canada 2013). Permafrost describes soil or bedrock that remains at or below freezing (0°C) for two or more years. The mean annual air temperature ranges from -11.5ºC to -6.6ºC at Goose (Rescan 2013b) and the continuous permafrost extends down past 500 m (Paananen and Ruskeeniemi 2003). Under these conditions, soil development generally occurs only close to the ground surface. The depth of active layer (the soil depth to which the permafrost melts each summer) is predominantly governed by the water/ice content of the surficial material and by the thickness of organic layer. The active layer can vary from 0.3 m with thick organic layer to over 3 m on well drained eskers or bedrock crests (more details can be found in Volume 5, Chapter 2).

Permafrost restricts the downward flow of water, causing precipitation and melt water to move horizontally, either as a surficial runoff or as shallow underground seepage within the active layer of the soil. Consequently, the soils within the seepage areas are often waterlogged throughout most of the growing season. Annual frost heaving of the soil upon freezing and its subsequent settlement upon thawing creates several phenomena, including cryoturbation (e.g., patterned ground and thermokarst) and solifluction (downslope movement of waterlogged soil). Organic Cryosols usually have particularly high ground ice content.

Permafrost has a strong influence on landform and soil dynamics. It affects local topography (e.g., its disintegration can cause thermokarst, thaw slumps, or active layer detachments), surficial hydrology (e.g., it affects flow patterns in soil active layer), wildlife habitat(e.g., it affects vegetation compositional patterns, and species diversity through changes in soil temperature, moisture, and nutrient availability), and can influence dynamics of greenhouse gas release from the soil (Jorgenson and Osterkamp 2005; Walter 2006; Shur and Jorgenson 2007; Turetsky et al. 2007; Schuur et al. 2009; Grosse et al. 2011).

The presence of shallow permafrost and cryoturbation affect both the pedogenic process and, thus, soil classification. Most soils in the region are classified as Cryosols, which are usually poorly developed. In general, the rates of soil development in the Project region are very slow, typically in the order of a few millimetres per century (SENES Consultants Limited 2013), while peat-derived organic materials accumulate considerably faster. This is due primarily to the very low rates of biological activity within the soil due to low temperatures.

Field results suggest that the mineral soils in the Project region are predominantly acidic, ranging from pH 4.5 to 6.8, with pH tending to increase with soil depth (Rescan 2013a, Appendix V5-3A).

3.1.2 Baseline Study Methods

Baseline characterization of local terrain and soils was conducted in 2012. Results of this work can be found in the Appendices V5-3A and V5-3B. Terrain mapping was completed as part of the baseline characterization and involved using PurVIEW and ArcMap software, which enables users to view stereo pairs of digital air photos in three dimensions at variable scales. Terrain polygons were delineated based upon observable characteristics such as surficial material, surface expression, and geomorphological processes. In the absence of a system for Nunavut, terrain attributes were described using BC's Terrain System Classification (Howes and Kenk 1997). The terrain maps were prepared at a 1:20,000 scale. The final terrain attributes were later adjusted according to the data collected during field inspections of terrain polygons.

The Terrain and Soils Baseline Field Program involved the assessment of terrain and soils at 323 inspection sites (Figure 3.1-2). Soil inspection followed hand excavation of a soil pit to a depth of 100 cm, where possible. The soil and site characteristics were described in detail according to the methodology specified in the Field Manual for Describing Terrestrial Ecosystems (BC MELP and BC MOF 1998) as there is no similar system developed for Nunavut. Soils were classified according to *The Canadian System of Soil Classification (Agriculture and Agri-Food Canada 1998)*. Field data was used to update terrain and soils mapping, and to characterize local baseline conditions.

Soil samples were collected at 51 sites within the Local Study Area (LSA) and in 20 reference sites located at least 10 km outside of the LSA (Figure 3.1-2), but within the Regional Study Area (RSA). Where possible, the samples were collected at two depths: 0 to 5 cm and 50 to 60 cm (at several of the inspected sites, the mineral soils were shallow and only the upper soil layer[s] could be sampled). The 0 to 5 cm layer represents the organically enriched horizon and the surface layer where atmospherically deposited particles (e.g., dust) could potentially accumulate. The 50 to 60 cm depth samples target subsoil conditions, which reflect parent material chemistry influenced by pedogenesis. Chemical analysis of sampled soil enabled a comparison of baseline concentration of extractable metals with the *Canadian Soil Quality Guidelines for Protection of Environmental and Human Health* (CCME 1999).

In addition to chemical analysis, the spatial distribution of total metal concentration (a sum of extractable and non-extractable forms not comparable with the CCME guidelines) in surficial soils was assessed with a portable X-ray Fluorescence (XRF) analyzer. The data collected at 129 geo-referenced sampling points were later interpolated using Geostatistical Analyst (ArcGIS program) with the Inverse Distance Weighting technique to produce metal distribution maps.

3.1.3 Characterization of Local Baseline Conditions

The Back River Project consists of two Potential Development Areas (PDAs): Marine Laydown Area PDA located on the southwest side of Bathurst Inlet and the Goose PDA located slightly over 100 km south east from Bathurst Inlet (Figures 3.1-1 and 3.1-2). The two PDAs will be connected by winter roads. Topography, surficial deposits, and soil types vary between these areas.

Landform and soil baseline data was collected within the Local Study Area (LSA). The following descriptions of topography, surficial deposits, and soils are based on the studies conducted within the extent of each of the three LSA sections: the Marine Laydown Area Sub-area, the Goose Sub-area, and the Winter Road Sub-area (Figure 3.1-1; Table 3.1-1). The Project development, however, will take place only within the two PDAs, which together cover 4.5% of the LSA (Goose PDA 4%, and Marine Laydown Area PDA 0.5%). The LSA sub-areas and the PDAs are delineated on the map in Figure 3.1-1. The average thickness of overburden and the type and extent of surficial materials in the Goose and MLA PDA are described in Tables 3.1-2 and 3.1-3.

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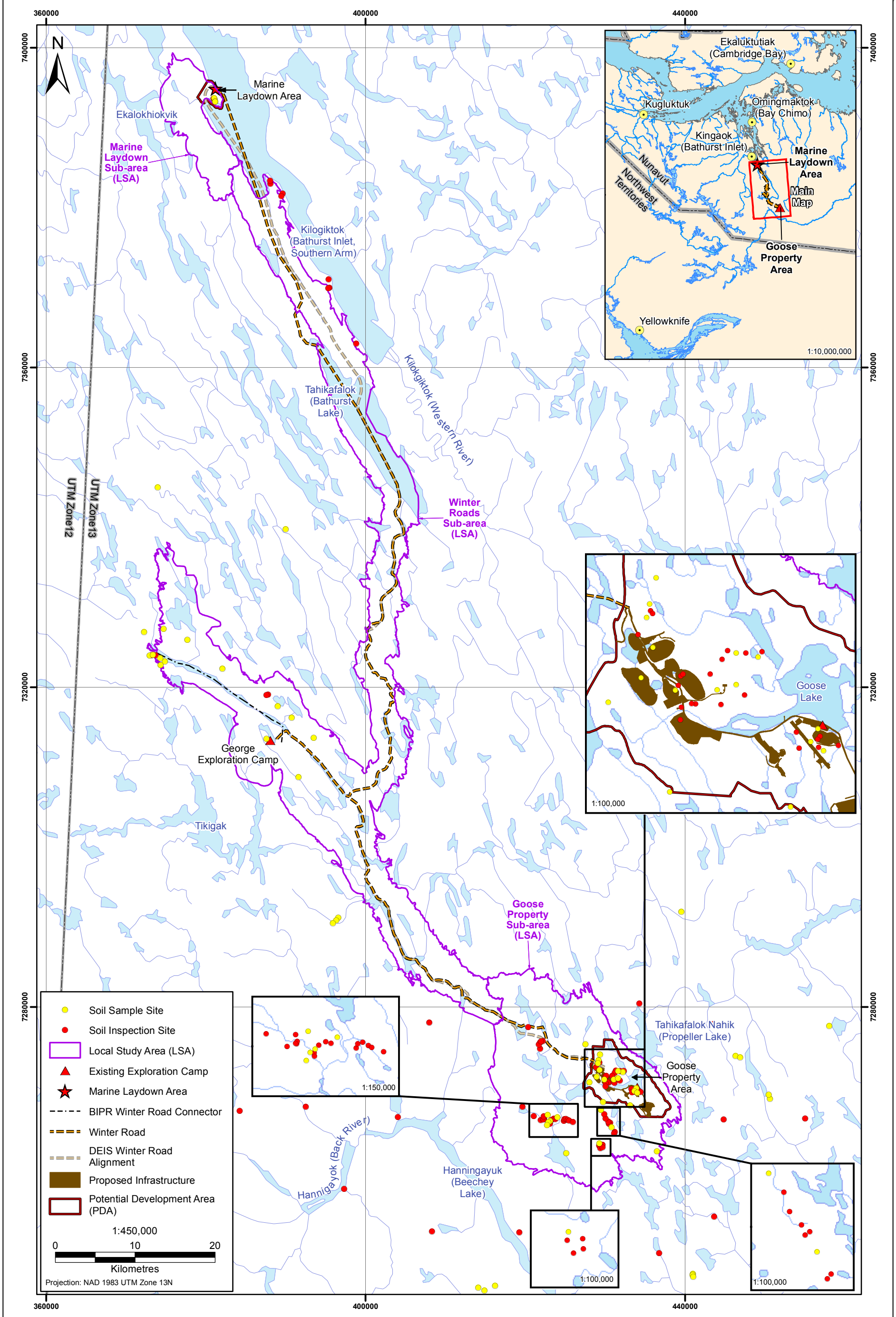

Figure 3.1-2

Soil Baseline Inspection Points and Sampling Locations

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Table 3.1-1. Proportions of Surficial Materials within the Local Study Sub-Areas

Dominant Surficial Materials	Local Study Sub-areas						LSA	
	Goose Sub-area		Winter Road Sub-area		Marine Laydown Area Sub-area			
	ha	%	ha	%	ha	%	ha	%
Anthropogenic	0	0.0	6	0.0	0	0.0	6	0.0
Bedrock	371	0.9	679	0.8	795	9.6	1,845	1.4
Colluvium	387	0.9	2,429	2.9	680	8.2	3,495	2.6
Eolian	828	1.9	711	0.9	0	0.0	1,539	1.1
Fluvial	285	0.7	461	0.6	61	0.7	807	0.6
Glaciofluvial	3,029	7.0	5,166	6.2	0	0.0	8,195	6.1
Lacustrine	1,065	2.5	2,182	2.6	0	0.0	3,247	2.4
Marine	0	0.0	4,183	5.1	3,597	43.3	7,781	5.8
Morainal	26,929	62.2	45,082	54.5	3,068	36.9	75,079	55.9
Open Water	6,501	15.0	17,236	20.8	45	0.5	23,783	17.7
Organic	3,756	8.7	2,617	3.2	29	0.3	6,402	4.8
River	27	0.1	110	0.1	0	0.0	137	0.1
Weathered Bedrock	114	0.3	1,907	2.3	34	0.4	2,054	1.5
Total	**43,290**	100	**82,769**	100	**8,309**	100	**134,370**	100

Table 3.1-2. Thickness of Overburden under Various Surficial Deposit Types

Surficial Material	Goose PDA		
	Overburden Depth (m)		
	Minimum	Average	Maximum
Colluvial	2.5	5.8	9
Eolian	-	-	-
Fluvial	6.6	14.8	20
Glaciofluvial	4.6	7	12.6
Lacustrine	-	-	-
Morainal	1	12.2	37
Organic	2.6	8.9	22
Shallow bedrock, boulder field	3	4.7	6
All Surficial Materials	**1**	**11.2**	**37**

Note: Overburden is defined as unconsolidated organic or mineral material (e.g., peat, till, sand, gravel, boulders, highly fractured bedrock) overlaying bedrock.

3.1.3.1 Goose Sub-area

Topography

The area is characterized as gentle to moderately sloped, undulating or rolling plains. Elevation ranges between 249 and 392 masl. While slopes range between 0 and 26%, only less than 1% of the Goose Sub-area has uneven relief and slopes in excess of 16%. Approximately 60% of the Goose Sub-area land is covered by plains and the rest is covered by gentle slopes. Open waterbodies cover a relatively small proportion of the Sub-area (15%) and, while the largest of the lakes covers more than 500 ha, the median lake area extends only over 2.4 ha.

Table 3.1-3. Proportions of Surficial Materials within the Potential Development Areas

	Goose PDA		MLA PDA	
Dominant Surficial Materials	**ha**	**%**	**ha**	**%**
Bedrock	157	2.9	-	-
Colluvium	39	0.7	27	4.1
Eolian	121	2.2	-	-
Fluvial	32	0.6	-	-
Glaciofluvial	824	15.2	-	-
Lacustrine	62	1.1	-	-
Marine	-	-	519	79.5
Morainal	3,073	56.6	-	-
Open water	719	13.2	107	16.4
Organic	389	7.2	-	-
Weathered Bedrock	10	0.2	-	-
Total	**5,427**	**100**	**653**	**100**

Unique landforms in close proximity to proposed Project infrastructure include an esker located 2.2 km northwest of Goose Lake (Figure 3.1-3). Several boulder fields and belts, as well as extensive areas of patterned ground covered by frostboils, are commonly found in the Goose Sub-area.

Surficial Deposits

Morainal deposits are found on over 62% of the Goose Sub-area (Table 3.1-1). This material is variable in characteristics, but dominated by moderately coarse and coarse textures (from silty loam to gravelly sand). The coarse fragment content ranges from 5% of gravels and cobbles, to greater than 75% of boulders and stones. Drainage is also variable (from well to poor) depending on site slope position, coarse fragment content, texture, and depth to restricting layer (such as permafrost).

Organic material accumulation over mineral parent materials in depressions and seepage are common. Accumulations of poorly decomposed, poorly drained, and saturated peat are generally less than 50-cm deep and cover approximately 8% of the Goose Sub-area. Since Organic Cryosols often have high ground ice content, potential degradation of permafrost in these areas may be associated with changes in topography and hydrology.

Coarse-textured glaciofluvial deposits (including eskers) typically contain high proportions of coarse mineral fragments and cover 7% of the Goose Sub-area.

Exposed bedrock can be found throughout the Goose Sub-area. Bedrock is also present close to the surface, covered with mineral or organic veneers. Associated sporadic colluvial materials are generally poorly sorted and contain a wide range of particle sizes, but are rare within the Sub-area.

In the Goose Sub-area, over 70% of the soil parent materials are deposited as blankets (thicker than 1 m). The thickness of surficial materials is highest in lowlands covered with morainal, organic, and fluvial deposits (up to 37.0 m deep, Table 3.1-2). Colluvial and glaciofluvial deposits, as well as boulder fields, are typically thinner (overburden up to 14.8 m deep, Table 3.1-2).

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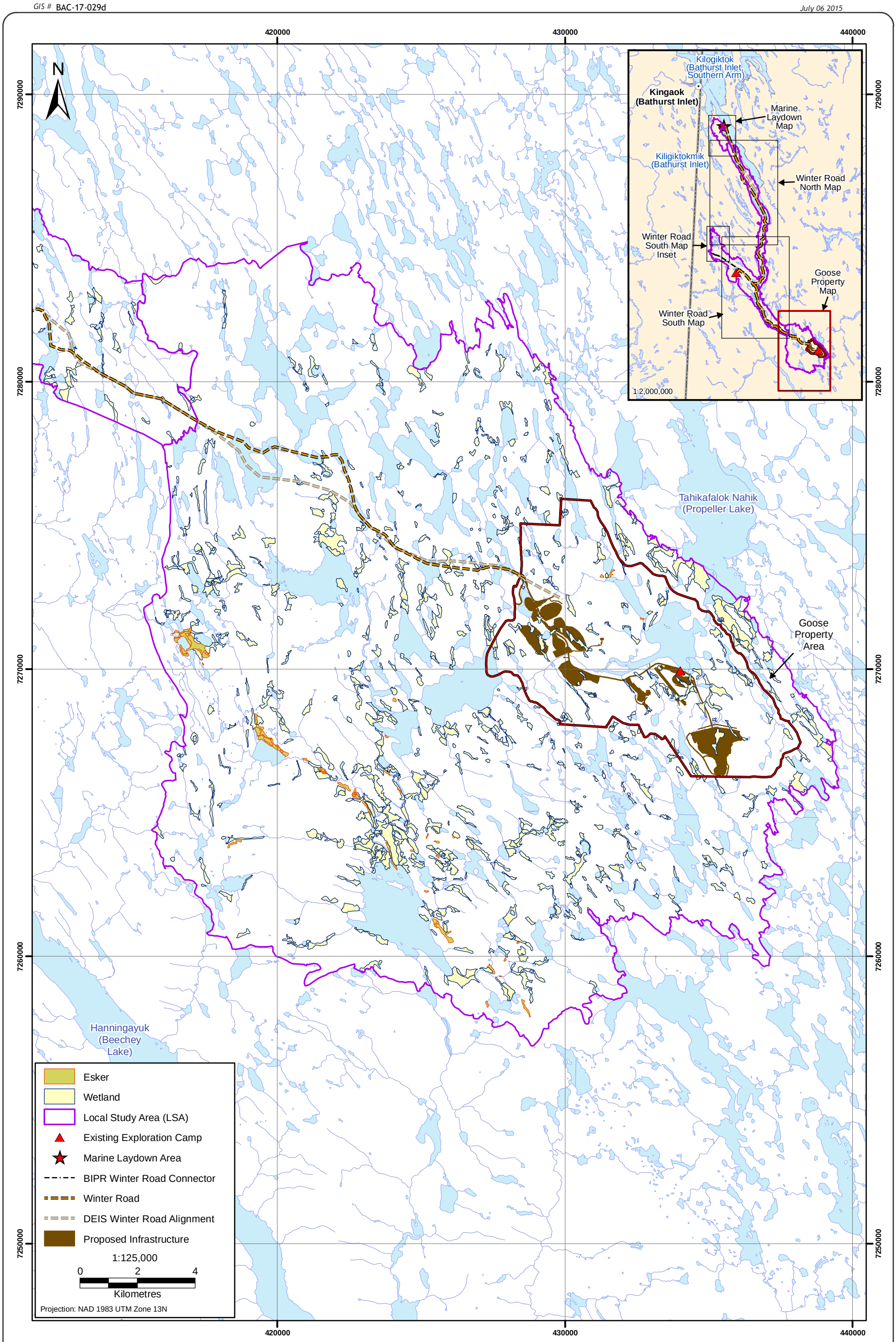

Figure 3.1-3

Back River Project: Goose Property Sub-area

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Soils

Most soils have a low proportion of coarse fragments (below 30%) and low surficial stoniness (below 15%). Median pH of mineral soils is 5.9 (range from 4.7 to 6.8; Rescan 2013a). Soil metal concentrations in the Goose Sub-area do not exceed Canadian Council of Ministers of the Environment (CCME) guidelines (2013). About two-thirds of the inspected Sub-area has been classified as Static Cryosols, and one-third as Turbic Cryosols. Median active layer depth is 75 cm.

3.1.3.2 Marine Laydown Area Sub-area

Topography

The deeply indented, rocky shoreline of Bathurst Inlet is surrounded by rugged ridges of massive granite rocks that reach about 610 masl (Ecological Framework for Canada 2012). Most of the proposed Marine Laydown Area (MLA) Sub-area, however, is near sea level with elevation ranging between 2 and 103 masl. Over half of the MLA Sub-area is covered by gentle slopes, about 30% by level plains, and the remaining 15% by steeper terrain (greater than 16% slope).

While the MLA Sub-area does not contain glaciofluvial deposits (Figure 3.1-4), two belts of prominent eskers are located on the uplands outside of the LSA, 5 km west of Bathurst Inlet (outside of the area shown on the map). These eskers are over 30 km long and reach 20 m in height.

Surficial Deposits

The MLA Sub-area is dominated by marine and morainal deposits, which cover respectively 43% and 37% of the MLA Sub-area. Marine deposits consist mainly of coarse sands with low proportion of coarse mineral fragments. Texture and coarse fragment content of morainal deposits are variable.

In general, besides a large number of small lakes, bedrock outcrops are one of the most prominent characteristics of the regional topography. Nevertheless, bedrock rarely extends over an area large enough to dominate the entire terrain polygon. The MLA PDA has the highest proportion of polygons dominated by bedrock; almost 10% of the mapped polygon area is covered by exposed bedrock. Due to greater relief, the MLA Sub-area has also the highest proportion of colluvial deposits in the LSA (8.2%).

Soils

Many soils developed within the proposed MLA Sub-area are coarse textured, and are generally poorly suited for reclamation. The area is generally dominated by Static Cryosols with pockets of Orthic Regosols in rapidly drained sites. The median pH of mineral soils near Bathurst Inlet is 5.8 (range from 5.1 to 7.0; Rescan 2013a, Appendix V5-3A). Soil metal concentrations in Bathurst Inlet areas did not exceed the CCME guidelines (CCME 2013).

3.1.3.3 Winter Access Road Sub-Area

Topography

The southern portion of the proposed road extends through plains and gentle slopes, while the northern section is characterized by stronger relief and steeper slopes. The elevation varies from about 310 masl in the Goose Lake area to above 400 masl near the George Exploration Camp area, to sea level near Bathurst Inlet over a distance of approximately 100 km.

The road will intersect several groups of eskers, boulder fields, areas of exposed bedrock, and several large wetland complexes (Figure 3.1-5; Figure 3.1-6).

A section of the winter access road to the Marine Laydown Area was realigned near Tahikafflok Lake (Bathurst Lake) in response to focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012) and a request by the Kitikmeot Inuit Association. The realigned portion of the winter access road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The previous DEIS road alignment was 47 km long with 25 km located on lakes or ocean and is shown on Figure 3.1-6. A small section (5.5 km) is outside the LSA but 5.3 km of this are located on lakes (Figure 3.1-6).

Surficial Deposits

The proposed winter access road corridor is underlain by mainly morainal deposits and open waterbodies. Morainal deposits, characterized by variable textures and coarse fragment content, form blankets and veneers over undulating bedrock. Coarse glaciofluvial deposits, often in the form of eskers, comprise over 6% of the Winter Road Sub-Area. Wetlands, as well as lacustrine, colluvial, fluvial, and eolian deposits, cover a minor component of the route (Figure 3.1-5; Figure 3.1-6).

Soils

Most soils along the route are of the morainal origin, characterized by variable textures (sandy loams to silty clays) and variable, but generally low coarse fragment content (most ranging between 5 and 35%). Due to high surface stoniness, shallow deposit thickness, and fine soil textures, the availability of soils suitable for reclamation is relatively low. Static and Turbic Cryosols are the most common soil great groups.

3.1.3.4 Mineral Soil Chemistry in the Project LSA

Analytical results indicate that most mineral soils in the LSA are slightly to very strongly acidic. These soils have low organic carbon content and are non-calcareous, which is typical of the upland tundra ecosystems in the region.

The mean pH of soils collected in the LSA is 4.9 at 0 to 5 cm depth and pH 5.5 at the depth of 50 to 60 cm. Soil pH variability within each soil depth is low. Inputs of organic acids derived from the decomposition of the detritus of low woody shrubs (i.e. crowberry) and the predominance of acidic bedrock contribute to the acidity of the soils in the LSA.

Metals reside in the soil in various forms, of which some are highly mobile and bio-available (e.g., Fe cations associated with soluble organic and inorganic soil complexes), while the other forms are much less mobile (e.g., Fe atoms associated with sesquioxides). The mobility and thus bio-availability of metals depends on soil mineral surface properties, organic matter content, and on the composition, pH and reduction-oxidation (redox) potential of soil solution (McLean and Bledsoe 1992). Typically only a portion of the total metal concentration is bioavailable and the CCME guidelines regulate the concentration of metals extractable from the soil by a particular, standard method (Rescan 2013a, Appendix V5-3A).

Metal concentrations in soil sampled within the LSA varied between sampling locations and depths. Naturally elevated concentrations of extractable arsenic, exceeding CCME industrial limits (2013), were found in mineral soil at several locations within the winter road Sub-area near the George Exploration Camp (in 5 out of 11 sampled sites) and in some of the reference areas located outside the LSA (in 5 out of 13 sampled sites). Detailed results of soil chemical analyses are presented in the Terrain and Soil Baseline Report and in the Plant Tissue and Soil Metal Compilation of 2012 Samples (Rescan 2013a, 2013c). Elevated levels of extractable metals were also found in organic wetland soils (with organic carbon content > 17%). The highest metal levels (i.e., above 90 percentile of recorded As, Cr, Cu, Pb, Ti, U, and V) were found in wetlands located in the Goose Sub-area.

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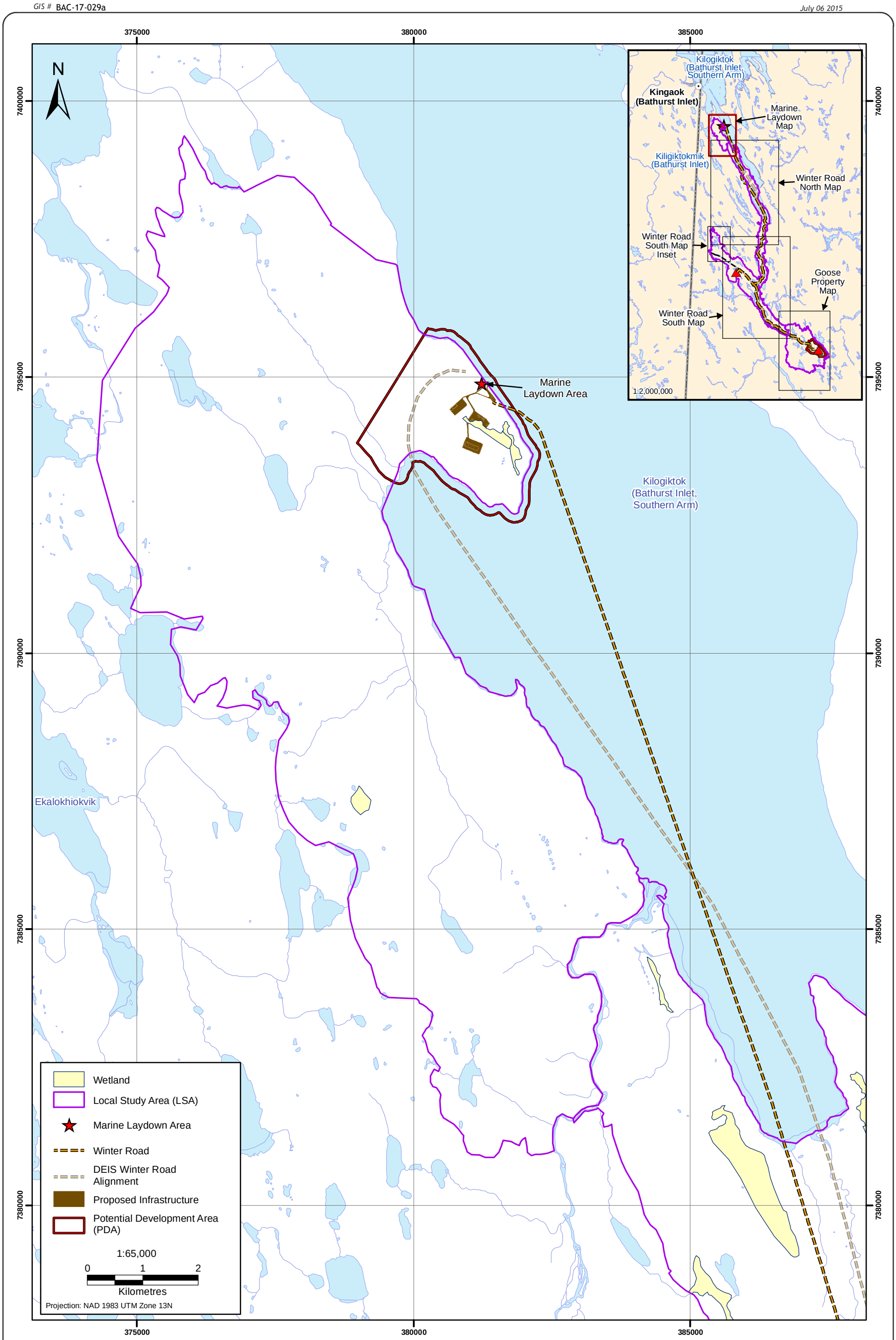

Figure 3.1-4

Back River Project: Marine Laydown Area Sub-area

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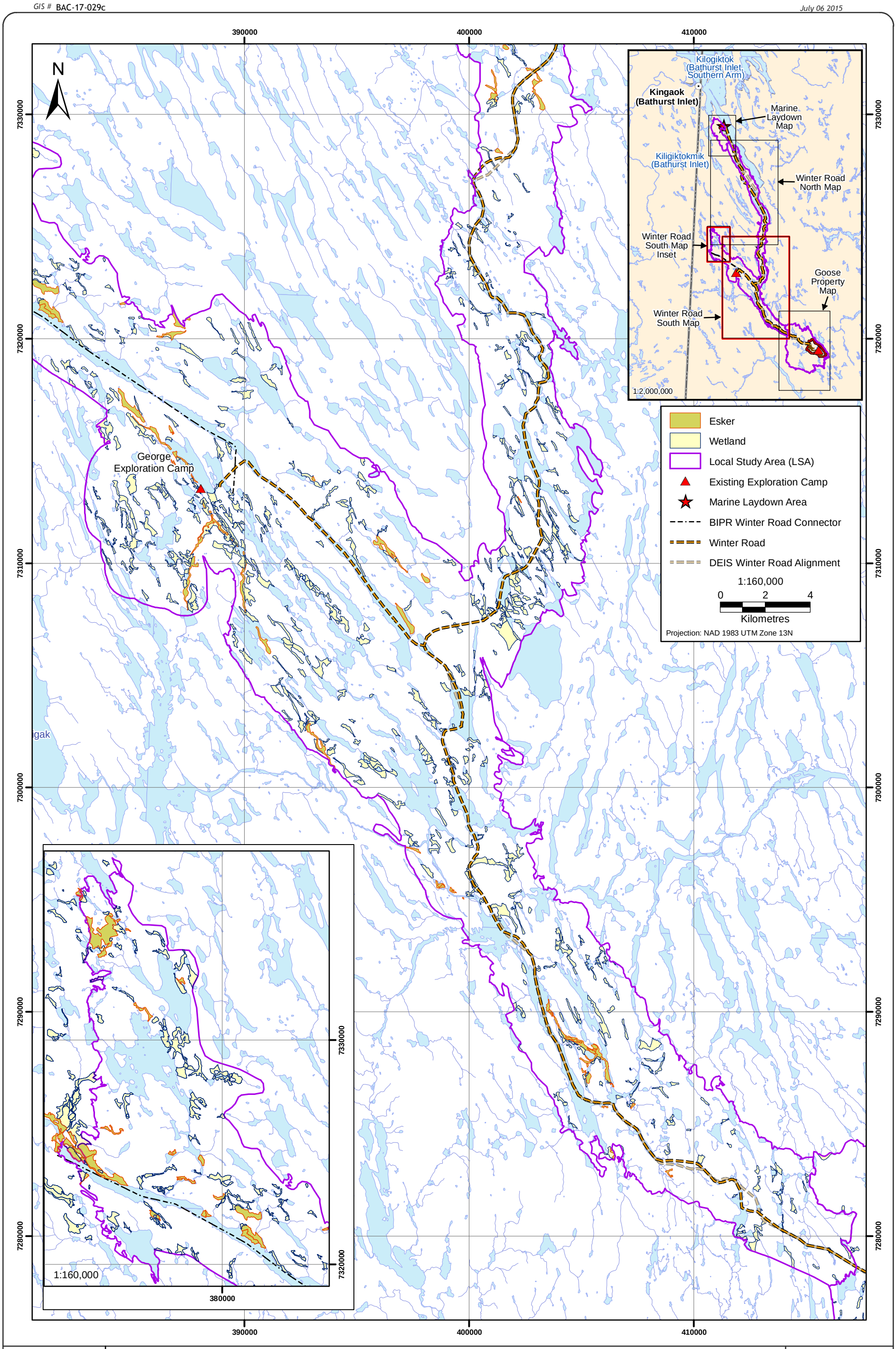

Figure 3.1-5

Back River Project: Winter Road Sub-area (South)

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July 06 2015

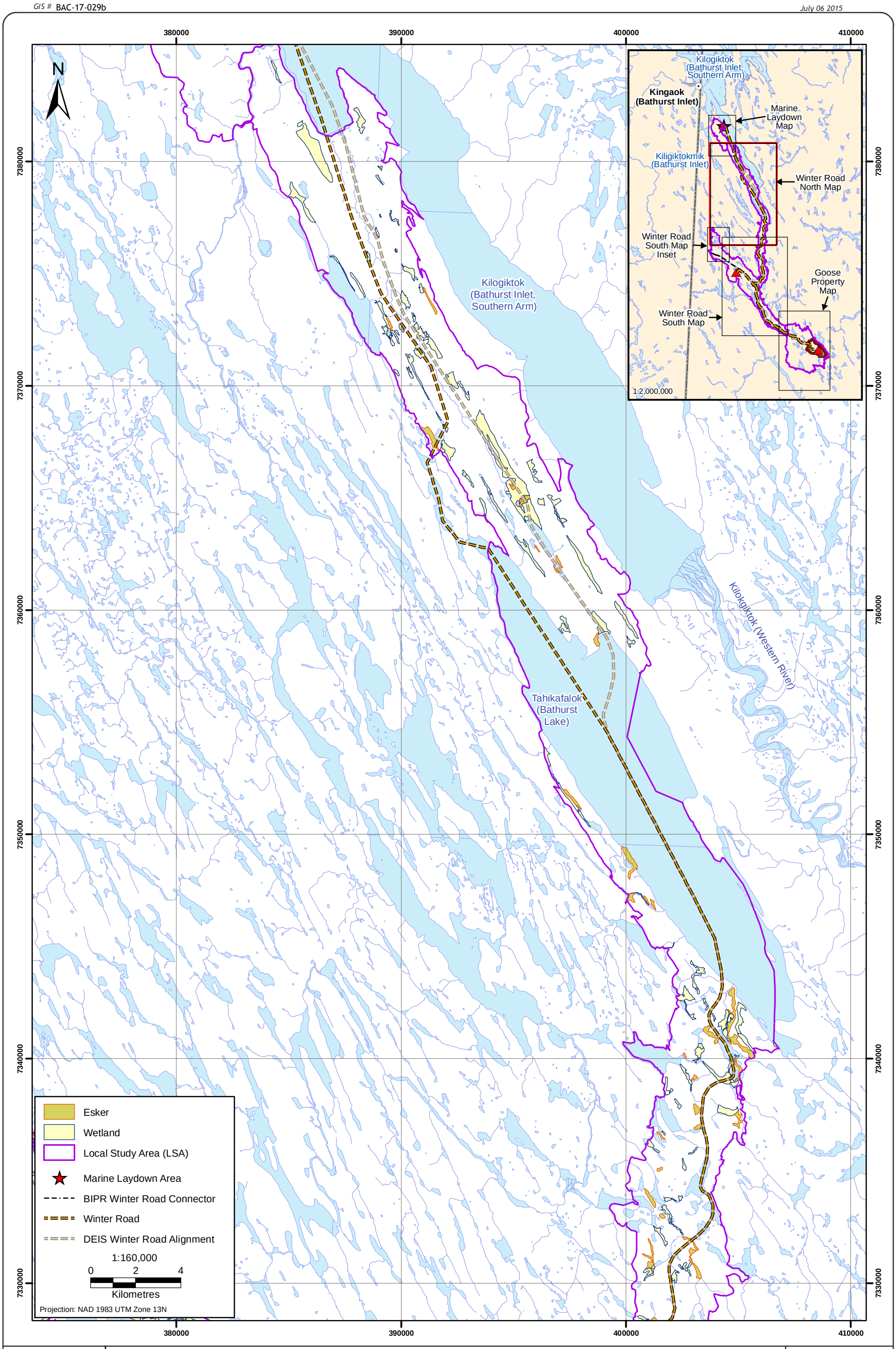

Figure 3.1-6

Back River Project: Winter Road Sub-area (North)

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One of the techniques that allow the assessment of the *total* concentration of metal in the soil (as opposed to the *extractable* metal fraction) involves the use of XRF equipment. During the 2012 Field Program, a portable XRF analyzer was used to evaluate the total concentration of several metals in soils within the LSA. The spatial distribution of five metals: arsenic, iron, manganese, nickel, and zinc in the LSA is shown in Figures 3.1-7, 3.1-8, 3.1-9, 3.1-10, and 3.1-11. While the distribution of total metal concentration provides important information on mineralogy of local soils, the values shown on the map are not directly comparable to the CCME guidelines, which are based on extractable metal concentrations.

3.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The effects assessment relies on the information collected from Inuit-led TK information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the evaluation of the potential effects of the Project on the environment. The following reports were reviewed for TK specific information related to landforms and soils:

- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014) (Appendix V3-3B of FEIS);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012) (Appendix V3-3A of FEIS);
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3C of FEIS).

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

3.2.1 Incorporation of TK for Existing Environment and Baseline Information

Available TK from the *Naonaiyaotit Traditional Knowledge Project - Hannigayok* (Sabina Gold & Silver Corp. Proposed Back River Project) results from Data Gaps Workshops, Final Report (June 2014) prepared for Sabina Gold & Silver Corp. by Kitikmeot Inuit Association: Kugluktuk, NU.The report (KIA 2012) was reviewed for *landforms and soils* existing environment and baseline information. The following information is included in the TK report:(Racine and Ahlstrand 1991)

1. Landforms such as eskers, cliffs, rocky ridges, wetlands, ocean shores and riverbanks are valuable because they provide a preferred habitat for wildlife such as caribou, grizzly bears, wolves, foxes, wolverines, and birds.

   Section 4.1:"During summer, when it was hot and the insects started to emerge, the caribou would take advantage of the wind relief and easy walking provided by eskers. They hid in the shade provided by hills, cliffs and eskers. The ocean shoreline and islands provided caribou much needed relief from biting flies and heat."

   "Grizzly bears would walk the cliff ridges to hunt caribou that were seeking relief in the shade of the cliff."

   "Wolves and foxes den at eskers used by caribou."

Section 4.5: "Wolverine stay under rocks, crevices and cliffs in "rough areas" to den, as it was used for security and hiding cover. Cliffs were used for scavenging and for caching food."

Section 4.11: "Cliffs were important nesting habitat for a variety of raptors, and other colonial nesting birds such as gulls and Cliff Swallows. Cliff nesters also included raves, geese and some ducks."

"Important wetlands for waterfowl are found around Perry Island, Ellice River, Perry River, and the coast of Bathurst Inlet from Omingmaktok south to Hiukkittak. There are also wetlands at the Kilingoyak Isthmus, and just above Parry Bay and part of Katimanak, which were used for nesting by Canada Geese, White-fronted Geese, and Brants. These ducks all nest together where it's wet and grassy."

"Snowy Owls nest on the ground near wetlands where they hunt mice."

2. Because eskers, cliffs, rocky ridges, wetlands, ocean shores, and riverbanks provide a preferred habitat for wildlife, they were also prime hunting and trapping grounds for people.

   Section 3.4: "Birds were an important source of food for ocean and coastal Inuit, because of the large concentrations of nesting waterfowl on the ocean coast."

   "Inuit trapped white fox in wetlands as well, where they were quite numerous."

   "They hunted ground squirrel in the late spring and throughout the summer, concentrating on riverbanks where higher densities were found."

3. Cliffs are also important to Inuits as a source of water when they travel across the land.

   Section 7: "Inuit obtained water and ice from: lake; rivers and creeks, as long as they were flowing; pools under cliffs; pools of water among deep rock crevasses…"

4. Ocean shores and riverbanks are also important sources of carving stone.

   Section 9: "Black soapstone called 'okohikhaat' was used to carve the large kudlik (stone oil lamps), and for making cooking pots. Inuit looked for this stone around riverbanks or the ocean shore."

3.2.2 Incorporation of TK for Valued Environmental Component Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential Valued Environmental Component/Valued Socio-economic Component (VEC/VSEC) list (see Volume 9, Chapter 1). The TK report presents distribution maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB ftp site. As a result of this process, landforms and soils were considered a subject of note.

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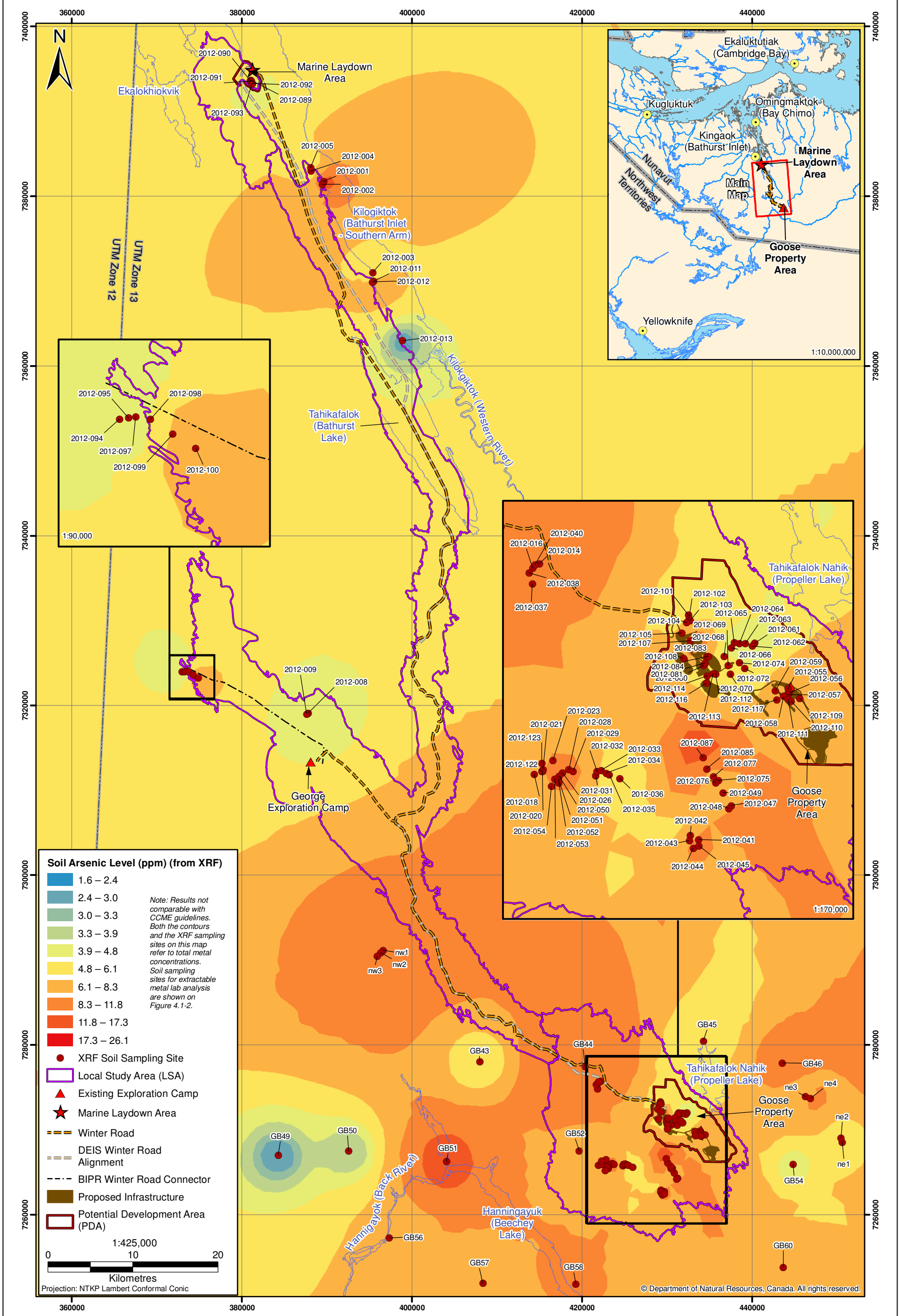

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Figure 3.1-7

Back River Project: Natural Distribution of Soil Arsenic in the Local Study Area

Rescan an ERM company

GIS # BAC-17-025b

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N

Marine Laydown Area

Ekalokhiokvik

2012-090
2012-091
2012-092
2012-089
2012-093
2012-005
2012-004
2012-001
2012-002
2012-003
2012-011
2012-012
2012-013
2012-009
2012-008

Kilogiktok (Bathurst Inlet - Southern Arm)

Kilokgiktok (Western River)

Tahikafalok (Bathurst Lake)

UTM Zone 13
UTM Zone 12

George Exploration Camp

Ekaluktutiak (Cambridge Bay)
Kugluktuk
Omingmaktok (Bay Chimo)
Kingaok (Bathurst Inlet)
Nunavut
Northwest Territories
Main Map
Marine Laydown Area
Goose Property Area
Yellowknife
1:10,000,000

2012-095
2012-098
2012-094
2012-097
2012-099
2012-100
1:90,000

2012-040
2012-016
2012-014
2012-038
2012-037
Tahikafalok Nahik (Propeller Lake)
2012-101
2012-102
2012-103
2012-104
2012-065
2012-064
2012-069
2012-063
2012-105
2012-068
2012-061
2012-107
2012-062
2012-083
2012-108
2012-066
2012-084
2012-074
2012-059
2012-081
2012-055
2012-072
2012-056
2012-114
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2012-028
2012-029
2012-123
2012-032
2012-033
2012-087
2012-085
2012-034
2012-122
2012-077
2012-076
2012-075
2012-031
2012-036
2012-049
2012-018
2012-026
2012-035
2012-048
2012-047
2012-020
2012-050
2012-042
2012-051
2012-054
2012-052
2012-043
2012-041
2012-053
2012-044
2012-045
Goose Property Area
1:170,000

nw1
nw2
nw3

GB45
GB44
GB43
GB46
Tahikafalok Nahik (Propeller Lake)
ne3
ne4
Goose Property Area
ne2
ne1
GB49
GB50
GB52
GB51
GB54
Hanningayuk (Back River)
Hanningayuk (Beechey Lake)
GB56
GB57
GB58
GB60

Soil Iron Level (ppm) (from XRF)

- 519.7 – 5,467.4
- 5,467.4 – 8,351.7
- 8,351.7 – 10,033.0
- 10,033.0 – 11,013.1
- 11,013.1 – 11,584.5
- 11,584.5 – 12,564.6
- 12,564.6 – 14,246.0
- 14,246.0 – 17,130.2
- 17,130.2 – 22,078.0
- 22,078.0 – 30,565.6
- XRF Soil Sampling Site
- Local Study Area (LSA)
- Existing Exploration Camp
- Marine Laydown Area
- Winter Road
- DEIS Winter Road Alignment
- BIPR Winter Road Connector
- Proposed Infrastructure
- Potential Development Area (PDA)

Note: Results not comparable with CCME guidelines. Both the contours and the XRF sampling sites on this map refer to total metal concentrations. Soil sampling sites for extractable metal lab analysis are shown on Figure 4.1-2.

1:425,000
0 10 20
Kilometres

Projection: NTKP Lambert Conformal Conic

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360000 380000 400000 420000 440000
7400000 7380000 7360000 7340000 7320000 7300000 7280000 7260000

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Figure 3.1-8

Back River Project: Natural Distribution of Soil Iron in the Local Study Area

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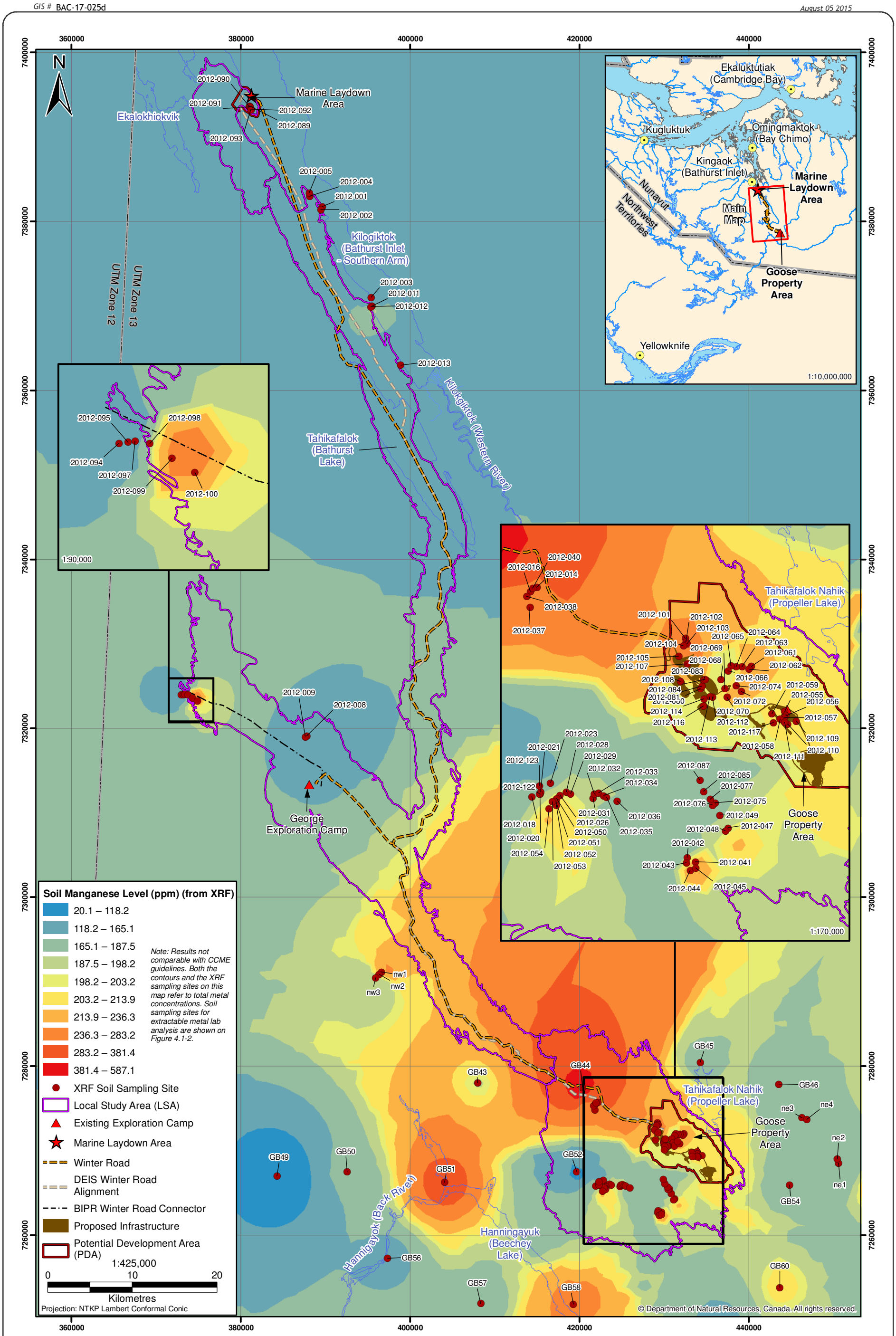

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Figure 3.1-9

Back River Project: Natural Distribution of Soil Manganese in the Local Study Area

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August 05 2015

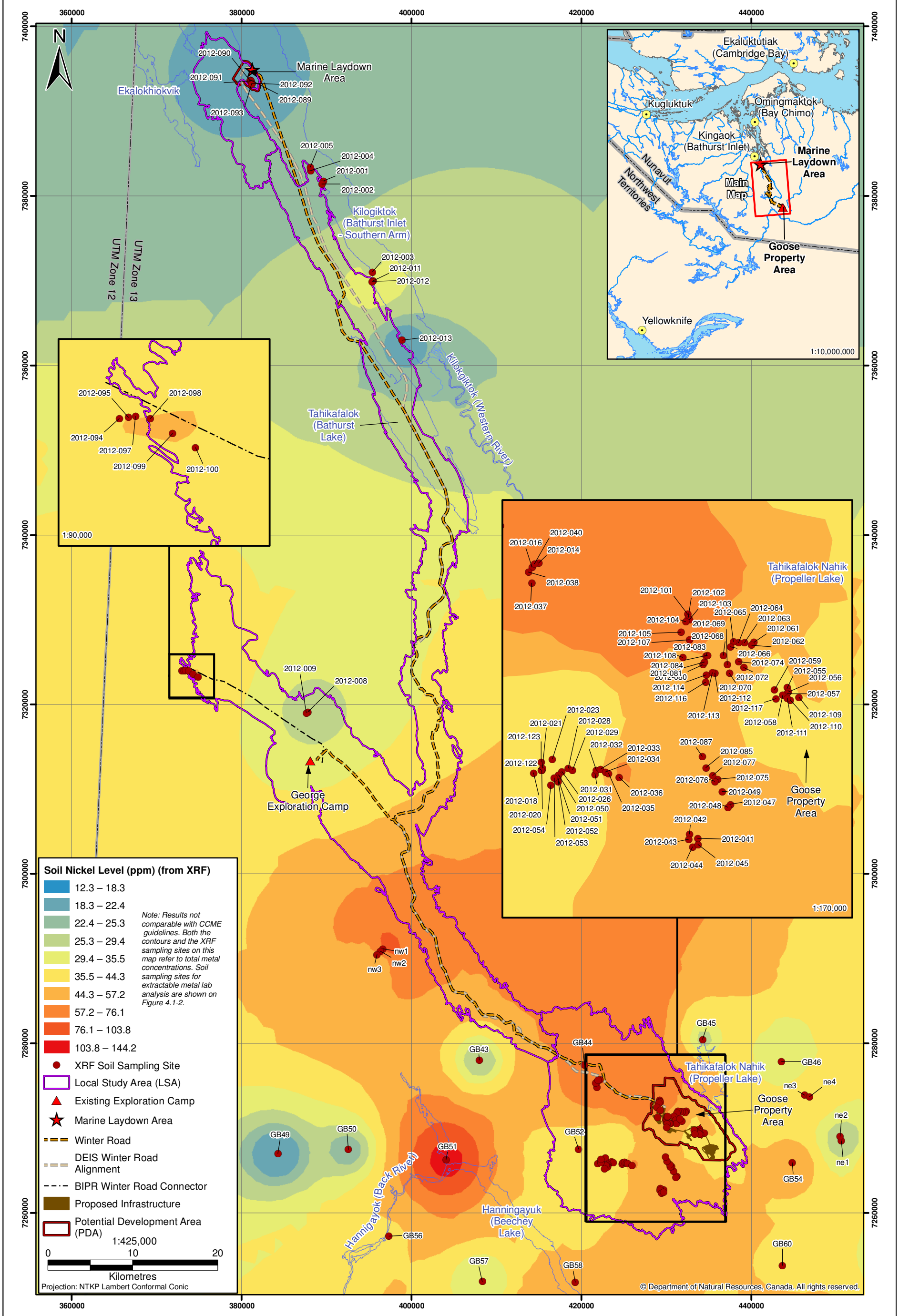

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Figure 3.1-10

Back River Project: Natural Distribution of Soil Nickel in the Local Study Area

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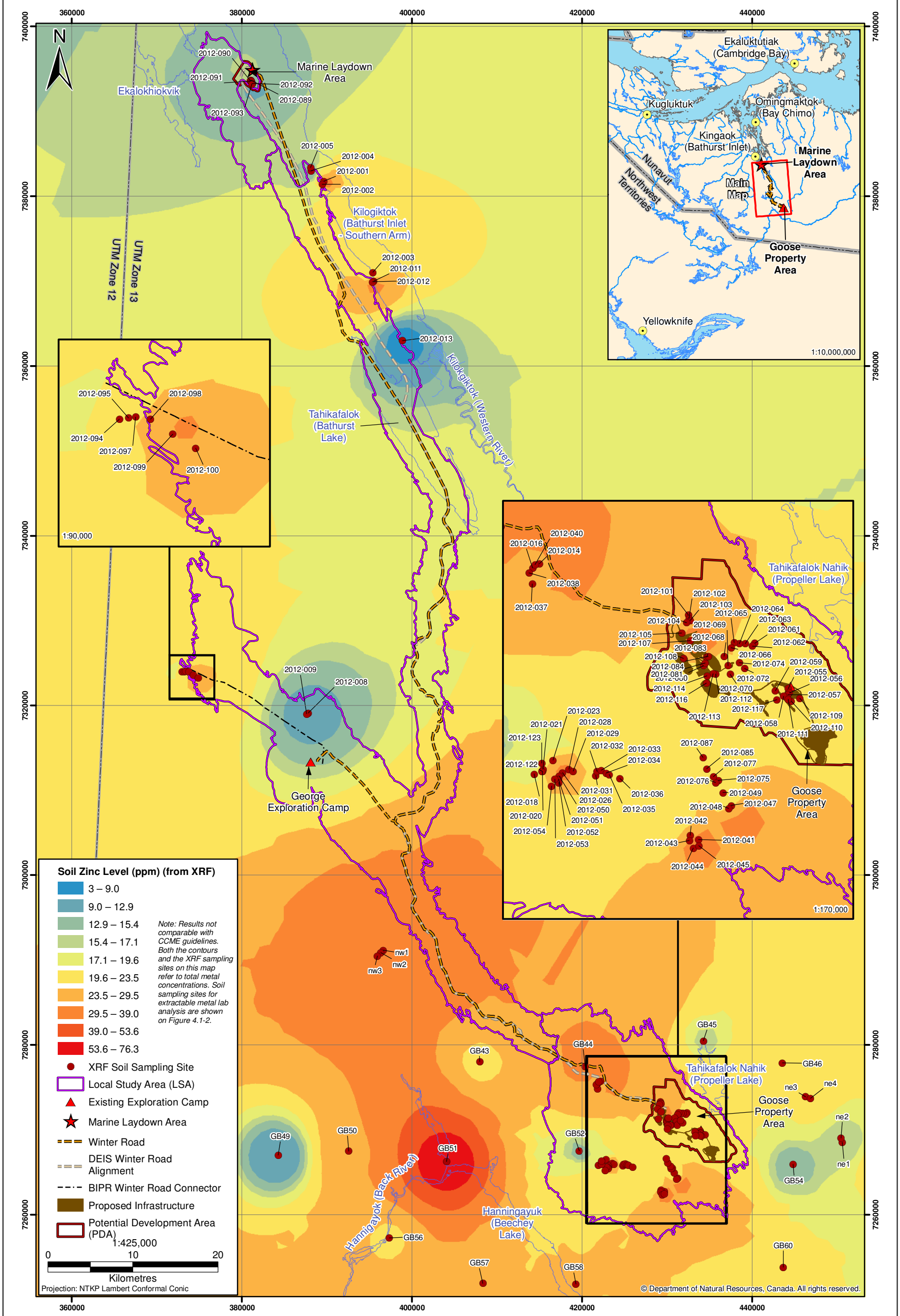

Sabina GOLD & SILVER CORP.

Figure 3.1-11

Back River Project: Natural Distribution of Soil Zinc in the Local Study Area

Rescan an ERM company

3.2.3 Incorporation of TK for Recommendations regarding Mitigation and Adaptive Management

Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the Marine Laydown Area in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012).

3.3 VALUED COMPONENTS

3.3.1 Potential Valued Components and Scoping

Landforms and Soils were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, Landforms and Soils are classified as a Subject of Note.

3.3.2 Valued Components Included in Assessment

Landforms and Soils are considered a Subject of Note for the draft EIS. All information requested in the NIRB-issued EIS guidelines relating to Landforms and Soils is included in this draft EIS.

3.4 SUPPORTING AND SUPPLEMENTAL INFORMATION

This section provides supplemental information as requested in the EIS guidelines (Nunavut Impact review Board (NIRB) 2013), Section 8.1.9.2).

3.4.1 Potential for Soil Erosion Associated with the Project Components and Activities

Soil disturbance associated with the Project that potentially may lead to erosion is expected only within the PDAs, as the development activity will be confined to these areas. Because it is assumed that the entire area of the PDAs is lost for the duration of the Project life (Project Description Volume 2, Section 4.2), the effects of project activities on soil erosion are assessed only for the Project closure phase.

The Project closure phase will be associated with the increased potential for soil erosion. In newly decommissioned/reclaimed areas where soil surface is disturbed or devoid of vegetation, the most fertile surficial fractions of soil may be lost due to wind erosion. Wind erosion of exposed soils may also result in dust and sediment entering waterways.

Exposed mineral soils are also sensitive to water erosion. For example, the ice rich surficial materials, once excavated and stockpiled, will thaw, process which is associated with of the release of seepage and sediment. On disturbed slopes soil erosion can also occur during spring snow/ice melt and during rainfall events. Even on relatively flat terrain, exposed finer soils may be susceptible to splash erosion, which can result in a loss of soil structure and crusting of the surface, thereby impeding development of seeded protective vegetation.

Areas dominated by bedrock and glaciofluvial deposits are expected to exhibit relatively low erosion potential. Morainal deposits are expected to display variable but generally higher erosion potential; especially if soil disturbance takes place on slopes exceeding 5% or if the soil is stockpiled. When disturbed, deposits currently covered by organic horizons may display high erosion potential due to typically finer mineral soil textures and shallow active layer above the permafrost. Disturbance of the surficial protective organic layer could lead to permafrost degradation and land subsidence (Racine and Ahlstrand 1991). Appendix V5-3A provides detailed information on spatial distribution of surficial deposits and their characteristics.

Streams in the LSA are generally well protected against current levels of stream bank erosion. Fluvial deposits are generally coarse, contain high proportion of coarse mineral fragments, and are often covered by a tough organic layer reinforced by a network of intertwined root systems. Construction work in the riparian zones is expected to temporarily increase stream bank erosion potential, but mitigation measures for erosion control will be in place as outlined in the Fish Habitat mitigation measures (See Volume 6, Chapter 6).

The Site Water Monitoring and Management Plan (Volume 10, Chapter 7) and the Mine Closure and Reclamation Plan (Volume 10, Chapter 29) include management measures to avoid or minimize soil erosion.

3.4.2 Potential Impacts to Soil Quality from Compaction

Soil disturbance leading to soil compaction is expected only within the PDAs. Because it is assumed that the entire area of each PDA will be lost for the duration of the Project life, the effects of Project activities on soil compaction are assessed only for the Project closure and post-closure phases.

During the Project closure increased machinery traffic will lead to soil compaction. Within the growing season, when soils are not frozen, most tundra soils are highly sensitive to compaction associated with even light intensity of traffic over the soil surface (Rescan 2011). Compaction results in significant soil temperature changes, degradation of the organic horizon, and reduction of pore space between soil particles, which in turn limits water, nutrient, and air movement in the soil, leading to a decline in soil fertility and reduction in plant establishment and growth. In the Arctic, soil compaction can also lead to ground surface subsidence due to thawing of ice-rich permafrost (Racine and Ahlstrand 1991).

Areas dominated by bedrock and glaciofluvial deposits are expected to exhibit relatively low susceptibility to compaction, whereas wetlands and tundra located in lower topographic positions (e.g., lower slopes, slope toes, depressions, and valley floors) are most vulnerable.

The assessment of potential soil degradation resulting from aerial deposition of acid and metals is provided in the Atmospheric Environment chapter (Volume 4, Chapter 1), and the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Potential of soil degradation resulting from spills is assessed in the Spill Contingency Plan (Volume 10, Chapter 5).

3.4.3 Implications to the Project Design Related to Terrain Conditions, in Particular Permafrost, Sensitive Landforms, High Ice-content Soils, Ice Lenses, Thaw-sensitive Slopes, and Talik Zones

One of the objectives of Project design is to minimize the area of impact on local landforms and soils, especially in areas where local terrain conditions indicate existence of sensitive surficial deposits, permafrost or high ice content soils. The total area (6,080 ha) of the Goose, and Marine Laydown Area PDAs will be considered lost from the time of Project construction to its closure. While varying levels of soil degradation are expected within the proposed Potential Development Areas (Table 3.4-1), the residual soil loss will affect only the areas delineated by the size of the maximum Project footprint (541 ha). This area will consist of two separate sections located in two PDAs: 517 ha in the Goose PDA and 24 ha in the MLA PDA. These losses correspond with 10% and 4% of the respective PDAs. It is expected that after mine closure, most of the soils located within the PDAs, but outside of the footprint areas (5,540 ha), will gradually regain their original ecological potential. This process is expected to occur over a long period of time.

Table 3.4-1. Summary of the Residual Effects of the Project Development on Soil Quantity

Dominant Surficial Materials	Goose Property Footprint		MLA Footprint	
	ha	%	ha	%
Bedrock	12.1	2.3	-	-
Colluvium	0.4	0.1	2.5	10.6
Eolian	24.6	4.8	-	-
Fluvial	6.4	1.2	-	-
Glaciofluvial	105.7	20.5	-	-
Marine	0.0	0.0	21.3	89.0
Morainal	289.5	56.0	-	-
Open water	40.8	7.9	0.1	0.4
Organic	37.1	7.2	-	-
Total	**517**	**100**	**24**	**100**

Note: The % columns list the lost proportion of the particular surficial material present within the PDA.

Table 3.4-1 quantifies the implications of the Project design in relation to specific surficial material types and provides an overview of the spatial extent of the residual effects of the Project development on soils. It lists the estimated areas of land that will be directly affected at the time of mine closure. The following Section 3.4.4 discusses sensitivity of particular deposits to surface disturbance. Permafrost chapter (Volume 5, Chapter 2) provides a review of potential interactions of Project with permafrost and talik zones.

3.4.4 Potential Impacts on the Thermal Stability of Terrain in the Vicinity of Facilities and Infrastructure due to the Thawing of the Ice-rich Permafrost Soils and Other Sensitive Landforms

It is expected that most of the areas dominated by colluvium, weathered bedrock, eolian, bedrock, and marine deposits will display relatively low sensitivity to surface disturbance. However, organic surficial deposits and riparian zones, where fluvial material is covered by organic veneers, are likely to exhibit high susceptibility to surface disturbance, which may result in permafrost or ice lens degradation. Similarly, morainal deposits located on slopes or in low topographical positions are expected to have high ice content and as such display high susceptibility to surface disturbance.

Evidence of massive ice cores located within glaciofluvial deposits (e.g., eskers) have been reported in a large number of studies conducted in Northwest Territories (S. R.; Dallimore and Wolfe 1988; S. R.; Dallimore and Davis 1992; Wolfe et al. 1997; Moorman and Michel 2003; Robinson et al. 2003; Macumber et al. 2011). The evidence suggests that ice cores are a characteristic feature of eskers at the time of their origin (Banerjee and McDonalds 1975; Moorman and Michel 2003; Huddart and Stott 2010). A review of the above evidence suggests that majority of glaciofluvial deposits located in the West Kitikmeot region of Nunavut may contain massive ice cores and that disturbance of mineral materials associated with them will likely affect ice core integrity. In the areas where the Project infrastructure will be built upon fill or foundation material (e.g., crushed rock) degradation of permafrost or ice lenses is less likely.

4. Vegetation and Special Landscape Features

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4. Vegetation and Special Landscape Features

4.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

Baseline studies to characterize the baseline ecosystems and vegetation present within the regional and local area of the Back River Project (the Project) were carried out in 2012. The focus of these studies was on ecosystems, habitat, and vegetation identified by Inuit, scientists, regulators, or the public as ecologically, socially or culturally important.

This information is provided in the 2012 Ecosystems and Vegetation Baseline Report (Rescan 2013a, Appendix V5-4A) and forms the basis for evaluating potential effects of the Project on ecosystems, vegetation, and special landscape features.

A local study area (LSA) of 134,370 ha was established, using watershed boundaries and buffers around project infrastructure. Baseline studies included a combination of ecosystem classification and mapping, field verification, rare plant surveys (Appendix 1 of Rescan 2013a), invasive plant surveys, and plant tissue collection for baseline metals analysis.

Studies affirmed a great variety and diversity of ecosystems present within the Project area. Generally speaking they include lichen-dominated ecosystems occupying large areas of exposed bedrock of the Canadian Shield, mesic tundra ecosystems on glacial till, sedge wetlands in the lowlands, perpetually supplied by runoff fed by the summer melt of permafrost, and areas at Bathurst Inlet with warmer temperature soils, relatively rich soils, and diverse flora. In order to facilitate classification, study, and assessment, the LSA was divided into three sub-areas, the delineation of which was based upon disturbance type, ecosystem heterogeneity, and spatial extent of infrastructure. The three sub-areas below are presented graphically in Figure 4.1-1. Changes to the winter road for the FEIS, made in response to TK identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012) and a request by the Kitikmeot Inuit Association, are shown as Winter Road and DEIS Winter Road alignments on all figures.

- Goose Property Sub-area (32% of LSA);
- Winter Road Sub-area (62% of LSA); and
- Marine Laydown Area Sub-area (6% of LSA).

Appendix 3 of Rescan 2013a provides the detailed data and descriptions for identified ecosystems. A summary of the environmental characteristics, including the typical site characteristics; structural development; dominant vegetation species; typical soil, terrain and parent material characteristics; and, where applicable, other vegetation associations that occur as complexes, is provided. The distribution of these mapped ecosystems within the LSA is presented in Figures 4.1-2a through 4.1-2d. For discussion purposes, these ecosystems were categorized as Vegetated, Sparsely-vegetated, and Non-vegetated (Table 4.1-1).

Vegetated ecosystems occur when adequate soil intersects with favourable climate. Soil is required for rooting, water storage, and nutrient supply, while favourable climate (and microclimate) reduce exposure to extensive snowpack and desiccating winds. This allows for colonization of the site by plants, and the subsequent development of ecosystems. Upland areas with soil parent materials such as glacial till and glaciofluvial deposits, and with adequate drainage, allow for the development of tundra ecosystems, with associated flora dominated by dwarf woody shrubs. Slow decomposition rates result

in accumulation of fibric and mesic peat, typically 20 to 50 cm in thickness. Within the LSA, vegetated ecosystems are largely dominated by mesic tundra, although dry-sparse tundra and moist to mesic shrubby tundra are also present. The mesic tundra association, the most extensively mapped ecosystem in the LSA, represents the "typical" tundra situation and is characterized by extensive areas dominated by dwarf woody shrub species, with a highly variable component of herbs, graminoids, mosses, and lichens. Dry sparse tundra is associated with windswept hillcrests, steeper slopes, and rockier substrate. Moist tundra forms in downslope positions, where seepage occurs from seasonal melting permafrost. These ecosystems are transitional to wetlands, as indicated by the presence of woody shrubs, sedges, and cottongrasses.

Sparsely-vegetated ecosystems are often associated with areas of thin morainal veneers or exposed bedrock ecosystems, windswept esker crests, blocky tundra, marine beaches and other disturbed or barren sites that limit vegetation establishment and vigour. Of the sparsely-vegetated ecosystems, the bedrock-lichen veneer and exposed bedrock associations were the dominant units mapped.

Sensitive ecosystems, or special landscape features, were classified as such due to their value as wildlife habitat or higher likelihood to support rare plants or culturally valued plant species. They include esker complexes, shrubby riparian ecosystems, sedge and shrub-dominated wetlands, marsh ecosystems, shallow open water, bedrock cliffs, and bedrock-lichen veneers.

Within the Project area, wetlands are particularly extensive and forming on plains, often previously occupied by lakes. The parent materials are the depositional product of erosion from upland areas; as a result, the mineral fraction of soils is very well sorted with medium to fine textures. Soils are saturated to the surface during the growing season, as permafrost at 50 to 80 cm depth restricts drainage. The vegetation is dominated by graminoids, specifically sedges and cottongrasses.

Two regional classification systems (Figure 4.1-3) were used to map ecosystems in the regional study area (RSA). The West Kitikmeot / Slave Study (WKSS) classification by Matthews, Epp, and Smith (2001) covers approximately 87% of the RSA, while the Geobase Land Cover data set (Government of Canada 2009) was use to infill areas that were lacking coverage. By using these two systems, regional classification was obtained for 99.6% of the RSA (Table 4.1-2). These two classification systems are reconciled in Table 4.1-2 into generalized ecosystem classes, similar to those mapped in Rescan 2013a. Assessment of the two datasets against the TEM field surveys suggests that, for the Project area, the WKSS data set more accurately represents the ecosystems on the ground. There are no existing or proposed parks, protected areas, special management areas, and conservation areas within the RSA.

Approximately 60% of the total RSA is comprised of ecosystems that are generalized, within this assessment, into Bedrock – Sparse and Tundra – Heath classes. Within these classes, the Boulder Association and Heath Tundra, mapped within the WKSS dataset, comprise the largest area. Regional ecosystems generalized into Wetland and Tussock classes, comprise a collective 16% of the RSA and non-vegetated units, dominated by lakes, ponds, and Bathurst Inlet, at the northern tip, comprise 21% of the RSA.

Each of the plants identified during the Socio-economic and Land Use Baseline (Rescan 2013b, Appendix V8-3A) as having cultural importance were identified during the 2012 baseline field sampling. Cloudberry, a preferred local country food species, was commonly identified within wetland ecosystems. A total of 890 species identifications were made during the TEM and rare plant field surveys. The largest species group is that of the vascular plants, followed by the macro-lichens. Of the 90 rare species identified, 20 are newly discovered vascular plants within Nunavut. None of the invasive plant species identified as potentially occurring in the LSA were identified.

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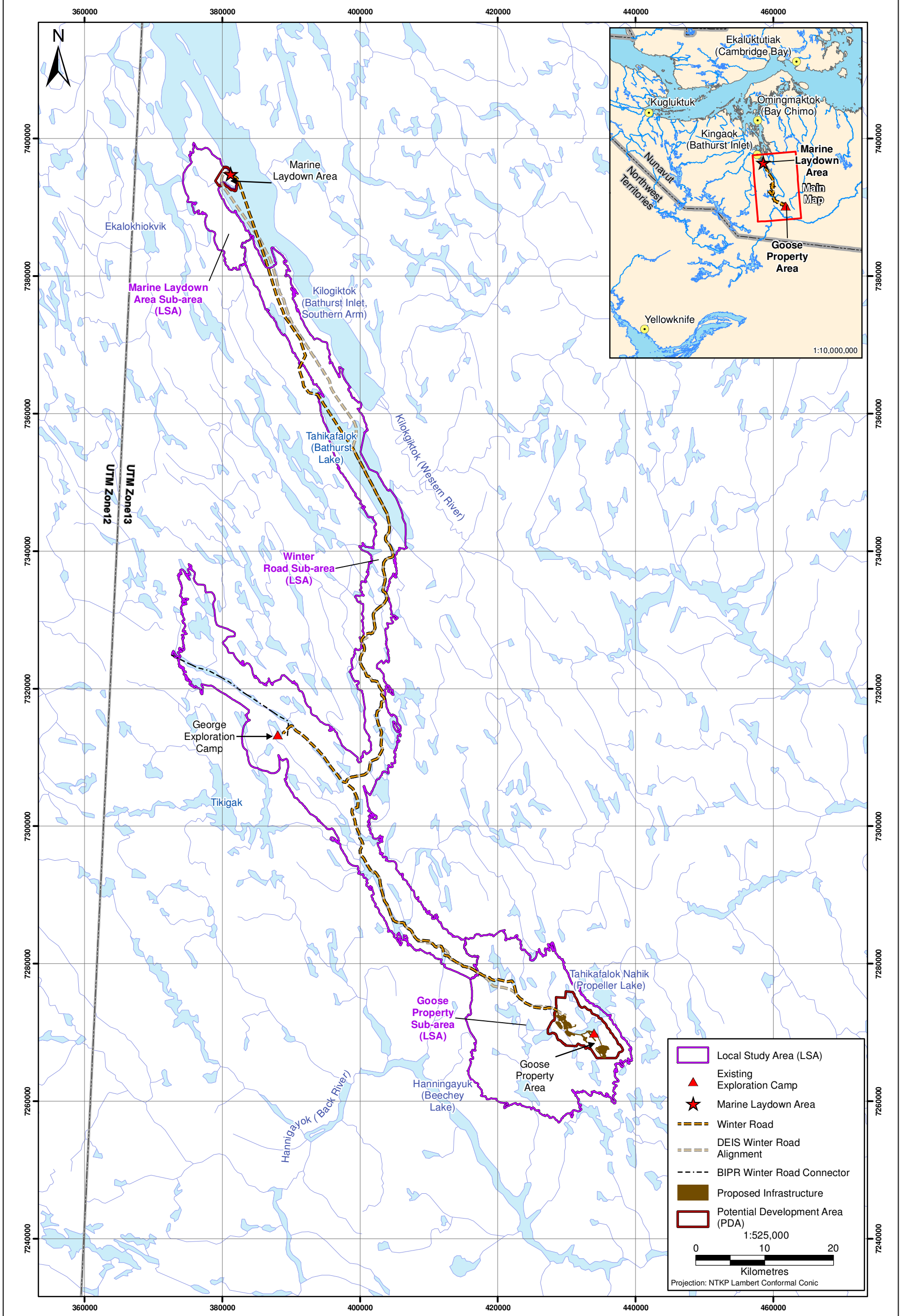

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Figure 4.1-1

Sub-areas of the Local Study Area

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Table 4.1-1. Summary of Mapped Ecosystems in the Local Study Area

					George Property Sub-area			Goose Property Sub-area			Marine Laydown Sub-area			Winter Road Sub-area		
Ecosystem Name	**TEM Code**	**Ecosystem Class**	**Area (ha)**	**% Total LSA**	**Area (ha)**	**% George**	**% LSA**	**Area (ha)**	**% Goose**	**% LSA**	**Area (ha)**	**% MLA**	**% LSA**	**Area (ha)**	**% Winter Rd**	**% LSA**
Non-vegetated Ecosystems																
Lake	LA	Freshwater	17961.8	13.4%	5310.5	11.1%	4.0%	3979.9	9.2%	3.0%	0	0%	0%	8671.4	24.7%	6.5%
Pond	PD	Freshwater	6173.7	4.6%	2342.1	4.9%	1.7%	2635.3	6.1%	2.0%	211	2.5%	0.2%	985.3	2.8%	0.7%
River	RI	Freshwater	289.6	0.2%	135.9	0.3%	0.1%	57.9	0.1%	0.0%	25.1	0.3%	0.0%	70.7	0.2%	0.1%
Saltwater	MW	Marine	4.1	0.0%	0	0%	0%	0	0%	0%	0	0%	0%	4.1	0%	0%
Mine camp	DR	Disturbed/Barren	10	0.0%	3.2	0%	0%	6.8	0%	0%	0	0%	0%	0	0%	0%
Road surface	DZ	Disturbed/Barren	3.2	0.0%	3.2	0.0%	0.0%	0	0%	0%	0	0%	0%	0	0%	0%
Total			**24442.4**	**18.2%**	**7794.9**	**16.4%**	**5.8%**	**6679.9**	**15.4%**	**5.0%**	**236.1**	**2.8%**	**0.2%**	**9731.5**	**27.7%**	**7.2%**
Sparsely Vegetated Ecosystems																
Exposed soil	ES	Disturbed/Barren	176.8	0.1%	10.5	0.0%	0.0%	5	0%	0%	11.3	0.1%	0.0%	150	0.4%	0.1%
Bedrock-lichen veneer	BL	Bedrock	6704.4	5.0%	3522.8	7.4%	2.6%	386	0.9%	0.3%	794.1	9.6%	0.6%	2001.5	5.7%	1.5%
Bedrock outcrop	BR	Bedrock	3381.8	2.5%	1492.2	3.1%	1.1%	600.3	1.4%	0.4%	527.1	6.3%	0.4%	762.2	2.2%	0.6%
Blockfield	TB	Bedrock	154.1	0.1%	85.9	0.2%	0.1%	5.5	0%	0%	0	0%	0%	62.7	0.2%	0.0%
Cliff	BC	Bedrock	8.1	0.0%	5.9	0%	0%	0	0%	0%	0	0%	0%	2.1	0%	0%
Talus	BT	Bedrock	4.6	0.0%	0	0%	0%	4.6	0%	0%	0	0%	0%	0	0%	0%
Sparsely vegetated esker	EC	Esker	577.6	0.4%	383.1	0.8%	0.3%	57.9	0.1%	0.0%	0	0%	0%	136.6	0.4%	0.1%
Shallow open water	WO	Wetland	81.2	0.1%	8.2	0%	0%	72.6	0.2%	0.1%	0	0%	0%	0.4	0%	0%
Saline shallow open water	MO	Wetland (Marine)	55.8	0.0%	0	0%	0%	0	0%	0%	3.6	0%	0%	52.2	0.1%	0.0%
Marine beach	MB	Marine	59.5	0.0%	0	0%	0%	0	0%	0%	42	0.5%	0.0%	17.4	0%	0%
Old beach heads	MH	Marine	476.3	0.4%	0	0%	0%	0	0%	0%	62.6	0.8%	0.0%	413.7	1.2%	0.3%
Total			**11680.2**	**8.7%**	**5508.6**	**11.6%**	**4.1%**	**1131.9**	**2.6%**	**0.8%**	**1440.7**	**17.3%**	**1.1%**	**3598.8**	**10.2%**	**2.7%**
Vegetated Ecosystems																
Disturbed vegetation	DV	Disturbed/Barren	0.7	0.0%	0.7	0.0%	0.0%	0	0%	0%	0	0%	0%	0	0%	0%
Dwarf shrub esker	EH	Esker	570.2	0.4%	306.3	0.6%	0.2%	64	0.1%	0.0%	0	0%	0%	199.9	0.6%	0.1%
Shrubby esker	EW	Esker	189.3	0.1%	118.7	0.2%	0.1%	15.1	0%	0%	0	0%	0%	55.5	0.2%	0.0%
Mesic dwarf-shrub tundra	TL	Tundra	40373.2	30.0%	14731.4	30.9%	11.0%	18556.1	42.9%	13.8%	891.1	10.7%	0.7%	6194.6	17.6%	4.6%
Dry-sparse tundra	TH	Tundra	22876	17.0%	9739.8	20.4%	7.2%	6373.8	14.7%	4.7%	1142	13.7%	0.8%	5620.4	16.0%	4.2%
Shrubby tundra	TS	Tundra	11144.4	8.3%	4446.6	9.3%	3.3%	4877.3	11.3%	3.6%	17.8	0.2%	0.0%	1802.8	5.1%	1.3%
Marine dwarf shrub tundra	MT	Tundra (Marine)	5447.3	4.1%	0	0%	0%	0	0%	0%	2719.6	32.7%	2.0%	2727.7	7.8%	2.0%
Marine shrubby tundra	MS	Tundra (Marine)	1831.1	1.4%	0	0%	0%	0	0%	0%	391.1	4.7%	0.3%	1440	4.1%	1.1%
Willow riparian	RW	Riparian	1405.1	1.0%	498	1.0%	0.4%	572.8	1.3%	0.4%	18.1	0.2%	0.0%	316.2	0.9%	0.2%
Low bench floodplain	RL	Riparian	36.5	0.0%	13.8	0%	0%	7.8	0%	0%	0	0%	0%	14.9	0%	0%
Mid bench floodplain	RM	Riparian	3.8	0.0%	0	0%	0%	3.2	0%	0%	0	0%	0%	0.7	0%	0%
Marine riparian shrub	MR	Riparian (Marine)	439.6	0.3%	0	0%	0%	0	0%	0%	229.7	2.8%	0.2%	209.9	0.6%	0.2%
Raised bog complex	WB	Wetland	4147.3	3.1%	1116.2	2.3%	0.8%	1776.3	4.1%	1.3%	64.9	0.8%	0.0%	1189.8	3.4%	0.9%
Cottongrass-sedge fen	WC	Wetland	3263.6	2.4%	1415.2	3.0%	1.1%	1165.8	2.7%	0.9%	0	0%	0%	682.5	1.9%	0.5%
Undifferentiated fen	WF	Wetland	2525.1	1.9%	1064.5	2.2%	0.8%	767.4	1.8%	0.6%	329.4	4.0%	0.2%	363.7	1.0%	0.3%
Water sedge marsh	WA	Wetland	2312.2	1.7%	733.3	1.5%	0.5%	1053	2.4%	0.8%	16.2	0.2%	0.0%	509.7	1.5%	0.4%
Willow-sedge fen	WS	Wetland	366.8	0.3%	142.5	0.3%	0.1%	186.2	0.4%	0.1%	0	0%	0%	38.1	0.1%	0.0%
Tussock meadow	WT	Wetland	64.5	0.0%	4.8	0%	0%	59.7	0.1%	0.0%	0	0%	0%	0	0%	0%
Saline Fen	MF	Wetland (Marine)	993.5	0.7%	0	0%	0%	0	0%	0%	695.8	8.4%	0.5%	297.8	0.8%	0.2%
Estuary marsh	ME	Wetland (Marine)	4.2	0.0%	0	0%	0%	0	0%	0%	0	0%	0%	4.2	0%	0%
Saline Marsh	MM	Wetland (Marine)	252.1	0.2%	0	0%	0%	0	0%	0%	116.9	1.4%	0.1%	135.2	0.4%	0.1%
Total			**98246.5**	**73.1%**	**34331.8**	**72.1%**	**25.6%**	**35478.5**	**82.0%**	**26.4%**	**6632.6**	**79.8%**	**4.9%**	**21803.6**	**62.1%**	**16.2%**
Grand Total			**134369.1**	**100.0%**	**47635.3**		**35.4%**	**43290.3**		**32.2%**	**8309.4**		**6.2%**	**35133.9**		**26.1%**

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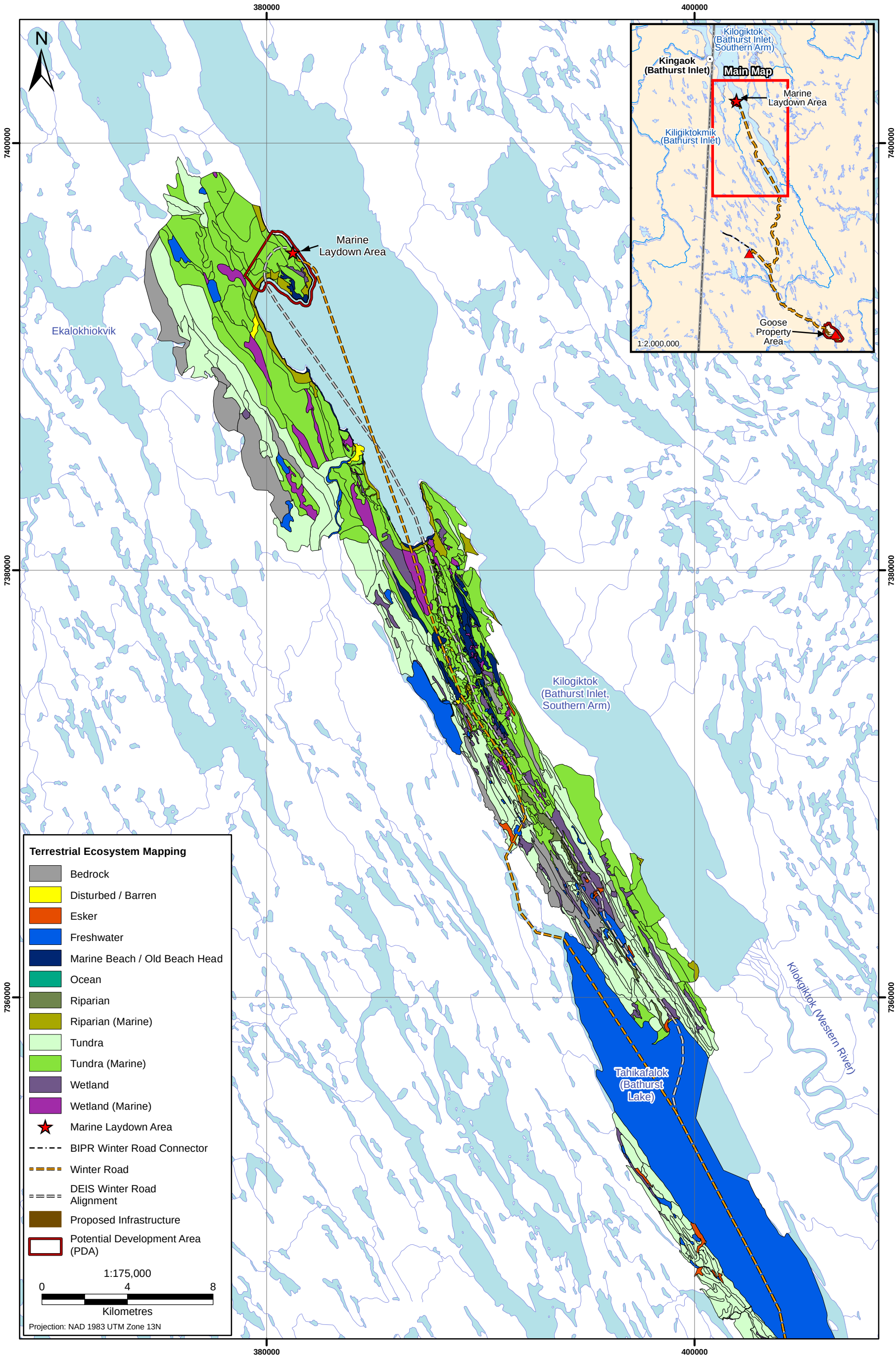
June 22 2015



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Terrestrial Ecosystem Mapping - Overview Map A

Figure 4.1-2a

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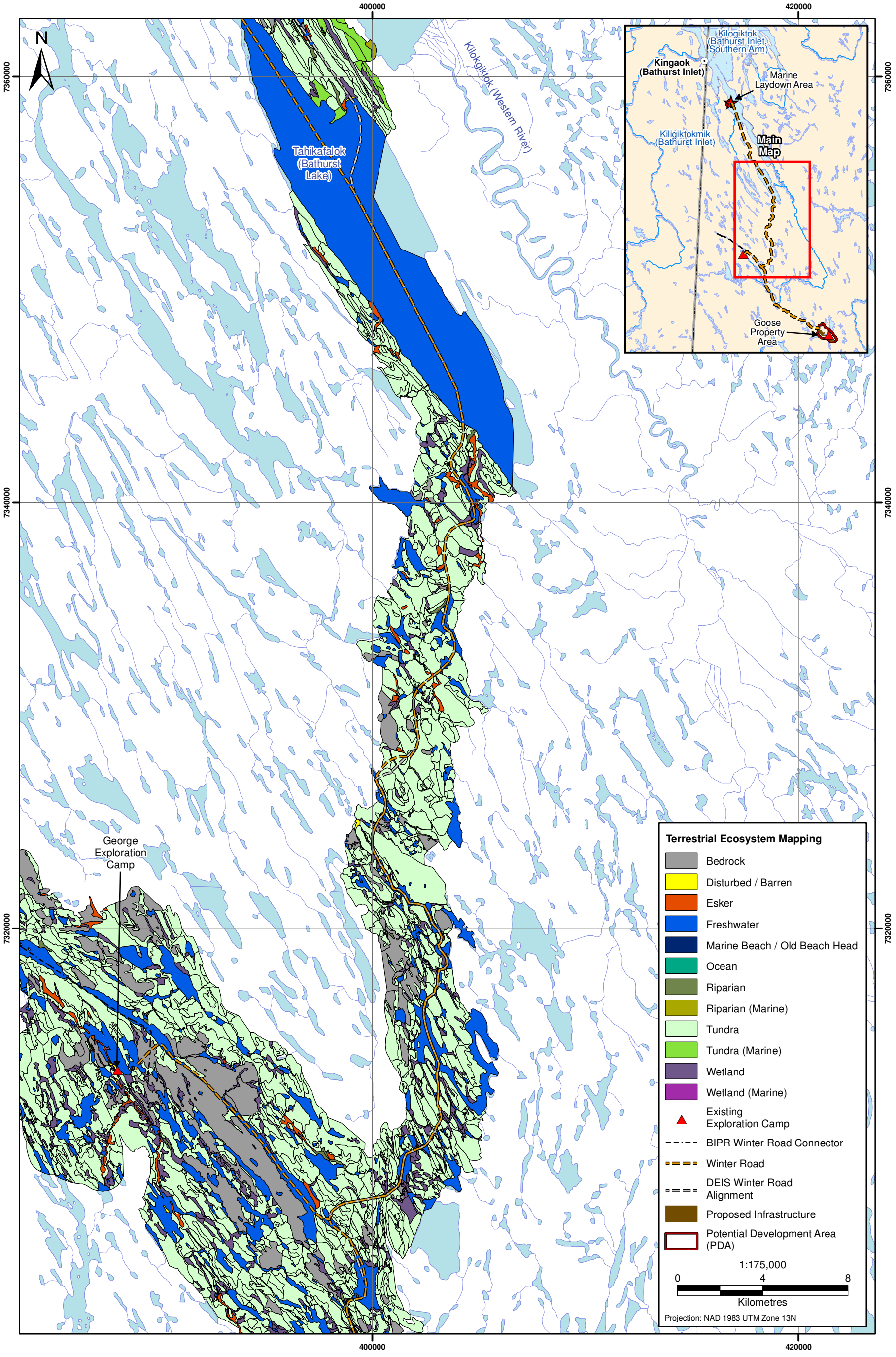

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Figure 4.1-2b

Terrestrial Ecosystem Mapping - Overview Map B

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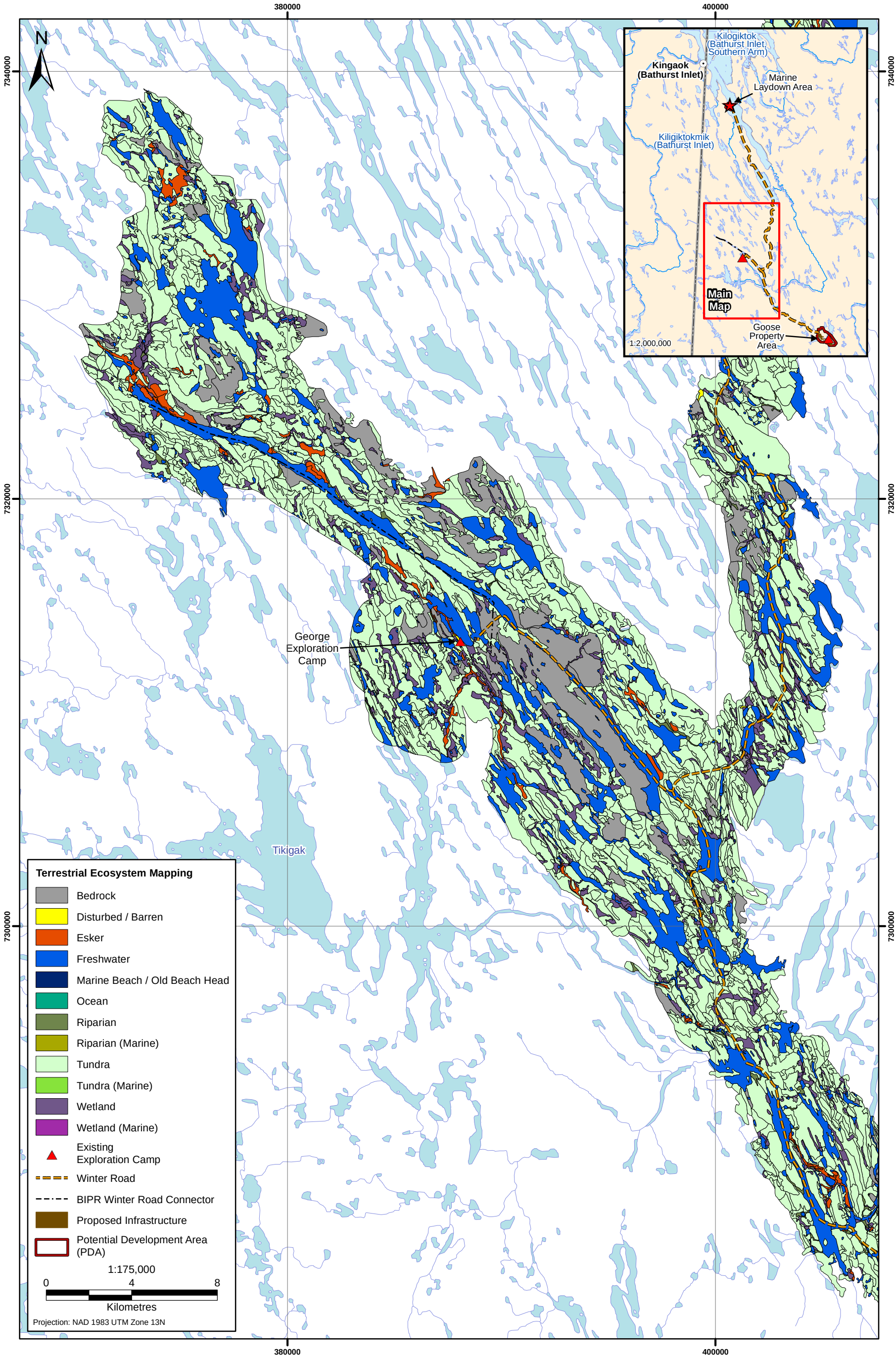

Figure 4.1-2c

Terrestrial Ecosystem Mapping - Overview Map C

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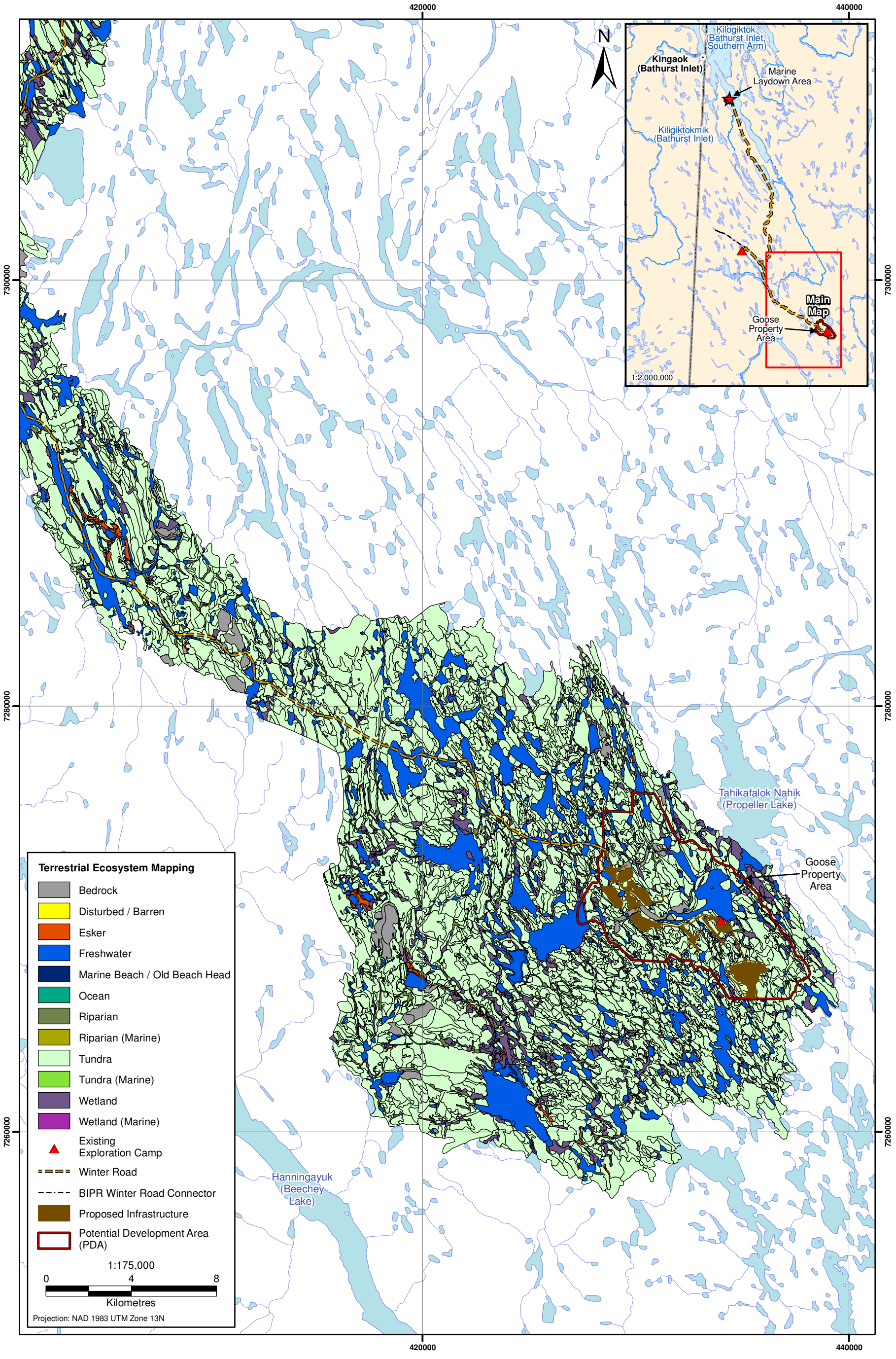

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Figure 4.1-2d

Terrestrial Ecosystem Mapping - Overview Map D

Rescan an ERM company

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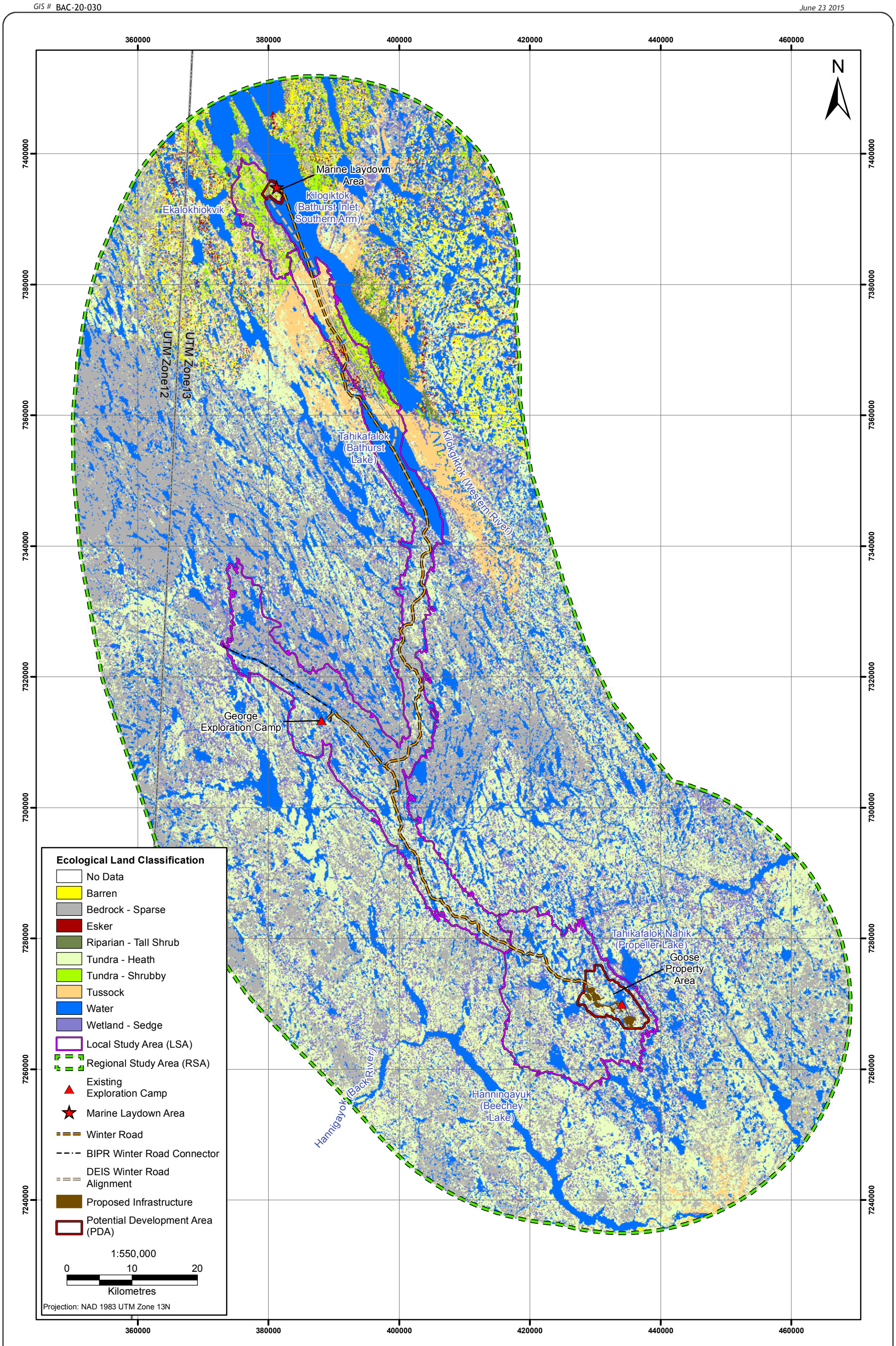

Figure 4.1-3

Regional Ecological Classification within the Regional Study Area

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Soil, berry, sedge, and lichen tissue samples were collected throughout the LSA, and from reference sites beyond the LSA, to determine baseline concentrations of metals. This includes 72 soil samples, 46 berry samples, 12 aquatic sedge samples and 49 lichen samples. The environmental media baseline data was used in the Country Foods assessment (Volume 8, Chapter 5).

Table 4.1-2. Ecological Land Classification Summary within the RSA

Regional Ecological Land Classification Unit	Generalized Ecosystem Class	RSA (ha)	Total Area (ha)	RSA (%)
Unclassified	No Data	4,797	4,852	0.4
No data		55		
Deep Water	Water	102,226	265,197	21.0
Ice and Snow		33,356		
Water[1]		27,709		
Shallow Water		101,906		
Bedrock Association	Bedrock - Sparse	14,877	337,670	26.8
Sparsely vegetated bedrock[1]		57		
Sparsely vegetated till-colluvium[1]		80		
Boulder Association		216,650		
Heath/Bedrock		62,909		
Tussock graminoid tundra[1]		42,040		
Lichen Veneer		1,057		
Bare Ground	Barren	4,912	24,383	1.9
Bare soil with cryptogam crust-frost boils[1]		69		
Barren/non vegetated[1]		229		
Gravel Deposit		19,174		
Esker Complex	Esker	5,457	5,457	0.4
Tall Shrub	Riparian - Tall Shrub	6,616	6,616	0.5
Heath Tundra	Tundra - Heath	228,591	418,525	33.2
Moist to dry non-tussock graminoid/dwarf shrub tundra[1]		3,034		
Prostrate dwarf shrub[1]		4,912		
Shrub low[1]		47,062		
Heath/Boulder		118,881		
Birch Seep	Tundra - Shrubby	54		
Low Shrub		15,992		
Tussock/Hummock	Tussock	37,697	199,302	15.8
Shrub tall[1]		23,888		
Wetland (Sedge Meadow)	Wetland - Sedge	131,934		
Wet sedge[1]		3,605		
Wetland[1]		2,178		
Total		**1,262,004.6**	**1,262,004.6**	**100.0**

[1] *Source: Government of Canada et al. (2009)*

4.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The effects assessment relies on the information collected from Inuit-led TK information, public scoping, focus group meetings, government engagement, and scientific knowledge. To the extent possible, available TK is incorporated into the evaluation of the potential effects of the Project on the environment. The following reports were reviewed for TK specific information related to vegetation and special landscape features:

- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014) (Appendix V3-3C of FEIS);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report* (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Omingmaktok as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3B of DEIS/FEIS).

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

4.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize vegetation, soils, and special landscape features, which form the foundation of the environment. In Section 4.3.1, berries are identified as an important food source for the Inuit. The 2012 baseline program included the collection and analysis of baseline metal concentrations within the berries of country food plants, including blueberries (*Vaccinium uliginosum*), bog cranberries (*Vaccinium vitis-idaea*), as well as collection of lichens (*Cladina stygia* and *Stereocaulon* spp.), wetland sedge (*Carex aquatilis*) tissue, and soil (Rescan (2013a);(KIA 2012). As berries are ingested directly, and lichens, wetland sedge tissue, and soil may be ingested by caribou, and subsequently by local Inuit, this information is used as baseline information for the Country Foods assessment (Volume 8, Chapter 5). While Inuit did indicate harvesting a variety of plants in areas within and beyond the LSA (KIA 2012, 2014), the harvested plant species are not unique to these areas and are also collected from outside the LSA. The baseline program also included a rare plant assessment, which targeted unique features on the landscape, such as cliffs, beaches, and brackish water communities, that have highest likelihood of supporting rare plants or communities.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores, and riparian ecosystems were mapped as unique ecosystems, wherever possible.

4.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used

to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site.

4.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Terrestrial ecosystem mapping, together with supporting field surveys, was completed during the baseline program within a study area that will encompass the measurable effects on vegetation resulting from development of infrastructure and other activities and equipment associated with the Project. To enable an assessment between vegetation and terrestrial ecosystems at local and regional scales, the results of the WKSS regional ecological classification (Matthews, Epp, and Smith 2001) and GeoBase Land Cover data (Government of Canada et al. 2009) are summarized within the regional study area (RSA). Given that terrestrial ecosystems provide habitat and forage to wildlife, the Vegetation RSA is consistent with the RSA developed for the assessment of wildlife habitat, which was delineated based on the expected use of the region by wildlife valued components. The vegetation and terrestrial wildlife RSA boundary represents an approximate 30 kilometre buffer surrounding proposed Project infrastructure.

4.2.4 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities. Specific comments are summarized in Section 4.3.1.

As terrestrial vegetation provides habitat and forage for valued wildlife species, mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial vegetation and special landscape features, which support unique plant communities and provides unique wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction. The known locations of rare plants were considered during the design of all-weather roads. In response to TK and a request by the Kitikmeot Inuit Association, the winter road north of Tahikafflok Lake (Bathurst Lake) to the Marine Laydown Area was realigned to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012).

The mitigation measures to minimize effects from physical loss and degradation are provided within Section 4.5.3. Volume 4 addresses the mitigation measures to minimize effects due to fugitive dustfall and atmospheric emissions and Volume 8 addresses mitigation measures pertaining to human health.

4.3 VALUED COMPONENTS

Defined within the EIS guidelines (NIRB 2013a), Valued Ecosystem Components (VECs) include "*those aspects of the environment considered to be of vital importance to a particular region or community, including:*

- *resources that are either legally, politically, publically, or professionally recognized as important, such as parks, land selections, and historical sites;*
- *resources that have ecological importance; and*
- *resources that have social importance."*

The sections below summarize the identification of potential VECs and Project scoping and define the final VECs carried through the effects assessment process relating to vegetation.

4.3.1 Potential Valued Components and Scoping

Described within the EIS guidelines (NIRB 2013a), NIRB developed a list of potential biophysical and socio-economic components of potential relevance for project scoping. The list of potential VECs (Section 7.6.1 of NIRB 2013a), including *Terrestrial Ecology* and V*egetation*, was provided to the Proponent for consideration. Summarized in Appendix B of the EIS guidelines, NIRB consulted with the public and interested parties to determine the scope of its review of Sabina Gold & Silver Corp.'s proposed Back River Project. This included consultation with local communities and interested parties throughout the Kitikmeot Region, and in Yellowknife, during February 2013 to determine the final scope of the EIS. From this consultation, a Public Scoping Meetings Summary Report (NIRB 2013b) and a Final Scope List for the NIRB's Assessment of the Back River Project (Appendix B of the EIS guidelines [NIRB 2013a]) were issued.

Section 3.0 of the Public Scoping Meetings Summary Report summarizes community feedback. Most comments included concerns regarding potential for loss, disturbance or contamination of vegetation consumed by important wildlife, such as caribou, a major supplier of subsistence to the Kitikmeot (KIA 2012). Specific vegetation-related concerns within the Public Scoping Meetings Summary Report include the:

- potential loss or disturbance of vegetation (i.e., from piling of overburden), and subsequent reduction in its availability to animals;
- potential effects on rare plants;
- potential effects of salt used in drilling on the ability of vegetation to regenerate;
- need for reclamation or re-vegetation after the mine closes;
- need to maintain vegetation and flowers to uphold aesthetic values; and
- potential impacts of fugitive dust on wildlife and vegetation, including the potential that caribou may not cross areas where dust and chemicals have settled and concerns that dust could affect vegetation near, and far away from (i.e., up 10-15 miles), the Project before settling (Kugluktuk Hunter Focus Group 2012).

Described further within the Socio-economic and Land Use Baseline (Rescan 2013b), harvesting of terrestrial plants was identified through a number of focus group meetings with hunters from the Kitikmeot study communities. Cloudberries (*Rubus chamaemorus)* were identified as being collected and consumed in large amounts and mountain sorrel (*Oxyria digyna)*, or sweet leaves, were identified as being eaten raw, as fresh greens, or prepared as tea. Plants identified as having medicinal or other cultural value included cottongrasses (*Eriophorum* spp.) and willows (*Salix* spp.). Table 4.3-1 lists specific plants identified by the Cambridge Bay Land Users (Cambridge Bay Hunter Focus Group 2012) and the Omingmaktok/Bathurst Inlet Land Users (Omingmaktok/Bathurst Inlet Hunter Focus Group 2012) with the utilized plant parts, where available. No comments pertaining to terrestrial ecology or vegetation were provided by the Kugluktuk Land Users (Kugluktuk Hunter Focus Group 2012).

Reflecting the influence of a maritime climate and relatively nutrient rich soils (compared with tundra-dominated plateaus of the interior), land users from Kingaok/Omingmaktok describe vegetation at Bathurst Inlet as lush, green, and much taller than vegetation elsewhere in the region.

Table 4.3-1. Terrestrial Vegetation Identified through Traditional Knowledge

Inuinnaktun Name(s)	English Name	Latin Name(s)	Specific Use / Part of Plant
Kublak[2]	Bear berry	*Arctous rubra, A. alpina*	fruit
Kabluk	Bear berry	*Arctous rubra, A. alpina*	fruit
Kublakot	Bear berry	*Arctous rubra, A. alpina*	leaves
Akpik; Aaukpik[1]	Cloudberry	*Rubus chamaemorus*	fruit
Paungak; Paungan[1]; Paurngait[2]	Crowberry; Blackberries	*Empetrum nigrum*	fruit
Mahok	Liquorice root	*Hedysarum alpinum*	root
Qunguliit[2]	Mountain sorrel	*Oxyria digyna*	leaves
Kimminait[2]	Bog cranberry	*Vaccinium vitis-idaea*	fruit
Kigutangirnait[2]	Blueberries	*Vaccinium uliginosum*	fruit
	Willow	*Salix* spp.	bark
Qijuktaaqpait[2] (Baffin)	Labrador tea	*Ledum palustre* subsp. *decumbens*	
Kangayot[1]	Cottongrass	*Eriophorum* spp.	Seed heads
Kablakot[1]	Unknown; plant used for tea	Unknown	
Avalakiak[1]	Unknown; low-growing plant for starting fires	Unknown	
Eehoktin[1]	Unknown; small plant for starting fires	Unknown	
Aatogoayak[1]; igloohoutinnik[1]	Unknown; mushrooms eaten by caribou	Unknown	

[1] *From the vocabulary in Section 11 of the NTKP report (KIA 2012). Where only the Inuinnaqtun names are provided, it is difficult to correlate them with corresponding English or Latin names.*
[2] *Inuktitut names from Mallory and Aiken (2004).*

4.3.2 Valued Components Included in Assessment

As described within the General Assessment Methodology Chapter (Volume 9, Chapter 1), the value of a component is considered in relation to its role in the ecosystem as a VEC, the value placed on it by humans for traditional use and to the inter-relationships between vegetation and other disciplines, including country foods, human health, and wildlife. Addressed in Section 4.2.2, TK information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC list.

4.3.2.1 Vegetation

Within Nunavut, Inuit cultural heritage, government structure and current land-use policies are closely tied to wildlife and vegetation patterns. Having an understanding of existing vegetation assists the development of land-use and management decisions and enables modelling of future vegetation patterns and ecosystem properties related to climate change (Gould, Raynolds, and Walker 2003). Based on the results of community consultation and the ecological importance of vegetation in providing important habitat for wildlife species, including culturally significant species such as barren-ground caribou, terrestrial vegetation (hereafter called *vegetation*) has been selected as a terrestrial environment VEC. It is considered key to understanding northern ecosystems and forms the basis for determining terrestrial primary productivity and, therefore, food chains (Aiken et al. 2007). Described within the Socio-economic and Land Use Baseline (Rescan 2013b), and previously within Section 4.3.1, current and traditional harvesting of terrestrial vegetation was identified through a series of Land and Resource Use Focus Group meetings with hunters from Kitikmeot communities.

Vegetation provides habitat and forage for many life requisites for Arctic wildlife species, some of which preferentially select specific vegetation communities or structure types. Within the 2012 Wildlife Baseline (Rescan 2013d), lichen heath is described as one of the main vegetation cover types within the calving grounds of the Bathurst herd (Griffith et al. 2001; Johnson et al. 2005), one of the three barren-ground caribou herds overlapping the Project RSA. Wetlands (natingnak), described as being the most important habitat type in Kitikmeot territory for grazing caribou (KIA 2012), also represent important calving habitat for caribou, denning habitat for foxes, and nesting habitat for waterfowl and snowy owls (KIA 2012). Several upland breeding bird communities have been differentiated on the basis of their habitat preferences based on vegetation structure (Rescan 2013d).

Vegetation is assessed as discrete associations, or terrestrial ecosystems, which form the base unit in the terrestrial ecosystem mapping process. Arctic plant community composition appears to depend largely on six variables: climate, local microclimate, soil drainage, nutrient availability, local soil type, and snow cover (Aiken et al. 2007). Described in Rescan (2013a), mapped ecosystems have been grouped into vegetated ecosystems, sparsely-vegetated ecosystems and non-vegetated ecosystems, typically ponds and lakes. Sparsely-vegetated ecosystems are often mapped in association with marine beaches and old beach heads, exposed crests of glaciofluvial features such as eskers, exposed bedrock outcrops, blockfields, and shallow veneers of glacial till. Non-vegetated ecosystems are excluded from further assessment. The results of ecosystem mapping are used to derive the habitat suitability estimates for the wildlife VECs in Volume 5, Chapters 5 through 10.

Individual plant and lichen species, with the exception of rare plants (Appendix 1 of Rescan 2013a), are not assessed. However, Appendix 3 of the same appendix provides a list of the dominant plant species occurring within each of the mapped ecosystems. Many of the species occur across a wide range of mapped ecosystems, with individual presence and cover often a function of site-specific parent material and soil properties. A list of all flora, rare and common, that were identified during the rare plant surveys is provided within Appendix 1 of Rescan (2013a).

4.3.2.2 Special Landscape Features

Special landscape features are also included as a terrestrial environment VEC, based on their limited representation on the landscape, their higher likelihood to support rare or unique plant species or communities, or their inherent value as wildlife habitat (Table 4.3-2).

The unique landforms identified in Section 2.4 of the 2012 Terrain and Soils Baseline Report (Rescan 2013c) include eskers, moraines and boulderfields. As no large moraine features were identified within either the LSA or RSA, they are excluded from the assessment of special landscape features. Similarly, boulderfields were typically neither identifiable nor mappable at the mapping scale and are excluded from assessment of special landscape features. Landscape features mapped within the LSA and RSA, or that can reliably be estimated using TEM data, are outlined within Table 4.3-2.

Detailed in Appendix 1 of Rescan (2013a), the following common habitats, together constituting a large majority of the assessment area, were found to support almost exclusively common species:

- small lakes and ponds;
- rocky or wet depressions;
- tussock-dominated ground, heaths;
- areas of low-pH surficial bedrock and boulders; and
- drumlins and associated solifluction lobes.

Table 4.3-2. Summary of Special Landscape Features

Special Landscape Feature	TEM Map Code(s)	Total Area in LSA (ha)	Rationale for Inclusion
Cliffs	Slopes > 25% (excluding TEM Esker ecosystems) BC	1,367.5	• Higher likelihood of supporting rare plants, plant communities[1] • Nesting habitat for variety of raptors, colonial nesting birds (incl. gulls and cliff swallows), raven, geese and some ducks[2] • Scavenging, denning, and security habitat for wildlife such as wolverine[2] • Hunting habitat for predators such as grizzly bears[2] • Thermoregulation and insect avoidance habitat[2]
Esker ecosystems	EC, EH, EW	1,337.1	• Denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels[2] • Traveling and security habitat for caribou[2] • Hunting habitat for predators such as grizzly bears and wolves[2] • Winter foraging habitat for caribou due to reduced snow depths[2] • Thermoregulation and insect avoidance habitat[2] • Unique habitat for flora requiring either very little snow or, alternately, prolonged snowpack[1] • Exposed crests possess higher cover of some culturally valued vegetation species such as blackberries, or crowberries
Bedrock-lichen and outcrop ecosystems	BL, BR	10,086.2	• Winter foraging habitat for caribou due to reduced snow depths[2] • High forage suitability for caribou, given abundance of terrestrial lichens
Riparian ecosystems	RL, RM, RW, MR	1,885.0	• Nesting and security habitat within dense shrub cover • Foraging habitat for ungulates
Wetland ecosystems	MF, MO, WA, WB, WC, WF, WS, WT, WO	13,810.0	• Foraging and calving habitat for caribou [2] • Denning habitat for foxes [2] • Nesting habitat for waterfowl and snowy owl[2] • High cover of some culturally valued vegetation species, including cloudberries and bog cranberries
Marine Beaches (including old beach heads), Shores, Marshes and Estuaries	MB, ME, MH, MM	792.1	• Gentle terrain used for trapping of wolves, foxes and wolverine [2] • Higher likelihood of supporting rare plants, plant communities [1] • Between Bathurst Lake and Bathurst Inlet, old beach heads resemble exposed esker crests • Exposed soils associated with active and old beaches can support a high cover of some culturally valued vegetation species
Total		**29,277.9**	

[1] *Source: Appendix 1 of Rescan (2013a)*
[2] *Source: KIA (2012)*

Landscape types within which the majority of rare plant species were located (Appendix 1 of Rescan 2013a) included the following:

- cliffs;

- beaches;
- sparsely vegetated gravel and sand near-shore benches;
- marine and lake shorelines; and
- estuaries, including brackish marshes, open water channels and saline mudflats.

Reflecting the uniqueness of landforms and ecosystems towards the coast, nearly 60% of all rare plant identifications were located within one kilometre of Bathurst Inlet. The Inlet and surrounding landscape are described as a particularly high conservation priority for rare plants and lichens, due to the wide diversity of habitats, numerous identified rare plant and lichen populations, and overall high species diversity (Rescan 2013a). Described further in Section 4.5, the Marine Laydown Area (MLA) Potential Development Area (PDA) comprises a relatively small area of shoreline and marine-influenced ecosystems within the LSA and RSA.

Habitats in the vicinity of Bathurst Inlet meriting special note include estuaries, which were found to harbour significant numbers of rare vascular plant species, a narrow canyon on the west shore of the Inlet (south of the MLA PDA), which bore a significant percentage of the rare species found in the Project Area, and sparsely vegetated, gravelly and sandy benches, which were found to support a concentration of rare plant and lichen species. Although rare species (primarily vascular plants) were identified along the shore in the southwest corner of the MLA PDA, none of the specific population 'hotspots' identified within Appendix 1 of Rescan (2013a) occurred within the PDA. Rare plants were commonly observed along the length of the Inlet shoreline between the MLA PDA and the Western River estuary, to the southeast. Many of these occurrences were outside of the LSA, but within the RSA.

Consistent with the assessment of potential cliff locations within the assessment of raptor habitat, a slope theme was created with slopes greater than 25% considered potential cliff habitat. To avoid confusing cliff ecosystems with esker features, the TEM esker ecosystems are excluded from the slope theme.

Described within Appendix 1 of Rescan (2013a), cliffs and their associated ledge and talus features possessed the greatest number of identified rare plant and lichen species. Most sampled cliffs were located in the vicinity of Bathurst Inlet; occurrence of cliffs further inland is rare. Features of cliffs that contribute to the unique flora include:

- a concentration of different microhabitats, with significant differences in temperature, shade, aspect, and snow duration;
- enrichment with mineral nutrients, due to precipitation of solutes from seepage water, that creates small hotspots of species diversity;
- a dense cover of cyanobacteria on seepage cliffs, which are among the only organisms that can convert atmospheric nitrogen into compounds vital to plant growth; and
- concentrated guano associated with nesting and perch sites, which promotes unique conditions conducive to rare plant establishment and growth.

Summarized in Table 4.3-2 and within the 2012 Wildlife Baseline Report (Rescan 2013d; Appendix V5-6C), cliffs provide nesting, denning, foraging, hunting, thermal and security, and insect avoidance habitat for many bird and mammal species. As these features are often too small to identify within a TEM polygon, or are not visible at the mapping scale, potential cliff habitat within the LSA was estimated by theming of slopes in excess of 25%.

Esker ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and are used as movement corridors and security habitat for many wildlife species.

During TEM field surveys, caribou were frequently observed travelling and resting upon esker crests. High land features such as eskers provide additional value to wildlife in the form of relief from heat and insects (KIA 2012). Although few rare plant species were identified in esker habitats, due to their well-drained sandy and gravelly soils, they represent a contrast to the dominant rocky or frost-heaved, poorly-drained soils that dominate much of the inland portion of the project area (Appendix 1 of Rescan 2013a). They generally have frozen cores, consistent with the surrounding continuous permafrost environment. However, those that are hydraulically connected to surface waterbodies that do not freeze to the bottom in winter months have been shown to exhibit talik, or unfrozen ground, within and beneath their cores. Esker landforms in the vicinity of George, Bob, and Dragon lakes may exhibit perennially non-freezing temperatures within and beneath their cores. Some plant species with berries of cultural value, such as Paungak (crowberries or blackberries) grow well on exposed esker soils.

Bedrock-dominated ecosystems are typically sparsely-vegetated, occurring within a matrix of bedrock outcrops and shallow, rapidly-drained soils. Summarized in Appendix 4 of Rescan (2013a), the BL association is among the driest ecosystem type in the LSA. Restricted to crest positions on bedrock outcrops with very thin morainal or organic veneers, it is limited in extent. The dry, windswept areas associated with this ecosystem often support an abundance of lichens, providing an important forage resource for caribou.

Riparian shrub ecosystems provide an important food source for ungulates, nesting habitat for birds and security and thermal habitat for many wildlife species. The deciduous shrub layer associated with the marine riparian (MR) association, mapped in the Marine Laydown Area, is taller and more diverse than the riparian units within the Goose Property Area. Shrubs in riparian ecosystems along slopes adjacent to Bathurst Inlet often reached two metres in height, much taller than the typical height throughout the inland Goose Property Area, which rarely exceed 1 metre.

Wetland ecosystems, in addition to providing an important forage source for caribou, represent calving habitat for caribou, denning habitat for foxes, and nesting habitat for waterfowl and snowy owls (KIA 2012) Described within Rescan (2013a), Nunavut does not presently have a defined site-level classification system for wetlands and it is therefore not possible to report on rarity of specific types. However, there are a number of wetland-related landscape features present within the Arctic that are considered uncommon or unique (NWT Department of Environment and Natural Resources 2012), including saline sulphur springs, pingos and karst wetlands.

Marine ecosystems, particularly estuaries, are recognized within Appendix 1 of Rescan 2013a as important habitat for rare vascular plants, some of which are ranked as globally rare. Species growing within estuarine marshes, open-water channels and saline mudflats are reliant upon the unique clayey, brackish estuarine soils. Other marine ecosystems near the Bathurst Inlet shoreline that support rare plant species include open and sparsely-vegetated gravelly and sandy benches, and eroding marine sediments. Beaches and old beach heads, the latter often possessing vegetation communities similar to exposed esker crests, are also assessed as special landscape features.

4.3.3 Supporting and Supplemental Information

A detailed report on rare plant and lichen species throughout the LSA and RSA is provided in Appendix 1 of Rescan (2013a), which can be found in Appendix V5-4A. Although potential effects on rare and culturally valued plants are not individually assessed, ecosystems or features with highest potential to support rare plant species, such as cliffs and marine beaches, shores and wetlands, are encompassed within the assessment of special landscape features. Table 4.3-2 identifies those features with highest likelihood of supporting rare and culturally valued plants. Section 4.3.1 discusses the plant species of traditional importance.

4.4 SPATIAL AND TEMPORAL BOUNDARIES

Spatial and temporal boundaries, as developed for the assessment of potential effects on vegetation and special landscape features, are outlined within Sections 4.4.1 and 4.4.2.

4.4.1 Spatial Boundaries

Terrestrial ecosystems are summarized and assessed within local and regional study areas.

4.4.1.1 Local Study Area

The vegetation Local Study Area (LSA), depicted in Figure 4.1-1, provides sufficient land base to effectively demonstrate the local context for baseline ecosystem distributions. It is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter access roads. To incorporate natural boundaries wherever possible, sub-watershed boundaries were retained as the LSA boundary where the watershed(s) encompassed the proposed Project components and were considered at least as large as the area of potential loss or degradation. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs.

Within the LSA, the project-related effects (Section 4.5) are assumed within the PDAs. Described within Section 4.5.2.1, the current footprints represent a small percentage of the respective PDA areas.

4.4.1.2 Regional Study Area

The vegetation Regional Study Area (RSA), depicted in Figure 4.1-3, is the same as the terrestrial wildlife RSA which is based on the expected regional use by wildlife species assessed as valued components.

4.4.2 Temporal Boundaries

The temporal boundaries used for the assessment are aligned with the Project phases, as follows:

- Mobilization and Construction — 4 years;
- Operation — 10 years;
- Reclamation and Closure — 8 years; and
- Post-closure Monitoring — 5 years.

Each Project phase will likely have potential interaction with vegetation and special landscape features, including direct, indirect, short-term, and long-term interactions. Direct, long-term effects are expected during the Construction phase, while a variety of indirect short-term effects could occur throughout all phases.

4.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

4.5.1 Methodology Overview

Described in the General Assessment Methodology Chapter (Volume 9, Chapter 1), the effect assessment process comprises a number of steps that collectively assess the manner in which the Project will interact with the terrestrial environment to produce effects on vegetation and special landscape features. The project-related effects assessment process can be summarized as follows:

1. Potential interactions between the Project, vegetation, and special landscape features were identified.

2. Potential effects that could result from these interactions were characterized.
3. Mitigation or management measures that could eliminate or reduce the potential effects were identified.
4. Residual effects that remain after mitigation and management measures have been applied were characterized.
5. The significance of potential residual effects was determined.

The change between the mapped area (in hectares) of terrestrial ecosystems at baseline versus the area remaining after loss of the two Back River Project PDAs formed the basis for the assessment of potential residual effects. Losses from vegetated ecosystems are reported as a percentage of their respective baseline distributions within the LSA.

Defined within Section 2.4.5 of the General Assessment Methodology Chapter (Volume 9, Chapter 1), attributes used to evaluate potential residual effects, including determination of significance, include the direction and nature, magnitude, geographic extent, frequency, timing, duration, and reversibility. The environmental sensitivity of the landscape that is subject to potential effects is also a consideration.

Defined magnitude or significance thresholds for vegetation and special landscape feature loss do not presently exist for Arctic ecosystems. Described within the assessment methodology sections for the wildlife VECs in Volume 5, Chapters 5 through 10, as vegetated ecosystems constitute habitat for wildlife, the magnitude rating scheme (Table 4.5-1) was developed through the use of threshold values derived from literature on wildlife habitat loss and disturbance.

Table 4.5-1. Definitions of Magnitude Criteria for Vegetation and Special Landscape Features Residual Effects

Magnitude	Description
Negligible	Loss less than 1% of LSA availability
Low	Loss between 1% and 10% of LSA availability
Medium	Loss between 10.1% and 20% of LSA availability
High	Loss greater than > 20% of LSA availability, or loss between 10.1% and 20%, for ecosystems considered of Very Low resiliency

Described in Price, Roburn, and MacKinnon (2009), habitat loss in excess of 30% was identified as a transition from low risk to a higher risk of uncertain magnitude within coastal forests of British Columbia. Consistent with the methodology for the wildlife habitat assessments, although 30-40% habitat loss can be defined as potentially causing unacceptable risks to species (Scrimgeour, Hvenegaard, and Tchir 2008; Price, Roburn, and MacKinnon 2009), a precautionary approach is adopted for this Project such that a high magnitude effect is predicted if the loss of vegetated ecosystems or special landscape features exceeds 20% of their respective distribution, or availability, within the LSA. High magnitude effects are also predicted for ecosystems of very low resiliency, such as esker-related ecosystems, where loss occurs in the range of 10.1% to 20%.

Potential effects range from negligible magnitude, where there is assumed to be no detectable change to baseline distributions, to high magnitude, where loss is assumed to result in a long-lasting effect on the distribution or availability of vegetation communities in the LSA.

The outcome of the significance determination indicates the effect on ecosystem integrity and function, on the sustainability of vegetation, or on its capacity to meet the present and future needs. Despite

assessments of potential loss and magnitude determinations at the level of specific ecosystems or generalized classes, the final magnitude for significance determination is based upon the loss of vegetated ecosystems and special landscape features, as a whole, not by specific ecosystems or features.

4.5.2 Potential Interactions with Project and Characterization

Development of Project infrastructure within the Goose Property and Marine Laydown Area (MLA), as identified within the Project Description (Volume 2), will result in loss and degradation of vegetation and special landscape features, which are considered throughout the assessment to be of direct, long-term consequence.

To characterize and assess the potential effects, all potential effects were examine using two indicators:

1. Loss of vegetation and special landscape features; and
2. Degradation of vegetation.

Table 4.5-2 identifies the main Project components proposed within the Goose Property and MLA expected to result in the loss of vegetation and special landscape features or degradation of vegetation. A more detailed Project interaction matrix, provided in Volume 9, Chapter 1, identifies proposed Project facilities and activities with potential to interact with vegetation and unique landscape features, such as eskers. The activities are presented by Project phase.

Table 4.5-2. Potential Effects on Vegetation and Special Landscape Features

	Loss	Degradation
Goose Property Area		
Open pits (Main Pit, Umwelt Pit, and Llama Pit)	X	X
Haul and access roads	X	X
Winter roads		X
Stockpiles	X	
Waste rock storage areas	X	
Explosives storage areas	X	
Goose Property Area *(cont'd)*		
Tailings Storage Facility	X	
Quarries	X	X
Landfill	X	X
Camp / Plant site	X	X
Airstrip	X	X
Other infrastructure (i.e., diversion channels, water intakes)	X	
Marine Laydown Area		
Barge landing location	X	X
Haul and access roads	X	X
Winter roads		X
Other infrastructure (i.e., interception ditch)	X	

4.5.2.1 Loss of Vegetation and Special Landscape Features

The vast majority of vegetation loss will occur from physical clearing during the Construction and Operation phases, although small incremental losses could also occur during activity associated with

the Reclamation and Closure phase. To maximize flexibility in infrastructure siting, this assessment assumes complete loss of vegetation within each of the PDAs. In actuality, development will be confined to the Project footprint, and the realized losses will be considerably less (Table 4.5-3).

Table 4.5-3. Summary of Project Footprints within the Potential Development Areas

Potential Development Area	PDA (ha)	Footprint Area (ha)	% of PDA
Goose Property PDA	5,427.0	669.0	12.3
Marine Laydown Area PDA	546.2	150.0	27.5
Total	5,973.2	819.0	13.7

Summarized within Section 4.5.4, potential loss of vegetation and special landscape features is characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on vegetation diversity, productivity, and resiliency. The latter three attributes may help predict how an ecosystem functions, for example, as wildlife habitat, and how readily an ecosystem is likely to respond to and recover from anthropogenic disturbances or other environmental stressors.

Within Section 4.5.4.1, the total loss of vegetation and special landscape features is assessed as a net change (in hectares) and expressed as a percentage of baseline distribution, or availability, within the LSA.

4.5.2.2 Degradation of Vegetation

In assuming total loss within the PDA boundaries, estimates are assumed to also encompass areas adjacent to infrastructure that are subject to potential degradation. Forbes, Ebersole, and Strandberg (2001) describe disturbance as a reduction in vegetation species richness or biomass, or any other sudden deviation from the normal state. Vegetation degradation can result from physical disturbances that produce patches of bare soil, thus enabling the establishment of invasive plant propagules and increasing potential for soil erosion. Recovery from any disturbance in Arctic environments is very slow (Miller 1989; Forbes, Ebersole, and Strandberg 2001). Disturbances that could result from the Project include trampling of vegetation, removal, or disturbance of the organic layers, and rutting from vehicles and machinery. The introduction and spread of invasive or exotic plant species could occur as a result of equipment and vehicles, including from aircraft and marine vessels. As they can aggressively compete with and displace native vegetation when introduced into natural settings (Haber 1997), invasive plants pose a threat to the diversity and abundance of native baseline vegetation.

Vegetation could also be degraded from airborne fugitive dustfall, including from increases in metal concentrations or bio-availability; airborne contaminants from emission sources, including NO_2 and SO_2; and from acid (nitrogen) deposition. Other potential degradation effects could occur as a result of Project-related changes to water quality and quantity, permafrost, and snow accumulation. Although localized degradation could result from development and use of the winter roads, including damage to tussock tundra ecosystems and short-term reductions in the active growth layer thickness (Gary Schultz, Alaska Department of Natural Resources, in Bailey 2012), project design has incorporated the crossing of water features as much as possible to minimize potential effect on terrestrial ecosystems.

Given the importance of lichen-dominated ecosystems to caribou, the paragraphs below briefly highlight the higher sensitivity of lichens to potential degradation from fugitive dust deposition.

Fugitive dust can have various effects on the health of vegetation depending on the amount and frequency of dusting, the chemical properties of dust, and receptor plant species. Cited in Auerbach, Walker, and Walker (1997), Rao (1982) identifies nonvascular taxa as especially vulnerable to dust disturbance due to structural characteristics rendering them more susceptible to the effects of atmospheric pollutants. Described by Berryman, Straker, and Straker (2009), in studies near remote mining operations, lichens are one of the most sensitive ecosystem components and can serve as "early-warning" indicators in air quality and effects monitoring programs. They lack the ability to control the exchange of water, nutrients, gases, and particles with the external environment and are not influenced by natural elements in soils, due to the lack of roots and a vascular system. As a result, sampling and monitoring of lichen tissue enables differentiation between natural soil-borne and anthropogenic airborne element enrichment Berryman, Straker, and Straker (2009).

In their assessment of dust effects along high-speed gravel highways in Arctic Alaska, Walker and Everett (1987) reported the band of snow-free vegetation within 30 m to 100 m of roads attracts waterfowl, ptarmigan, raptors, caribou, grizzly bears and other predators in early spring. Other dust-induced effects described by Walker and Everett (1987) include the development of roadside thermokarst features, or irregular patterns of slumps and depressions. Everett (1980), within Auerbach, Walker, and Walker (1997), reported a maximum dustfall zone of 300 metres from roads, beyond which remained essentially undisturbed by dust. This coincides well with the dustfall estimates for the Project, where the majority of dustfall is predicted within 100 m, with very little change beyond approximately 300 m.

Air quality modelling was conducted to predict the emissions and fugitive dust that could result from the Project (Volume 4, Chapter 3). Results from the air quality modelling were used for quantification of the potential effects of fugitive dust on vegetation and soils (see the Country Foods chapter (Volume 8, Chapter 5) and the Human and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of this quantitative modelling showed that fugitive dust will not change metal levels in vegetation or soils above baseline levels within the Country Foods study area (Volume 8, Chapter 5). A qualitative assessment was conducted on the potential effects of emissions on vegetation (Volume 8, Chapter 5) and no residual effects were identified. Hence, vegetation is not expected to be degraded from the Project due to fugitive dust, airborne emissions, or other media, and potential degradation is not discussed further.

For potential effects on water quality and quantity, refer to Volume 6, Chapter 4 (freshwater quality) and Volume 6, Chapter 1 (surface hydrology).

4.5.3 Identification of Mitigation and Management Measures

To minimize potential for loss and degradation of vegetation and special landscape features, mitigation and management measures have been embedded throughout the Project design and others will continue throughout construction and operation. The need for specific adaptive management and monitoring activity will be determined by the results of many of the plans provided in Volume 10.

Specific Plans that will help minimize the loss or degradation of vegetation and special landscape features include the:

- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17);
- Fuel Management Plan (Volume 10, Chapter 4);
- Spill Contingency Plan (Volume 10, Chapter 5);
- Site Water Monitoring and Management Plan (Volume 10, Chapter 7);

- Ore Storage Management Plan (Volume 10, Chapter 8);
- Mine Waste Rock Management Plan (Volume 10, Chapter 9);
- Waste Management Plan (Volume 10, Chapter 10);
- Incineration Management Plan (Volume 10, Chapter 11);
- Hazardous Materials Management Plan (Volume 10, Chapter 12);
- Explosives Management Plan (Volume 10, Chapter 13);
- Road Management Plan (Volume 10, Chapter 14);
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16);
- Aquatic Effects Management Plan (Volume 10, Chapter 19);
- Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20);
- Tailings Management Plan (Volume 10, Chapter 22); and
- Mine Closure and Reclamation Plan (Volume 10, Chapter 29).

4.5.3.1 Mitigation for Loss of Vegetation and Special Landscape Features

The following mitigation measures and best management practices will reduce the potential for loss of vegetation and special landscape features:

- the Project has been designed to employ winter road-only access corridors that travel primarily over lakes and rivers, thereby minimizing potential negative effects on terrestrial vegetation and limiting dust emissions;
- infrastructure, waste rock storage areas, and the TSF at the Goose Property have been confined to the local watersheds where the deposits are located, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment;
- the clearing of vegetation and removal of soil from unique landscape features will be minimized, including eskers, wetlands, exposed bedrock, cliffs etc., which often provide high value habitat to wildlife and may support sensitive vegetation communities and growth forms. Exceptions to this management will only be considered after assessing and weighing all implications; and
- tailings disposal methods have been designed to reduce beach/dust sources and generation.

4.5.3.2 Mitigation for Degradation of Vegetation

The following mitigation measures and best management practices will reduce the potential for degradation of vegetation and special landscape features:

- the design of haul roads has been optimized to minimize the distance travelled which will minimize emissions associated with construction and operation;
- all vehicles and machinery will restrict travel to designated road surfaces; thus avoiding creation of ruts in vegetated ecosystems;
- the discharge heights from the crushers onto conveyers will be minimized, and the discharge heights from conveyors onto stockpiles will be minimized. The discharge from crushers onto conveyors or into other equipment will be enclosed as far as is practicable (e.g., free fall of materials from conveyors carrying material will be fitted with a full hood such as a plastic chute);
- loads carried by vehicles will be enclosed or covered when possible;

- storage areas will be kept in a condition that does not give rise to measurable dust emissions;
- windbreaks or fences may be installed around known problem areas or stockpiles to limit the dispersion of dust emissions from equipment and stockpiles, or activities likely to generate dust;
- regular wheel-cleaning will be undertaken of vehicles travelling around and leaving the site;
- all-weather roads (local site roads) will be regularly compacted and kept in good repair;
- vehicles will be driven at designated speeds on site roads;
- water or other dust suppressant (non-wildlife attracting) will be used for site roads if needed to minimize dust from ore and waste rock haulage and grading, when ambient air temperatures permit;
- water sprays or dust suppression fluids will be used to suppress dust generation from equipment in the crushing facility. Dust suppression methods will be approved by the Government of Nunavut as outlined in the Nunavut environmental guideline for dust suppression (Government of Nunavut 2002) and will be suitable for use at below freezing temperatures; and
- conditioning materials which are likely to generate dust will be sprayed with water prior to transfer.

4.5.3.3 Adaptive Management

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include:

- if results from the Site Water Monitoring and Management Plan show non-compliance related to tundra discharges; or
- if results from the Wildlife Mitigation and Monitoring Program (WMMP), which will monitor select wildlife species and habitat around the mine infrastructure and activities, show adverse effects to wildlife or wildlife habitat.

4.5.3.4 Monitoring

Monitoring Plans, outlined in Section 4.5.3, outline programs to monitor air quality, water, and waste management, which will help eliminate or minimize effects to vegetation and special landscape features.

A Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) will be in place that outlines the WMMP that will be carried out during all phases of the Project. The WMMP will include monitoring select wildlife species.

4.5.4 Characterization of Residual Effects

Despite application of mitigation and management measures, and best management practices, presented in Section 4.5.3, loss of vegetation and special landscape features will result from construction and operation of Project facilities within the two PDAs. The estimated loss of vegetation and special landscape features is characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on:

1. distribution of vegetated terrestrial ecosystems;
2. distribution of special landscape features; and
3. vegetation diversity, productivity, and resiliency.

4.5.4.1 Loss of Vegetation and Special Landscape Features

To enable flexibility in siting Project infrastructure, complete loss of vegetation is assumed within each of the PDAs (Goose Property and MLA PDAs). Consequently, degradation effects are also assumed to occur throughout the entire PDA. The areas assessed within this section include the total area within which the effects of loss could occur. Although localized effects could occur, loss resulting from construction and use of the connecting winter roads is not assessed.

Direct loss of vegetation due to clearing activities within the footprint will result in local long-term decreases in the abundance, diversity, and percent cover of vegetation. Project activities may also result in the disturbance and degradation of terrestrial vegetation adjacent to the cleared areas and adjacent to active infrastructure such as roads, camp / plant sites, waste rock storage areas etc. Depending on the nature of disturbance, they could include direct or indirect, and short or long-term effects.

The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of availability within the LSA and RSA. In actuality, the area developed, and subject to loss, will be much smaller as determined by the final Project design. Consequently, estimates throughout this section represent maximum values. Loss estimates are characterized and reported in relation to the distribution of vegetated ecosystems and special landscape features, and on the basis of their potential effect on vegetation diversity, productivity, and resiliency.

Vegetated Terrestrial Ecosystems

Table 4.5-4 summarizes assumed areas of loss for each mapped ecosystem within the PDAs. Although reported as loss in the text below, it is assumed that localized physical degradation resulting from compaction, loss of organic matter, erosion, or the introduction of invasive plant species, could occur concurrently. Total loss estimates are expressed as a percentage of the mapped baseline distribution, or availability, within the LSA. Potential loss of vegetation from development and use of winter roads is assumed to be largely mitigated through proper design and seasonal use of winter roads, as summarized within Chapter 6 of the Project Description (Volume 2).

Table 4.5-4. Summary of Loss within Potential Development Areas

Ecosystem Class	Ecosystem Name	TEM Map Code	LSA (ha)	Potential Development Areas		Total PDA Loss (ha)	Loss within LSA (%)
				Goose Property (ha)	MLA (ha)		
Bedrock	Cliff	BC	8.1	0.0	0.0	0.0	0.0
	Bedrock – lichen veneer	BL	6,704.4	52.0	0.0	52.0	0.8
	Bedrock Outcrop	BR	3,381.8	155.1	0.0	155.1	4.6
	Talus	BT	4.6	0.0	0.0	0.0	0.0
	Blockfield / Boulderfield	TB	154.1	0.0	0.0	0.0	0.0
Disturbed/ Barren	Existing Exploration Camp	DR	10.0	6.8	0.0	6.8	68.0
	Disturbed Vegetation	DV	0.7	0.0	0.0	0.0	0.0
	Road surface	DZ	3.2	0.0	0.0	0.0	0.0
	Exposed Soil	ES	176.8	0.3	0.0	0.3	0.2

(continued)

Table 4.5-4. Summary of Loss within Potential Development Areas (completed)

Ecosystem Class	Ecosystem Name	TEM Map Code	LSA (ha)	Potential Development Areas		Total PDA Loss (ha)	Loss within LSA (%)
				Goose Property (ha)	MLA (ha)		
Esker	Esker Crest	EC	577.6	2.2	0.0	2.2	0.4
	Dwarf Shrub Esker	EH	570.2	8.6	0.0	8.6	1.5
	Shrubby Esker	EW	189.3	0.0	0.0	0.0	0.0
Marine Beach	Marine beach	MB	59.5	0.0	14.3	14.3	24.0
	Old beach head	MH	476.3	0.0	53.5	53.5	11.2
Tundra	Dry-Sparse Tundra	TH	22,876.0	574.3	0.0	574.3	2.5
	Mesic Dwarf Shrub Tundra	TL	40,373.2	2,338.8	0.0	2,338.8	5.8
	Shrubby Tundra	TS	11,144.4	910.6	0.0	910.6	8.2
Tundra Marine	Marine shrubby tundra	MS	1,831.1	0.0	10.1	10.1	0.6
	Marine dwarf shrub tundra	MT	5,447.3	0.0	275.5	275.5	5.1
Riparian	Floodplain - Low	RL	36.5	0.0	0.0	0.0	0.0
	Floodplain - Middle	RM	3.8	0.0	0.0	0.0	0.0
	Willow Riparian	RW	1,405.1	64.2	0.0	64.2	4.6
Riparian Marine	Marine riparian shrub	MR	439.6	0.0	89.8	89.8	20.4
Wetland	Water Sedge Marsh	WA	2,312.2	101.6	10.4	112.0	4.8
	Raised Bog Complex	WB	4,147.3	231.5	5.4	236.9	5.7
	Cottongrass - Sedge Fen	WC	3,263.6	132.6	0.0	132.6	4.1
	Undifferentiated Fen	WF	2,525.1	78.0	0.0	78.0	3.1
	Shallow Open Water	WO	81.2	4.5	0.0	4.5	5.5
	Willow – Sedge Fen	WS	366.8	23.2	0.0	23.2	6.3
	Tussock Meadow	WT	64.5	3.6	0.0	3.6	5.6
Wetland Marine	Estuary marsh	ME	4.2	0.0	0.0	0.0	0.0
	Saline Fen	MF	993.5	0.0	73.3	73.3	7.4
	Saline Marsh	MM	252.1	0.0	13.7	13.7	5.4
	Saline shallow open water	MO	55.8	0.0	0.0	0.0	0.0
Freshwater	Lake	LA	17,961.8	461.9	0.0	461.9	2.6
	Pond	PD	6,173.7	273.7	0.0	273.7	4.4
	River	RI	289.6	3.5	0.2	3.7	1.3
Marine Ocean	Saltwater	MW	4.1	0.0	0.0	0	0.0
Total LSA			**134,369.1**	**5,427.0**	**546.2**	**5,973.2**	**4.4**
Total LSA excluding non-vegetated units[1]			**109,749.2**	**4,680.8**	**546.0**	**5,226.8**	**4.8**

[1] Excluding non-vegetated freshwater and saltwater areas (lakes, ponds, rivers and ocean), and existing roads and exploration camps.

An estimated 5226.8 ha of vegetated ecosystems would be lost from development of the PDAs, representing 4.8% of the availability within the LSA (Table 4.5-4). Of the vegetated ecosystems within the RSA (summarized in Table 4.1-2, excluding the Marine Ocean, Freshwater and the Disturbed/Barren Ecosystem Class), the loss of vegetation represents 0.5% of availability. These effects are considered of low and negligible magnitude within the LSA and RSA, respectively. Percentage losses due to loss of the PDAs within the Goose Property, and MLA represent 4.3% and 0.5%, respectively, of the distribution of vegetated ecosystems within the entire LSA.

Potential losses from specific vegetated ecosystems range from <1% (negligible effect) to 24% (high magnitude effect). Of the thirty vegetated ecosystems (Table 4.5-4), excluding waterbodies and ecosystems within the Disturbed/Barren Ecosystem Class, negligible effects are estimated for 11 ecosystems, low magnitude effects are estimated for 16 ecosystems, medium magnitude effects are estimated for one ecosystem, and high magnitude effects are estimated for two ecosystems. The highest magnitude loss is estimated from the MB (Marine Beach) ecosystem within the MLA, with 14.3 ha (24%) loss of the mapped area in the LSA.

Table 4.5-5 summarizes areas of loss by ecosystem class. For each class, loss is expressed as total hectares lost within each PDA, and as a percentage of the total availability of each class within the LSA. Losses within most ecosystem classes are below 10% of their respective availability within the LSA, within the range of low magnitude effect. Within the Wetland Ecosystem Class, estimated losses are below 10% and are considered low. Within the Marine Beach Ecosystem Class, the estimated loss of 12.6% is considered a high magnitude effect due to the very low resiliency of these sparsely-vegetated ecosystems.

Table 4.5-5. Summary of Loss, by Ecosystem Class, within Potential Development Areas

		Potential Development Area			
Ecosystem Class	**LSA (ha)**	**Goose Property (ha)**	**MLA (ha)**	**Total PDA Loss (ha)**	**% Loss within LSA**
Bedrock	10,253	207.1	0.0	207.1	2.0
Disturbed / Barren	190.7	7.1	0.0	7.1	3.7
Esker	1,337.1	10.8	0.0	10.8	0.8
Marine Beach	535.8	0.0	67.8	67.8	12.6
Tundra	74,393.6	3,823.7	0.0	3,823.7	5.1
Tundra Marine	7,278.4	0.0	285.6	285.6	3.9
Riparian	1,445.4	64.2	0.0	64.2	4.4
Riparian Marine	439.6	0.0	89.8	89.8	20.4
Wetland	12,760.7	575.0	15.8	590.8	4.6
Wetland Marine	13,05.6	0.0	87	87	6.7
Freshwater	24,425.1	739.1	0.2	739.3	3.0
Marine Ocean	4.1	0.0	0.0	0.0	0.0%
Total	**134,369.1**	**5,427.0**	**546.2**	**5,973.2**	**4.4**
% of LSA[1]		**4.3%**	**0.5%**	**4.8**	

[1] *Excluding non-vegetated freshwater and saltwater areas (lakes, ponds, rivers and ocean), and existing roads and exploration camps.*

An estimated loss of 20.4% occurs from ecosystems within the Riparian Marine Ecosystem Class, within the range of high magnitude effect. This ecosystem class, influenced by a maritime climate and found

on marine-derived soils adjacent to Bathurst Inlet, supports a taller deciduous shrub layer, with greater diversity of species, than does the Riparian Ecosystem Class. Summaries of estimated losses, specific to each PDA, are provided in the paragraphs below.

Goose Potential Development Area

The majority of vegetation loss (by percentage) within the Goose PDA is expected from the Tundra (71%), Wetland (11%), and Bedrock (4%) Ecosystem Classes (Table 4.5-5). Within the Tundra Ecosystem Class, the loss will occur within the TL, TS, and TH ecosystems, representing 6%, 8%, and 3% of their respective LSA distributions (Table 4.4-5 and Table 4.5-5). Including all ecosystems within the Tundra Ecosystem Class, losses comprise 5% of their collective distribution within the LSA. Within the Wetland Ecosystem Class, the largest losses are estimated within the WS, WB, WT, and WO ecosystems. The Project will result in removal of 6%, of each of these wetland ecosystems within the of their respective LSA classes. Including all ecosystems within the Wetland Ecosystem Class, losses comprise 5% of their collective distribution within the LSA. Within the Bedrock Ecosystem Class, largest loss is estimated within the BR ecosystem, representing 5% of the LSA distribution. Including all ecosystems within the Bedrock Ecosystem Class, losses comprise 2% of their collective distribution within the LSA.

Collectively totaling less than 2% of the Goose PDA, losses are expected within the Riparian, Esker and Disturbed / Barren Classes. Within the Riparian Ecosystem Class, loss from the RW ecosystem represents 5% of its distribution within the LSA and, within the Esker Ecosystem Class, losses from the EC and EH ecosystems represent less than 2% of their LSA distribution. The existing Goose exploration camp facility accounts for most of the area mapped within the Disturbed / Barren Ecosystem Class.

MLA Potential Development Area

Marine-influenced ecosystems dominate the Marine Laydown PDA. The majority of vegetation loss (by percentage) is expected from the Riparian Marine (20%) and the Marine Beach (13%) Ecosystem Classes (Table 4.5-5). Vegetation loss is also expected within the Wetland Marine and Tundra Marine Ecosystem Class, which account for 7% and 4%, respectively.

Loss within the Riparian Marine Ecosystem Class is expected to occur solely within the Marine riparian shrub (MR) ecosystem. Loss within Marine Beach Ecosystem Class will occur in active beach shores and old beach heads (MB and MH ecosystems, respectively) which are 24% and 11% of their respective LSA distributions.

Within the Wetland Marine Ecosystem Class, most loss is estimated from the Saline Fen (MF) ecosystem, with smaller loss from the Saline Marsh MM ecosystems. Respective losses within these units represent 7% and 5% their LSA distributions. Within the Tundra Marine Ecosystem Class, losses comprise 4% of their collective distribution within the LSA. Collectively totaling just 2% of the MLA PDA, small losses are expected within the Wetland Ecosystem Classes, all within the Water Sedge Marsh (WA) and Raised Bog Complex (WB) ecosystems. Respective losses within these units collectively represent 0.5% of their LSA distributions.

Special Landscape Features

Table 4.5-6 summarizes the potential loss of special landscape features resulting from development of the Goose Property and MLA PDAs. The final column represents the loss as a percentage of availability within the LSA.

Table 4.5-6. Summary of Loss from Special Landscape Features within the Potential Development Areas

Special Landscape Feature	TEM Map Code(s)	LSA (ha)	Goose PDA (ha)	MLA PDA (ha)	Total Loss (ha)	% of Availability in LSA
Cliffs[1]	BC + slope theme	1,367.5	0.2	1.1	1.3	0.1
Esker ecosystems	EC, EH, EW	1,337.1	10.8	0.0	10.8	0.8
Bedrock-lichen and outcrop ecosystems	BL, BR	10,086.2	207.1	0.0	207.1	2.1
Riparian ecosystems	RL, RM, RW, MR	1,885.0	64.2	89.8	154.0	8.2
Wetland ecosystems	MF, MO, WA, WB, WC, WF, WO WS, WT	13,810.0	575.0	89.0	663.9	4.8
Marine Beaches (including old beach heads), Shores, Marshes and Estuaries	MB, ME, MH, MM	792.1	0.0	81.5	81.5	10.3
Total		**29,277.9**	857.3	**261.4**	**1118.6**	**3.8**

[1] As cliffs are often too small to be identified using TEM, potential cliff habitat is based upon modelling slopes > 25% (source: LiDAR data); consistent with wildlife habitat assessment for potential raptor nesting habitat.

With the exception of the marine-associated features, with a collective medium magnitude loss of 10.3%, the potential losses of special landscape features are each below 10% of their respective LSA availabilities and are considered low magnitude (Table 4.5-6). Effects are largely concentrated within wetland, bedrock-lichen and bedrock outcrop ecosystems and riparian ecosystems. The largest area of loss within each of these landscape features occurs with the loss of the Goose PDA.

Vegetation Diversity

Species richness is frequently used to characterize biodiversity across scales (Magurran 1988; Gould and Walker 1999). Vascular richness increases as the complexity of landscapes, and therefore number of plant communities, increases. As well, decreasing heterogeneity potentially results in reduction of overall biodiversity (Holmes et al. 2013). Using species richness as a parameter for diversity analysis is complicated by trend differences between vascular plants, lichens and bryophytes, when assessed along environmental gradients such as pH and moisture (Gould and Walker 1999). For example, whereas lichen richness decreased with increasing moisture, bryophyte richness generally increased and there was no significant difference between vascular plants.

To quantify the estimate of vegetation diversity loss, diversity estimates for each of the TEM-derived ecosystems within the LSA are adapted from the results of a multiple-scale vegetation analysis conducted by Gould (1998) along the Hood River valley, west of Bathurst Inlet. Gould's research was conducted within a relatively rich, riparian region, whereas the majority of the LSA (with exception of the marine-influenced ecosystems near Bathurst Inlet) occurs within nutrient poor, upland tundra-dominated ecosystems. As expected for poorer sites and colder continental climates, the total species recorded within equivalent TEM ecosystems are typically lower than reported by Gould within the Hood River region.

Gould (1998) summarizes the number of vascular plants, bryophytes and lichens within 24 unique vegetation communities that were derived through a supervised classification of Landsat TM data; species

richness ranged from 5 (the "*wet sedge tundra 3*") to 33 (the "*moist nonacidic shrub tundra*"). This range was used to derive arbitrary diversity class groupings for the Back River diversity assessment (Table 4.5-7). However, the relative proportions and richness estimates in Gould's assessment are assumed to be applicable within the LSA; based on the TEM diversity summary, albeit a comparatively smaller dataset, a similar trend was apparent indicating that higher relative diversity was associated with heath and shrub-dominated tundra units and lower diversity was associated with the wettest sedge-dominated units.

Table 4.5-7. Diversity Class and Estimated Species Richness

Diversity Class	Species Richness Estimates[1]
Very Low	5 to 11
Low	12 to 20
Moderate	20 to 25
High	26 to 33

[1] *adapted from Gould (1998)*

Based on the species richness results within Gould (1998), where applicable, Table 4.5-8 provides diversity class estimates for each TEM ecosystem, with the respective species richness values based on their ecosystems of nearest ecological equivalence.

Table 4.5-8. Ecosystem Diversity Estimates within the LSA

Ecosystem Class	Ecosystem Name	TEM Map Code	Diversity Class	Species Richness (within Gould 1998)
Bedrock	Cliff	BC	Low	14
	Bedrock – lichen veneer	BL	Low	14
	Bedrock Outcrop	BR	Low	14
	Talus	BT	Low	14
	Blockfield / Boulderfield	TB	Low	14
	Disturbed Vegetation	DV	Low	12
	Exposed Soil	ES	Very Low	9
Esker	Esker Crest	EC	Moderate	20
	Dwarf Shrub Esker	EH	Moderate	23
	Shrubby Esker	EW	Moderate	24
Marine Beach	Marine beach	MB	Moderate	20
	Old beach head	MH	Moderate	20
Tundra	Dry-Sparse Tundra	TH	Moderate	23
	Mesic Dwarf Shrub Tundra	TL	High	26
	Shrubby Tundra	TS	Moderate	24
Tundra Marine	Marine shrubby tundra	MS	Moderate	24
	Marine dwarf shrub tundra	MT	High	26
Riparian	Floodplain - Low	RL	Low	12
	Floodplain - Middle	RM	Low	12
	Willow Riparian	RW	Low	18
Riparian Marine	Marine riparian shrub	MR	Low	18

(continued)

Table 4.5-8. Ecosystem Diversity Estimates (completed)

Ecosystem Class	Ecosystem Name	TEM Map Code	Diversity Class	Species Richness (within Gould 1998)
Wetland	Water Sedge Marsh	WA	Very Low	9
	Raised Bog Complex	WB	Moderate	15
	Cottongrass - Sedge Fen	WC	Low	12
	Undifferentiated Fen	WF	Low	12
	Shallow Open Water	WO	Low	n/a
	Willow - Sedge Fen	WS	Low	12
	Tussock Meadow	WT	High	33
Wetland Marine	Estuary marsh	ME	Low	n/a
	Saline Fen	MF	Low	12
	Saline Marsh	MM	Low	12
	Saline shallow open water	MO	Low	n/a

Table 4.5-9 summarizes the results by Diversity Class, within each PDA, and for the sum of the PDA areas (6,080 ha). For each Diversity Class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. For example, development of the PDAs results in the loss of 9.4% of the area rated as "Very Low" diversity within the total LSA. The results are depicted in Figures 4.5-1 and 4.5-2, for the Goose and MLA PDAs, respectively. Estimated losses within all diversity classes are less than 10% of their respective LSA availabilities, within the range of low magnitude effects.

Table 4.5-9. Summary of Loss by Diversity Class within the Potential Development Areas

Diversity Class	Loss Estimates (ha)			% of Availability (LSA)
	Goose PDA	MLA PDA	Total PDA	
High	2342.4	275.5	2617.9 (43%)	6
Moderate	1727.2	83.3	1810.5 (30%)	4
Low	509.6	163.1	672.7 (11%)	3
Very Low	101.9	24.0	125.9 (2%)	5
Nil (Non-vegetated and Water)	745.9	107.5	853.4 (14%)	3
Total	**5427.0**	**653.4**	**6080.4** (100%)	

Assessment of the Goose, and MLA PDAs together, suggests approximately 73% of total vegetation loss occurs from ecosystems with high (43%) and moderate (30%) vegetation diversity. There are, however, notable differences between individual PDAs. Within the Goose PDA, 75% of loss occurs within ecosystems of moderate and high vegetation diversity, with just 11% loss within ecosystems of very low and low diversity. Loss in the MLA PDA mostly occurs within ecosystems of moderate and high vegetation (55%) diversity with 29% loss within ecosystems of very low and low diversity.

Within the LSA, loss estimates within each diversity class are less than 10% of their respective baseline distributions, with largest losses estimated from ecosystems in the High Diversity Class, at 6% of baseline distribution.

Vegetation Productivity

To quantify potential vegetation productivity loss, annual net primary productivity (ANPP) estimates, adapted from vegetation biomass and productivity mapping by Gould, Raynolds, and Walker (2003), are provided for each TEM ecosystem. Described within Gould, Raynolds, and Walker (2003), the ANPP categories are themselves modified from earlier research conducted by Walker (1999).

The estimates within Gould, Raynolds, and Walker (2003) were based on vegetation classes (grouped under broader headings of Dry, Mesic, Wet and Riparian) that were modified from Arctic vegetation mapping conducted by Gould et al. (2002). The TEM ecosystems were compared against the vegetation class descriptions within Gould et al. (2003), and the productivity estimate for the vegetation class with which each TEM ecosystem had closest "ecological equivalence" was applied.

Productivity classes ranging from Very Low through Very High (Table 4.5-10) were subjectively assigned to the range of ANPP values (in $g/m^2/y$). Based on the abundance of deciduous leaves, the highest values are applied to deciduous shrub-dominated tundra and riparian ecosystems in the TEM data, each rated as Very High productivity. In their study of carbon exchange among different Arctic ecosystem types, Williams et al. (2006) reported that leaf area index (LAI), measured in $1m^2$ chamber plots, tended to be highest in the *Salix*, *Rubus,* and *Betula* sites, on foot- and back-slopes with deeper soils and increased nutrient cycling. The LAI measurements were lowest in wet sedge, open tussock, and hill-top tussock sites. Sparsely vegetated ecosystems, typically associated with exposed soil, bedrock, or shallow till veneers, were estimated as Very Low productivity and sedge- or cottongrass-dominated wetlands were estimated as Low productivity.

Table 4.5-10. Productivity Classes

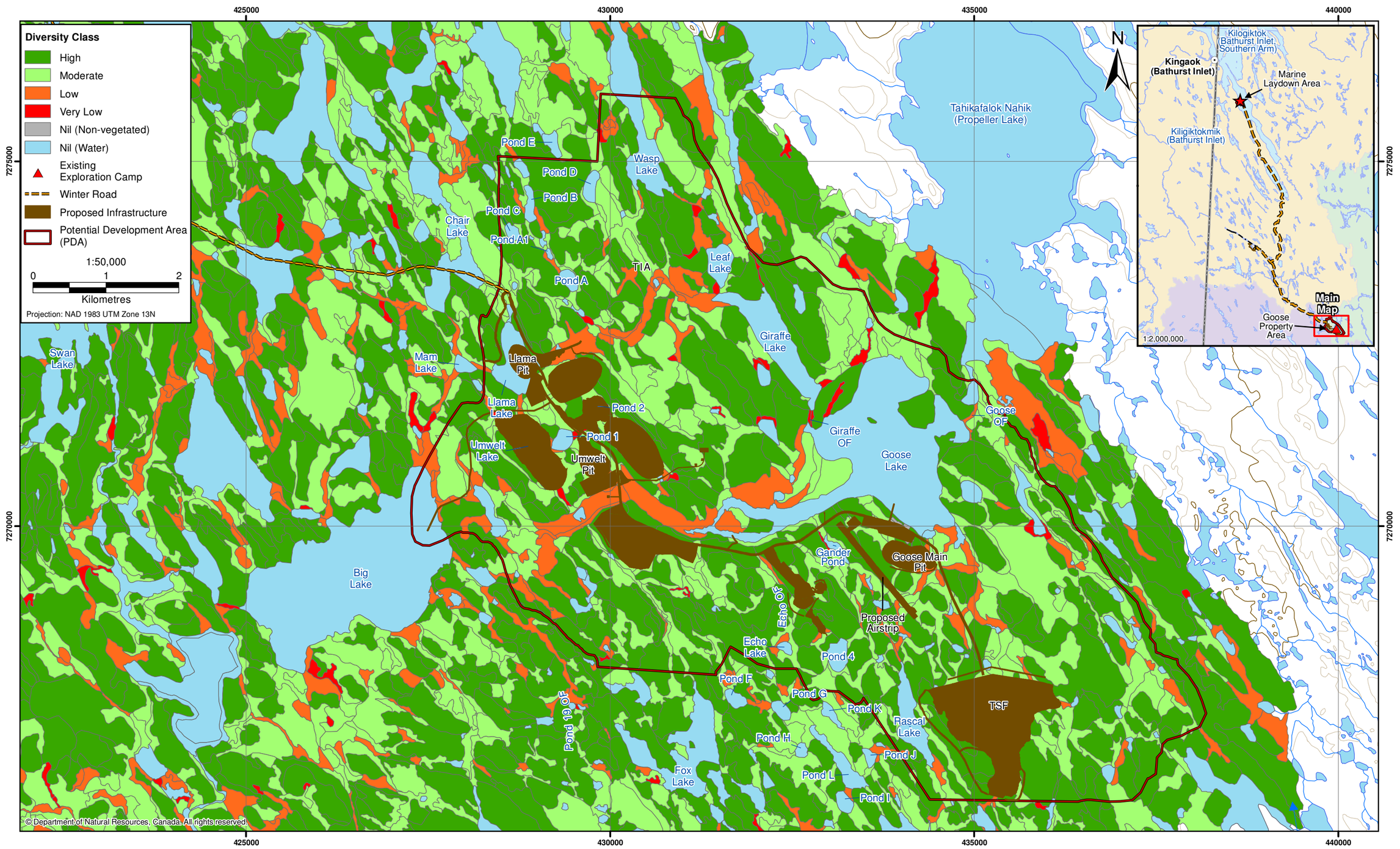
Productivity Class	Annual Net Primary Productivity[1] Range ($g/m^2/y$)
Very Low	< 20
Low	20 - 50
Moderate	50 - 150
High	150 - 250
Very High	250 – 1,000

[1] *Source: Gould, Raynolds, and Walker (2003)*

Given the maritime influence and relatively richer soils in the vicinity of Bathurst Inlet, resulting in more extensive and lusher riparian shrub ecosystems, the MLA PDA likely has relatively higher ANPP values than the riparian counterparts within the Goose PDA. Table 4.5-11 provides the net change in area for each of the mapped ecosystems and Table 4.5-12 summarizes the results by Productivity Class, within each PDA, and for the sum of the PDA areas (6,080 ha).

For each class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. For example, development of the PDAs results in the loss of 6% of the area rated as "High" productivity within the total LSA. The results are depicted in Figures 4.5-3 and 4.5-4 for the Goose and MLA PDAs, respectively.

Assessment of the Goose, and MLA PDAs, together, suggests an approximate 9% loss within ecosystems with very high vegetation productivity. Within the Goose PDA, due primarily to the large amount of productive Mesic Dwarf Shrub Tundra mapped, 61% of loss occurs within ecosystems of high and very high productivity, with just 22% loss within ecosystems of very low (4%) and low (19%) productivity. Similar to results within the Goose PDA, most loss (57%) in the MLA PDA occurs within ecosystems of high and very high vegetation productivity with 24% loss within ecosystems of very low (10%) and low (14%) productivity.



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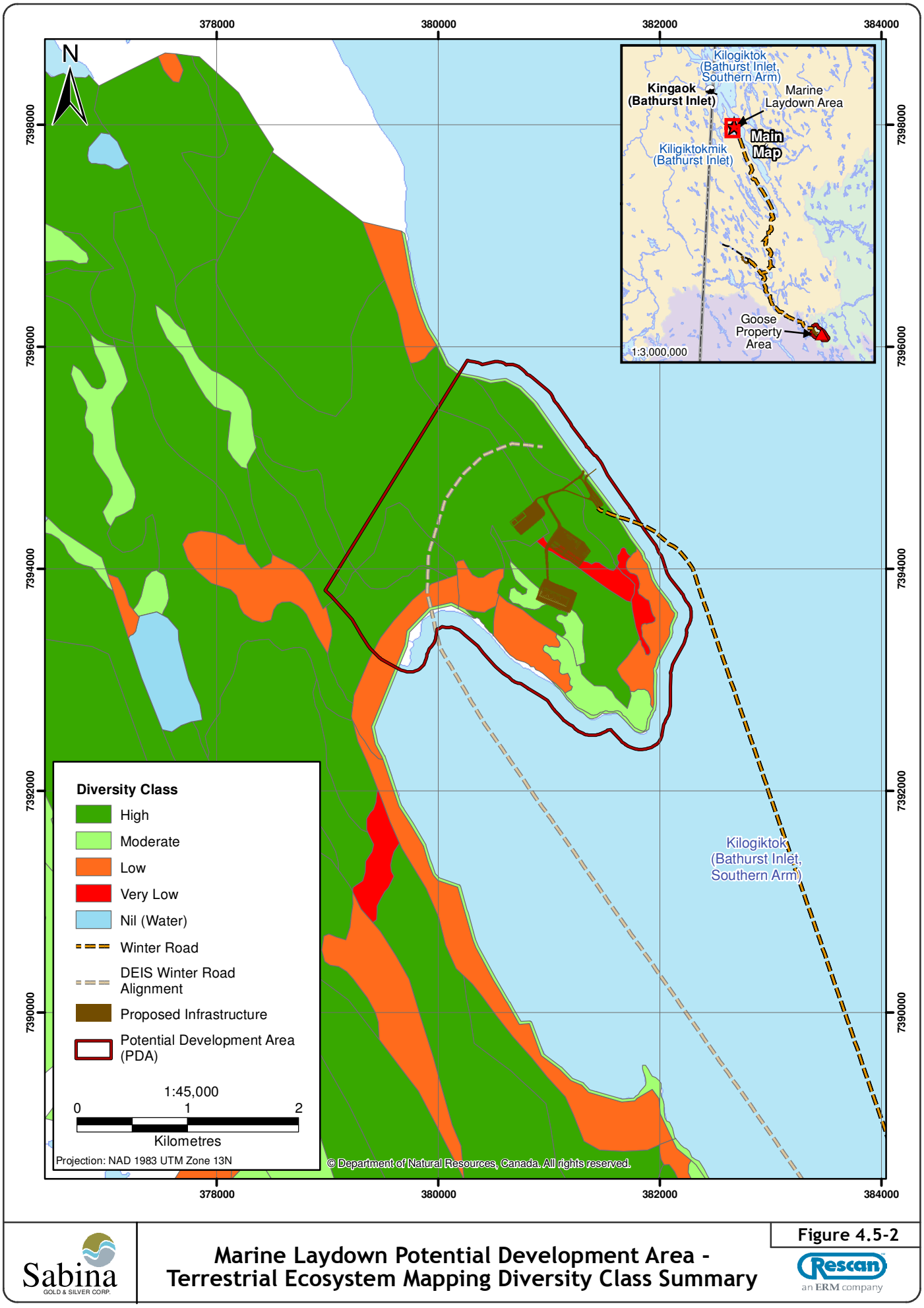
Goose Potential Development Area - Terrestrial Ecosystem Mapping Diversity Class Summary

Figure 4.5-1

Rescan an ERM company



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Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Diversity Class Summary

Figure 4.5-2

Rescan an ERM company

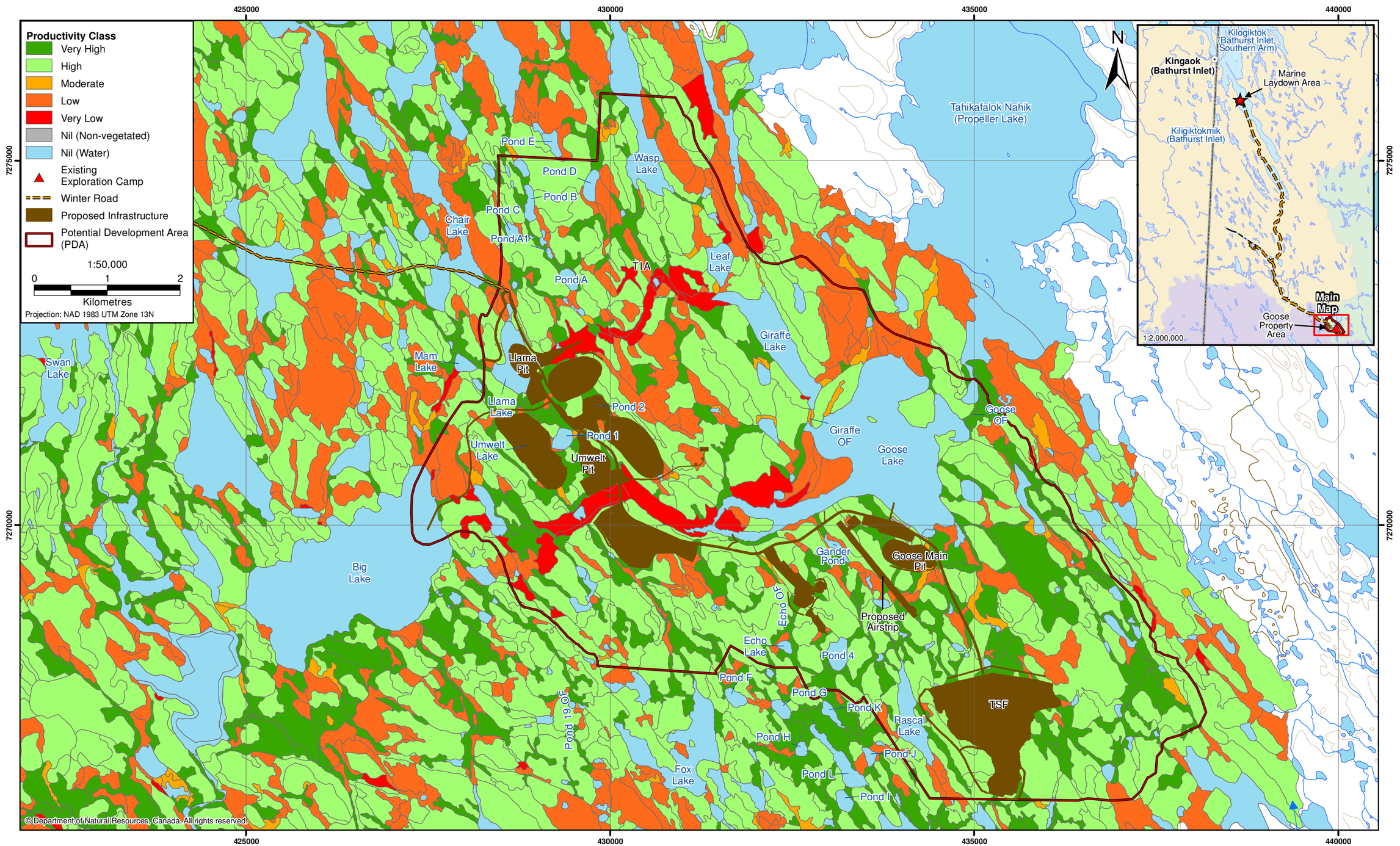
Table 4.5-11. Ecosystem Productivity Estimates

Ecosystem Class	Ecosystem Name	TEM Map Code	Annual Net Primary Productivity[1] Range ($g/m^2/y$)	Productivity Class
Bedrock	Cliff	BC	< 20	Very Low
	Bedrock – lichen veneer	BL	< 20	Very Low
	Bedrock Outcrop	BR	< 20	Very Low
	Talus	BT	< 20	Very Low
	Blockfield / Boulderfield	TB	< 20	Very Low
	Disturbed Vegetation	DV	< 20	Very Low
	Exposed Soil	ES	< 20	Very Low
Esker	Esker Crest	EC	< 20	Very Low
	Dwarf Shrub Esker	EH	20 - 50	Low
	Shrubby Esker	EW	150 - 250	High
Marine Beach	Marine beach	MB	< 20	Very Low
	Old beach head	MH	< 20	Very Low
Tundra	Dry-Sparse Tundra	TH	20 - 50	Low
	Mesic Dwarf Shrub Tundra	TL	150 - 250	High
	Shrubby Tundra	TS	250 – 1,000	Very High
Tundra Marine	Marine shrubby tundra	MS	250 – 1,000	Very High
	Marine dwarf shrub tundra	MT	150 - 250	High
Riparian	Floodplain - Low	RL	20 - 50	Low
	Floodplain - Middle	RM	250 – 1,000	Very High
	Willow Riparian	RW	250 – 1,000	Very High
Riparian Marine	Marine riparian shrub	MR	250 – 1,000	Very High
Wetland	Water Sedge Marsh	WA	50 - 150	Moderate
	Raised Bog Complex	WB	20 - 50	Low
	Cottongrass - Sedge Fen	WC	20 - 50	Low
	Undifferentiated Fen	WF	20 - 50	Low
	Shallow Open Water	WO	< 20	Very Low
	Willow - Sedge Fen	WS	50 - 150	Moderate
	Tussock Meadow	WT	20 - 50	Low
Wetland Marine	Estuary marsh	ME	20 - 50	Low
	Saline Fen	MF	20 - 50	Low
	Saline Marsh	MM	20 - 50	Low
	Saline shallow open water	MO	< 20	Very Low

[1] *Source: Gould, Raynolds, and Walker (2003)*

Table 4.5-12. Summary of Loss by Productivity Class

Productivity Class	Loss Estimates (ha)			% of Availability (LSA)
	Goose PDA	MLA PDA	Total PDA	
Very High	974.8	100.0	1074.8 (18%)	7
High	2338.8	275.4	2614.2 (43%)	6
Moderate	124.8	24.0	148.8 (2%)	6
Low	1028.6	78.7	1107.3 (18%)	3
Very Low	214.1	67.8	281.8 (5%)	2
Nil (Non-vegetated and Water)	745.9	*107.5*	853.4 (14%)	3
Total	5427.0	**653.4**	6080.4 (100.0%)	



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Goose Potential Development Area - Terrestrial Ecosystem Mapping Productivity Class Summary

Figure 4.5-3

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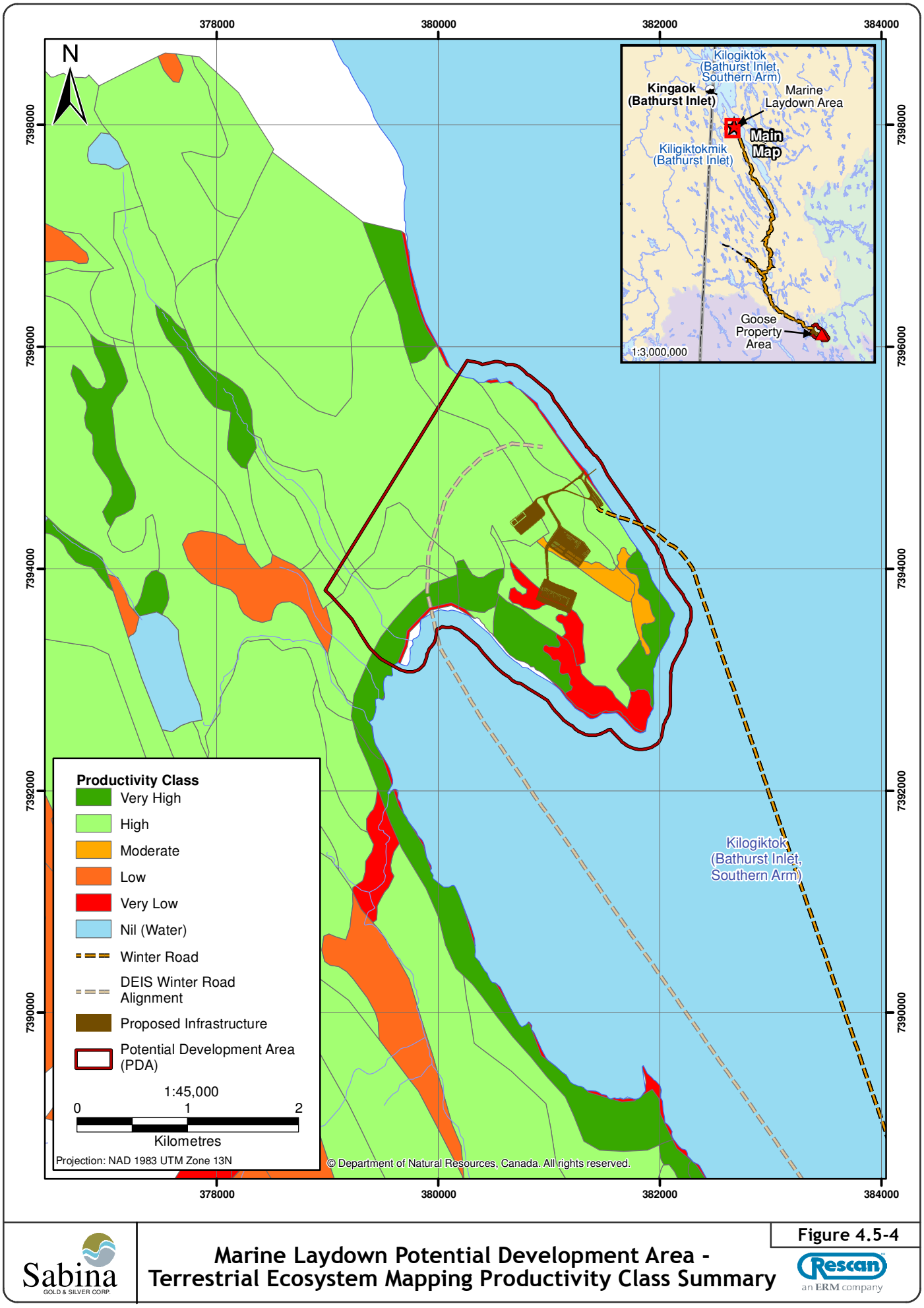

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Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Productivity Class Summary

Figure 4.5-4

Rescan an ERM company

Within the LSA, loss estimates within each class are less than 10% of their respective baseline distributions (low magnitude), with largest losses estimated from ecosystems in the Very High Productivity Class, at 7% of baseline distribution of ecosystems with high productivity within the LSA.

Vegetation Resiliency

Arctic ecosystems differ in resiliency to disturbance, with some describing them as having no real resilience in the ecological sense due to the harsh environmental conditions that places plants under extreme stress, and low productivity of vegetation (Miller 1989). Even low intensity disturbances can have lasting effects on Arctic vegetation due to low vegetation diversity, low productivity and simple structure (Forbes, Ebersole, and Strandberg 2001) and, consequently, ecosystems may be greatly affected by stresses from physical disturbance and chemical pollution (Miller 1989). For example, fruticose and crustose taxa failed to recolonize within light, low-intensity disturbances from trampling or single vehicle passes (Forbes, Ebersole, and Strandberg 2001).

Many factors contribute to the resistance and resilience of vegetation and to the possible recovery outcomes. This includes the type, severity, and frequency of disturbance; natural vegetation composition; presence or absence of snow at the time of disturbance; soil moisture and biogeochemical properties; temperature regime; availability of native seed; and nature of re-vegetation effort. Native vegetation type represents the most important factor in predicting response to disturbance as, due to it being present, has inherently integrated responses to the existing temperature, nutrient regime, wind and snow, and natural disturbances (Walker and Walker 1991).

In a study of the circumpolar North, Forbes, Ebersole, and Strandberg (2001) described responses by type of disturbance, including trampling, removal of organic layers, mounding of soil and organic matter, and vehicle tracks. Each of these represents disturbances potentially resulting from each Project phase. Trampling resulted in soil compaction, leading to increased bulk density, increased decomposition, reduced moisture, and restriction of lateral and horizontal root penetration. Vegetation necrosis (premature death of plant tissue) resulted in decreased surface albedo, which increased the soil temperature and thaw depth (Forbes, Ebersole, and Strandberg 2001). Walker and Walker (1991) also report warmer surface soils, lower organic matter and higher nutrient regimes from disturbance. Vegetation regeneration within mounded areas was generally favourable, with development and richness dependent upon the amount of organic matter (Forbes, Ebersole, and Strandberg 2001). Within vehicle tracks, vascular plants were maintained in mesic areas with slight to moderate damage, and rhizomatous graminoids, willows, and horsetails increased in abundance. The recovery of vegetation was related to pre-disturbance soil moisture regime; recovery within small (less than 300 m^2) wet disturbances was evident within 20 to 75 years. It was not guaranteed within mesic sites and dry sites exhibited a reduction in vegetation cover, biomass, and richness. Walker and Walker (2001) identified quicker recovery within wet tundra ecosystems than within mesic uplands, despite being more easily disturbed, a response related to the increased moisture and nutrient influx. Similarly, in a discussion on ice-road construction techniques (Bailey 2012), wet sedge vegetation was identified as especially resilient to ice road impacts, in contrast to the more sensitive tussock vegetation.

It is assumed that no ecosystems will be resilient to physical disturbances such as pits, rock storage facilities, camps, and buildings etc., all of which require clearing or removal of vegetation and/or organic matter. The resiliency estimates below are assumed to apply to potential degradation from activities or disturbances that do not physically remove vegetation or soil matter. Such effects could include trampling, soil compaction, deposition of fugitive dust, or introduction of invasive plant species. In this section, it is assumed that resiliency pertains largely to the relative ability to recover to anthropogenic disturbances within a short distance of infrastructure. Degradation due to compaction and trampling along road verges or from equipment and material traveling or stored upon non-designated surfaces will be minimized to the extent possible.

Table 4.5-13 provides the ecosystem resiliency estimates for each of the mapped ecosystems and Table 4.5-14 summarizes the results by Resiliency Class, within each PDA, and for the sum of the PDA areas (6080 ha). For each class, the respective loss estimates are provided as a percentage of the total baseline distribution within the LSA. The results are depicted in Figures 4.5-5 and 4.5-6, for the Goose and MLA PDAs, respectively.

Table 4.5-13. Ecosystem Resiliency Estimates

Ecosystem Class	Ecosystem Name	TEM Map Code	Resiliency Class
Bedrock	Cliff	BC	Very Low
	Bedrock – lichen veneer	BL	Low
	Bedrock Outcrop	BR	Low
	Talus	BT	Low
	Blockfield / Boulderfield	TB	Low
	Disturbed Vegetation	DV	Low
	Exposed Soil	ES	Very Low
Esker	Esker Crest	EC	Very Low
	Dwarf Shrub Esker	EH	Low
	Shrubby Esker	EW	Low
Marine Beach	Marine beach	MB	Very Low
	Old beach head	MH	Very Low
Tundra	Dry-Sparse Tundra	TH	Low
	Mesic Dwarf Shrub Tundra	TL	Moderate
	Shrubby Tundra	TS	Moderate
Tundra Marine	Marine shrubby tundra	MS	Moderate
	Marine dwarf shrub tundra	MT	Moderate
Riparian	Floodplain - Low	RL	High
	Floodplain - Middle	RM	High
	Willow Riparian	RW	High
Riparian Marine	Marine riparian shrub	MR	High
Wetland	Water Sedge Marsh	WA	Low
	Raised Bog Complex	WB	Low
	Cottongrass - Sedge Fen	WC	Low
	Undifferentiated Fen	WF	Low
	Shallow Open Water	WO	Low
	Willow - Sedge Fen	WS	Low
	Tussock Meadow	WT	Low
Wetland Marine	Estuary marsh	ME	Low
	Saline Fen	MF	Low
	Saline Marsh	MM	Low
	Saline shallow open water	MO	Low

Table 4.5-14. Summary of Loss by Resiliency Class within the Potential Development Areas

Resiliency Class	Loss Estimates (ha)			% of Availability (LSA)
	Goose PDA	MLA PDA	Total PDA	
High	64.2	89.8	154.0 (1.8%)	8
Moderate	3249.4	285.6	3535 (44.9%)	6
Low	1365.0	102.7	1467.7 (37.0%)	3
Very Low	2.5	67.8	70.3 (1.2%)	5
Nil (Non-vegetated and Water)	745.9	107.5	853.4 (15.0%)	3
Total	**5427.0**	**653.4**	**6080.4 (100.0%)**	

Assessment of the Goose and MLA PDAs, together, identifies loss of 6% of moderate resiliency, 3% of low resiliency, and 5% of very low resiliency ecosystems.

4.5.4.2 Degradation of Vegetation

As previously addressed in Section 4.5.2.2, degradation of vegetation was not identified as a residual effect for the following reasons:

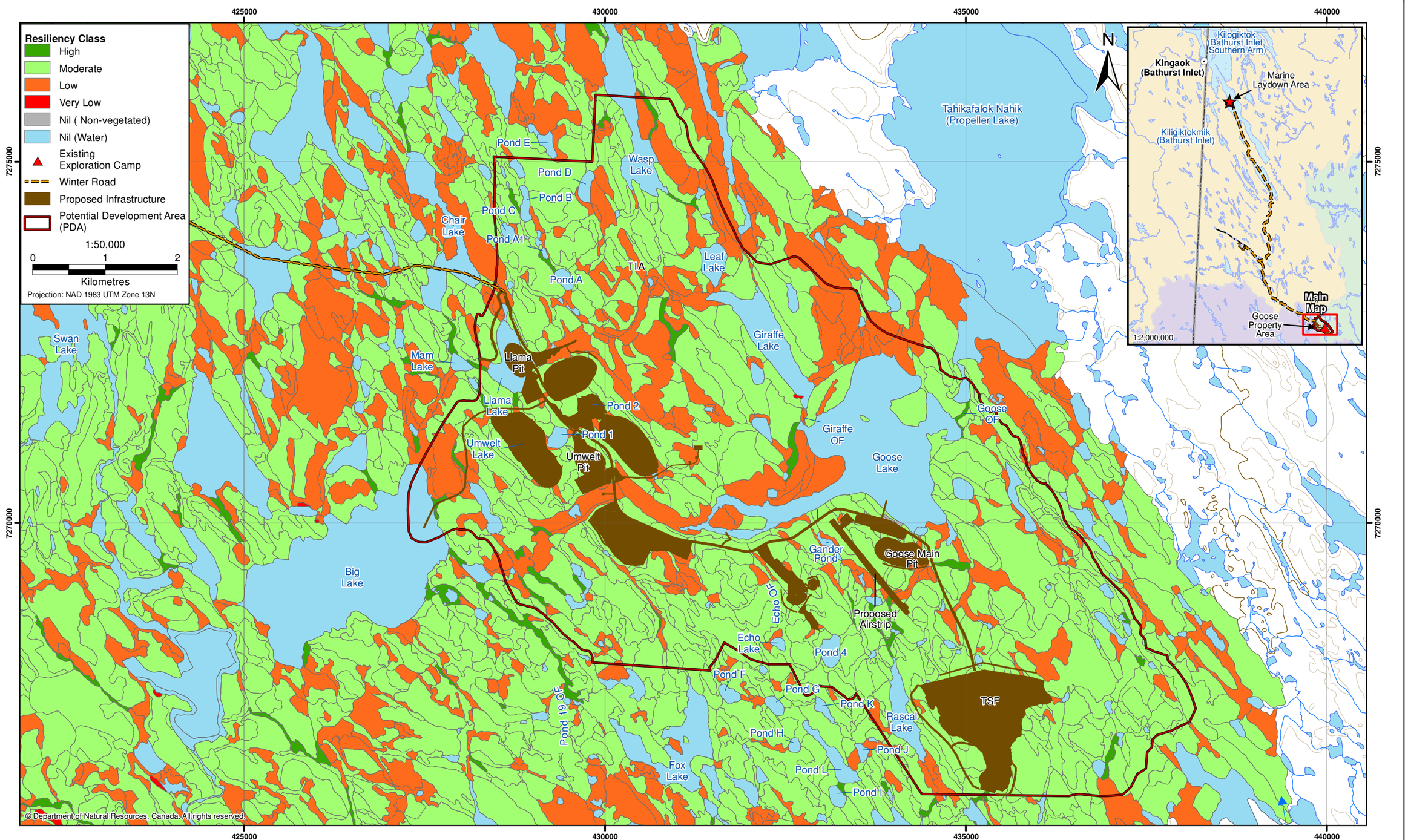
- The assumption that the entire PDA will be lost, and that potential degradation of vegetation would occur within this area; and
- Potential degradation due to fugitive dust, airborne emissions, water quality and soil changes were assessed as part of the Country Foods VEC assessment (Volume 8, Chapter 5) and the environmental risk assessment (Volume 8, Chapter 6) and potential effects to vegetation were found to have no residual effects beyond the PDA boundaries (the Country Foods LSA).

For potential effects on water quality and quantity, refer to Volume 6, Chapter 4 (freshwater quality) and Volume 6, Chapter 1 (surface hydrology).

4.5.5 Significance of Residual Effects

Table 4.5-15 summarizes the residual effects and significance determination for loss of vegetation and special landscape features. The attributes used to evaluate significance are defined within the General Assessment Methodology in Volume 9, Chapter 1, and the Magnitude Table (Table 4.5-1 in Section 4.5.1). The final magnitude for significance determinations is based upon the loss of vegetated ecosystems and special landscape features, as collective units, not by specific ecosystems or landscape features.

Mitigation measures and best management practices (Section 4.6.3) will be implemented; however, residual loss of vegetation and special landscape features is anticipated. The entire PDAs were assumed to be lost for this assessment.



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Goose Potential Development Area - Terrestrial Ecosystem Mapping Resiliency Class Summary

Figure 4.5-5

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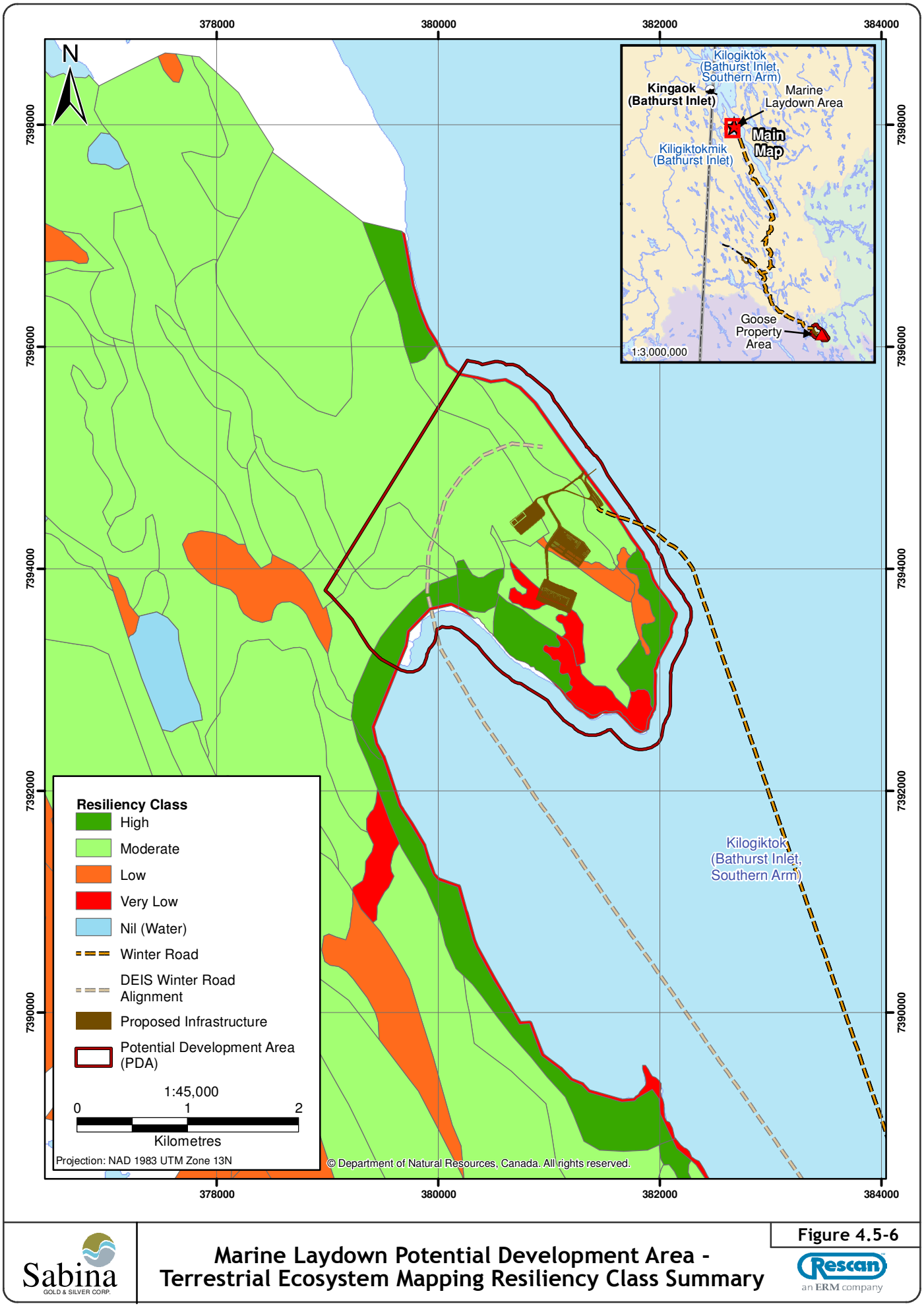

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Marine Laydown Potential Development Area - Terrestrial Ecosystem Mapping Resiliency Class Summary

Figure 4.5-6

Rescan an ERM company

Table 4.5-15. Summary of Residual Effects Significance Determination

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating			
	Direction	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Certainty	Probability	Confidence	Rating
Vegetation Loss	Negative	Low	Long	Once	Footprint	Irreversible	High	Likely	Medium	Not Significant (N)
Special Landscape Feature Loss	Negative	Low	Long	Once	Footprint	Irreversible	High	Likely	Medium	Not Significant (N)

Loss of terrestrial vegetation represents a negative effect that, given the harsh climate, short growing season and low resiliency of Arctic vegetation, is assumed to be of permanent (long-term) duration, and irreversible. Collective loss of vegetation is considered low magnitude, given the magnitude criteria definitions in Table 4.5-1. Although not assessed for specific ecosystems, highest relative effect is expected within the Riparian Marine and Marine Beach ecosystem classes, which are mapped in the vicinity of Bathurst Inlet. Project activities resulting in loss of vegetation will occur once, coinciding with the Project phase within which physical removal of vegetation and organic material occurs. Although total loss of vegetation is assumed throughout the PDAs in order to calculate maximum potential effect, actual loss will be smaller than reported for the PDA, as determined by the final Project footprint, which is expected to comprise a small proportion of the total PDA.

There is high certainty, and likely probability, that loss of terrestrial vegetation will occur, as the effect relationship (loss due to physical clearing) is well understood and terrestrial ecosystem mapping reveals that most of the PDA, with the exception of water features and existing exploration infrastructure, is comprised of vegetated ecosystems. Ongoing baseline data collection and feasibility work will further refine the footprint of the Project within each PDA. The estimated vegetation losses and impact assessment will be updated, accordingly.

Considering the over-estimation of residual effects in assuming loss within entire PDAs, and that the effects are estimated to be primarily of low and negligible magnitude within the LSA and RSA, respectively, the overall significance of vegetation loss is considered **Not Significant**. Based on results of ecosystem mapping and the ecological classifications throughout the LSA and RSA, the mapped ecosystems, including those within the marine-associated riparian and beach ecosystem classes, within which local high magnitude effects are estimated, appear common throughout the surrounding region.

Similarly, loss of special landscape features represents a negative effect that is assumed to be of permanent (long-term) duration and irreversible. Project activities resulting in loss of special landscape features will occur once, coinciding with the Project phase within which physical removal of vegetation and organic material occurs. Although total loss of special landscape features is assumed throughout the Goose and MLA PDAs in order to calculate maximum potential loss, the actual extent of loss, for reasons explained above, will be smaller, as determined by the final Project footprint.

There is high certainty, and likely probability, that loss of special landscape features will occur in each PDA, given the abundance of landscape features such as wetlands and bedrock-dominated ecosystems. The effect relationship (loss due to physical clearing) is well understood. There is medium certainty regarding loss from specific features (Table 4.5-4), as the final infrastructure ultimately determines which features within the PDA are affected.

Given the small percentage of loss compared to the distribution of special landscape features within the LSA (8.7% loss), especially when considering the over-estimation of expected effects, the overall significance of loss is considered **Not Significant**. Based on results of ecosystem mapping and the ecological classifications throughout the LSA and RSA, the features mapped within the PDAs appear common throughout the region.

4.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

As residual effects are expected from the project, they are carried through the assessment of potential cumulative effects.

4.6.1 Methodology Overview

Described within Volume 9, Chapter 1, the cumulative effects assessment was conducted according to the General Assessment Methodology in Volume 9, Chapter 1. This included:

1. Undertaking scoping exercise to identify potential for Project-related residual effects to interact with other projects and human activities;
2. Identifying and predicting potential cumulative effects and implementing additional mitigation measures;
3. Identifying cumulative residual effects after implementation of additional mitigation measures; and
4. Determining the significance of any cumulative residual effects.

The two residual effects estimated from the effects assessment in Section 4.5 are:

1. Vegetation loss, and
2. Special landscape feature loss.

The potential cumulative losses of vegetation and special landscape features were assessed within the cumulative effects assessment boundary, which is the same as the vegetation and terrestrial wildlife RSA (Figure 4.6-1). Residual effects from the Back River Project were assessed against those past, present and reasonably foreseeable future projects listed within Volume 9, Chapter 1 that overlap the vegetation and terrestrial wildlife RSA. For each overlapping project, only the infrastructure proposed within the RSA is included in the cumulative effects assessment.

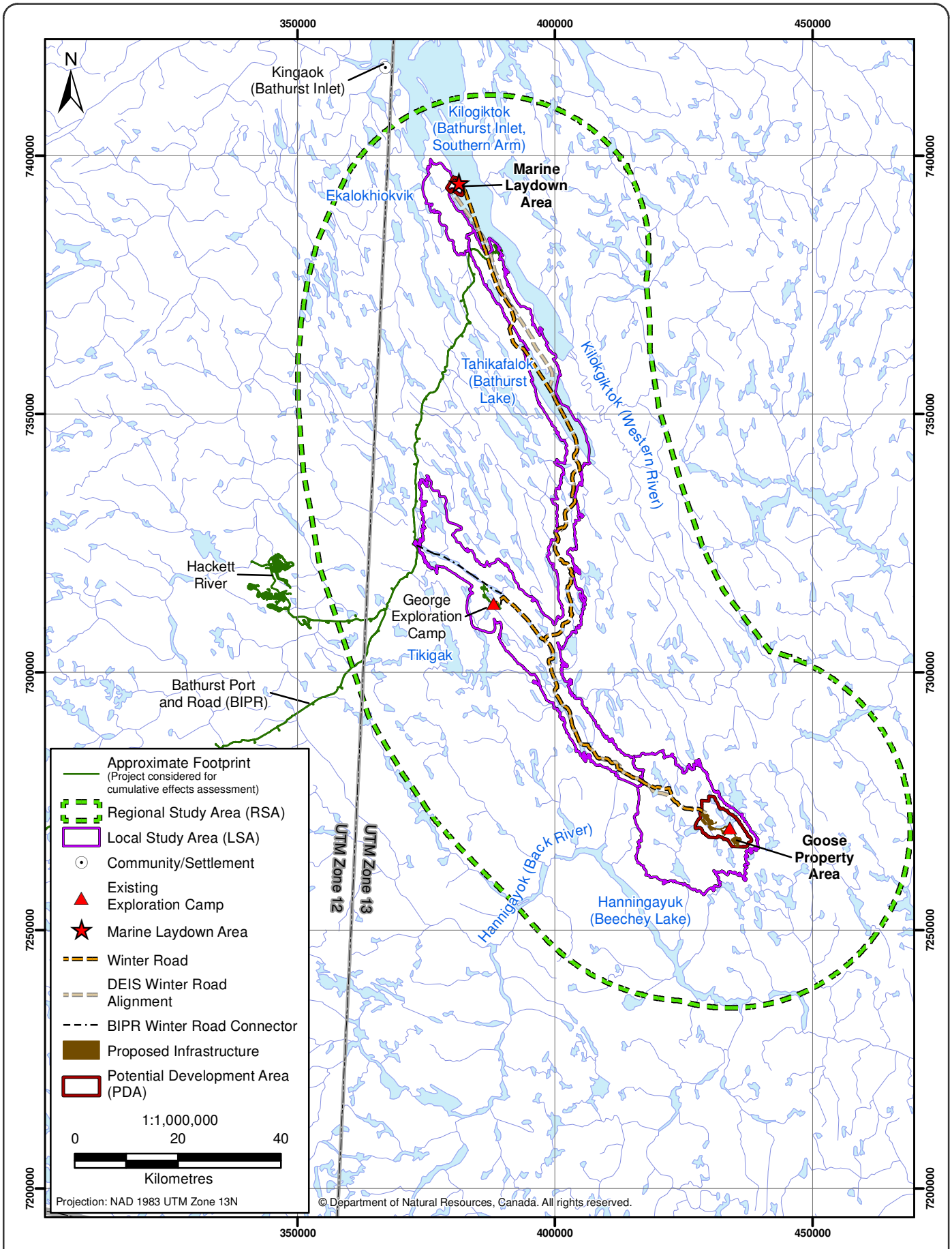
Defined within the General Assessment Methodology Chapter (Volume 9, Chapter 1), attributes used to evaluate potential cumulative effects, including determination of significance, include the direction and nature, magnitude, geographic extent, frequency, timing, duration, and reversibility. The environmental sensitivity of the landscape that is subject to potential effects is also a consideration.

Consistent with the assessment of residual effects, the magnitude rating scheme (Table 4.5-1) was developed through the adoption of threshold values derived from literature on wildlife habitat loss and disturbance. Effect magnitudes range from negligible, where there is assumed to be no detectable change to baseline distributions, to high magnitude, where loss is assumed to result in a long-lasting effect on the distribution of vegetation communities within the RSA.

4.6.2 Potential Interactions with Project and Characterization

Detailed in Section 4.5.4.1, residual effects resulting from the Project were identified and include the loss of vegetation and special landscape features, each of which can result in reductions to the natural baseline patterns of diversity, productivity, and resiliency on the landscape. The loss of special landscape features such as cliffs, eskers, riparian and wetland ecosystems, marine beaches and shores etc., can affect unique habitats that have high likelihood of supporting rare plants and which provide important habitat features for wildlife.

Of the potential past, existing, and reasonably foreseeable future projects summarized within Figure 3.4-1 and Table 3.4-1 of the General Assessment Methodology (Volume 9, Chapter 1), the reasonably foreseeable Hackett River Mine, Bathurst Inlet Port Road (BIPR), and George Property projects have spatial and/or temporal overlap with the Back River Project vegetation and terrestrial wildlife RSA (Figure 4.6-1). Loss and/or degradation of vegetation resulting from these two projects would add to the respective loss estimates for the Back River Project, within the vegetation and terrestrial wildlife RSA. Each located well over 100 km from the Project, the other past and existing projects are assumed to have negligible cumulative contribution to the potential effects of the Project, however, and are excluded as projects of potential cumulative interaction in this assessment.



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Spatial Boundary for Vegetation and Special Landscape Feature Potential Cumulative Effects Assessment

Figure 4.6-1

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Summarized in Volume 9, Chapter 1, the Bathurst Inlet Port and Road (BIPR), presently on hold in the NIRB review process, is a proposed future project consisting of facilities at Bathurst Inlet (approximately 12 km southeast of the MLA) and an all-weather access road connection to the existing Tibbitt to Contwoyto winter road (TCWR), 211 km to the southwest. The proposed port facilities, including a wharf, 200-person camp, and 1,200 m airstrip, and portions of the proposed all-weather access road, overlap the Back River Project Vegetation LSA and RSA, but not the PDAs.

Should the BIPR project be approved, construction is scheduled to begin in 2017, with an estimated 20 year operational life (Volume 9). With this schedule, the BIPR Project would have spatial and temporal overlap with the Back River Project.

The proposed future Hackett River Project consists of a planned open pit and underground base metals mine with a spur road connection to the proposed BIPR road, 23 km to the east. Pre-feasibility and environmental baseline studies have been conducted, but the DEIS completion is presently on hold. Situated approximately 95 km northwest of the existing Goose Exploration Camp, small areas of proposed infrastructure and access road overlap the Back River Project Vegetation RSA. Should the Hackett River Project proceed, it has an estimated operational mine life expectancy of 14 years.

The proposed future George Property will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. George was included in the original Back River DEIS submission but has been removed from the FEIS submission. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the George Exploration Camp. All processing of ore is planned to be completed at Goose Property, only mining and activities in support of mining are planned for George Property.

Table 4.6-1 summarizes the potential loss resulting from each of the proposed projects with the estimated loss from the Back River Project.

Table 4.6-1. Interactions of Residual Effects from Back River Project with Other Projects

	Description of Residual Effect	Proposed Infrastructure within CEA Boundary[1]
Back River Project	Vegetation Loss Special Landscape Feature Loss	Pits, haul and access roads, waste rock and explosives storage areas, landfills, tailings storage facility, camps, airstrips, barge landing location
BIPR	Vegetation Loss and Degradation	Port facilities (wharf, 200-person camp, airstrip) and quarry; 98 km of all-weather access road
George Property	Vegetation Loss and Degradation	Pits, haul and access roads, waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications
Hackett River	Vegetation Loss and Degradation	Quarry and 10 km of all-weather access road

[1] *The Back River Project vegetation and terrestrial wildlife RSA*

4.6.3 Identification of Mitigation and Management Measures

Although not available for the future Hackett River Project, which is presently on hold in the NIRB process, it is assumed that future mitigation and management measures to minimize the loss and degradation of vegetation and special landscape features will be consistent with those presented for the Back River Project in Section 4.5.3.

Described within Rescan (2007) for the future BIPR Project, a Vegetation Management Plan (VMP) and Invasive Plants Management Plan (IPMP) are proposed to help identify areas where vegetation and invasive plant management are required. The VMP outlines a series of general practices, such as minimizing footprints and optimizing infrastructure placement, to minimize loss and disturbance to vegetation and ecosystems. The objectives of the IPMP, which is proposed within the framework of the VMP, are to prevent the establishment of invasive plant species and to maintain healthy vegetative cover in, and around, development areas. Coordination of these plans with additional plans associated with the implementation of fugitive dust management and dustfall monitoring, soil management, spill management, hazardous materials, and closure and reclamation, will further minimize potential for adverse effects on vegetation.

Mitigation measures for the George Property to reduce loss and degradation of vegetation and special landscape features will be consistent with those presented for the Back River Project in Section 4.5.3.

4.6.4 Characterization of Cumulative Residual Effects

The two residual effects for the Back River Project, both of which are confined to the PDAs, include the loss of vegetation and loss of special landscape features.

In addition to the loss of vegetated ecosystems mapped within the two PDAs (approximately 5,227 ha, excluding water features, existing exploration camps and road surfaces), an estimated 560 ha of cumulative loss within the vegetation and terrestrial wildlife RSA could result from development of infrastructure and roads associated with the proposed Hackett River Mine, BIPR, and George Property projects. Table 4.6-2 summarizes the potential cumulative interaction of reasonably foreseeable future projects with the Back River Project. For the purposes of the cumulative effects assessment, it is assumed that all areas of overlap are vegetated ecosystems.

Table 4.6-2. Summary of Potential Cumulative Interaction with the Back River Project

Project	Back River Project RSA		Total RSA Overlap (ha)
	Infrastructure (ha)	Roads (ha)*	
Hackett River Mine	19.3	20.6	39.9
Bathurst Inlet Port and Road	63.8	265.7**	329.5
George Property	171.6	15.0	186.6
Total	**255.1**	**35.6**	**556.0**

** Area estimates based on 20 metre road widths.*
*** Area includes associated quarries.*

The majority of the loss is attributable to the proposed George Property. Most vegetation loss within the George Property is expected to occur within the Tundra Ecosystem Class with smaller losses of the Wetland and Bedrock Ecosystem Classes. Within the Tundra Ecosystem Class, the largest area of loss is estimated to occur within the TH and TL ecosystems. Within the Wetland Class, the largest loss is estimated to occur in the WC ecosystem. Within the Bedrock Ecosystem Class, the largest losses are estimated within the BL and BR ecosystems. Small losses are also expected within the Esker Ecosystem classes.

The BIPR-related infrastructure, with exception of the all-weather road connection to the TCWR, occurs within a region of marine-derived parent materials and losses are expected from marine beaches, shorelines and other marine-influenced riparian, wetland, and tundra ecosystems. Described in the draft environmental impact assessment for the Bathurst Inlet Port and Road Project (Rescan 2007), heath tundra was the most common ecosystem affected by the proposed port and road footprints and was also the most abundant plant community in both the BIPR vegetation LSA and RSA. Despite estimated local high magnitude effects from loss of plant communities (including those of

ecological interest), the loss was considered to have low influence on resource capacity as all of the plant communities that would be lost are identified throughout the surrounding area. Degradation of plant communities was considered low magnitude, also with a low influence on resource capacity. Residual loss and degradation were rated as moderate and low significance, respectively.

Within the RSA, the proposed Hackett infrastructure occurs within a landscape supporting a relatively higher (than the Goose and MLA PDAs) proportion of sparsely-vegetated ecosystems on thin, rocky parent materials. Losses from vegetated ecosystems are expected predominantly from mesic dwarf-shrub and dry-sparse tundra ecosystems.

The estimated cumulative loss of vegetated ecosystems within the 1,262,000-ha RSA represents less than 1% of baseline availability.

4.6.5 Significance of Cumulative Residual Effects

Table 4.6-3 summarizes the residual cumulative effects and significance determination for loss of vegetation and special landscape features.

Despite the application of mitigation measures and best management practices, development of each project would result in incremental loss of vegetation and special landscape features, beyond the estimates for the Back River Project. Loss of Arctic vegetation and special landscape features represents a negative effect that is assumed to be of long-term (permanent) duration, and irreversible. Project activities resulting in loss will be limited to the project footprints and will occur once, coinciding with the Project phases within which physical removal of vegetation and organic material occurs.

As reported in Section 4.5.4, loss of vegetation and special landscape features was assessed as low magnitude. Within specific ecosystems, highest losses, relative to their baseline distribution, were estimated in close proximity to Bathurst Inlet, which was identified within this assessment as unique due to the vigour and richness of vegetation and the higher likelihood of supporting rare plants. The importance of ecosystems near Bathurst Inlet, specific to their function as wildlife habitat, is detailed within Volume 5, Chapters 5 through 10.

Should one or more of the projects proceed, there is high certainty that loss of vegetation will occur, as the effect relationship (loss from physical clearing) is well understood. There is less certainty regarding loss from specific ecosystems and special landscape features, due to the absence of final infrastructure footprints and field confirmation of ecosystems underlying the proposed infrastructure. However, given the abundance of wetlands and other special landscape features, including marine beaches, shores, and riparian shrub ecosystems near Bathurst Inlet, the probability of loss of special landscape features from the BIPR is considered likely.

Given the small areas of incremental loss expected from the proposed Hackett River Mine, BIPR, and George Property projects, compared to the estimated losses within the Goose Property and MLA PDAs (collectively comprising 0.5% of vegetation within the RSA), the estimated cumulative loss remains less than 1% of the RSA. Consistent with the residual effects results, the tundra-dominated ecosystems, which are likely to be most affected from the proposed BIPR facilities and access roads, are relatively common throughout the surrounding region. Shrub-dominated riparian ecosystems and other marine beaches, shorelines, and wetland ecosystems, are also common throughout the RSA.

In summary, cumulative loss of vegetation and special landscape features from development of the proposed Back River Project, Hackett, BIPR, and George Property projects is considered **Not Significant**.

Table 4.6-3. Summary of Cumulative Residual Effects Significance Determination

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating			
	Direction	Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Certainty	Probability	Confidence	Rating
Vegetation Loss	Negative	Low	Long	Once	Footprint	Irreversible	High	Likely	High	Not Significant (N)
Special Landscape Feature Loss	Negative	Low	Long	Once	Footprint	Irreversible	Medium	Likely	Medium	Not Significant (N)

4.7 TRANSBOUNDARY EFFECTS

As all potential Project and cumulative residual effects from loss and/or degradation of vegetation and special landscape features are expected to remain within the PDA, LSA or RSA, which are all within Nunavut, transboundary effects are not expected and are not further addressed.

4.8 MITIGATION AND ADAPTIVE MANAGEMENT

Section 4.6.3 previously identifies the recommended mitigation measures and best management practices pertaining to vegetation and special landscape features. To minimize potential for loss of vegetation and special landscape features, mitigation and management measures have been embedded throughout the Project design and others will continue throughout construction and operation. Table 4.8-1 summarizes the specific measures under each category below.

4.8.1 Mitigation by Project Design

The measures implemented during the design phase to minimize loss and disturbance to the terrestrial environment include maximizing the use of lakes and rivers for winter access roads and confining proposed infrastructure, waste rock storage areas and the tailings storage facility to the local watersheds within which the deposits are located. The design of haul roads was optimized to minimize travel distances and associated emissions, and infrastructure such as stockpiles and windbreaks were proposed in locations that minimize potential for dustfall effects.

For the FEIS, a section of the winter road was realigned near Tahikafflok Lake (Bathurst Lake) to the Marine Laydown Area in response to focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012) and a request by the Kitikmeot Inuit Association. The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The previous DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) is outside the LSA but 5.3 km of this are located on lakes.

4.8.2 Best Management Practices

Best management practices to minimize loss and disturbance to the terrestrial environment include measures to minimize clearing of vegetation and soil from unique landscape features, reduce the potential for introduction and spread of invasive plants, minimize the potential for degradation from the creation of ruts, and minimize the potential for fugitive dust-related effects.

4.8.3 Adaptive Management and Monitoring

The need for specific adaptive management and monitoring activity will be determined by the results of many of the plans provided in Volume 10. Specific Plans that will help minimize the loss or degradation of vegetation and special landscape features include the:

- Air Quality Monitoring and Management Plan (Volume 10, Chapter 17)
- Fuel Management Plan (Volume 10, Chapter 4)
- Spill Contingency Plan (Volume 10, Chapter 5)
- Site Water Monitoring and Management Plan (Volume 10, Chapter 7)
- Ore Storage Management Plan (Volume 10, Chapter 8)
- Mine Waste Rock Management Plan (Volume 10, Chapter 9)
- Waste Management Plan (Volume 10, Chapter 10)
- Incineration Management Plan (Volume 10, Chapter 11)

- Hazardous Materials Management Plan (Volume 10, Chapter 12)
- Explosives Management Plan (Volume 10, Chapter 13)
- Road Management Plan (Volume 10, Chapter 14)
- Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16)
- Aquatic Effects Management Plan (Volume 10, Chapter 19)
- Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20)
- Tailings Management Plan (Volume 10, Chapter 22)
- Mine Closure and Reclamation Plan (Volume 10, Chapter 29)

4.8.4 Summary Table of Mitigation and Adaptive Management Measures

Table 4.8-1 summarizes the mitigation and adaptive management measures applicable to vegetation and special landscape features.

4.9 IMPACT STATEMENT

For the assessment of the vegetation and special landscape feature VECs, it was assumed that the entire Project Development Areas (PDAs) would be lost. This represents a worst case scenario, but provides flexibility in future Project siting. Direct loss from clearing activities within the PDAs will result in local long-term decreases in the abundance, diversity and percent cover of vegetation. Although complete loss within the PDAs is assumed for the assessment, actual loss is dictated by the final Project design and will be localized to the actual footprint.

Collectively, loss of vegetated and sparsely-vegetated ecosystems within the PDAs comprises nearly 4.4% of the baseline distribution for vegetated ecosystems within the LSA, and less than 1% within the RSA. Reflective of ecosystem distributions at baseline, the majority of loss within each PDA is expected from tundra ecosystems, with greatest loss (by area) within the Goose PDA from the Mesic Dwarf-Shrub Tundra ecosystem. Within the Marine Laydown Area PDA, greatest loss (by area) occurs from the Marine Dwarf Shrub Tundra ecosystem. Losses within Ecosystem Classes (Table 4.5-4) are typically below 10% of their respective baseline distributions in the LSA, with exception of the Marine Beach and Riparian Marine ecosystem classes within the Marine Laydown Area PDA. Losses from these two classes represent 13% and 20%, respectively, of their baseline distribution. Ecosystems within these classes include marine beaches, old beach heads, and shrub-dominated riparian ecosystems and were commonly observed beyond the LSA boundary and throughout the RSA.

Similarly, estimated loss of special landscape features within the PDAs comprises approximately 4% of their collective baseline distribution within the LSA. For specific features, losses are also typically below 10% of their respective baseline distributions, with the exception of the Marine Beach (MB), Marine Riparian Shrub (MR), and Old beach head (MH). The majority of loss of special landscape features within the Goose PDA occurs from wetland ecosystems (Table 4.5-5). Within the Marine Laydown Area PDA, losses are split nearly equally between riparian and wetland ecosystems, marine beaches and old beach heads.

Table 4.8-1. Summary of Mitigation and Adaptive Management Measures for Vegetation and Special Landscape Features

Mitigation by Project Design
• The Project has been designed to employ winter road only access corridors that travel primarily over lakes and rivers thereby minimizing potential negative effects on terrestrial vegetation and limiting dust emissions. • Infrastructure, waste rock storage areas, and the TSF at the Goose Property have been confined primarily to the local watersheds (except for Water Intake Pipeline in Big Lake) where the deposits are located, thereby confining the Project footprint and minimizing the disturbance to the terrestrial environment. • The design of haul roads has been optimized to minimize the distance travelled which will reduce emissions associated with construction and operation.
• Tailings disposal methods have been designed to reduce beach/dust sources and generation.
Best Management Practices
• The clearing of vegetation and soil from unique landscape features will be minimized to the extent possible, including eskers, wetlands, exposed bedrock, cliffs etc., which often provide high value habitat to wildlife and may support sensitive vegetation communities and growth forms. • All vehicles and machinery will restrict travel to designated road surfaces; avoid creation of ruts in vegetated ecosystems. • Best Management Practices to reduce dust and hence reduce influence of dust on vegetation will include: – The discharge heights from the crushers onto conveyers will be minimized, and the discharge heights from conveyors onto stockpiles will be minimized. The discharge from crushers onto conveyors or into other equipment will be enclosed as far as is practicable (e.g., free fall of materials from conveyors carrying material should be fitted with a full hood such as a plastic chute). – Loads carried by vehicles will be enclosed or covered when possible. – Storage areas will be kept in a condition that does not give rise to visible dust emissions. – Windbreaks or fences may be installed around known problem areas or stockpiles to limit the dispersion of dust emissions from equipment and stockpiles, or activities likely to generate dust. – Regular wheel-cleaning of vehicles travelling around and leaving the site. – Regular removal of dust deposits on external parts of the plant in order to minimize the potential for wind entrainment. – All-weather roads (local site roads) will be regularly compacted and kept in good repair. – Vehicles will be driven at designated speeds on site roads. – Water or other dust suppressant (non-wildlife attracting) will be used for site roads if needed to minimize dust from ore and waste rock haulage and grading, when ambient air temperatures permit. – Water sprays or dust suppression fluids will be used to suppress dust generation from equipment in the crushing facility. Dust suppression methods will be approved by the Government of Nunavut as outlined in the Nunavut environmental guideline for dust suppression (Government of Nunavut 2002) and will be suitable for use at below freezing temperatures. – Conditioning materials which are likely to generate dust will be sprayed with water prior to transfer. • The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: – if results from the Site Water Monitoring and Management Plan show non-compliance related to tundra discharges; or – if results from the Wildlife Mitigation and Monitoring Program, which will monitor select wildlife species and habitat around the mine infrastructure and activities, show adverse effects to wildlife or wildlife habitat.
Monitoring
• Monitoring Plans, indicated in Section 4.5.3, outline programs to monitor air quality, water, and waste management, which will help eliminate or minimize effects to vegetation and special landscape features. • A Wildlife Mitigation and Monitoring Plan (Volume 10, Chapter 20) will be in place that outlines the Wildlife Mitigation and Monitoring Program (WMMP) that will be carried out during all phases of the Project. The WMMP will include monitoring select wildlife species and habitat.

Consistent with the small percentage of total loss of vegetation and special landscape features compared to their mapped distributions within the LSA (4% and 5%, respectively), residual vegetation loss is considered of low magnitude. Within specific ecosystems, the greatest change to baseline occurs within marine-influenced ecosystems near Bathurst Inlet. This is due to the higher proportion of deciduous shrub-dominated ecosystems that support greater species diversity, the importance of riparian ecosystems that provide wildlife habitat, and the special landscape features that create unique microsystems that support the majority of rare plants (most occur within a kilometre of the Inlet). Residual vegetation loss is assumed to be irreversible but **Not Significant** (Table 4.5-15) as ecosystems lost within each PDA are common beyond the LSA boundary and throughout the RSA.

The two project residual effects were included in a cumulative effects assessment, the boundary of which was the vegetation and terrestrial wildlife RSA. In addition to assumed losses within the PDAs (approximately 5,227 ha, excluding water features, existing exploration infrastructure, and road surfaces), a further 556 hectares of cumulative loss could occur within the RSA from developing roads and infrastructure associated with the future Hackett River Mine, Bathurst Inlet Port and Road (BIPR), and George Property projects (Table 4.6-2). Only the future BIPR project would result in cumulative loss within the LSA due to the proposed port location; whereas cumulative loss from the Hackett River project would occur in the RSA of the Project.

The cumulative loss and degradation of vegetation and special landscape features from development of the proposed Back River Project, Hackett, and BIPR projects is considered **Not Significant.**

4.10 SUPPORTING AND SUPPLEMENTAL INFORMATION

A detailed report on rare plant and lichen species throughout the LSA and RSA is provided in Appendix 1 of Rescan (2013a), which can be found in Appendix V5-4A. Although potential effects on rare and culturally valued plants are not individually assessed, ecosystems or features with highest potential to support rare plant species, such as cliffs and marine beaches, shores and wetlands, are encompassed within the assessment of special landscape features. Table 4.3-2 identifies those features with highest likelihood of supporting rare and culturally valued plants. Section 4.3.1 discusses the plant species of traditional importance.

5. Caribou

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5. Caribou

5.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

5.1.1 Introduction

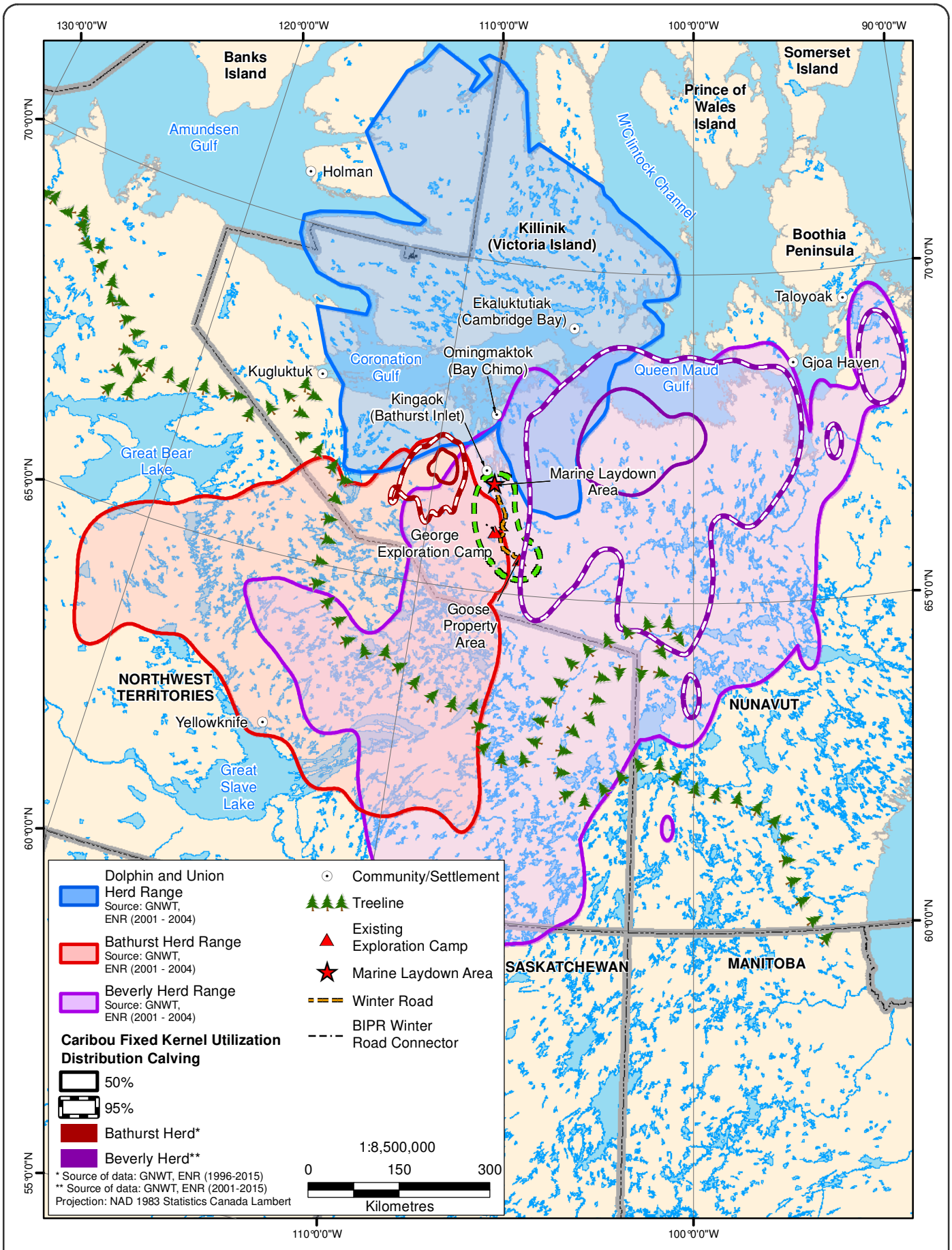
There are more than 2.4 million caribou in Canada and about half are barren-ground caribou comprising eight large migratory herds found across Nunavut, the Northwest Territories, and Yukon (Kelsall 1968; F.L. Miller, Rothfels, and Russell 2005). Distinct from woodland caribou that inhabit much of the boreal forest across Canada, barren-ground caribou (*Rangifer tarandus groenlandicus*) are smaller, lighter in colour, and spend much of the year on the tundra. Caribou herds are classified based on their calving ground fidelity and similar demographic characteristics (Fisher, Roy, and Hiltz 2009). Barren-ground caribou are a keystone species in the Arctic both biologically and culturally and are a main prey item for grizzly bears and wolves. Other carnivores such as wolverines, foxes, and golden eagles scavenge on the caribou remains left from grizzly bear and wolf predation on caribou. Inuit TK of the Kitikmeot region includes observations of close associations between the abundance of these carnivore species and caribou abundance at a local scale (KIA 2012, 2014). The barren-ground caribou alter the Arctic ecosystem by modifying the composition of plant communities and seasonal distribution of predators. In winter and fall, caribou feed primary on lichen and during the summer months, caribou feed on herbaceous vegetation, shrubs, flowers, and sedges on the tundra (F.L. Miller, Rothfels, and Russell 2005).

Caribou continue to be the lifeblood of many Inuit communities and the most important wildlife species for the western Kitikmeot region (KIA 2012, 2014). The life cycle of the caribou was a major influence on where Inuit travelled and lived as they relied on caribou for food and clothing. Caribou, and caribou hunting, are central to Inuit culture, identity, recreation, and kinship. The Inuit have a long history of observing caribou behaviour, movement, and life cycle during their hunting activities. Further information on Inuit and their reliance and relationship with caribou can be found in the socio-economic chapter (Volume 8, Chapter 3).

Most of the barren-ground caribou migrate annually between the calving grounds on the tundra and over-wintering grounds in the south. During winter, some herds migrate south below the treeline, such as the Bathurst herd, while other herds over-winter on the tundra including the Dolphin and Union herd, named after the Dolphin and Union Strait. The Peary caribou herd (*Rangifer tarandus pearyi*), a smaller distinct subspecies of barren-ground caribou, migrate on the sea ice between islands of the Arctic Archipelago.

Four barren-ground caribou herds have been identified, whose ranges overlaps the area of the Project wildlife Regional Study Area (RSA). The Bathurst herd is found in the RSA, primarily during post- calving period (Figure 5.1-1). The Beverly herd and Ahiak caribou herds are found in the wildlife RSA primarily during the late summer and fall and to a lesser extent during the winter. The winter distribution of Dolphin and Union caribou likely overlaps the marine wildlife RSA to a small extent during the winter.

The Beverly herd and Ahiak herd have traditionally been two separate herds. The Ahiak herd calved in the western Queen Maude Gulf area by the coast, and the Beverly herd calved on the tundra near Garry Lake, south east of the Ahiak calving grounds. Since 2002, the Beverly herd has shifted its calving range to join the Ahiak herd in the western Queen Maude Gulf area. The two herds are referred to as the Beverly herd in Government of Nunavut reports and in this chapter (Nagy et al. 2011; Campbell et al. 2012; Nagy, Campbell, and Kelly 2012). Baseline reports and other parts of the FEIS may still refer to this herd as the Ahiak herd.



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Annual Ranges of the Bathurst, Beverly and Dolphin and Union Caribou Herds

Figure 5.1-1

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A fifth herd, the Peary caribou herd may overlap the commercial Northwest Passage shipping route outside of the marine wildlife RSA only (outside of assessment area). Peary caribou are at risk of effects due to winter ice breaking. The Project will not be conducting ice breaking and will not, therefore interact with this her and is not discussed further in this assessment. The Dolphin and Union herd is SARA listed as a species of special concern while the Bathurst herd and the Beverly herd have not been assessed by COSEWIC.

There are three additional herds that calve on the eastern edge of the Nunavut mainland; the Queen Maude Gulf herd, the Lorillard and Wager Bay herds. The Queen Maud gulf herd calves on the eastern Queen Maude Gulf area, adjacent to the Beverly herd, while the Lorillard and Wager Bay herds calve to the south-east of the Queen Maude Gulf herd. These three herds overwinter on the tundra and in some years the extreme western edge of their winter distribution overlaps with the south-east portion of the wildlife RSA. In addition to a discussion of the potential effects of the Project on the Bathurst herd, the effects assessment discusses potential effects due to the Project on the Beverly herd, which has a portion of its summer, fall and winter ranges overlaps with the wildlife RSA in most years, The Beverly herd is therefore used as a proxy for the Queen Maude Gulf, Lorillard and Wager Bay herds, for whom any effects is anticipated to be smaller because they overlap with the wildlife RSA for fewer seasons, frequency and extent.

The following environmental setting provides background on the distribution, movement, habitat, and population viability and health of caribou in the Project area. Distribution and movement of caribou herds are described using Traditional Knowledge and baseline studies conducted over the Project area.

5.1.2 Bathurst Caribou

5.1.2.1 Introduction

The Bathurst caribou herd is named for Bathurst Inlet, where this herd has historically calved. The Bathurst herd moves yearly between calving grounds on the tundra and wintering range in the boreal forest. In the 1980s, the Bathurst herd was one of the largest migratory herds in Arctic Canada, estimated at approximately 450,000 animals in 1986 (D.C. Heard and Williams 1991; Boulanger et al. 2011). But like some other North American caribou herds, the Bathurst herd has declined (L. S. Vors and Boyce 2009; Boulanger et al. 2011), likely due, in part, to relatively high winter harvests of females (4,000 to 5,000 per year), which coincided with declines between 1986 and 2006 (J. Adamczewski et al. 2009). Between 2006 and 2012, assessments of caribou body condition, pregnancy rates, and cow-calf ratios suggested improvements in breeding productivity, and the population appeared to be stabilizing or increasing slightly (J. Adamczewski et al. 2009). However, recent reconnaissance surveys conducted on the calving grounds in 2014 suggest that the herd may be in further decline (ENR GNWT 2014).

5.1.2.2 Distribution and Migration Patterns

Seasonal movements of the Bathurst herd have been tracked from 1996 to 2015 using satellite collars, primarily on cows with several males added recently (between 8 and 35 animals per year; GNWT ENR unpublished data). The yearly distribution and movements of caribou can be classified into six distinct periods: spring migration, calving, post-calving, summer, fall migration, and winter (Table 5.1-1). The timing of each period was derived from published estimates of life cycle timing (see footnote in Table 5.1-1), which were primarily based on the movements of GPS collared cows.

Maps presented in the following sections were created using fixed kernel utilization distributions from satellite collar data (Figures 5.1-7a-f). The methods for this analysis are presented in Section 5.1.2.5 (Baseline data for Bathurst Caribou Herd).

Table 5.1-1. Timing of Life History Stages of Bathurst Caribou

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

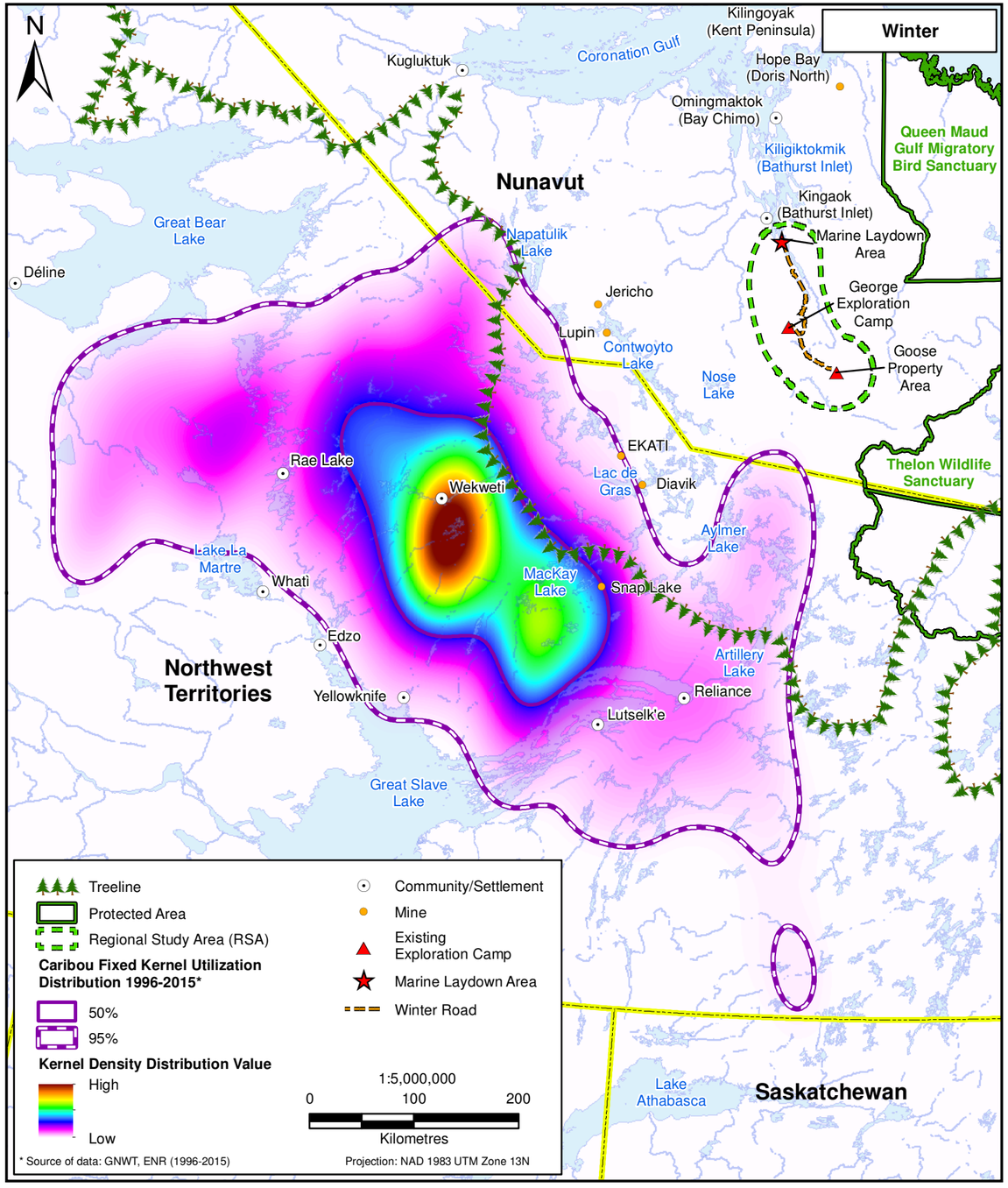
[1] Gunn et al. (2008); Johnson et al. (2005b).
[2] Russell, Kofinas, and Griffith (2002); Gunn et al. (2008); Gunn and Poole (2009).
[3] Five weeks post-calving, which includes post-calving and early summer periods defined in Gunn et al. (2008); Russell, Kofinas, and Griffith (2002).
[4] Gunn et al. (2008).
[5] Johnson et al. (2005b); includes rut period defined in Gunn et al. (2008).
[6] Includes late fall and winter periods defined in Gunn et al. (2008).

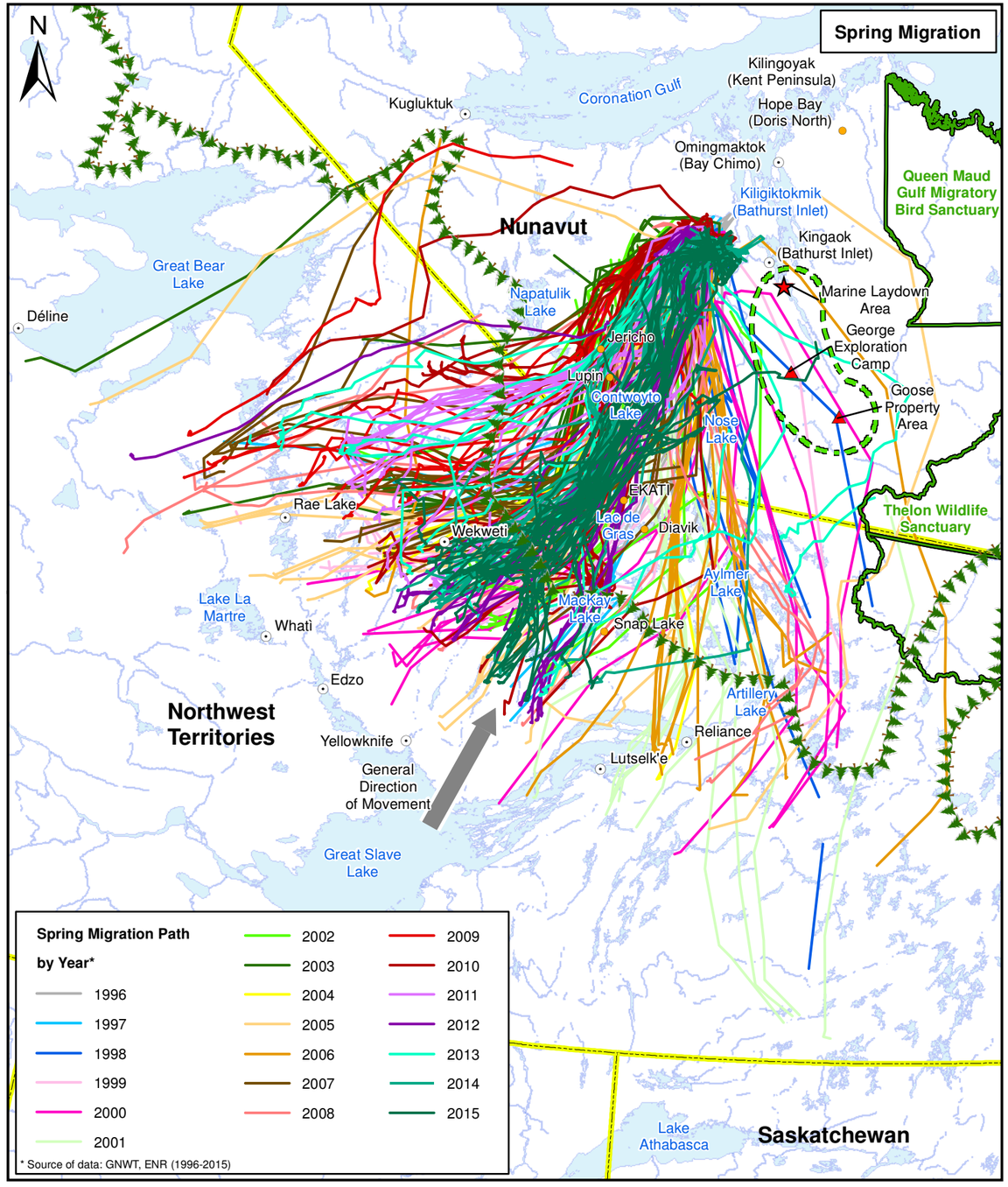
Spring Migration (April 15 to June 4)

In the spring, during a relatively short period of time, the Bathurst caribou herd migrates over a large area (275,000 km^2) from their wintering range below the tree line in the Northwest Territories to their calving grounds, which in recent years have been concentrated in the area between the James and Burnside Rivers, west of Bathurst Inlet (Figure 5.1-2; A. Gunn, Poole, and Wierzchowski 2008; Nishi et al. 2010). Pregnant cows are the first to migrate to the calving grounds, while bulls and juveniles follow later in the spring, but usually do not travel as far as the calving grounds. Movement corridors vary depending on the distribution of caribou on the wintering grounds (A. Gunn and D'Hont 2002; A. Gunn et al. 2008). Cows usually arrive in late May, but sometimes as early as April, and calving begins in early June (KIA 2012). Non-parturient cows (not pregnant) can be identified by their lack of hard antlers during northern migration, and lack of distended udders and new antler growth during the calving period. These cows migrate more slowly than pregnant cows, but still reach calving grounds during peak calving (Figure 5.1-3; A. Gunn et al. 2008). Bulls and juvenile caribou (born in the year previous) probably also follow females as some are present during calving, but generally north-bound males and juveniles are thought to meet females with calves in late June and early July, on the post-calving range, when females have begun their southward movement (A. Gunn and D'Hont 2002). It is thought that bulls and juveniles re-unite with female caribou by about mid-June onward (D.C. Heard, Williams, and Melton 1996).

Calving (June 5 to June 15)

The calving period refers to the time when cows are giving birth, which is defined both by the initiation of calving and the one week period of "peak calving", when 50% of cows have calved (D. E. Russell, Kofinas, and Griffith 2002; A. Gunn and Poole 2009). The dates for the peak calving period can be identified by the relatively slow movement rate of satellite-collared cows during calving (<4 km/day during calving versus 14-20 km/day before calving, and about 12 km/day after calving (A. Gunn and D'Hont 2002; A. Gunn, Dragon, and Boulanger 2002; A. Gunn and Poole 2009; Nishi et al. 2010). Calves have very limited movement ability in the first days of life (A. Gunn and Poole 2009). Between 1996 and 2007, peak calving has shifted later, from June 4 to June 14, except for 2005 when calving was one week later (A. Gunn, Poole, and Wierzchowski 2008). However, more recent estimates suggest a shift in peak calving to early June (J. Adamczewski et al. 2009). Calving grounds tend to be areas with few predators, and with lichen cover to provide additional forage to support birthing females until vegetation greens (Griffith et al. 2001; R. R. Wilson et al. 2012). Cow density is usually concentrated within one to a few core areas within a larger area over which calving cows are found (Nishi et al. 2010). However, calving cows can be distributed at lower densities over more extensive areas in some years if snow cover is too deep or forage quality inadequate at preferred sites (D. E. Russell, Kofinas, and Griffith 2002).





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Range of Satellite-collared Bathurst Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 1996 to 2015

Figure 5.1-2

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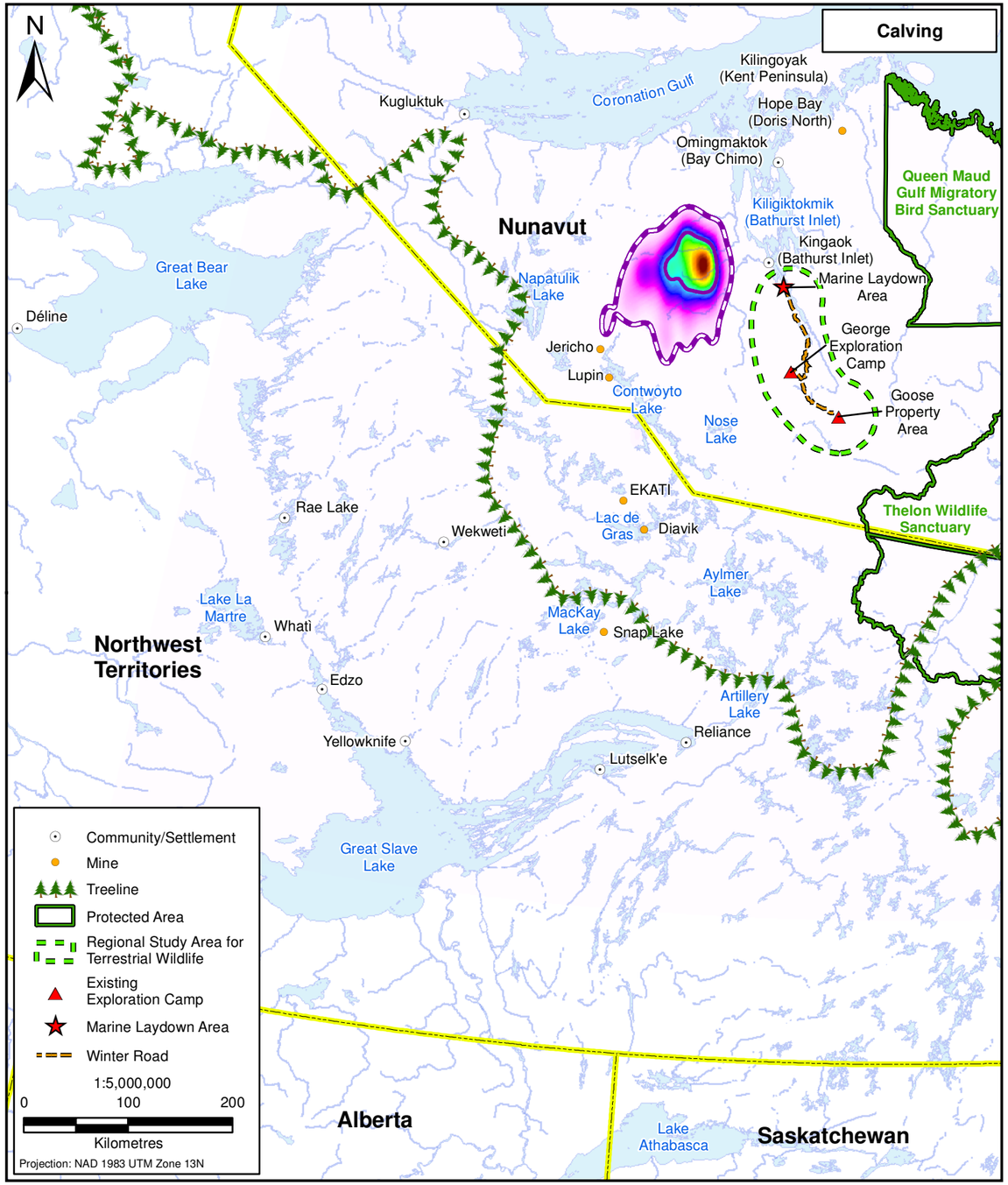

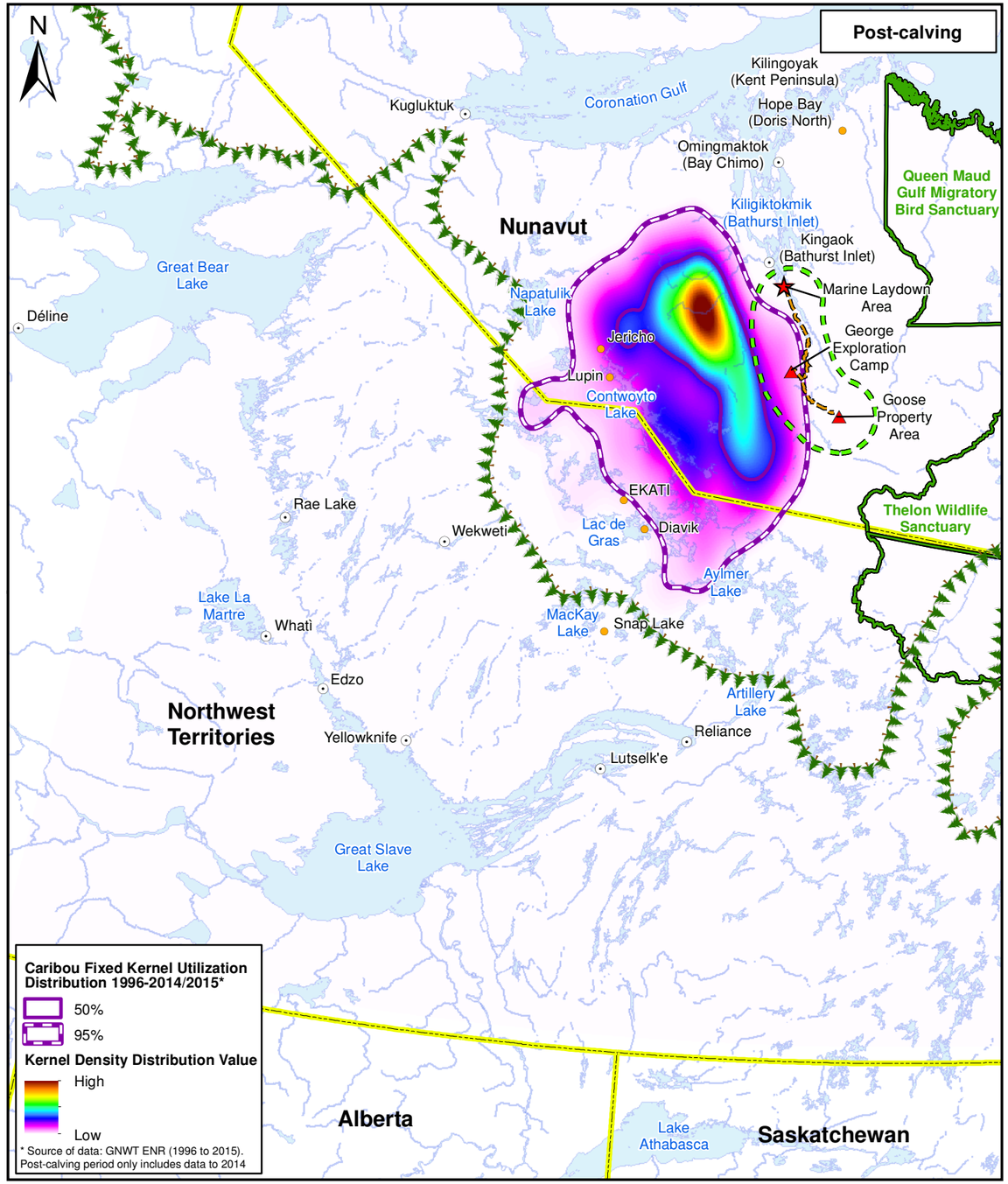

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Range of Satellite-collared Bathurst Caribou during Calving (5 June to 15 June) and Post-calving (16 June to 20 July), 1996 to 2014/2015

Figure 5.1-3

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In addition, there exists year-to-year variation in the spatial extent of calving because cows sometimes calve en route to calving grounds, or calve over a wider area when snow cover is too deep or forage quality inadequate within the core calving area (D. E. Russell, Kofinas, and Griffith 2002). Both Bathurst and Beverly cows have been observed calving outside of core calving grounds in some years (e.g., A. Gunn and D'Hont 2002). Calving outside the calving area occurs during years with high snow cover or other unfavourable conditions (A. Gunn and D'Hont 2002).

Though caribou cows return to the same general area to calve every year, the spatial extent and location where most calving occurs is dynamic over longer periods (Figure 5.1-4; D. E. Russell, Kofinas, and Griffith 2002). Shifts in the location of calving grounds over several years have been observed for several barren-ground caribou herds, including the Bathurst herd (A. Gunn, Poole, and Wierzchowski 2008; Taillon, Festa-Bianchet, and Cote 2012).

Results from aerial surveys and satellite collars indicate that the Bathurst caribou have calved both east and west of Bathurst Inlet over time. Urquhart (1981) compiled the historical evidence for the location of the Bathurst caribou between the 1930s to the 1970s, reporting that there was evidence of calving both east, west and south of Bathurst Inlet. Kelsall (1951 and 1953) reported calving both east and west of Bathurst Inlet, however the majority of calving was thought to be on the eastern side of the Inlet (Kelsall, 1955).

The first formal aerial surveys of the calving grounds were conducted in 1965 and 1966 and reported that calving occurred on the eastern side of Bathurst Inlet (Figure 5.1-3; Williams 1966). Throughout the late 1960s and 1970s, calving and aerial surveys were conducted on the eastern side of Bathurst Inlet, although there were reports of additional calving west of the Inlet (Figure 5.1-3; (M. Sutherland and Gunn 1996).

During the 1980s and early 1990s, calving appears to have occurred exclusively on the eastern side of Bathurst Inlet (Figure 5.1-4; (A. Gunn et al. 2008). Between the aerial surveys conducted in 1990 and 1996, the Bathurst Caribou shifted their calving range from the east side of Bathurst Inlet to the west side of the Inlet, between the Hood and Burnside Rivers (Figure 5.1-3; (A. Gunn et al. 2008). The calving range has remained centered in that location ever since based on aerial surveys conducted on the western calving grounds and yearly satellite collar data (Figure 5.1-3).

According to Inuit TK, distribution and movements of the Bathurst herd changes frequently, especially the spring migration, and the calving areas are located both inland and near the ocean around Bathurst Inlet (KIA 2012). Inuit TK indicates that the traditional calving grounds of Bathurst caribou are located near Bathurst Inlet (Thorpe et al. 2001b), after which the herd is named (Figure 5.1-4). The "traditional calving grounds" is the area encompassed by yearly and long-term shifts in the calving grounds and so defines a larger area than core areas used in consecutive years.

Post-calving (June 16 to July 20)

Typically, the post-calving period is defined as the three week period following calving, which is the amount of time needed to wean calves from lactation (D. E. Russell, Kofinas, and Griffith 2002). The spatial extent of cows three weeks after peak calving has been suggested as a way to delineate annual calving grounds from post-calving grounds (Figure 5.1-3; D. E. Russell, Kofinas, and Griffith 2002). For the purposes of this assessment, a five week period is used to define the post-calving period, to accommodate years with late calving, such as the one that occurred in 2005. The calving and post-calving stages are defined separately because these periods occur in different areas, and can thus interact with the Project differently.

Summer (July 21 to August 31)

During the summer, most of the Bathurst caribou pass the southern end of Contwoyto Lake and move south, west, and then northwest in a clockwise direction across the summer range (Figure 5.1-5; A. Gunn et al. 2008; A. Gunn, Poole, and Wierzchowski 2008). Movement rates of caribou are moderately paced at this time (A. Gunn et al. 2008; A. Gunn, Poole, and Wierzchowski 2008). Annual fidelity to the summer range is high; the Bathurst herd has been found in the same general areas in summer from year to year (A. Gunn et al. 2008; A. Gunn, Poole, and Wierzchowski 2008)

Fall Migration (September 1 to October 31) and Winter (November 1 to April 14)

During the fall, Bathurst caribou migrate towards the winter range (Figure 5.1-5), most of which is below the treeline (Figures 5.1-2 to 5.1-5). Bathurst caribou remain in the wintering grounds until mid-April when they begin their migration north to the calving grounds. Winter survival of Bathurst herd caribou calves is related to post-calving and summer range biomass availability. In years with poor biomass availability, the overwinter survival of calves the following winter is reduced and the growth rate of the herd declines or is negative (Wenjun Chen et al. 2014).

Bathurst Caribou Distribution and Movements from Inuit TK

The Inuit through their TK have identified historic patterns in caribou movements and distribution, which indicates that the location of calving and over-wintering areas shift through time (KIA 2012, 2014). Based on the predictability of finding caribou at various times of the year, Inuit TK suggests that calving ranges are more static over time than over-winter ranges (KIA 2012), an observation that fits with recent analyses based on collar data (Nagy, Campbell, and Kelly 2012).

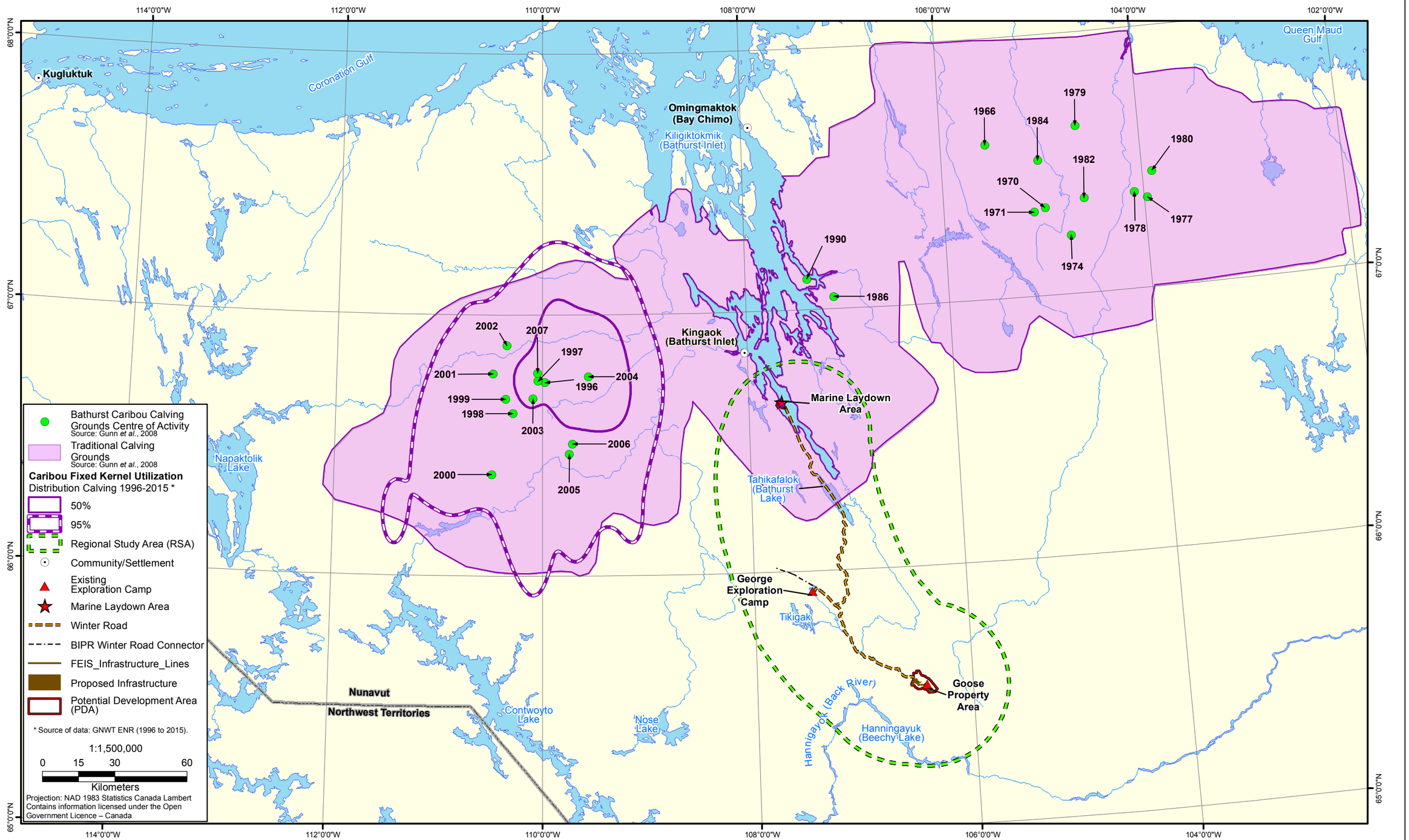
Within the Kitikmeot region, three main areas were inhabited by Inuit because caribou were predictably found there in large numbers throughout the year: Contwoyto Lake, Beechey Lake, and the whole Bathurst Inlet area (KIA 2012, 2014). The abundance of caribou, and of their main predators, wolves, was high enough around Beechey Lake to support a large winter camp, the settlement of families for multiple years, and two fur trading posts. Inuit TK includes reference to an important community at Beechey Lake called Tudlak (KIA 2012, 2014).

Several historic calving areas are recognized for the Bathurst caribou, including a large calving ground east of Bathurst Inlet, in coastal areas around Bathurst Inlet, and two areas immediately to the north of Contwoyto and Nose Lakes (Thorpe et al. 2001b; KIA 2012). Calving was also reported around Beechey Lake within the wildlife RSA (Figure 13 & 14; KIA 2012, 2014). Both TK and scientific literature indicate that barren-ground caribou select flat, open terrain areas with abundant lichen and green vegetation for calving (Griffith et al. 2001). Large flat areas exist on the south side of Beechey Lake and the northwest side of Contwoyto and the north side of Nose Lake.

Inuit TK includes a main migration route and observations of large numbers of caribou migrating across Beechey Lake, across the Western River, and past the community of Kingaok (KIA 2012, 2014). The islands of Bathurst Inlet were considered to be good places to hunt caribou in the open water season, and several key nadlok (crossing places) were observed where caribou swam across Bathurst Inlet. Given the historic distribution of the Bathurst calving range on the eastern side of Bathurst Inlet, these observations likely indicate the migration route of the Bathurst herd during the periods when the calving range of the herd was centred on Bathurst Inlet. Caribou migrating across Beechey Lake were also likely to have been those of the Beverly herd.

GIS # **BAC-23-390**

November 9, 2015



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Traditional Calving Grounds of Bathurst Caribou (1966 to 2015)

Figure 5.1-4

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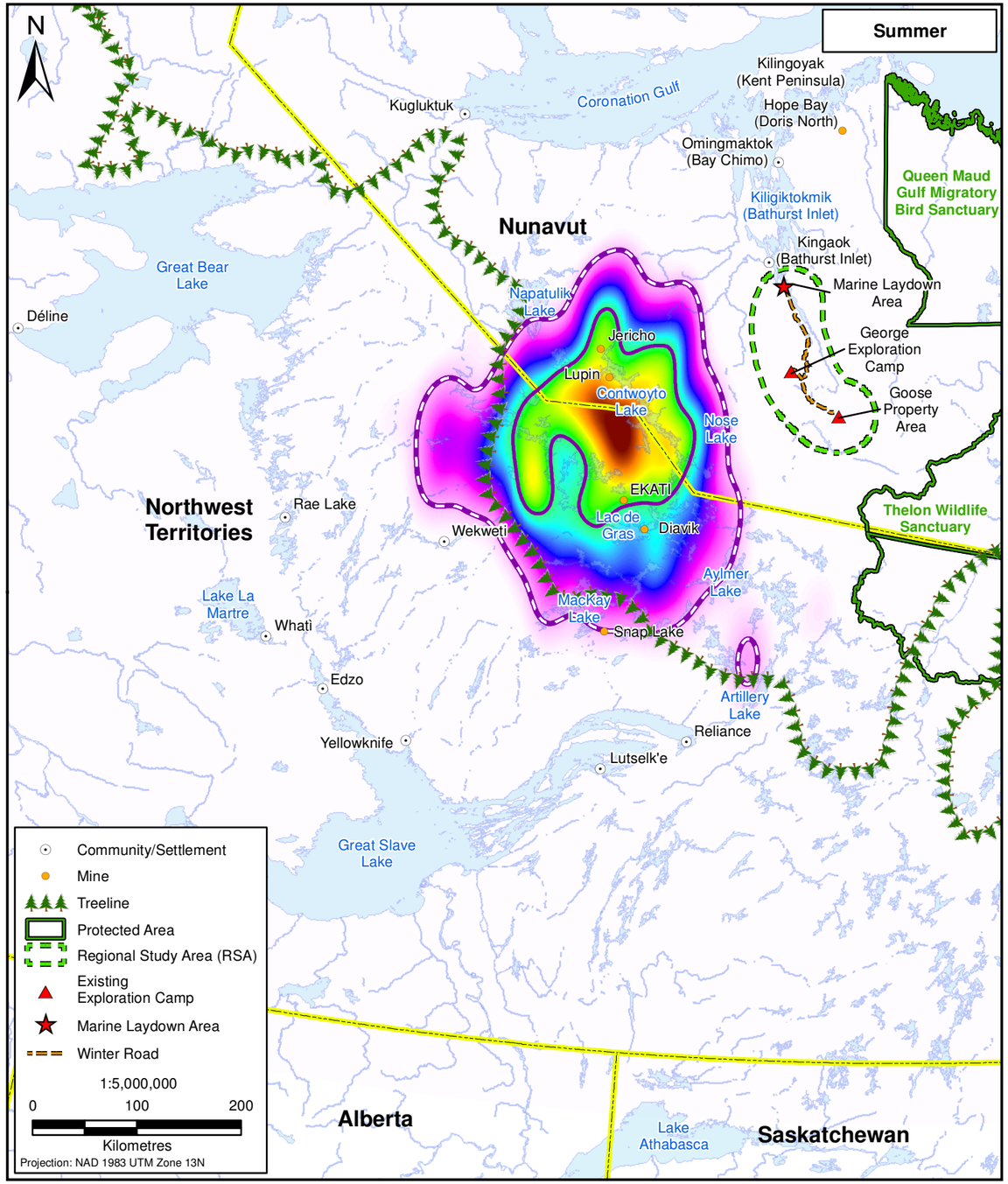

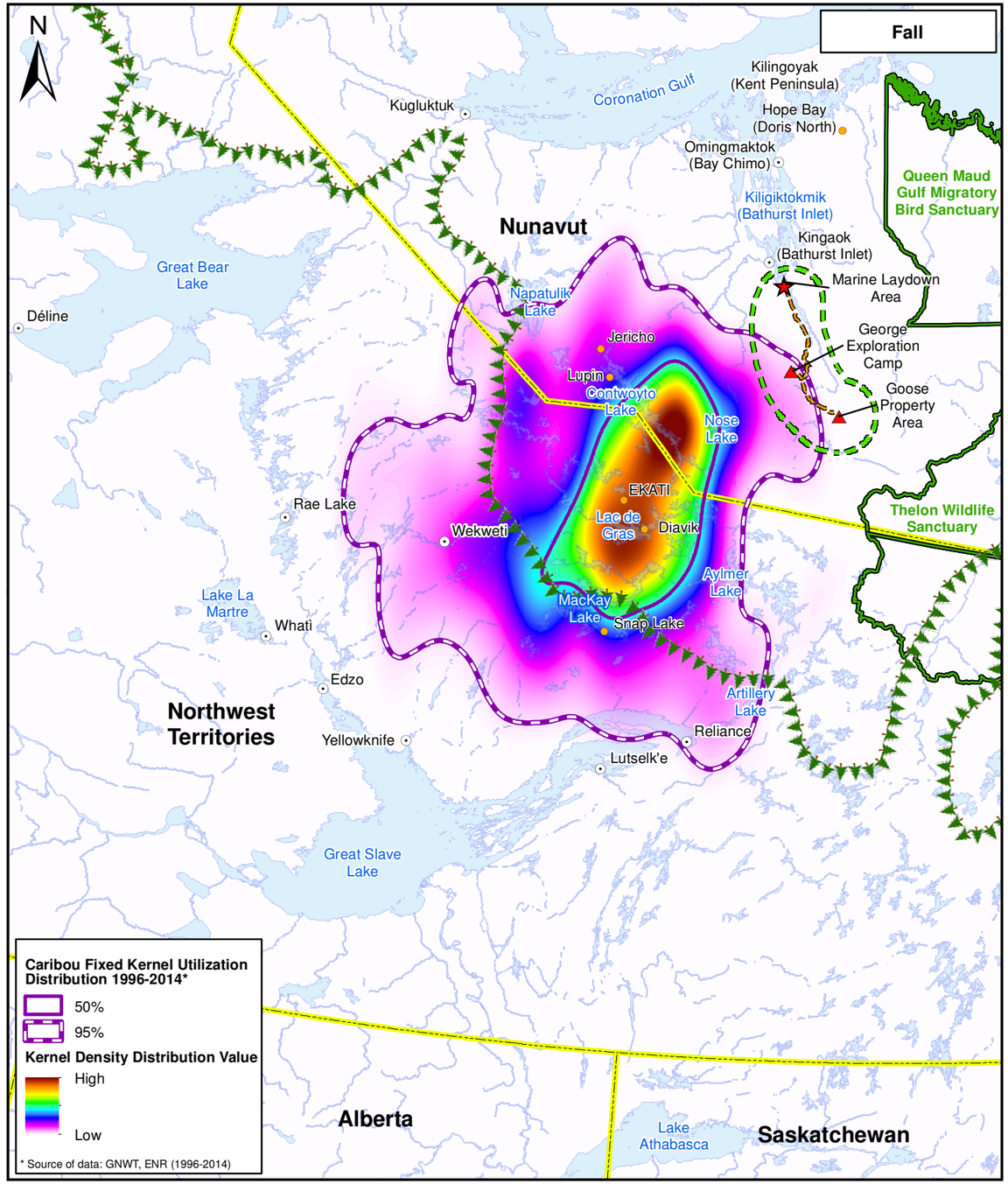

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Range of Satellite-collared Bathurst Caribou during Summer (21 July to 31 August) and Fall (1 September to 31 October), 1996 to 2014

Figure 5.1-5

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Caribou freshwater crossings tend to occur where water crossing during summer and fall is easier, such as where lakes and rivers are narrowest. These are referred to as nadloks, and are places often evidenced by deeply rutted pathways in the tundra vegetation. Several key nadloks were identified along Beechey Lake (KIA 2012). Inuit TK has been used to identify designated crossings of migrating caribou across water and ice in the Kitikmeot Region (Figure 5.1-6). These have been identified as key habitats for caribou (NPC 2005, 2012a). Caribou are thought to be particularly susceptible to disturbance at designated crossings, and mitigation measures have been proposed that include no blasting within 10 km of designated crossings (NPC 2005). Several designated crossings occur in the wildlife RSA on Contwoyto Lake, Nose Lake, the southern end of Bathurst Inlet, and across Bathurst Lake (Figure 5.1-6).

Caribou habitat is one of six main issues identified in the draft Nunavut Land Use Plan (NLUP) for environmental protection (NPC 2012a). In addition to calving areas, migration routes "especially at water crossings" have been identified as key aspects of caribou habitat. The plan stipulates that herds are vulnerable to ice breaking, and considerations for mitigation and management fall under Recommendation PSE-R3, which states "Project Proposals located in and/or near known caribou sea ice crossing areas should take into account impacts that may impede the ability of caribou to cross the ice." Water crossings are also considered (NPC 2012b). The Nunavut Planning Commission (NPC) recommends that all land uses near caribou water crossings be permitted, and also recommends that regulators and project proponents should "consider potential impacts on caribou migration routes" (NPC 2012b). The Nunavut Planning Commission recognizes the Caribou Protection Measures designed and implemented by Aboriginal Affairs and Northern Development Canada (AANDC).

Summary of Bathurst Herd Movements and Distribution

Bathurst caribou overwinter in the boreal forest and in spring move relatively quickly to their calving grounds, which in recent years (since 1996) has been located outside and to the northwest of the wildlife RSA. After calving, the herd moves south east to their summer range. Very low numbers of Bathurst caribou cross into the western portion of the wildlife RSA during this post-calving movement in some years. Non-parturient females follow parturient females to calving grounds, and after calving, but usually most arrive about a week later than pregnant females. Because males and immature caribou follow females but also range more widely, it is hypothesized these caribou may interact with the wildlife RSA, primarily from mid-April to mid-October.

Bathurst caribou may cross the western portion of the wildlife RSA in small numbers. Throughout the rest of the summer and during fall, Bathurst caribou will likely not occur within the wildlife RSA with the exception of when the population of the herd is at a high, such as in the late 1990s, and a small portion of the summer range overlaps with the RSA.

5.1.2.3 Population Trends and Conservation

The Bathurst caribou population has declined from approximately 472,000 animals in 1986 to 31,900 animals in 2009 (Table 5.1-2). These estimates are based on calving ground surveys of breeding females. The data suggest an average annual population decline of about 6% per year from 1986 to 2006 (Boulanger et al. 2004; A. Gunn et al. 2005).

Boulanger et al. (2011) proposed that the population has likely declined due to decreasing calf and female survival (and possibly reductions in female fecundity), as well as a constant hunter harvest pressure while the herd was in decline. Annual monitoring of calf survival indicates that mean winter calf survival and calf-cow ratios for the Bathurst herd declined by almost 50% in 2001-2004 compared with 1985-1996 (A. Gunn, Boulanger, and Williams 2005). Like other caribou herds, the size of the Bathurst herd has fluctuated with a periodicity between 40 and 70 years, likely dependent on weather and forage availability, which affect female fecundity and calf survival (Zalatan, Gunn, and Henry

2006; Beaulieu 2012). While initial declines in the Bathurst caribou numbers may have been a consequence of natural population cycles, biologists have proposed that relatively high winter mortality rates of females to hunting probably resulted in accelerated declines, especially between 2006 and 2009 (J. Adamczewski et al. 2009; Boulanger et al. 2011).

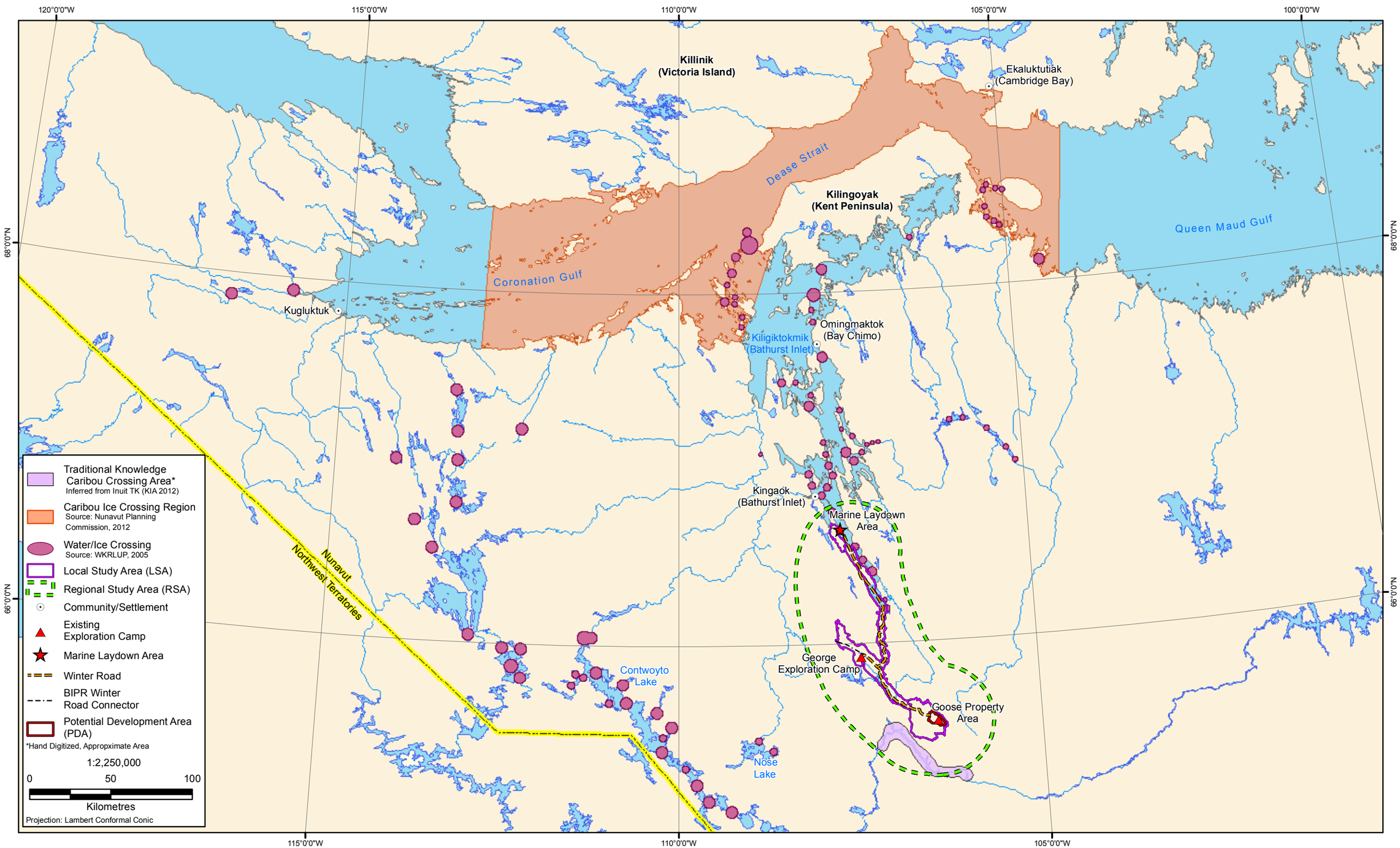
Table 5.1-2. Bathurst Caribou Herd Population Numbers and Breeding Females from 1986 to 2009

Year	Total Population	Breeding Females
1986	472,000 ± 72,900 SE[1]	203,800 ± 12,696 SE[4]
1996	349,000 ± 94,900 SE[2]	151,393 ± 34,144 SE[4]
2003	186,000 ± 40,100 SE[3]	80,756 ± 13,167 SE[4]
2006	128,000 ± 27,300 SE[1]	55,593 ± 8,813 SE[4]
2009	38,388 ± 7,400 SE[5]	16,650 ± 2,181 SE[5]
2012	34,690 ± 4,691.1 SE[6]	15,935 ± 1,407.2 SE[6]
2014	-	3,594 ± 2,133[7]
2015	16,000 to 22,000[8]	-

[1] *GNWT ENR (2012)*
[2] *Gunn, Dragon, and Nishi (1997)*
[3] *Gunn et al. (2005)*
[4] *Nishi et al. (2007)*
5 Nishi et al. (2014)
[6] *Boulanger et al. (2014)*
[7] *Boulanger et al. (2014)*
[8] *CBC (2007)*

Recently (2007-2009), indicators of breeding productivity such as increased cow-calf ratios, high pregnancy rates, and good body condition suggest that the herd was experiencing better environmental conditions and may have stabilized or begun to increase (J. Adamczewski et al. 2009). Though the population appeared to have stabilized between 2009 and 2012 to about 35,000 individuals in 2012, a reconnaissance survey of the Bathurst caribou calving grounds in 2014 suggests that the herd may be continuing to decline (ENR GNWT 2014). The current Bathurst caribou population is low compared to its historic size, which can make the herd vulnerable to disturbance, weather and other factors (BCMPC 2004; GNWT ENR, pers. comm.).

Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut. Most northern communities, including Bathurst Inlet, Kugluktuk and Omingmaktok, harvest Bathurst caribou during spring migration and post-calving (GNWT ENR 2012). Data from Inuit hunters indicates that between 1996 and 2001, the average number of caribou harvested annually by Inuit hunters (averaged by community) were: 93 in Bathurst Inlet (Bathurst Inlet Lodge 2007), 1,575 in Kugluktuk and 176 in the community of Omingmaktok (Priest and Usher 2004). However, these data include harvests of caribou from the Dolphin and Union herd and the Bluenose-east herd. Limits on the number of caribou that can be harvested for both traditional and commercial use have recently been implemented (GNWT ENR 2012). The annual harvest for the herd in Nunavut was set at 240 males and 60 females for the 2012-2013 winter hunting season (J. Adamczewski et al. 2009; Wekʼèezhìi Renewable Resources Board 2012). Since 2014, the Northwest Territories has placed a total harvest ban on Bathurst caribou during the winter hunting season, aside from a 15 individual limit for First Nations' ceremonial use. The Bathurst herd has not yet been assessed by COSEWIC.



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Designated Caribou Crossings

Figure 5.1-6

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5.1.2.4 Habitat Use and Diet

Overview

Habitat selection and diet of barren-ground caribou on the tundra is thought to be similar among herds (Gustine et al. 2012). Thus, the information presented in this section pertains to all three herds in this assessment. Winter diet is described in more detail for the Beverly herd in Section 5.1.3.4

Habitat selection on the tundra by caribou is mainly dictated by predator and insect avoidance, and the distribution and availability of suitable forage (G. W. Calef 1981; D.C. Heard, Williams, and Melton 1996; J. H. Russell 1998; R. R. Wilson et al. 2012). Caribou also select travel routes during migration that provide easier movement, such as frozen lakes in winter, and sometimes eskers (Thorpe et al. 2001b; KIA 2012).

The following sections outline habitat selection and diets of caribou during each of the six life history stages discussed in Section 5.1.2.2: spring migration, calving, post-calving, summer, fall migration and winter. The post-calving and summer periods have been combined because habitat selection by caribou is similar during these two periods.

Detailed habitat mapping and usage information for the Bathurst caribou herd is included in Section 5.1.2.5 in the sections on Habitat Suitability Ratings and Resource Selection Function for Bathurst Caribou Herd.

Spring Migration (April 15 to June 4)

During migration to calving grounds, female caribou move relatively quickly; Bathurst females were estimated to move about 14-20 km/day during the last three weeks of May (versus < 4 km/day during calving; Gunn and Poole 2009; Nishi et al. 2010). Pregnant females initiate migration to calving grounds, while non-parturient females follow at a slower rate (A. Gunn and D'Hont 2002). Because bulls were not satellite-collared prior to 2015, their movements are less well known but they, along with juvenile caribou, likely follow females; by mid-June bulls comprise up to 10% of caribou on the calving grounds (D.C. Heard, Williams, and Melton 1996; A. Gunn and D'Hont 2002; A. Gunn, Dragon, and Boulanger 2002). In years with delayed snow melt or deep snow that makes travel difficult, some females may calve before reaching calving grounds, while other females birth low weight calves with reduced chances of survival (Griffith et al. 2001).

Snow and ice remain on the tundra during spring migration and thus Bathurst and Beverly caribou use large frozen lakes and rivers as travel corridors, while the Dolphin and Union caribou travel across the frozen ocean. Caribou also use other areas that facilitate travel on the tundra, such as eskers and open snow-free upland, and follow the contours of steeper terrain before crossing it (LeResche and Linderman 1975; Thorpe et al. 2001b). When travelling over tundra, caribou must also seek places where snow cover is shallow so they can readily dig for graminoids and lichen, which are their main foods during winter (D. E. Russell, Martell, and Nixon. 1993; Ferguson, L. Gauthier, and F. Messier 2001).

Calving (June 5 to 15-20)

Key characteristics of caribou calving grounds on the tundra are believed to be areas that facilitate predator avoidance, and where forage availability after snowmelt offers females the nutritional requirements they need for lactation (Griffith et al. 2001; R. R. Wilson et al. 2012). There appears to exist a trade-off between safety and forage availability; calving females may choose calving grounds that are relatively safe from predators but are not necessarily places where snow melts earlier nor where vegetation biomass is greatest (R. R. Wilson et al. 2012). For example, though forage availability was higher near the treeline where Bathurst bulls and juveniles may still be found relative to the calving grounds where females migrate to for calving, wolf densities were much lower on calving

grounds (D.C. Heard, Williams, and Melton 1996). During calving, females are relatively sedentary, and move on average less than 4-5 km/day (A. Gunn and Poole 2009; Nishi et al. 2010).

Though forage availability may be lower, it is thought that calving grounds generally are located in areas where forage quality is high (reviewed in Wilson et al. 2012; Griffith et al. (2001). Green foliage is rarely available during calving (e.g., in only three years between 1985 and 2006) on the Bathurst calving grounds (W. Chen et al. 2009). Lichen provides caribou with additional nutrients before green-up (Ferguson, L. Gauthier, and F. Messier 2001). Lichen heath is one of the main vegetation cover types for the Bathurst herd calving grounds (Griffith et al. 2001; C. J. Johnson et al. 2005b). Bathurst cows appear to compensate for low nitrogen intake on the calving grounds by digging for nitrogen-rich *Oxytropis* rhizomes (Griffith et al. 2001; Thorpe et al. 2001b).

Post-calving and Summer (June 16-21 to August 31)

Just after calving, female caribou and calves migrate from calving grounds toward summer ranges. During this time, cows and calves may aggregate into large groups, ranging from hundreds to even thousands at times when populations are large (A. Gunn and D'Hont 2002). From mid-June onward, most bulls and juveniles have joined females on summer ranges (D.C. Heard, Williams, and Melton 1996). Movement rates of collared females increase steadily from mid- to the end of June from about 5 to 12 km/day (Nishi et al. 2010).

Access to high quality forage is likely the key driver of habitat selection in the post-calving period (L. A. Witter et al. 2012), as females need to acquire adequate nutrient reserves for lactation, which provides all nutrient intake for calves until about three weeks of age when calves begin foraging on their own. Calf body condition at birth and in the first few weeks of life, and thus calf survival, are highly dependent on female nutritional status (reviewed in Couturier et al. 2009). Studies in Alaska show that female caribou with calves select areas with a high density of sedge meadows during the post-calving period, where they forage on highly nutritious *Eriophorum* spp. (cotton grass) and *Carex aquatilis* (R. R. Wilson et al. 2012).

During summer, after the post-calving period, insect harassment and forage quality are believed to be the two main drivers of habitat selection by caribou (Skarin et al. 2008). During the summer months, females must acquire adequate forage to store enough nutrient resources to survive, and to maintain pregnancy throughout the winter (Helle and Tarvainen 1984; Colman et al. 2003b). Thus, access to high quality forage is not only important to calf survival within the year, but also to the survival of females and yearlings in the subsequent winter, and to the ability of females to birth healthy calves in the subsequent spring (R. G. White 1983; Couturier et al. 2009).

After the post-calving period, females expand their selection of vegetation from sedge meadows to include other vegetation types, but tend to remain in moist habitat where grasses, sedges, and willow and birch shrubs are abundant (Griffith et al. 2001; Thorpe et al. 2001b; R. R. Wilson et al. 2012; Zamin and Grogan 2012). Inuit TK indicates that cotton grass is important forage for newly weaned calves (Thorpe et al. 2001b), and that wetlands in general are important forage sites for cows and calves (KIA 2012). Despite a wider selection during the post-calving period, foraging throughout summer probably predominately occurs in sedge meadows, where caribou can graze up to 50% of the net primary productivity (Jefferies 1992).

Harassment by black flies and especially bot (oestrid) flies can cause significant disturbances to tundra caribou in July and August (L. A. Witter et al. 2012). Insects are abundant on warm days when wind speeds are low (Boulanger et al. 2004) especially for the two weeks spanning late June to early July (Thorpe et al. 2001b). Caribou compensate for harassment by engaging in avoidance behaviours

(on average 5% of the day) such as head tossing and erratic running when insects are active, from about 0800 to 2100 hours (L. A. Witter et al. 2012). Caribou are often seen swimming in lakes to escape the heat and insects (Thorpe et al. 2001b), and standing under cliffs for shade (KIA 2012). Caribou also attempt to avoid insects by moving for some part of the daytime to windier, cooler places, such as on top of eskers and hills, at the edges of large rivers and lakes, and to higher elevation tundra where insects are less dense (D. E. Russell, Martell, and Nixon. 1993; Skarin et al. 2008; KIA 2012; R. R. Wilson et al. 2012; L. A. Witter et al. 2012). At night when there are few insects, caribou move downward to lower elevation sites where the forage quality is usually higher (Skarin et al. 2008). Caribou also make larger scale seasonal movements to areas with fewer insects (R. R. Wilson et al. 2012). Depending on topography and the location of large lakes, such movements may occur through relatively narrow travel corridors (R. R. Wilson et al. 2012).

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

Fall Migration (September 1 to October 31)

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

Winter (November 1 to April 14)

Bathurst caribou spend the winter within the boreal forest, in mature forest stands where their main forage item, mat-forming lichens, are most abundant (W. Chen et al. 2009; Barrier and Johnson 2012);. Areas with deep snow are generally avoided by caribou because they are energetically costly to move through and also because deep snow makes lichens more difficult to access (S.G. Fancy and R.G. White 1985; J. Adamczewski et al. 1988). Due to snow depth, Bathurst caribou select windswept areas such as ridges and forest opening where lichens are more accessible (Barrier and Johnson 2012). The habitat preferences of caribou for old forest stands (80-150 years) is likely because lichens require 80 to 150 years of growth to reach sizes that are favorable to caribou as forage (reviewed in Barrier and Johnson 2012). Lichen biomass on the winter range of Bathurst caribou is relatively high compared to lichen in the winter range of caribou in Alaska and the Yukon, indicating the Bathurst herd is likely not currently limited by forage availability during winter (Barrier and Johnson 2012). However, climate change has likely caused an increase in the number of forest fires within the winter range of Bathurst caribou, resulting in decreased availability of lichen, which require many years to grow back after fire (W. Chen, Russellb, et al. 2013).

5.1.2.5 Baseline Data for Bathurst Caribou Herd

The objectives of baseline studies were to highlight where the Bathurst caribou herd is located during each season, to what degree these movements overlapped with the Project area, and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from

government agencies and other information was directly collected in the field. Five separate types of baseline studies were conducted, including:

1. Analysis of satellite collar data (1996–2012) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered camera studies (2012, 2013, 2014, and 2015) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features;
4. Habitat suitability modelling to determine the location and abundance of various habitat type identified from literature review as important for caribou; and
5. A resource selection function for Bathurst caribou to determine detailed information on what habitat features the herd selects for and avoids, including vegetation types, landforms, lakes and waterbodies, and industrial developments.

Full details for the results of caribou distribution and movements within the wildlife RSA can be found in the 2001-2002, 2007, 2010, 2012, 2013, 2014, and 2015 Wildlife Baseline Reports (Rescan 2007a, 2007b, 2011a, 2013e).

Specific sources of baseline terrestrial wildlife information used in this section, Section 5.1.3.5 (Beverly Caribou), and Section 5.1.4 (Dolphin and Union Caribou), include the following Back River reports:

- *Back River Project: 2010 Caribou and Muskox Baseline Report* (Rescan 2011a; Appendix V5-5E);
- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012a; Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013e; Appendix V5-5C);
- *Back River Project: 2013 Habitat Selection by Bathurst Caribou during the Post-calving and Summer Periods* (Rescan 2013d; Appendix V5-5B); and
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014a, Appendix V5-5F);
- *Back River Project*: *2014 Wildlife Camera Baseline* (Rescan 2013a; Appendix V5-5A).
- *Back River Project*: *2015 Wildlife Camera Baseline* (Rescan 2013a; Appendix V5-5A).

Other sources of supplementary wildlife data used in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association* (KIA 2012) (Appendix V3-3A of FEIS);
- *Naonaiyaotit Traditional Knowledge Project – Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)* (KIA 2014) (Appendix V3-3B of FEIS);
- *Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories* (Appendix V3-3C of FEIS);
- Field Report – Back River Project Wildlife and Wildlife Habitat 2007 (Gartner Lee Ltd. 2008); and
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008).

Satellite Collar Data

The satellite collar program was initiated by the governments of Northwest Territories and Nunavut in 1996 for the Bathurst and Beverly herds. Each year satellite collars are fitted on a group of female caribou, typically during the winter season. In March of 2015, collars were fitted to a group of male caribou for the Bathurst and Beverly herds. The data generated from these programs allow researchers to investigate seasonal trends in habitat use as well as track real time movement patterns of caribou herds. Until 2008, all collars deployed on Bathurst and Beverly caribou were satellite collars, which typically provided one (fixed) location every one to five days (depending on programming and season), with each location having an associated error of between 150 m and 1,000 m depending upon the location class (C. J. Johnson and Gillingham 2005). Beginning in 2008, GPS collars with satellite uplink were deployed resulting in three to six locations provided daily with much greater location accuracy (generally < 15-25 m). Thus, analyses using collaring data are heavily weighted on the last ten years as the contribution of location data is much greater between 2005 and 2015 relative to earlier years (Table 5.1-3). In addition, in recent years the Bathurst herd population has been in a low compared to the 1990s. Thus, satellite collars represent a greater proportion of the herd in recent years relative to early years.

Table 5.1-3. Average number of Satellite-collared Bathurst Caribou and Locational Data Points per Season from 1996 to 2015

Year	Average Number of Collared Caribou per Season	Average Number of Location Data Points per Season
1996	9.8	96.2
1997	7.3	90.2
1998	13.5	86.0
1999	14.5	157.8
2000	12.2	129.7
2001	10.3	106.3
2002	11. 7	139.5
2003	11.8	164. 7
2004	9.3	107.0
2005	15.5	234.8
2006	14.8	261.0
2007	20.3	390.0
2008	15.2	350.2
2009	12.0	579.5
2010	15.0	573.2
2011	16.8	671.2
2012	19.2	658.0
2013	14.5	627.5
2014	17.8	794.5
2015*	30.8	949.8
Average	14.3	348.3

** Excludes 14 males that were collared in winter 2015, representing an average of 300 locational data points per season, from winter to post-calving periods.*

Caribou use of the land can broadly be classified into two groups: 1) migrations (spring and fall) when the animals are moving quickly across the landscape, and 2) sedentary periods (calving, post-calving,

summer, and winter) when the daily movement rate of caribou is lower than migrations and the herd tends to occupy a distinct range of the landscape. In order to map habitat use by caribou during each season, two methods were used. Satellite collar data provides data on the movement of caribou during the migratory period. For the sedentary periods, an analysis of the habitat usage using fixed kernel utilization distributions provided information on areas of high usage.

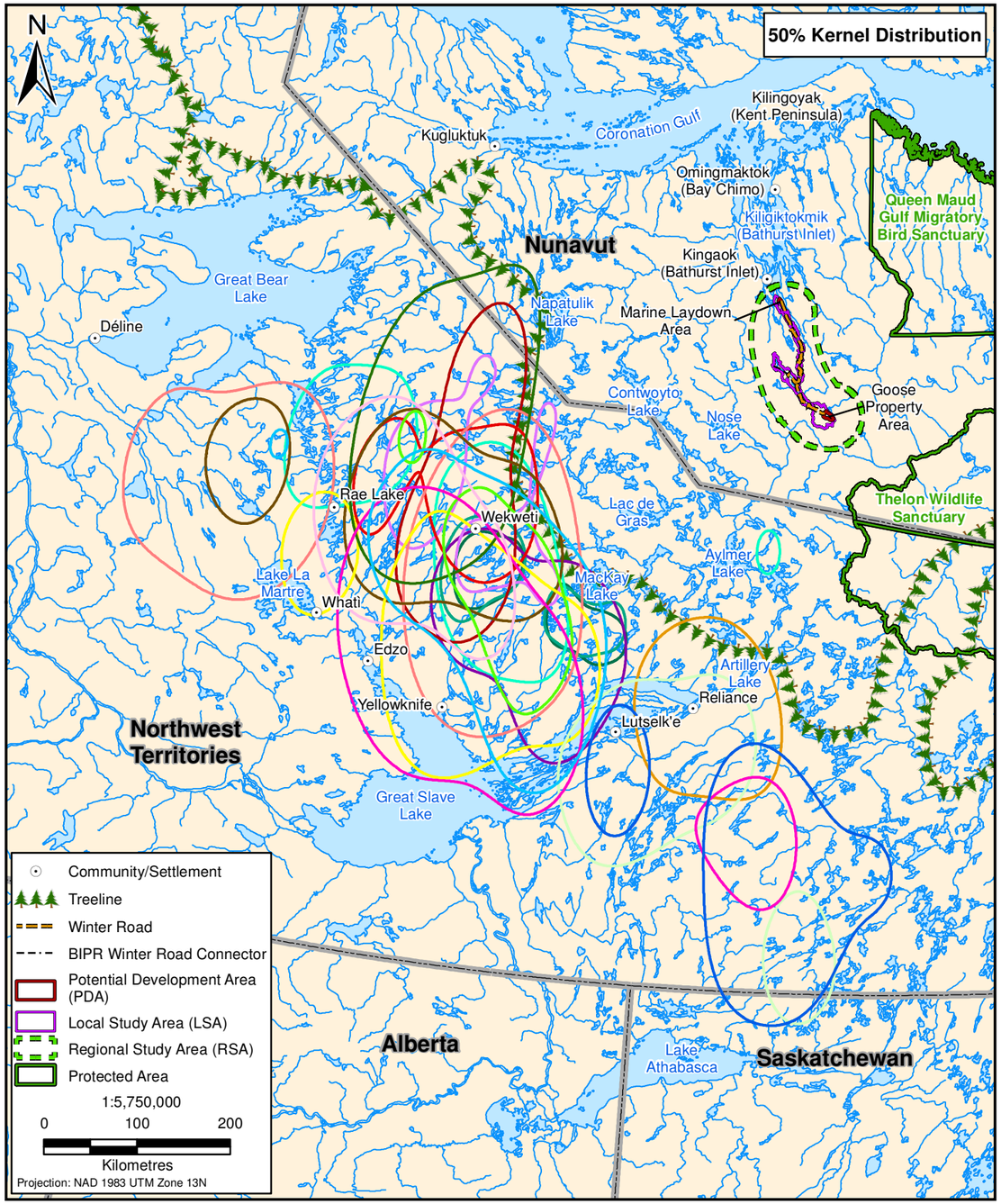
During migrations, satellite collars provided point data on the movement of the caribou across the landscape. With these data, linear routes were created outlining key spring migration routes north to the calving grounds, corridors and river crossings.

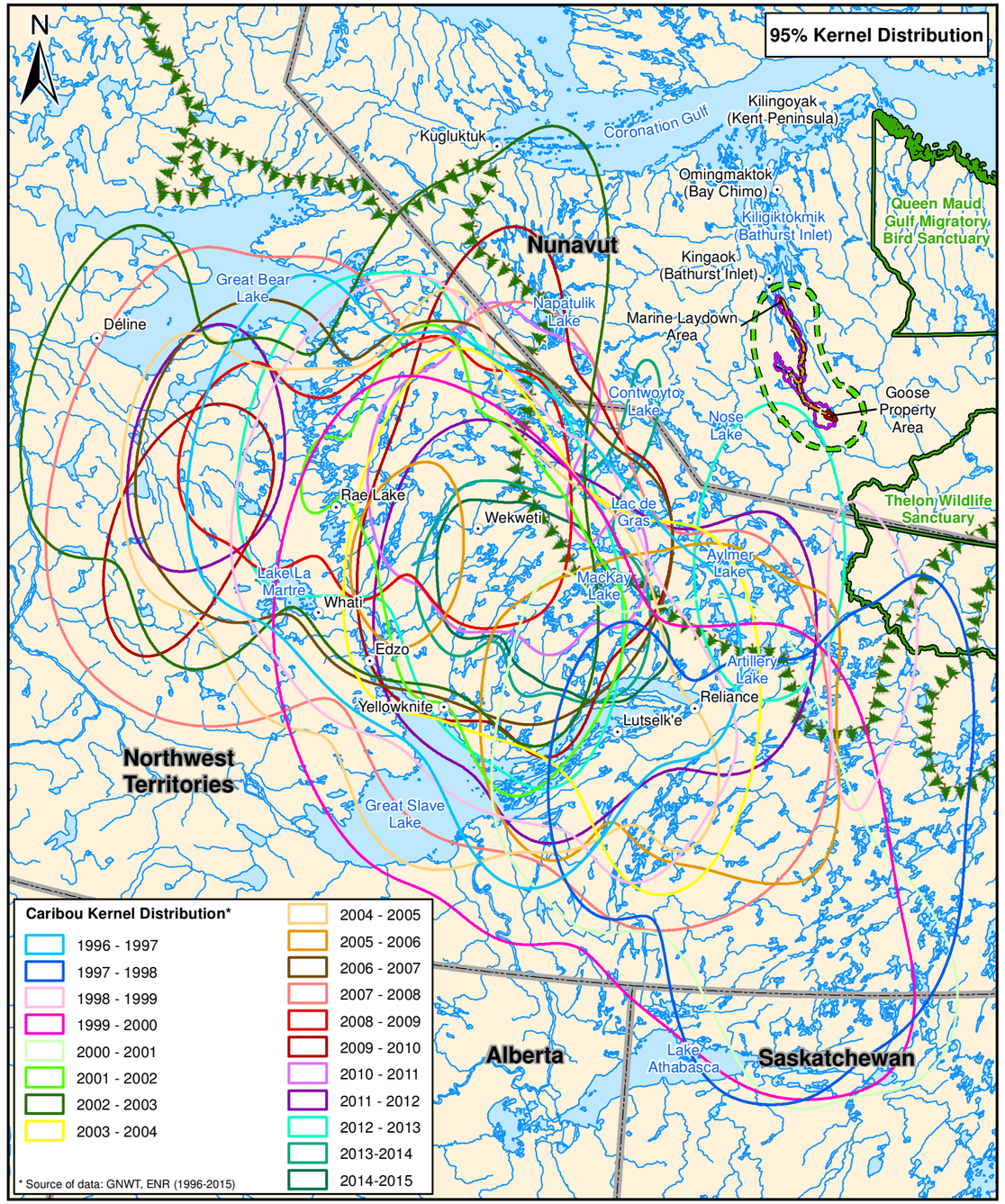
During sedentary periods, satellite collared data were analysed using fixed kernel utilization distributions (UDs) indicating areas of high usage. These areas are associated with key habitats for caribou during winter, calving, post-calving and summer, where caribou movement is reduced and they occupy a definable range on the landscape (e.g., the summer range). Fixed kernel UDs were calculated for the core use areas (termed 50% kernel UD) as well as the areas of active use (termed 95% kernel UD). The 50% kernel UD represents an area with a 50% probability that an animal (or group of animals) is inside that area; similarly, the 95% kernel UD represents the area with a 95% probability that an animal (or group of animals) is inside that area. The 95% kernel UD captures a wider extent of caribou range utilization relative to the core use areas captured by the 50% kernel UD and therefore represents a more conservative approach. A further assessment of changes in range area and year-to-year overlap in range based on the more conservative 95% kernel UD was completed for the sedentary periods when Bathurst caribou inhabit the tundra (calving, post-calving, and summer ranges).

The calculated fixed kernel UDs were analyzed by season/life history stage. The time period for winter, calving, post-calving, summer, and fall stages vary between herds and are defined by movement rates for spring and fall migrations relative to more sedentary periods when caribou occupy their winter, summer, calving, and post-calving range (C. J. Johnson et al. 2005b). The peak of calving (the day when 50% of the caribou have calved) and the weaning of calves are used to define the calving period and post-calving periods, respectively. Calves are typically weaned three to five weeks after they are born (D. E. Russell, Kofinas, and Griffith 2002). These life history stages vary seasonally, particularly dates defining calving and post-calving; thus, a wider spread in dates is used here than in more recent studies (e.g., Flanders et al. 2009). Data were also separated by year to identify annual trends in habitat utilization.

The calculated fixed kernel UDs are based on the data from collared females. In some cases, males and juveniles lag behind the females as they move from seasonal range to range. Males were not collared until recently (2015), when 14 Bathurst herd males and 13 Beverly herd males to track movements of male caribou relative to females. Locations of collared males were mapped using all data available (mid-March to end June) for spring, calving, and partial post-calving seasons in 2015. Aerial surveys and motion-triggered cameras were used to identify additional time periods when caribou may be present in the Project area. Details of data analysis are reported in the 2012, 2013, 2014, and 2015 Wildlife Baseline Reports (Rescan 2007a, 2007b, 2011a, 2013e).

Fixed kernel utilization distributions (UDs) for collared data from 1996 to 2015 indicated that the female Bathurst caribou may use the wildlife RSA predominantly during the post-calving period in late June to mid/late July and are mainly absent from the wildlife RSA at other times of the year (Figure 5.1-7a to Figure 5.1-7i). The herd may also pass through on their way north from the wintering grounds to the calving grounds in the spring (May), following migratory routes to the west of the wildlife RSA , but this use is very infrequent based on the collar data (Figure 5.1-7j). These data represent the current condition during the last 10 to 15 years. The 2015 data from collared males agrees with theory that males follow and lag behind females on their way to the calving grounds during spring migration, and typically remain south of calving grounds during the calving period, although this data is based on a limited number of collared individuals (14; Figure 5.1-7j).





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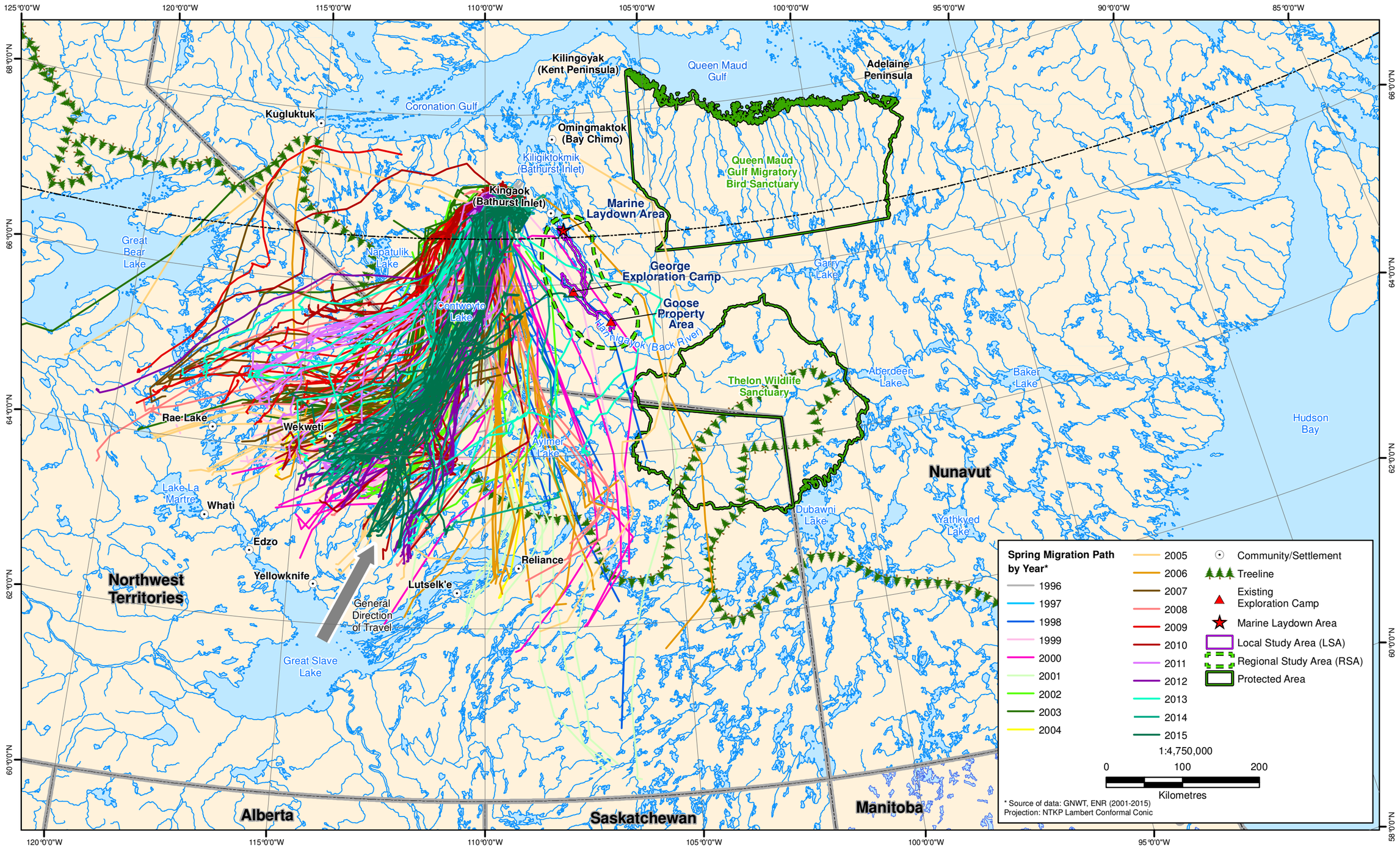
Yearly Distribution of Satellite-collared Bathurst Caribou during Winter (1 November to 14 April), 1996 to 2015

Figure 5.1-7a

Rescan an ERM company

GIS # **BAC-23-388a**

November 9, 2015



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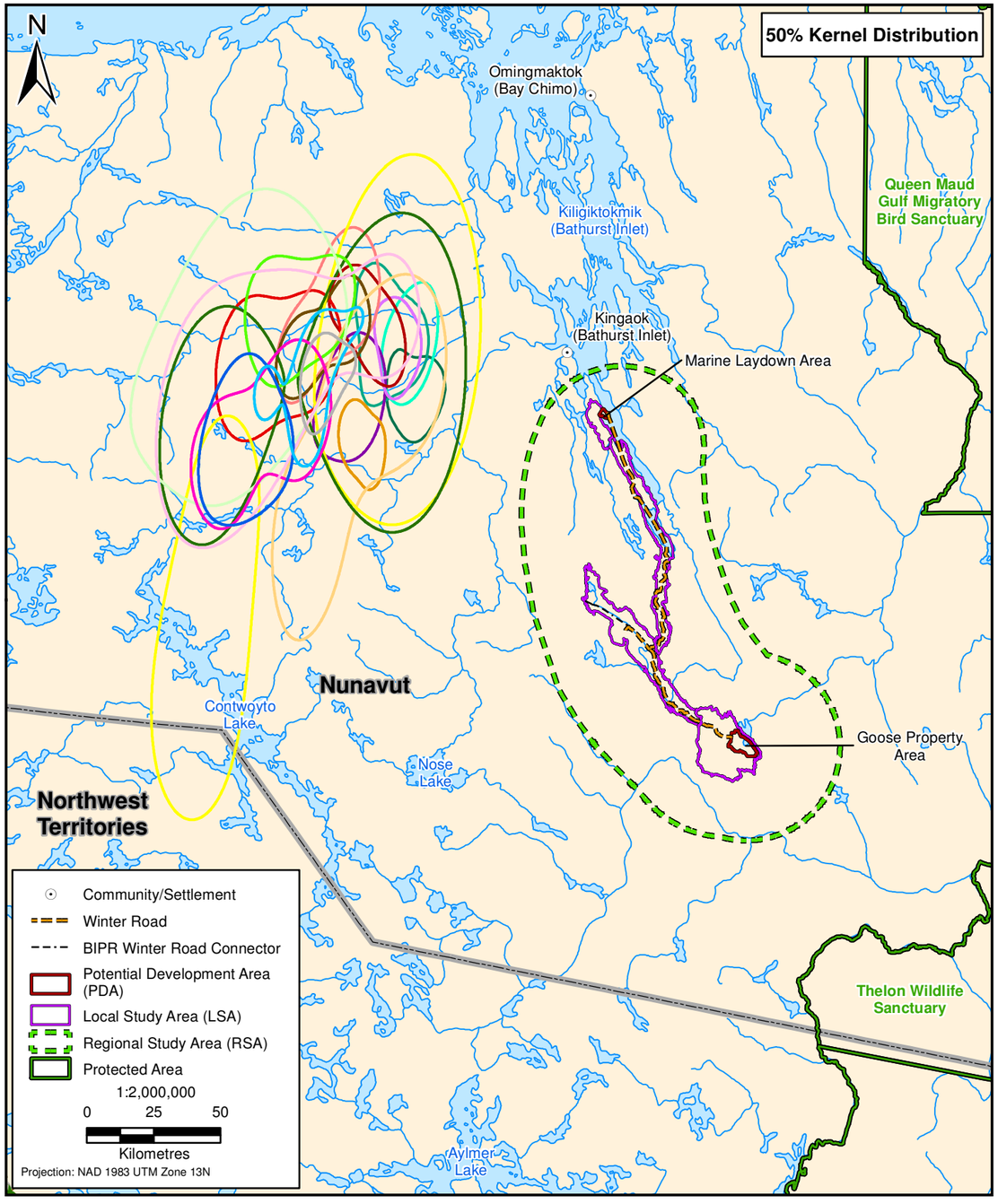
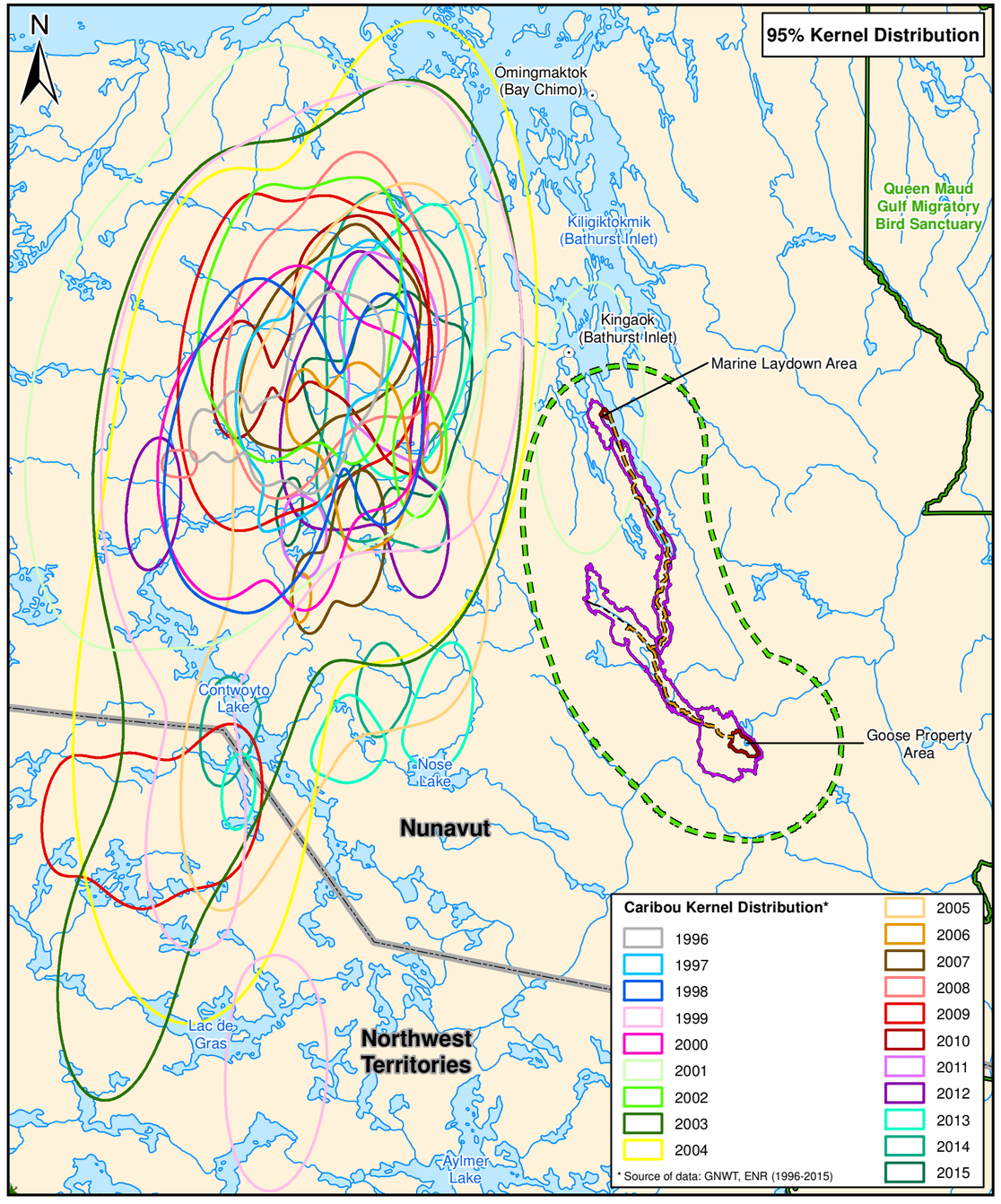
Yearly Spring Migration (15 April to 4 June) Paths of Satellite-collared Bathurst Caribou, 1996 to 2015

Figure 5.1-7b

Rescan an ERM company





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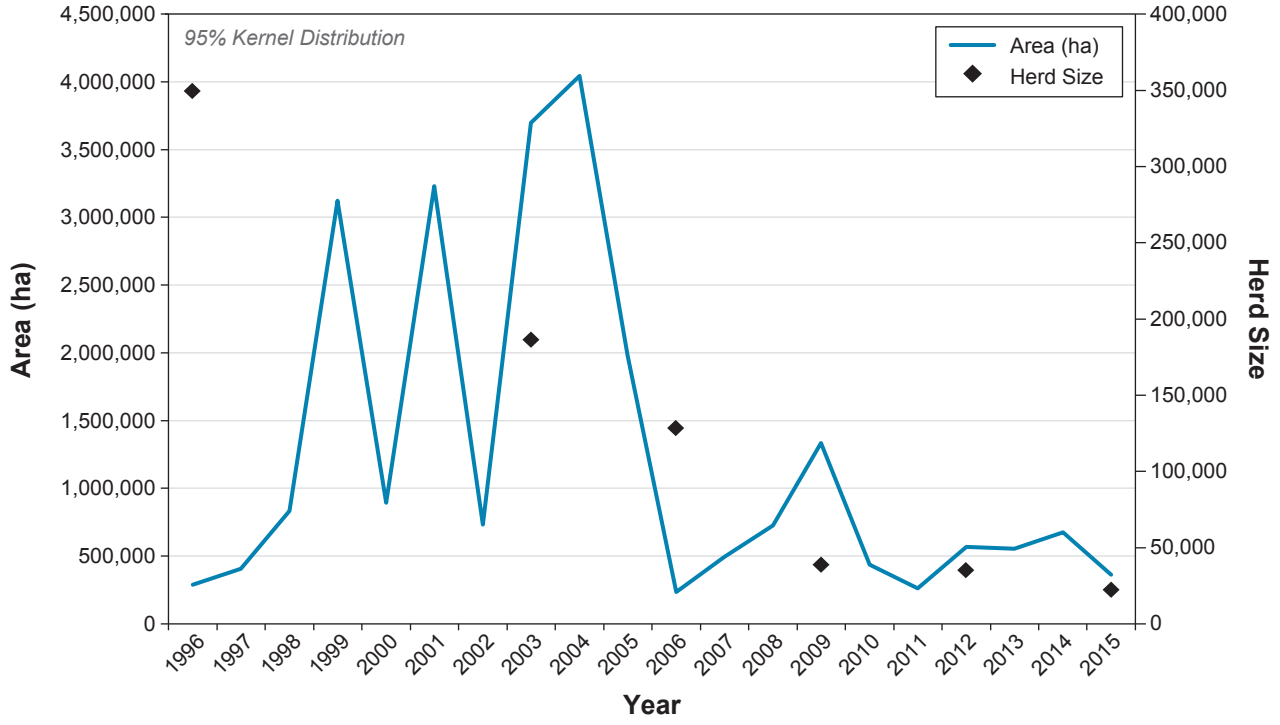
Yearly Distribution of Satellite-collared Bathurst Caribou during Calving (5 June to 15 June), 1996 to 2015

Figure 5.1-7c

Rescan an ERM company



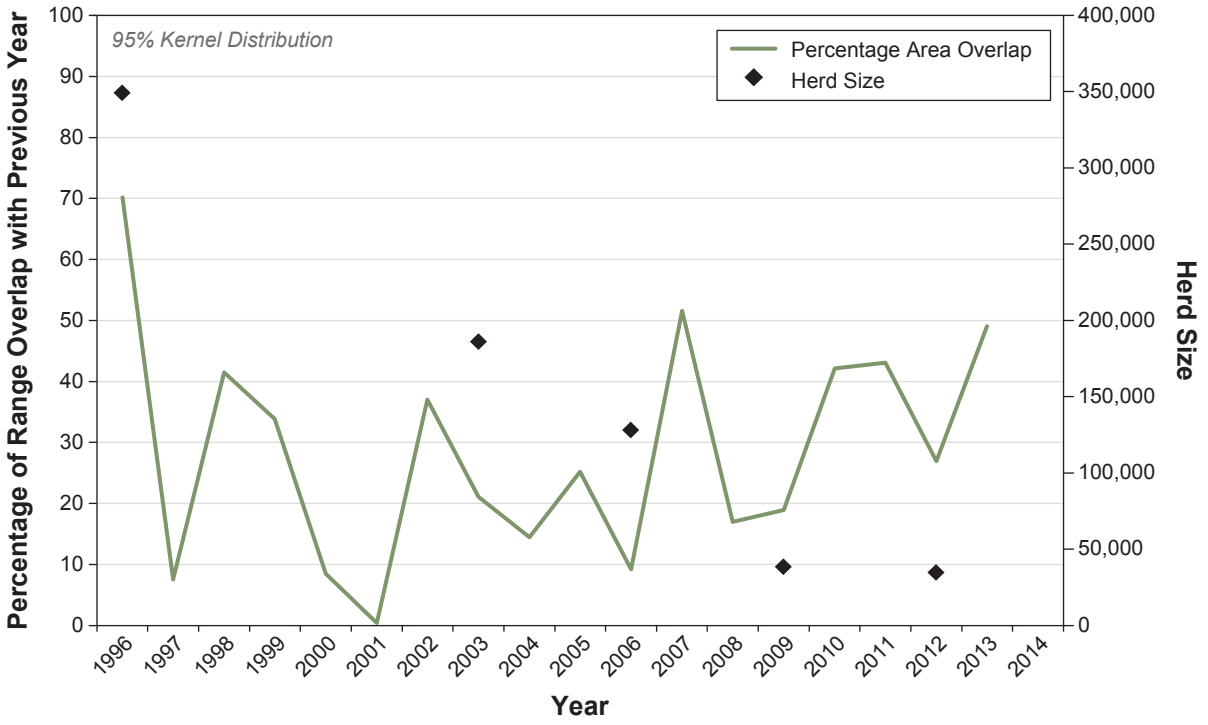


Figure 5.1-7d

Yearly Calving Ground Range Size and Spatial Overlap of Bathurst Caribou, 1996 to 2015

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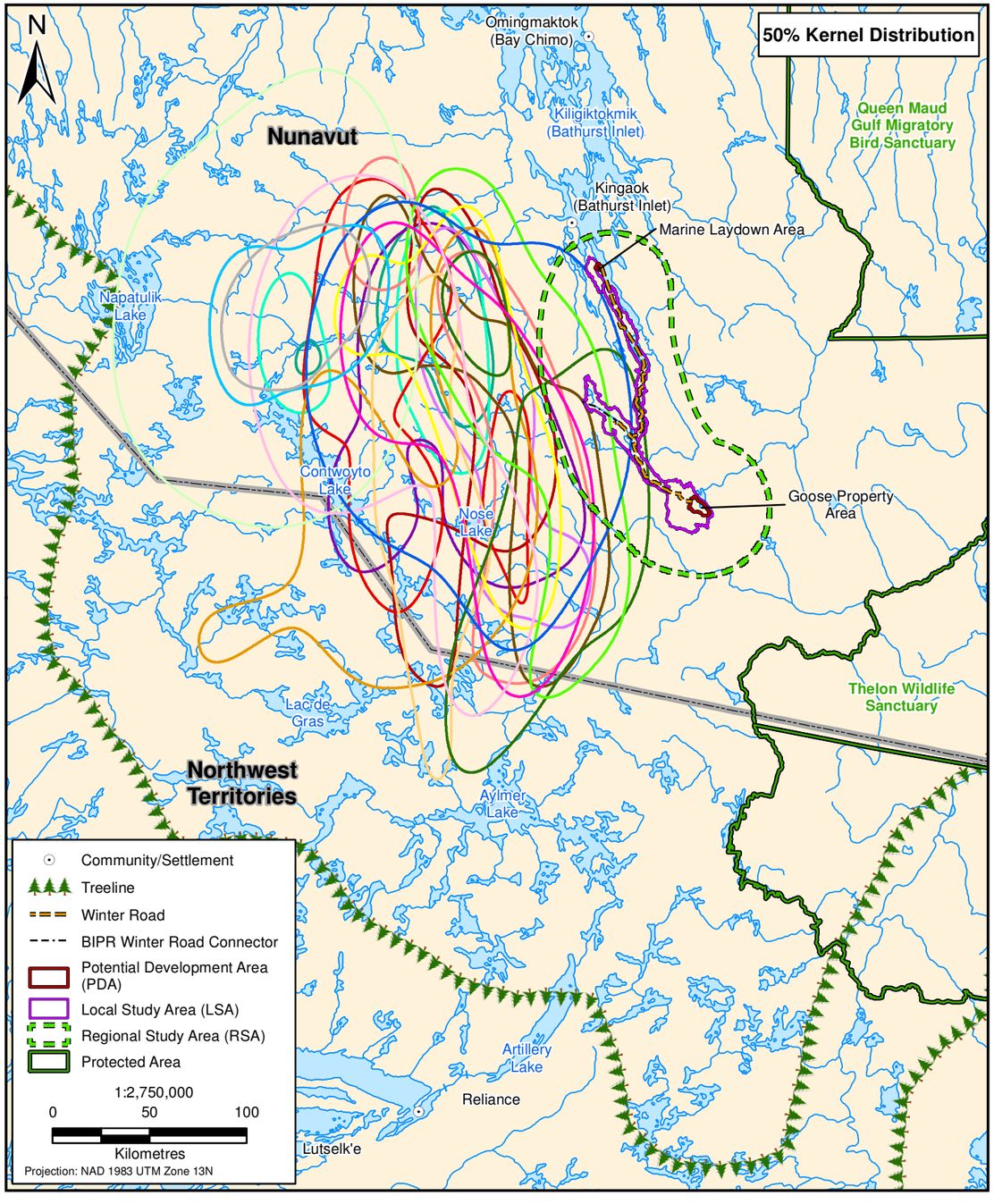
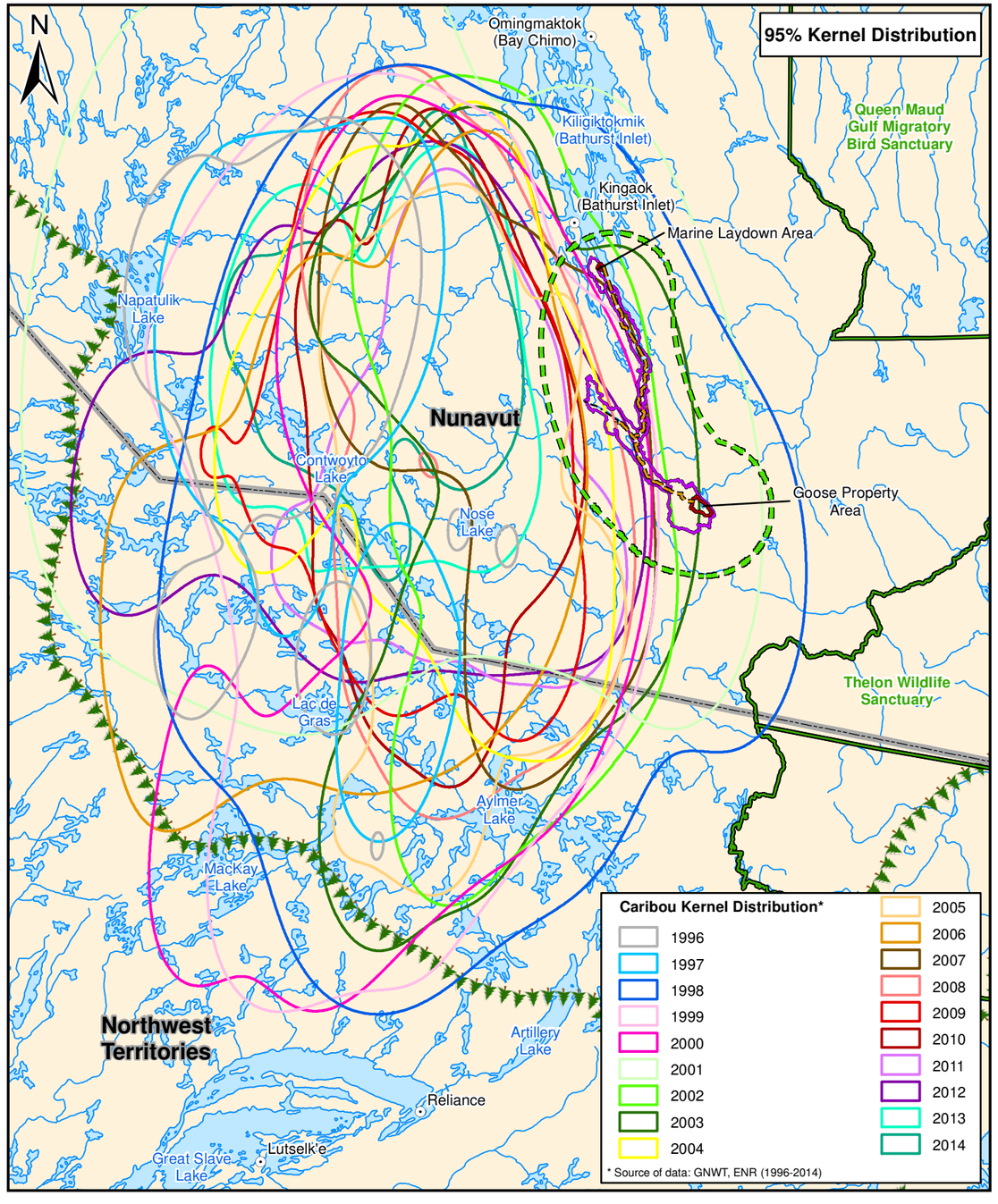
The calving range of collared Bathurst caribou for the years between 1996 and 2015 was located between James River and Contwoyto Lake approximately 100 to 150 km northwest of the wildlife RSA, with the most concentrated use taking place between the Hood and Burnside Rivers (Figure 5.1-7-b). The distribution of Bathurst caribou overlapped the RSA during the calving period in only one year since 1996 (Figure 5.1-7c). A small isolated calving range (95% kernel UD) overlapped the northern RSA at the MLA in 2001, when herd size was estimated to be between 186,000 ± 40,100 SE^3 and 349,000 ± 94,900 SE^2 caribou. However, the larger, core calving area in 2001 occurred outside of the RSA to the northwest (Figure 5.1-7c). Shifts in calving grounds have been recorded in most Arctic caribou herds. These shifts may be a result from the overall habitat selection of females at this time. The calving ground of Bathurst caribou has gradually shifted from the western side of Bathurst Inlet (in the 1950s) to the eastern side (1960s to mid-1980s) and in recent years (since the late 1990s) has shifted back to, and remained on the western side (M. Sutherland and Gunn 1996; Thorpe et al. 2001b; A. Gunn and D'Hont 2002). Overall, in years following the calving ground shift to the western side of Bathurst Inlet, the size of the calving ground has remained relatively stable, despite a reduction in herd size (Figure 5.1-7d). Calving ground size has peaked in some years (1999, 2001, 2003, and 2004), however these results may be due to variation in the number of collars deployed or the number of collar locations over time (Table 5.1-3). Although the calving ground has been consistently within same general area since the late 1990s, the year-to-year percentage of calving range overlap between has varied between 12% overlap from 2005 to 2006 and 53% overlap from 1996 to 1997 (Figure 5.1-7d).

During the post-calving period, the Bathurst caribou migrate in a south-east direction, largely south of the wildlife RSA to their summering grounds (Figure 5.1-7e and Figure 5.1-7f). Core use areas for post-calving Bathurst caribou overlapped the very western edge of the RSA in seven of the last eighteen post-calving periods, the most recent being in 2008 (Figure 5.1-7e). Annual post-calving ranges (95% kernel UDs) have overlapped the RSA in most years, however only overlapped with the Goose Property PDA and MLA in four years (1998, 2001, 2002, and 2003; Figure 5.1-7e). These were years when the herd size was estimated at 186,000 ± 40,100 SE^3 or greater. There has been a general contraction of post-calving range that corresponds with reduced herd size (Figure 5.1-7f). The post-calving range has remained more stable over time relative to the calving range, with a year-to-year percentage of post-calving range overlap of 26% between 1997 to 1998, and 74% between 2002 to 2003 (Figure 5.1-7f).

During the summer, caribou herds are relatively dispersed, as illustrated by the large spread of the summer range and associated core use areas to the south of the wildlife RSA (Figure 5.1-7g). Summer core use areas in all years since 1996 have been located to the southwest of the RSA, and annual summer ranges overlapped the RSA in four years in the late 1990s and early 2000s (1997, 1998, 1999, 2001); with the exception of 1997, three of these years overlapped the Goose Property PDA and MLA (Figure 5.1-7g). Like the post-calving period, there has been a general contraction of summer range that corresponds with reduced herd size (Figure 5.1-7h).

For Bathurst caribou, the areas around Lac De Gras have been highlighted as an area that has been occupied by rutting caribou (GNWT ENR 2010). Following the reunion of bulls and immature caribou with the cows and calves in the late summer, caribou herds migrate southwards during the fall (Figure 5.1-7i). Since 1996, no fall core use areas have overlapped the RSA, and annual fall ranges overlapped the RSA and the Goose Property PDA in three years during the late 1990s (1997, 1998, 1999), and more recently in 2014 (Figure 9.4-5). During the winter, most caribou within the Northwest Territories and Nunavut are found below or at the treeline (Figure 5.1-7a). Annual core use areas (50% kernel UD) and winter ranges (95% kernel UD) have not overlapped the RSA in any year, except for the winter of 2012 - 2013 (November 2012 to April 2013), where the overall winter range overlapped the southern tip of the RSA, south of the Goose Property PDA (Figure 5.1-7a).





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Yearly Distribution of Satellite-collared Bathurst Caribou during Post-calving (16 June to 20 July), 1996 to 2014

Figure 5.1-7e

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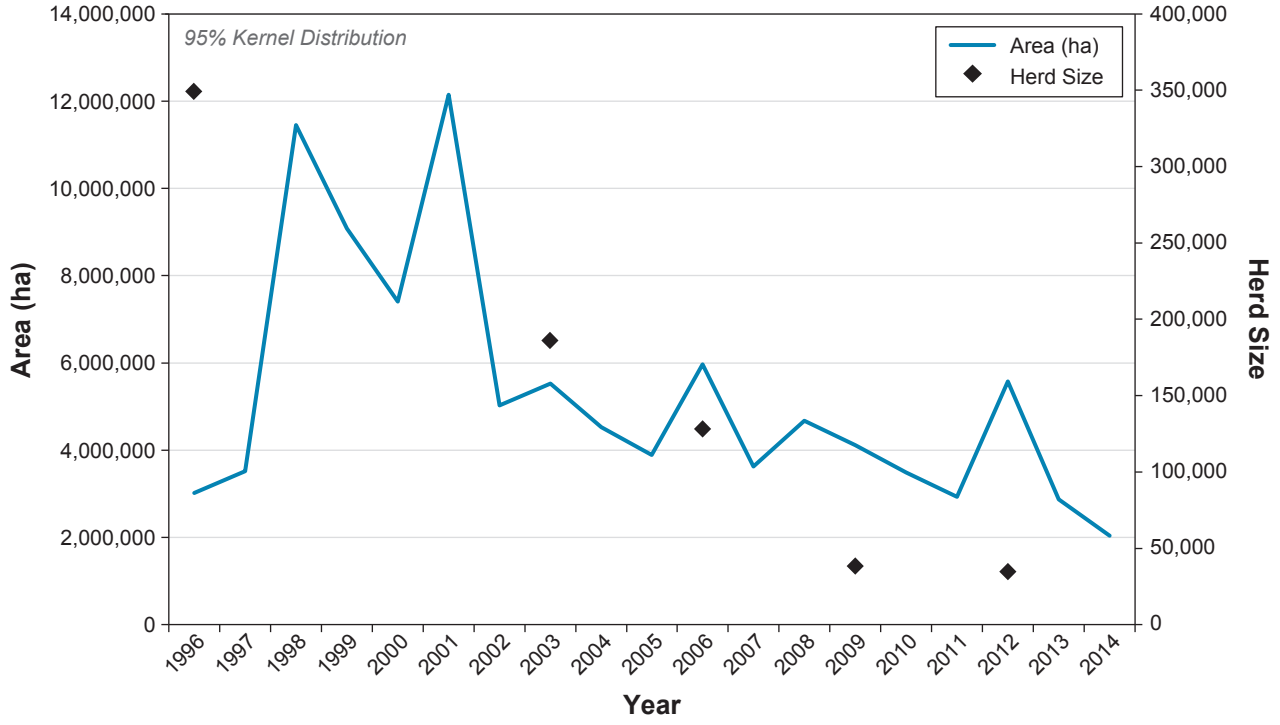

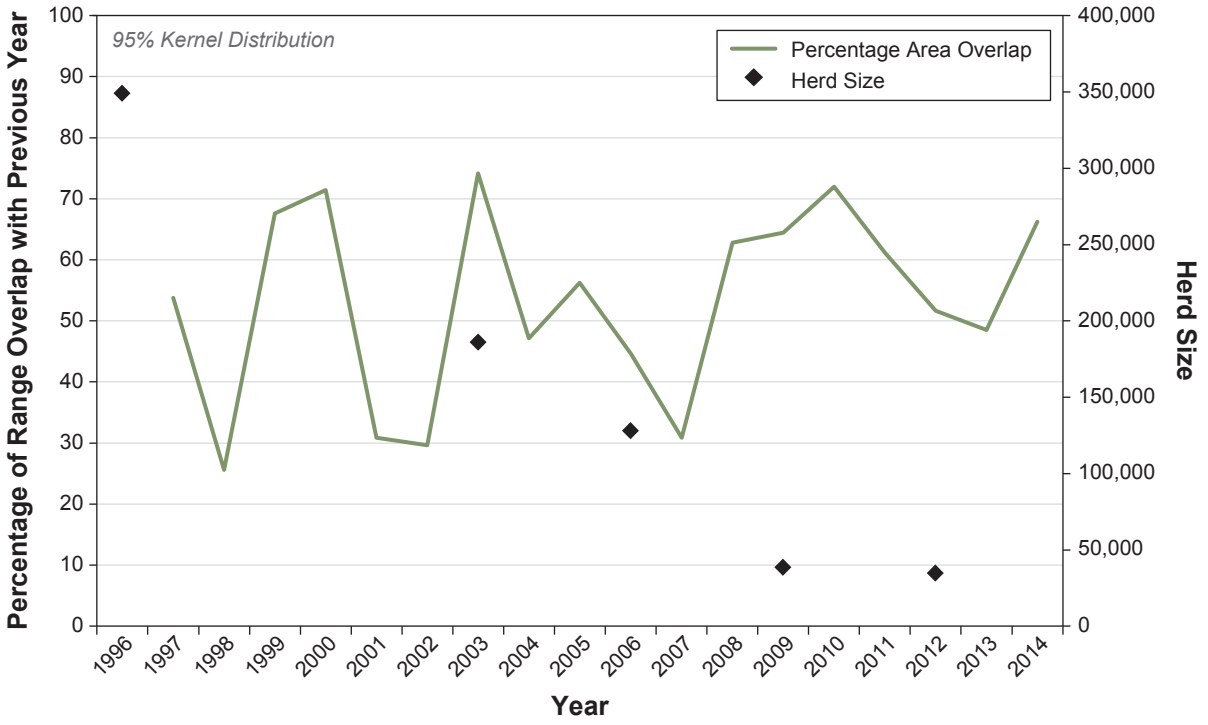

Figure 5.1-7f

Yearly Post-calving Ground Range Size and Spatial Overlap of Bathurst Caribou, 1996 to 2014

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Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a; Gartner Lee Ltd. 2008; Rescan 2011a, Appendix V5-5E). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-4). The aircraft followed transect lines using an onboard Garmin GPS at an elevation of 120 to 150 m and speed of approximately 150 km/h. Surveys were conducted along 20 pre-determined transect lines within the wildlife RSA; transect lines were parallel at a distance of 8 km apart. The width of the survey transect was 500 m on either side of the airplane. Each observer calibrated this distance before the survey by having the airplane fly over two markers at an elevation of approximately 122 m. The markers were spaced 500 m apart and the observers noted the angle of the outside marker against calibration markers that were placed on the aircraft wing struts.

Table 5.1-4. Aerial Survey Flights in the Regional Study Area

Survey Year	Spring Migration Survey Dates	Calving and Post-calving Survey Dates	Summer Survey Dates	Early Fall Survey Dates
2001	--	--	July 21 and 29 and August 9 and 21	September 7 and 20
2002	March 22 and May 28	June 7 and July 7	--	--
2007	May 16-18	June 11-12	July 12-13 and July 29-30	September 7-12
2008	May 8-9	--	July 15-16	--
2010	May 7-8	June 7-8	July 13-15	--

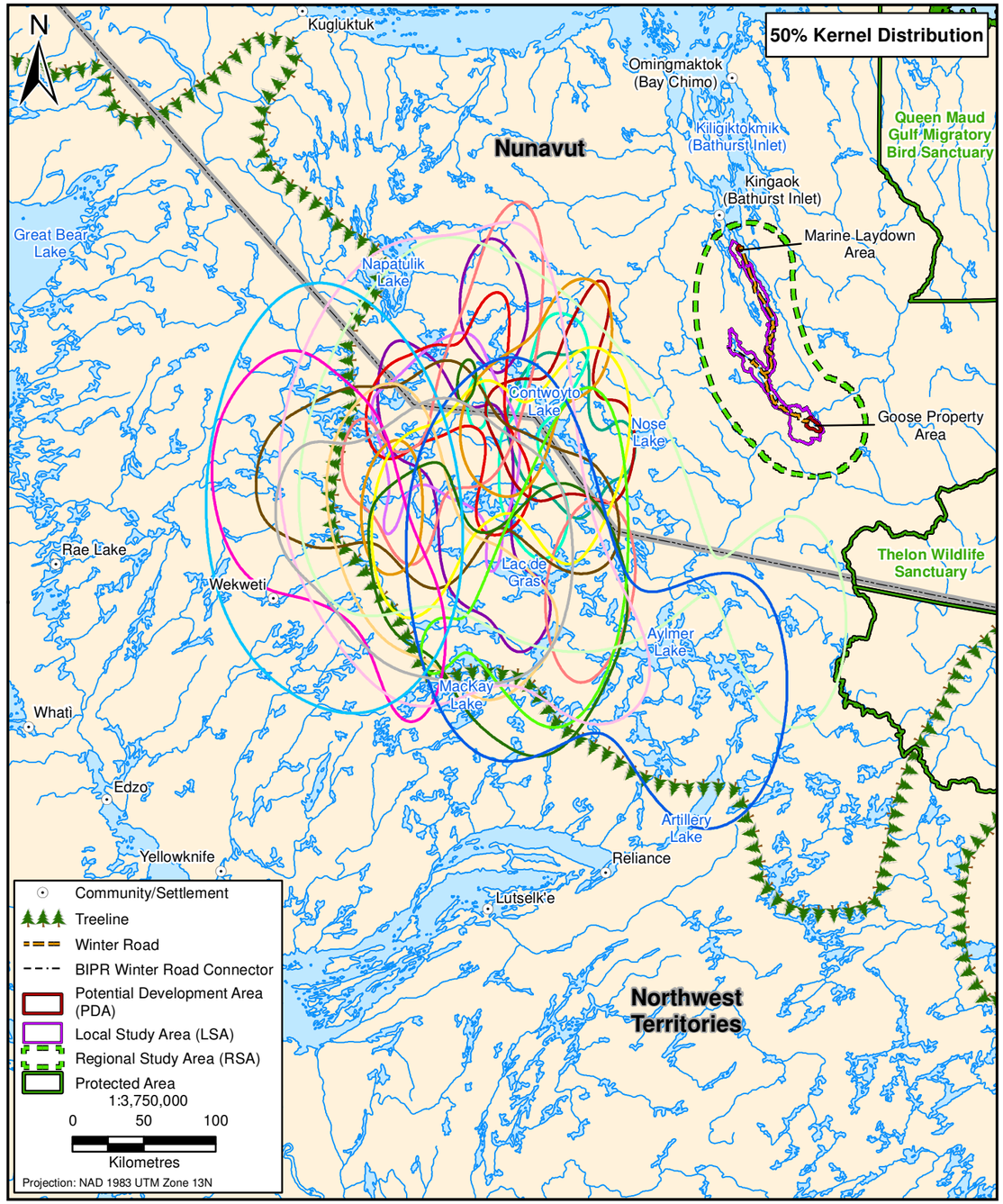
-- = no surveys were conducted.

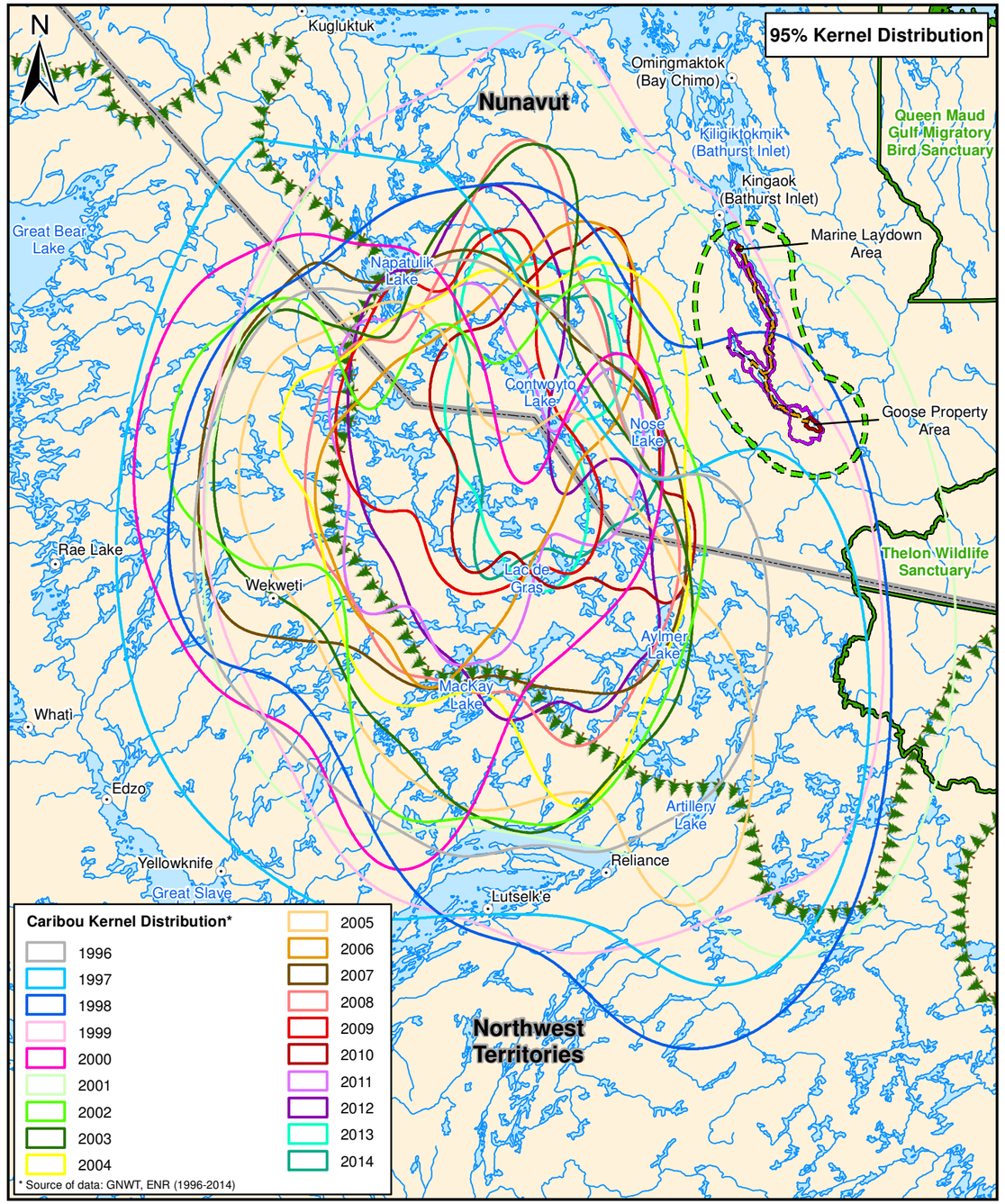
During survey flights, observers noted the sex, if possible, and number of caribou observed and the approximate distance that the animals were from the aircraft in 100 m increments. When large groups of ungulates were observed, the airplane circled the group in order to achieve a more accurate count. Each observer counted the caribou independently and counts of each observer were averaged. Caribou were classified as bulls, cows or young; nursery groups were also identified. The location and habitat for each observation were also recorded. All caribou observed off-transect (greater than 500 m from the aircraft or during non-survey flights) were recorded as incidentals.

Survey conditions were noted for each survey flight, including the snow cover, air temperature, wind speed, visibility, and survey time. Incidental observations were also recorded for a variety of wildlife that could be identified from aircraft. Species, numbers of adults and/or offspring, GPS location, and habitats in which they were observed were documented whenever possible. Full details of the surveys are reported in the 2001-2002, 2007, and 2010 Wildlife Baseline Reports (Rescan 2002, 2007a, 2011a).

The locations of caribou observed in the wildlife RSA from aerial surveys during baseline studies confirm and improve knowledge of the distribution of caribou based on satellite collar data (Figure 5.1-8). A total of 3,153 caribou were observed during surveys conducted in 2001 and 2002 (Rescan 2002). In 2002, 103 caribou were observed during the post-calving and summer surveys (Rescan 2002).

In 2007, 401 caribou were observed between May and September during aerial surveys (Rescan 2007a). Only two caribou were recorded during two surveys in 2008 (not mapped). During the 2010 aerial surveys, 65 caribou were observed (Rescan 2011a, Appendix V5-5E). Caribou observed during surveys conducted in the spring were likely Beverly caribou migrating to calve near Queen Maud Gulf. Low numbers of caribou were observed during the calving period with the highest numbers observed during the post-calving and summer periods.





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Yearly Distribution of Satellite-collared Bathurst Caribou during Summer (21 July to 31 August), 1996 to 2014

Figure 5.1-7g

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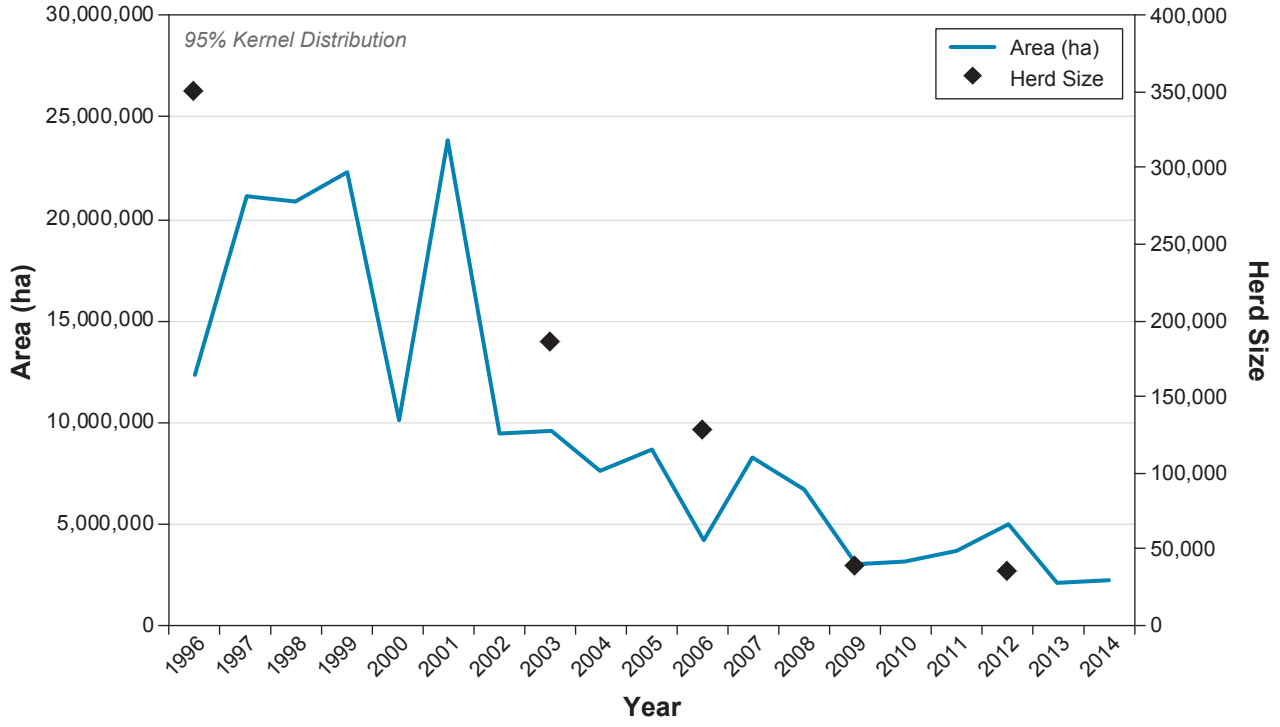

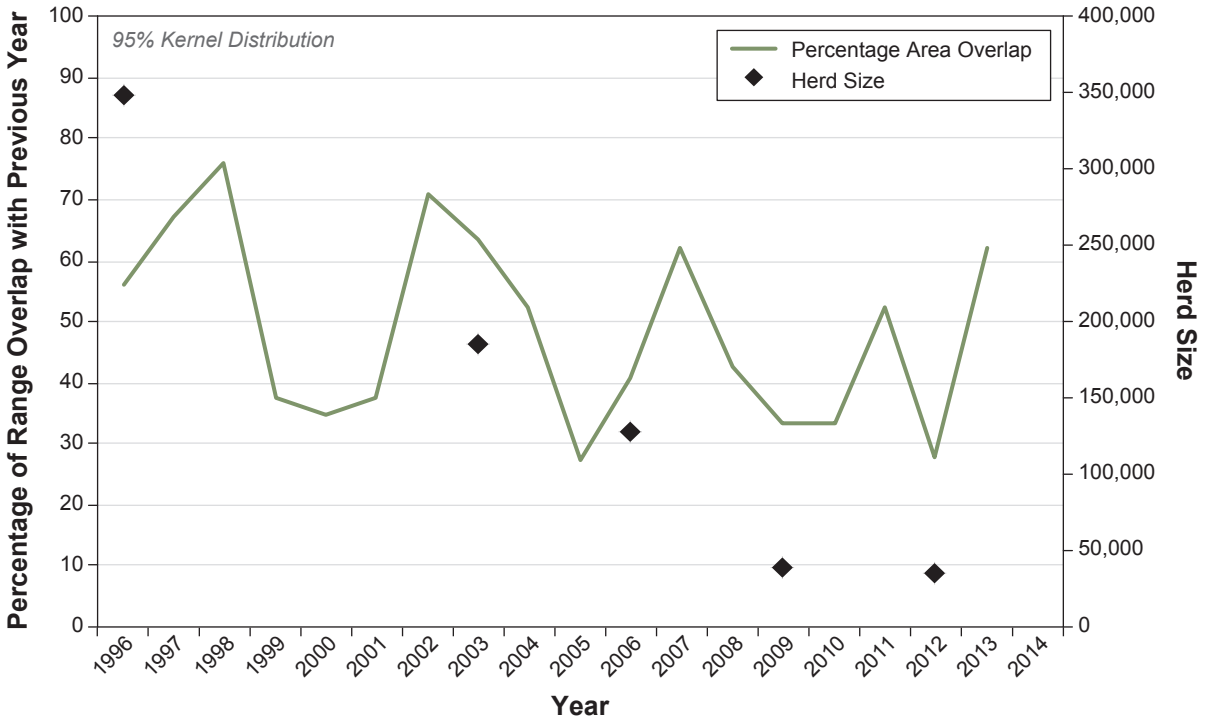

Figure 5.1-7h

Yearly Summer Ground Range Size and Spatial Overlap of Bathurst Caribou, 1996 to 2014

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Rescan an ERM company

These data support the Kernel UD maps that indicate:

1. Few caribou during the spring migration, and those that were observed are likely Beverly caribou (Section 5.1.3).
2. Very few caribou in the wildlife RSA during calving, and those that were observed tended to be males and located on the western edge or incidental observations of caribou west of the wildlife RSA. This is consistent with the calving grounds being located outside and to the west of the wildlife RSA.
3. The majority of caribou observed were recorded during the post-calving period, principally at the southern and western edge of the wildlife RSA — these animals were likely Bathurst caribou, based on herd movements from collar data.
4. Few observations of caribou during summer and fall, with the exception of a small number of large groups observed principally at the southern end of the wildlife RSA — this is consistent with summer use of the southern portion of the wildlife RSA by Beverly caribou.

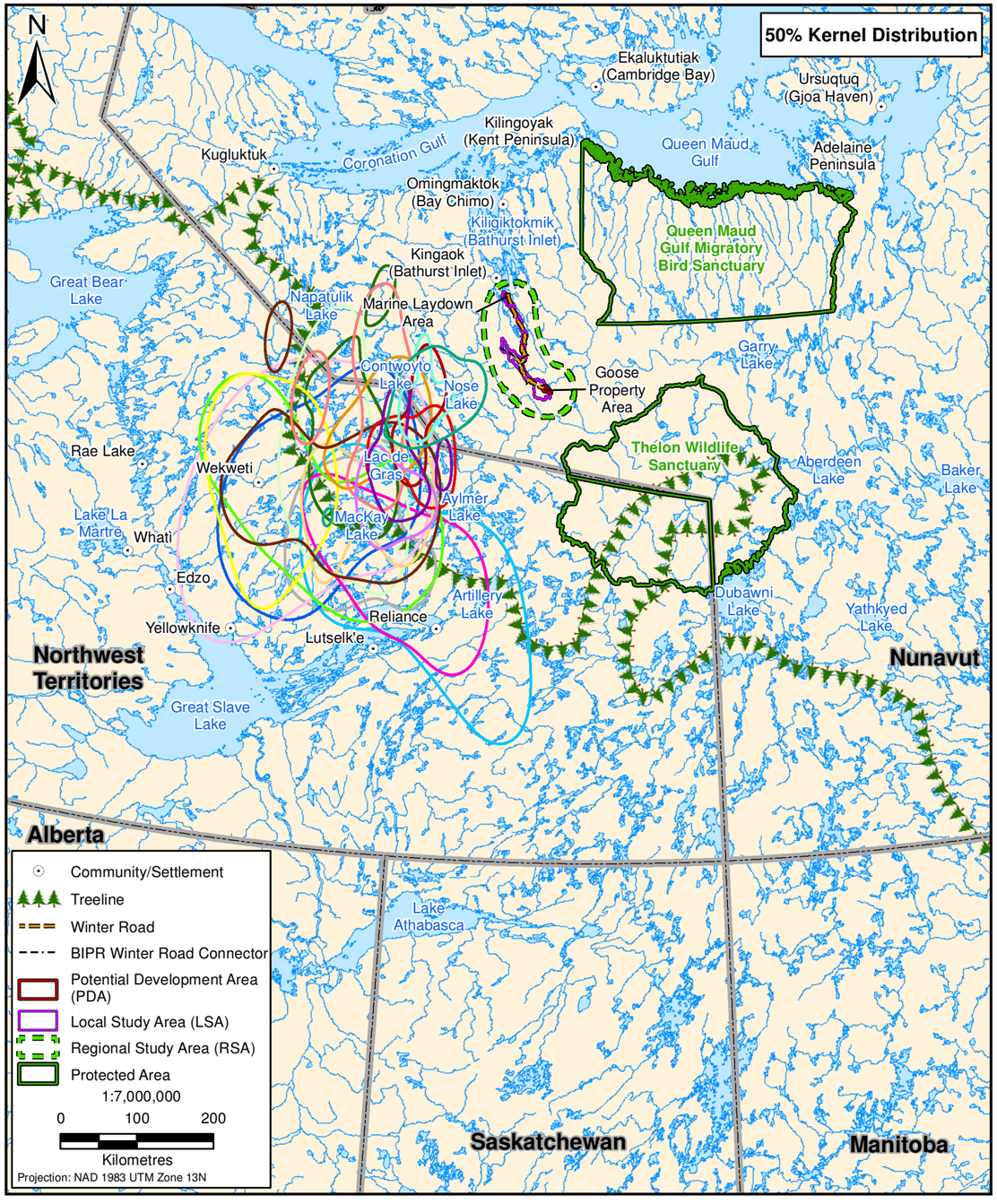
Remote Cameras

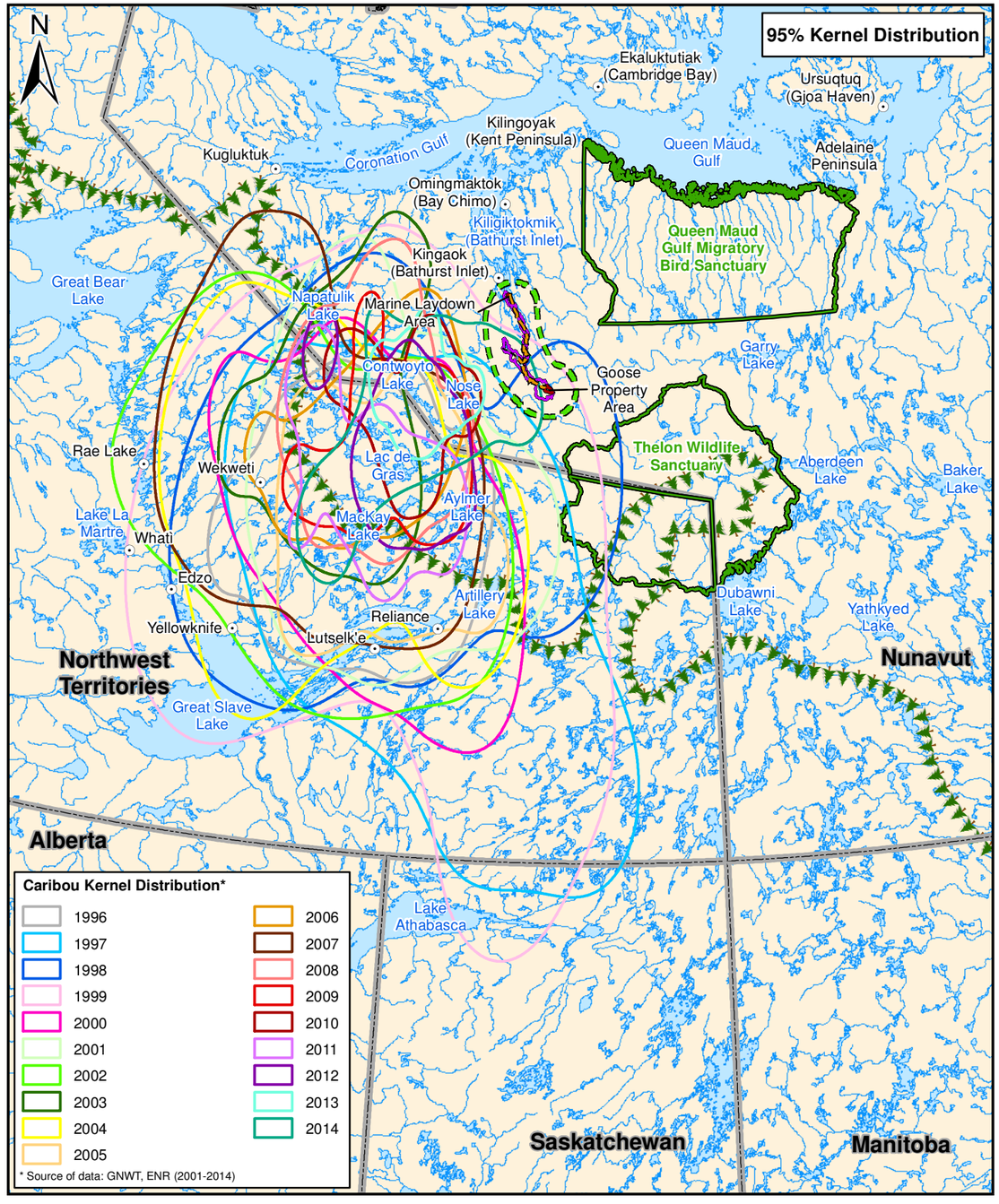
Remote digital cameras are a reliable method for examining ungulate migratory timing and habitat associations given the landscape's short vegetation and features such as eskers and river crossings that direct caribou movement through the landscape (Cutler and Swann 1999; Noel et al. 2006).In order to examine when caribou are using the Project area, and examine their use of selected features on the landscape, motion-triggered cameras were deployed in the wildlife RSA. Cameras were also placed 10-200 km west of the wildlife RSA in the Bathurst caribou post-calving range to look at spatial trends on a larger scale. The objectives of the camera program were to:

1. monitor the timing, abundance, and location of caribou within the wildlife RSA;
2. examine caribou use of high values areas identified by TK;
3. examine the timing, abundance and location of Bathurst caribou in their post-calving range outside the wildlife RSA, and;
4. examine the use of the marine RSA by Dolphin and Union caribou during winter.

Remote cameras were deployed within the RSA, in the Bathurst post-calving area west of the RSA, and within the Marine RSA; the number of cameras deployed varied by camera study year and by season (Table 5.1-5, Figures 5.1-9a-f). Thirty cameras were deployed in the wildlife RSA and an additional 30 cameras in the area adjacent to the wildlife RSA for the 2012 camera study (June 2012 to August 2012; Table 5.1-5), and an additional 30 cameras were added in these areas in 2013, for a total of 65 cameras in operation for the 2013 camera study (August 2012 or May 2013 to August 2013. Further details on the 2013 camera study design and camera placement rationale can be found in Rescan (2014a).

Camera locations were adjusted for the 2014 camera study (August 2013 to July 2014); 25 cameras were collected from within the wildlife RSA at locations surrounding the Goose Property area and the MLA, and were re-installed within the Marine RSA (Table 5.1-5). An additional 22 cameras that were deployed outside of the wildlife RSA in August 2013 to monitor the Tibbitt to Contwoyto Lake Winter Road Winter Road Connector, an winter road considered in the DEIS, but no longer being considered for the FEIS, were also in operation in the 2014 reporting year (Table 5.1-5). Further details on the 2014 camera study design and camera placement rationale can be found in Rescan (2014b, 2014a).





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Yearly Distribution of Satellite-collared Bathurst Caribou during Fall (1 September to 31 October), 1996 to 2014

Figure 5.1-7i

Rescan an ERM company

GIS # **BAC-23-403a**

October 23, 2015

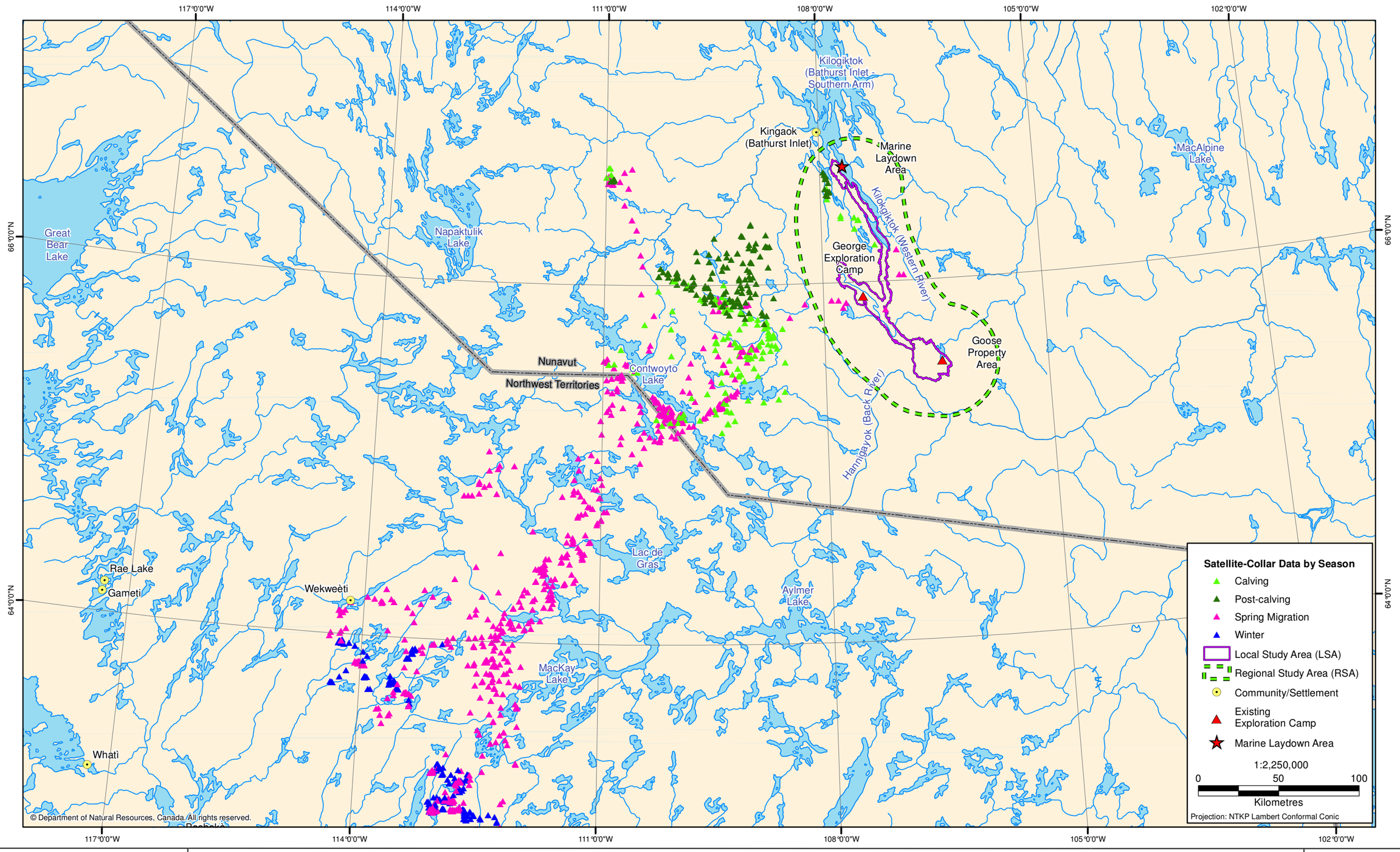

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Figure 5.1-7j

Locations of Collared Males from the Bathurst Herd during Winter, Spring Migration, and Calving, 2015

Rescan an ERM company

GIS # BAC-23-396

November 09 2015

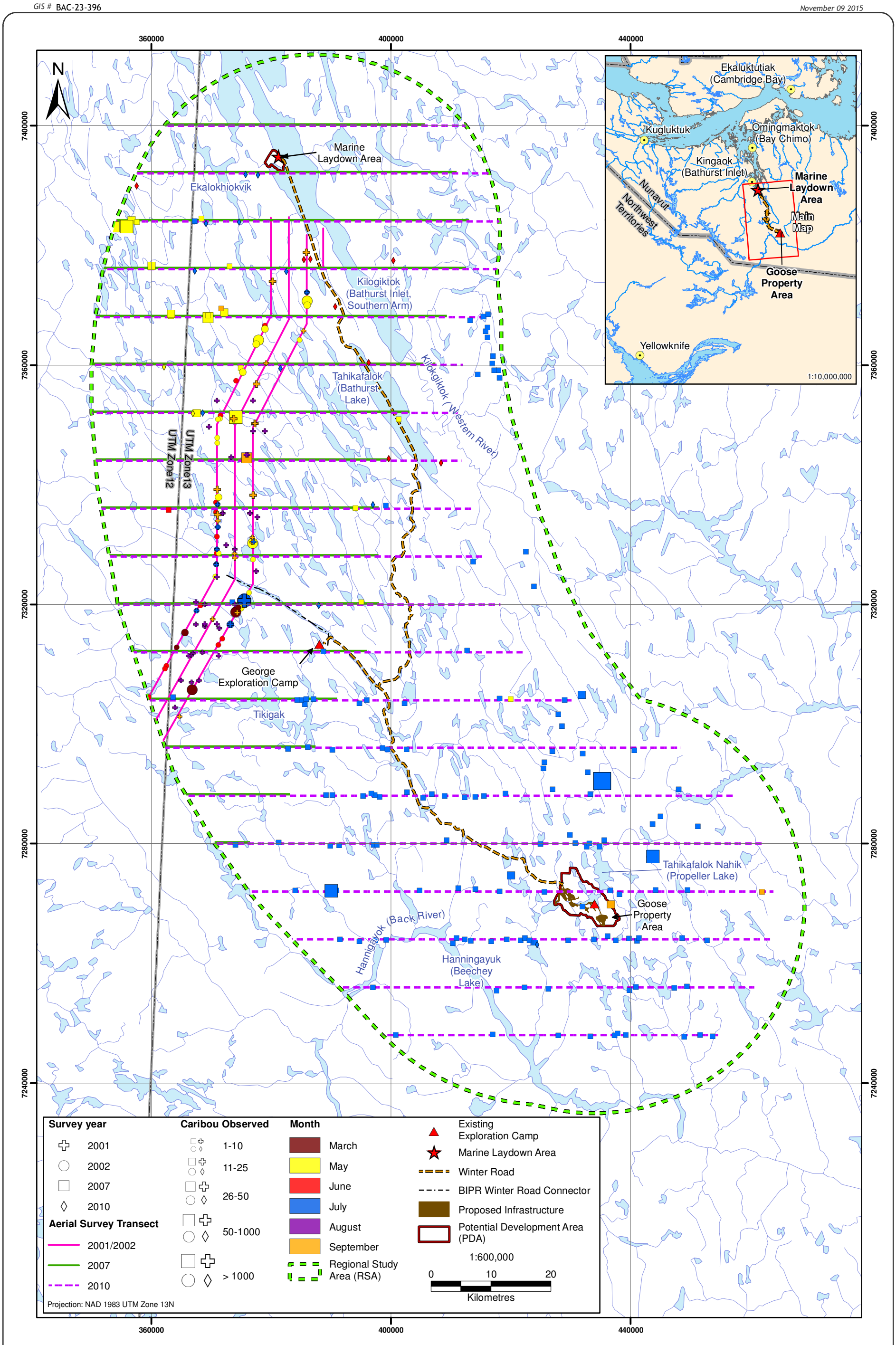

Figure 5.1-8

Caribou Observations during Aerial Surveys, 2001 to 2010

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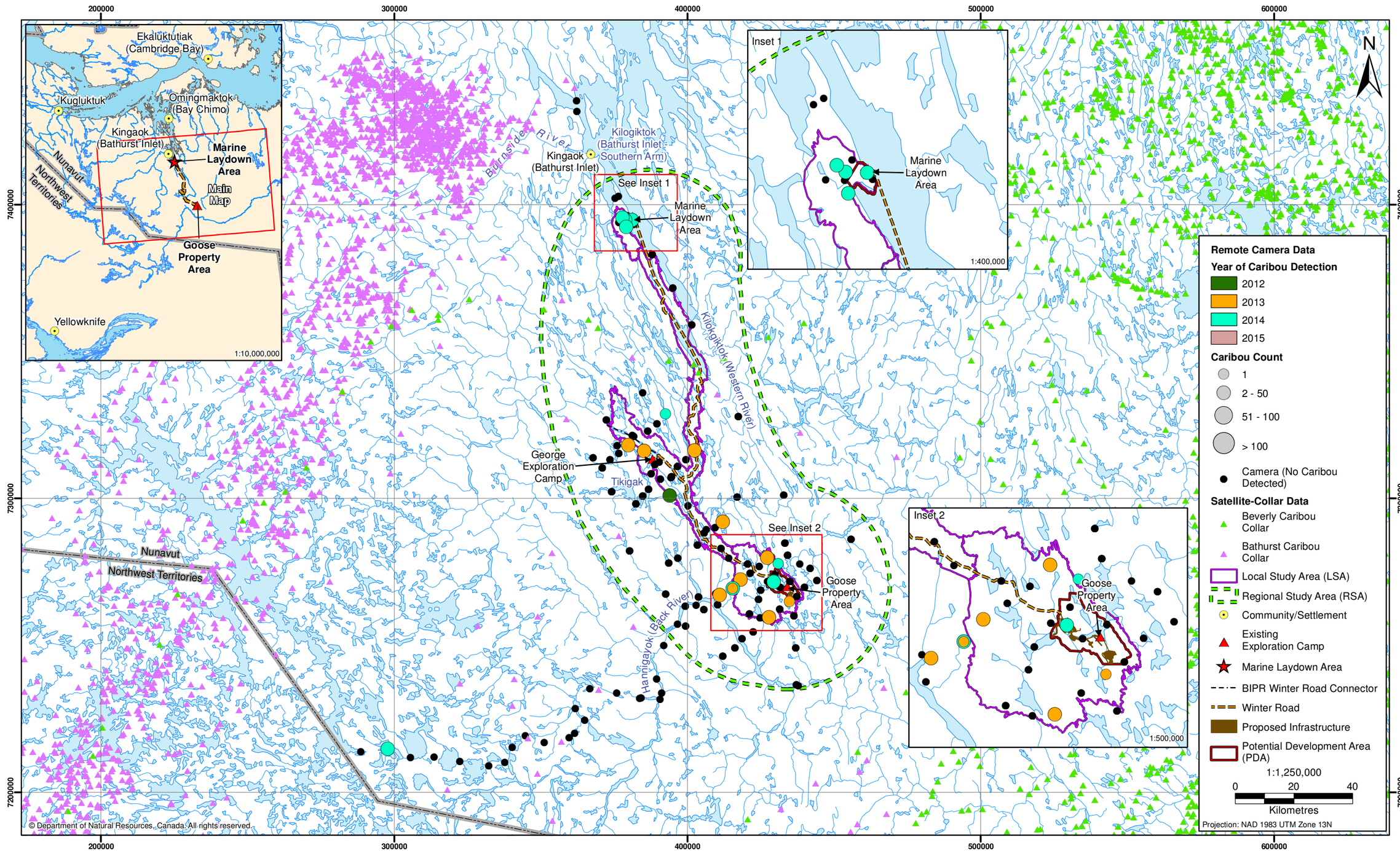
Rescan an ERM company

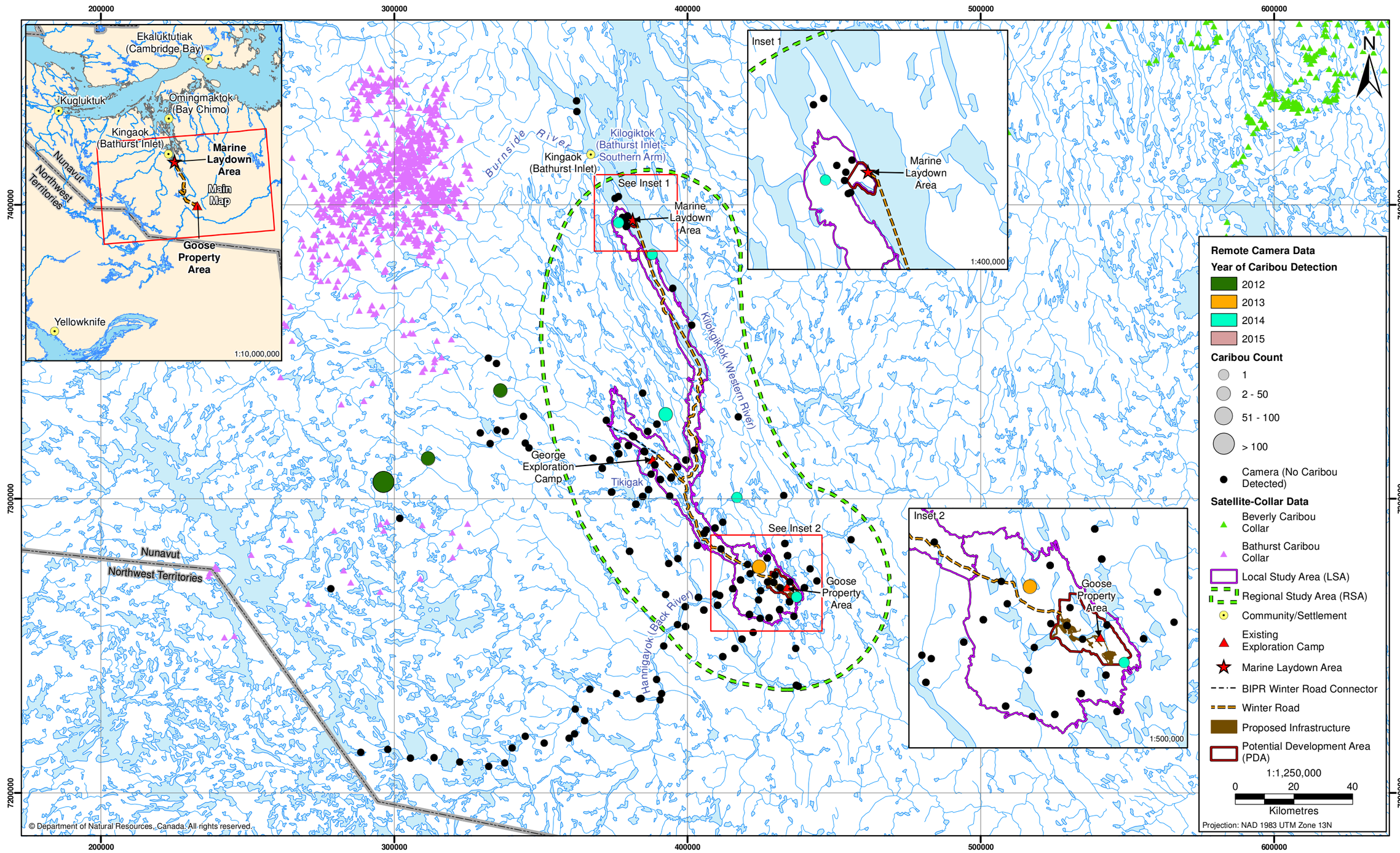


Sabina GOLD & SILVER CORP.

Caribou Recorded by Remote Camera and Satellite-collar in the RSA, to the west of the RSA, and Marine RSA during Spring Migration, 2012 to 2015

Figure 5.1-9a

Rescan an ERM company



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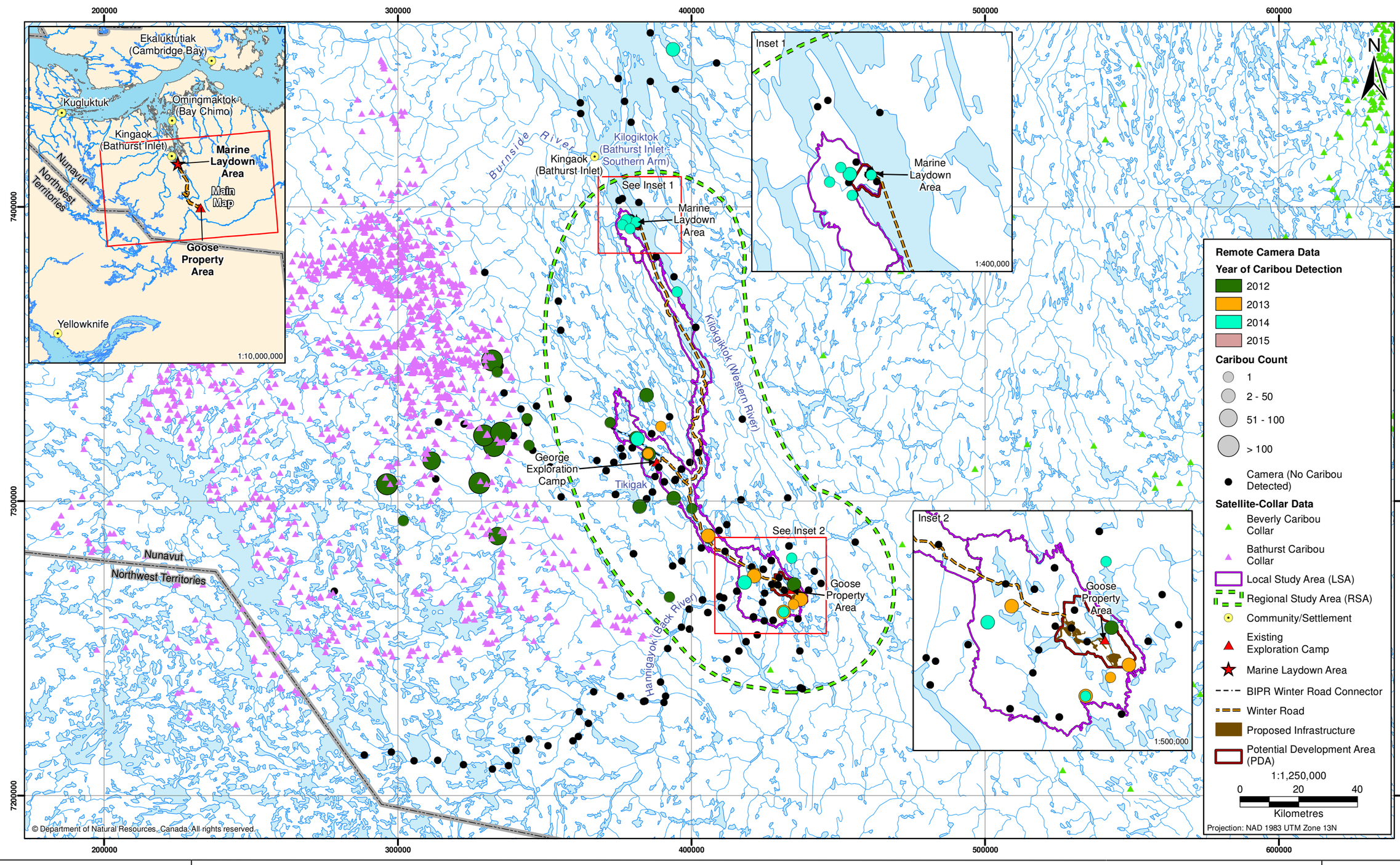
Caribou Recorded by Remote Camera and Satellite-collar in the RSA, to the west of the RSA, and Marine RSA during Calving, 2012 to 2015

Figure 5.1-9b

Rescan an ERM company



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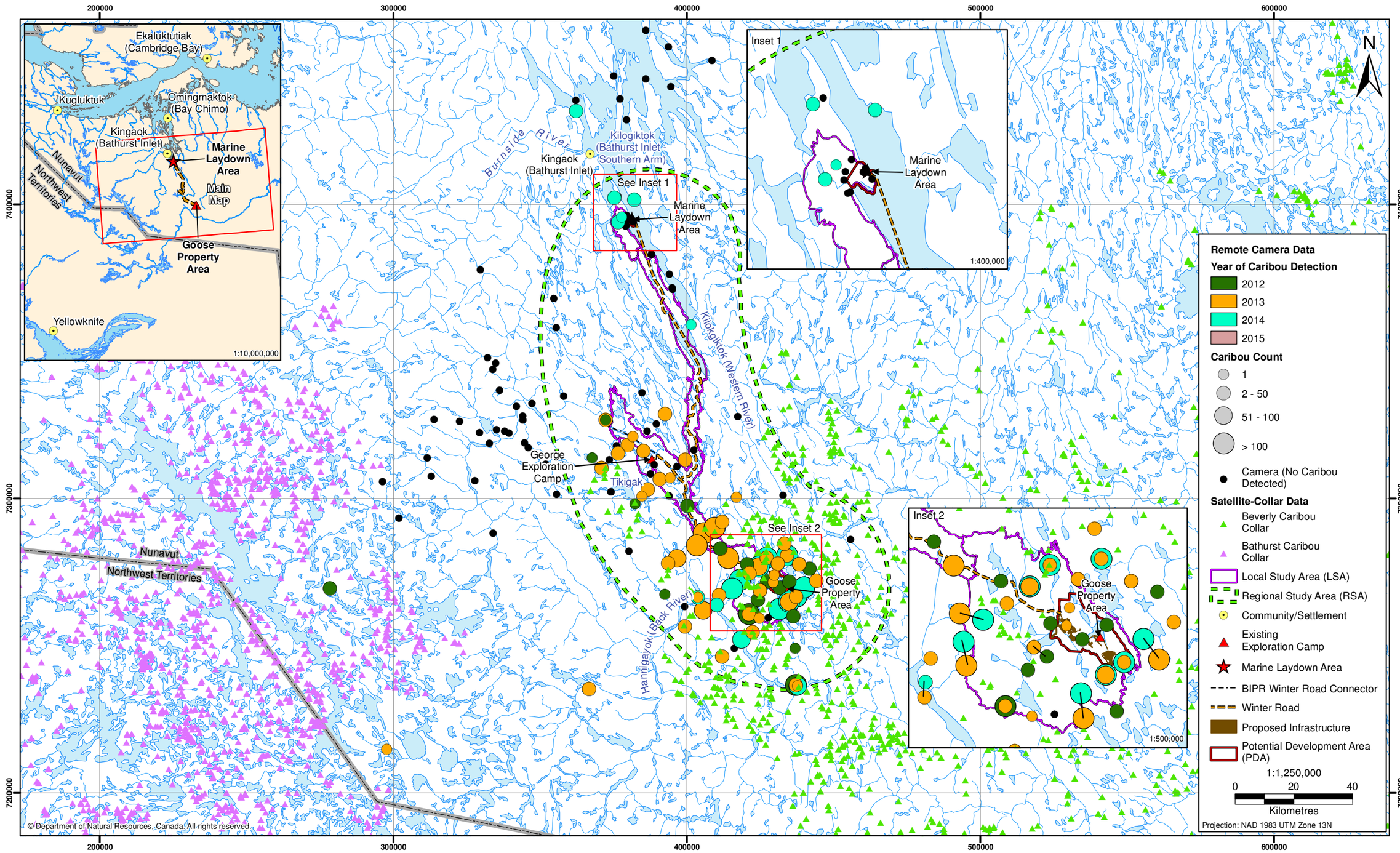
Caribou Recorded by Remote Camera and Satellite-collar in the RSA, to the west of the RSA, and Marine RSA during Post-calving, 2012 to 2015

Figure 5.1-9c

Rescan an ERM company



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Caribou Recorded by Remote Camera and Satellite-collar in the RSA, to the west of the RSA, and Marine RSA during Summer, 2012 to 2015

Figure 5.1-9d

Rescan
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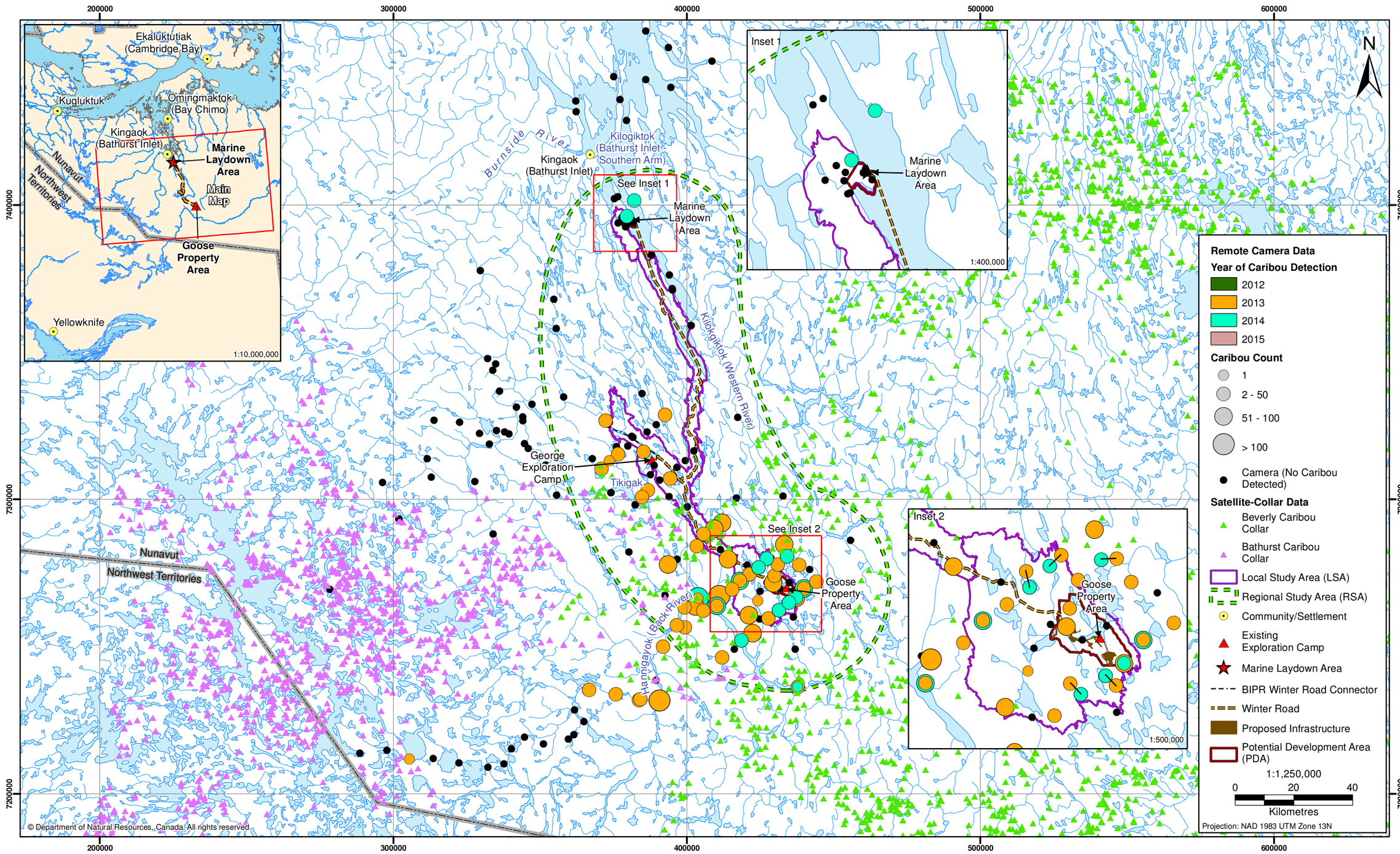

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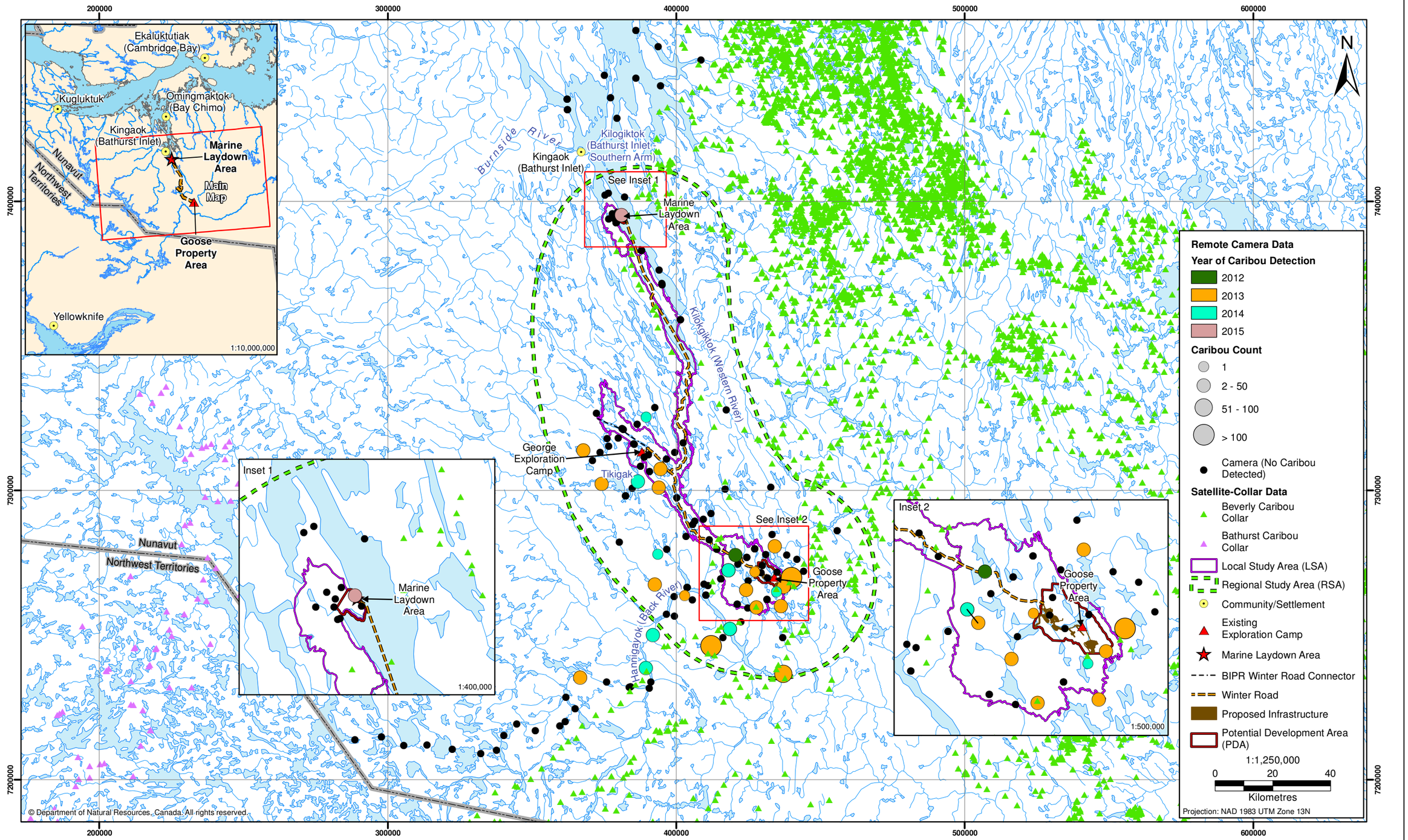
Caribou Recorded by Remote Camera and Satellite-collar in the RSA, to the west of the RSA, and Marine RSA during Fall, 2012 to 2015

Figure 5.1-9e

Rescan an ERM company



Sabina GOLD & SILVER CORP.

Caribou Recorded by Remote Camera and Satellite-collar, in the RSA, to the west of the RSA, and Marine RSA during Winter, 2012 to 2015

Figure 5.1-9f

Rescan an ERM company

Table 5.1-5. Remote Camera Observations of Total Caribou and Caribou Groups in the Wildlife RSA, West of the Wildlife RSA, and in the Marine RSA, 2012 to 2015

Camera Study Region	Camera Reporting Year	No. Cameras Deployed	No. Observations	No. Single Caribou	No. Groups (2-50 Caribou)	No. Groups (51-100) Caribou)	No. Groups (>100 Caribou)	Total Caribou Observed
Wildlife RSA								
Spring Migration								
	2012	29	1	0	1	0	0	**2**
	2013	88	11	2	9	0	0	**90**
	2014	67	7	3	4	0	0	**16**
Calving								
	2012	29	0	0	0	0	0	**0**
	2013	66	1	0	1	0	0	**2**
	2014	42	3	2	1	0	0	**4**
Post-calving								
	2012	30	30	28	2	0	0	**36**
	2013	67	14	12	2	0	0	**17**
	2014	42	6	6	0	0	0	**6**
Summer								
	2012	30	100	67	28	0	5	**1,225**
	2013	74	473	238	227	5	3	**2,750**
	2014	7	56	23	31	2	0	**468**
Fall								
	2012	30	0	0	0	0	0	**0**
	2013	77	253	80	172	1	0	**1,472**
	2014	7	56	23	31	2	0	**468**
Winter								
	2012-2013	31	67	32	33	2	0	**446**
	2013-2014	67	10	7	3	0	0	**22**
	2014-2015	13	0	0	0	0	0	**0**
West of RSA								
Spring Migration								
	2014	22	1	0	1	0	0	**34**
Calving								
	2012	13	32	8	24	0	0	**208**
	2014	22	0	0	0	0	0	**0**
Post-calving								
	2012	30	80	10	37	16	17	**5301**
	2014	22	0	0	0	0	0	**0**
Summer								
	2012	30	4	4	0	0	0	**4**

(continued)

Table 5.1-5. Remote Camera Observations of Total Caribou and Caribou Groups in the Wildlife RSA, West of the Wildlife RSA, and in the Marine RSA, 2012 to 2015 (completed)

Camera Study Region	Camera Reporting Year	No. Cameras Deployed	No. Observations	No. Single Caribou	No. Groups (2-50 Caribou)	No. Groups (51-100) Caribou)	No. Groups (>100 Caribou)	Total Caribou Observed
West of RSA *(cont'd)*								
Fall Migration								
	2012	30	0	0	0	0	0	**0**
	2013	22	31	8	23	0	0	**210**
Winter								
	2014-2015	22	5	3	2	0	0	**10**
Marine RSA								
Spring Migration								
	2014	6	1	5	0	0	0	**28**
Calving								
	2014	10	2	2	0	0	0	**2**
Post-calving								
	2014	25	9	8	1	0	0	**11**
Summer								
	2014	25	11	8	3	0	0	**15**
Fall								
	2014	22	31	8	23	0	0	**210**
Winter								
	2014-2015	25	2	2	0	0	0	**2**
	Total		**1,537**	**655**	**820**	**31**	**31**	**15,442**

**Note: Camera numbers deployed per season include all cameras functional for 7 days or more of the seasons, based timing of life history stages for Bathurst caribou*

For the 2015 reporting year (July 2014 to April 2015), a total of 38 cameras were in operation within the RSA in areas surrounding the Goose Property Area (13 cameras) and the marine RSA (25 cameras). Further details on the 2015 camera study design and camera placement rationale can be found in Rescan 2015). All deployed cameras were attached to tripods during their initial deployment or during camera location adjustments and memory cards collected and downloaded in July and August 2012, May, July, and August 2013, May 2014 and/or July 2014, and April 2015. Cameras were programmed to take one photo every half hour and 10 photos when cameras are triggered by motion.

For each photo that included a wildlife observation the following data were recorded: date, time, photo type (M = motion or T = timed (T) photos), photo number, number of photos, number of triggers, species, number of animals, and their behavior (i.e., resting, foraging, traveling). Individual caribou that were recorded 30 minutes apart in triggered photos were considered different individuals, unless behaviour suggested that they were the same individual (i.e., individuals resting on the tundra). Motion triggered photos detected individual caribou that were traveling, sometimes in small numbers and at other times in large herds of hundreds of individuals. For small numbers of caribou observed by motion triggered photos, the exact number of individuals was easily determined. For large numbers of caribou in herds, the number of individuals was determined over entire motion triggered photo set where the greatest number

of individuals observed was recorded for that time period. All photo observations of caribou were checked by a second observer to ensure that the number of individuals was recorded accurately.

To assess the temporal and spatial distribution of caribou in the wildlife RSA, and in areas adjacent to the terrestrial RSA, and within the marine RSA, the data were pooled by day (temporal trends), camera (spatial trends) and within each season of caribou life history stages such as calving, post-calving, and summer. The size of caribou groups were characterized as large groups (> 100 caribou), medium to large groups (51 to 100 individuals), small to medium (26 to 50 individuals) or small groups (1 to 25 individuals).

Across all camera study years, a total of 15,442 caribou were detected by camera in the wildlife RSA, in the Bathurst post-calving areas to the west of the RSA, and in the marine RSA. The total number of caribou and number of caribou groups detected within the wildlife RSA varied by year with the highest counts occurring in 2015 (3,514 individuals) and the lowest in 2014 (2,016 individuals; Table 5.1-5). Total caribou observations per year were not related to the number of cameras deployed per year (e.g. 38 cameras deployed in 2015 vs. 90 in 2014).

The data generated by the cameras generally agreed with the movement patterns of the Bathurst and Beverly caribou mapped via collars (Section 5.1.2.2 and Section 5.1.3.2) and indicate that:

1. Few caribou observed in the wildlife RSA during the spring migration, and those that were observed are likely Beverly caribou based on collar data (Figure 5.1-9b).
2. Very few caribou observed in the wildlife RSA during calving, and those that were observed tended to be located on the western edge of the wildlife RSA, in a similar location to the Bathurst collared males. This is consistent with the Bathurst caribou calving grounds being located outside and to the west of the wildlife RSA, and the Beverly herd calving grounds being located to the east of the wildlife RSA throughout the entirety of the camera study (Figure 5.1-9c).
3. Following calving, peak numbers of caribou were observed in the wildlife RSA during the post-calving period. The majority of caribou recorded during the post-calving period, occurred principally at the southern and western edge of the wildlife RSA, with some observations being focused at the MLA. This is consistent with the Bathurst herd movements south east from their calving ground to their summer range, as indicated from collar data (Figure 5.1-9c).
4. The majority of caribou observed in the wildlife RSA during the summer and early fall period were observed principally at the southern end of the wildlife RSA, including the Goose Property PDA (Figure 5.1-9d and Figure 5.1-9e). In some years of study (i.e. 2012 and 2013), large groups of caribou were observed at cameras positioned near Beechey Lake, at important nadloks (crossings) identified by Inuit TK (KIA 2012). This is consistent with known temporal and spatial distribution of the Beverly herd during summer and fall (Figure 5.1-9d and Figure 5.1-9e). Calves were often recorded as part of large groups that travelled past cameras, confirming the presence of post-calving groups of females, likely from the Beverly herd (Figure 5.1-9c). Based on collaring data, Bathurst caribou spend the summer period primarily to the south of the Project area, and south of the Beverly herd, in the area surrounding Contwoyto Lake (Figure 5.1-9d).
5. Few caribou were observed in the wildlife RSA during the winter period, with the exception of a small number of caribou observed principally at the southern end of the wildlife RSA and near the Goose Property Area in winter 2012-2013 and 2013-2014. Those observed are likely Beverly caribou based on collar data (Figure 5.1-9f).
6. Caribou generally observed in low numbers at the marine RSA in all seasons. Infrequent observations were made in the spring, coinciding with collar movement data from the Beverly herd during northward migration towards their calving grounds (Figure 5.1-8b). Observations of

small groups or lone individuals were observed sporadically during the calving (Figure 5.1-9b), post-calving (Figure 5.1-9c), early summer (Figure 5.1-9d), and fall migration periods (Figure 5.1-9e); observations occurred more frequently in the lower portion of Bathurst Inlet (south of Kingaok), particularly around the MLA. With the exception of two caribou individuals recorded in February 2015, no caribou were observed in the marine RSA during the winter period. The two caribou recorded during the winter are likely from the Beverly herd, whose winter range has had variable overlap with portions of southern Bathurst Inlet in recent years (Figure 5.1-9f), but could also be Dolphin and Union caribou, because this herds winter range is thought to include habitat up to 100 km from the mainland coast (which includes the marine RSA).

Habitat Suitability Modelling

Wildlife habitat suitability studies were conducted within the wildlife Local and Regional Study Areas (LSA and RSA) to inventory and rate the habitat types for caribou and quantify suitable habitat available for this species within the local and regional study areas. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by standards issued by the BC Resource Information Standards Committee (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km^2 of the West Kitikmeot / Slave Study Area, which stretches from the arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

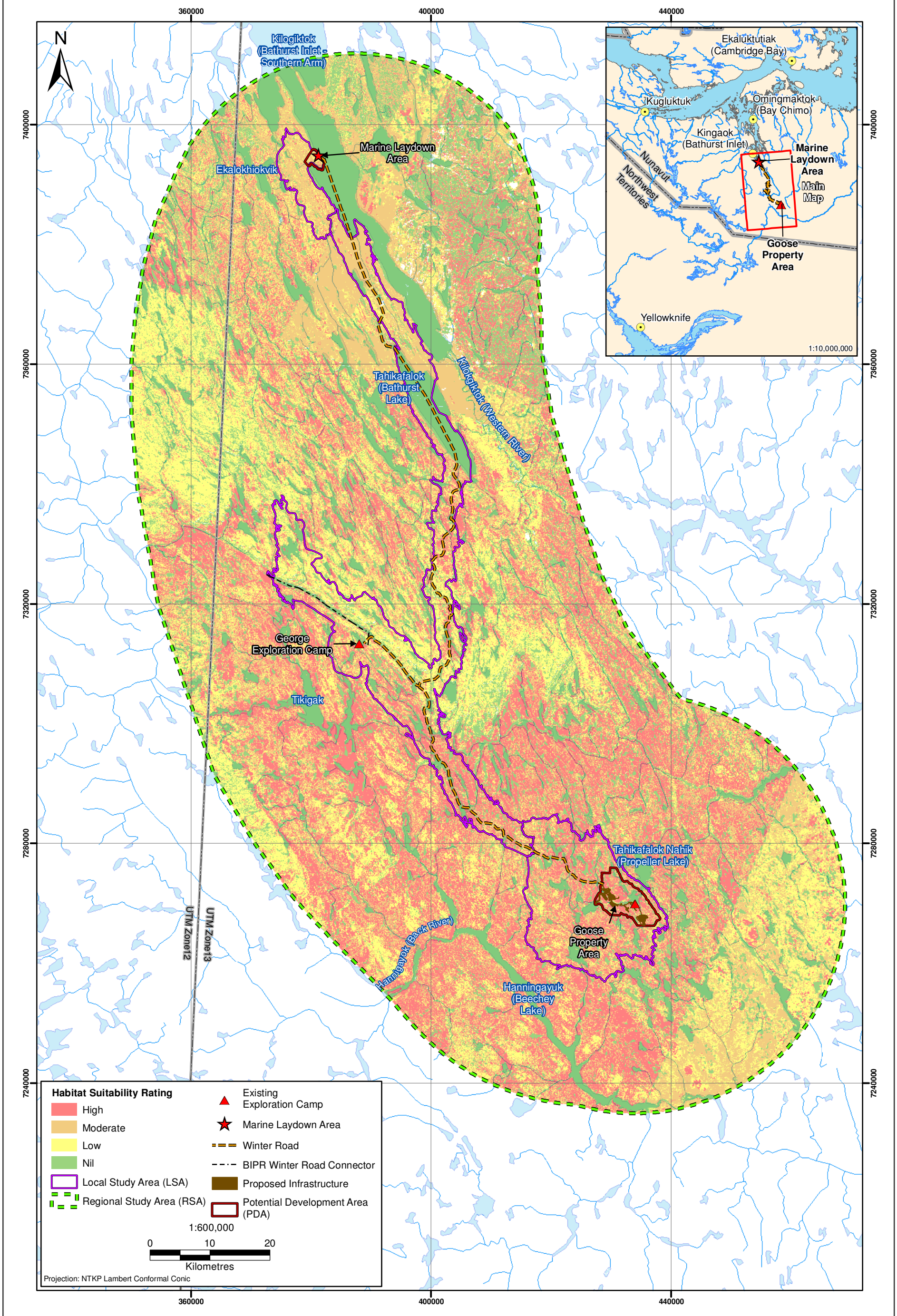
For the purposes of this study, individual herds are not assessed separately as it is assumed that habitat requirements are similar, if not identical, for all individuals by season (Gustine et al. 2012). Caribou habitat suitability was assessed for calving (June 1 to ca. June 20), post-calving (ca. June 20 to July 15), summer (July 16 to August 31) and the fall rut (September 1 to October 31).

Habitat selection for each season was developed from literature searches, local knowledge, previous wildlife surveys, and project specific habitat assessments. Table 5.1-6 provides a summary of the seasons and life requisites that were assessed, with the following sections expanding on the habitat preferences for each season and HSR ratings for each vegetation association that occurs in the wildlife RSA.

The results of the caribou suitability modelling indicate that wildlife LSA contained a considerable amount of potential high value calving habitat (53%), while the wildlife RSA was evenly distributed between high, moderate, low and nil rated habitats. For the post-calving and summer season, the wildlife LSA contained proportionally less high value habitat (19%) relative to the wildlife RSA (27% high value habitat) and both the wildlife LSA and RSA were dominated by moderate value habitat (66% and 59%, respectively). The majority of the fall season was rated high in the wildlife LSA (75%), while the wildlife RSA had approximately 45% of the area rated high and 36% considered low. Table 5.1-7 contains the complete results of the modelling. Figures 5.1-10, 5.1-11, and 5.1-12 display the mapped results in the wildlife LSA and RSA.

GIS # BAC-23-397a

November 05 2015



Sabina GOLD & SILVER CORP.

Figure 5.1-10

Caribou: Calving Habitat in the Local Study Area and Regional Study Area

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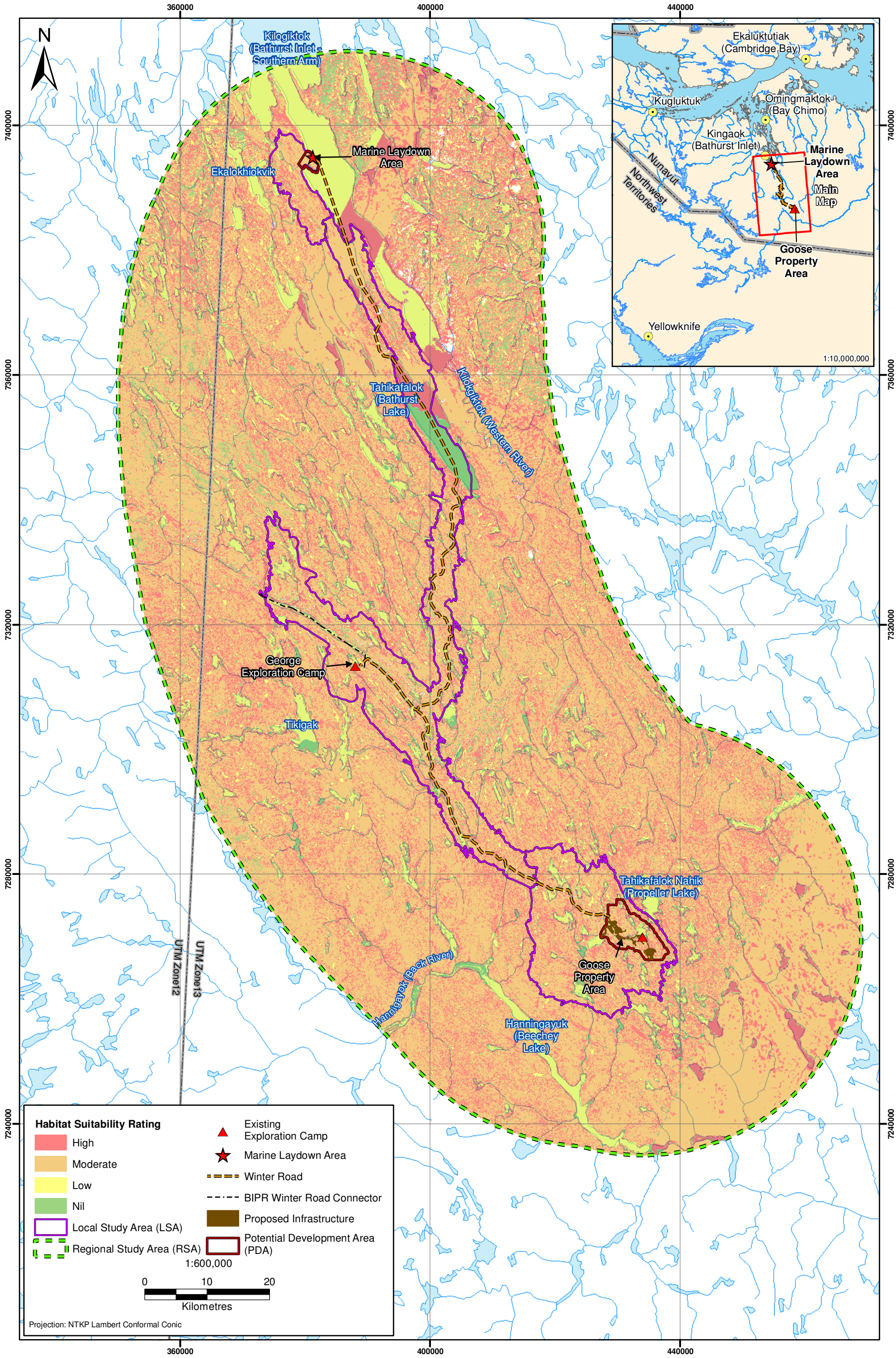
November 05 2015



Sabina GOLD & SILVER CORP.

Caribou: Post-calving and Summer Habitat in the Local Study Area and Regional Study Area

Figure 5.1-11

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GIS # BAC-23-397c

November 05 2015

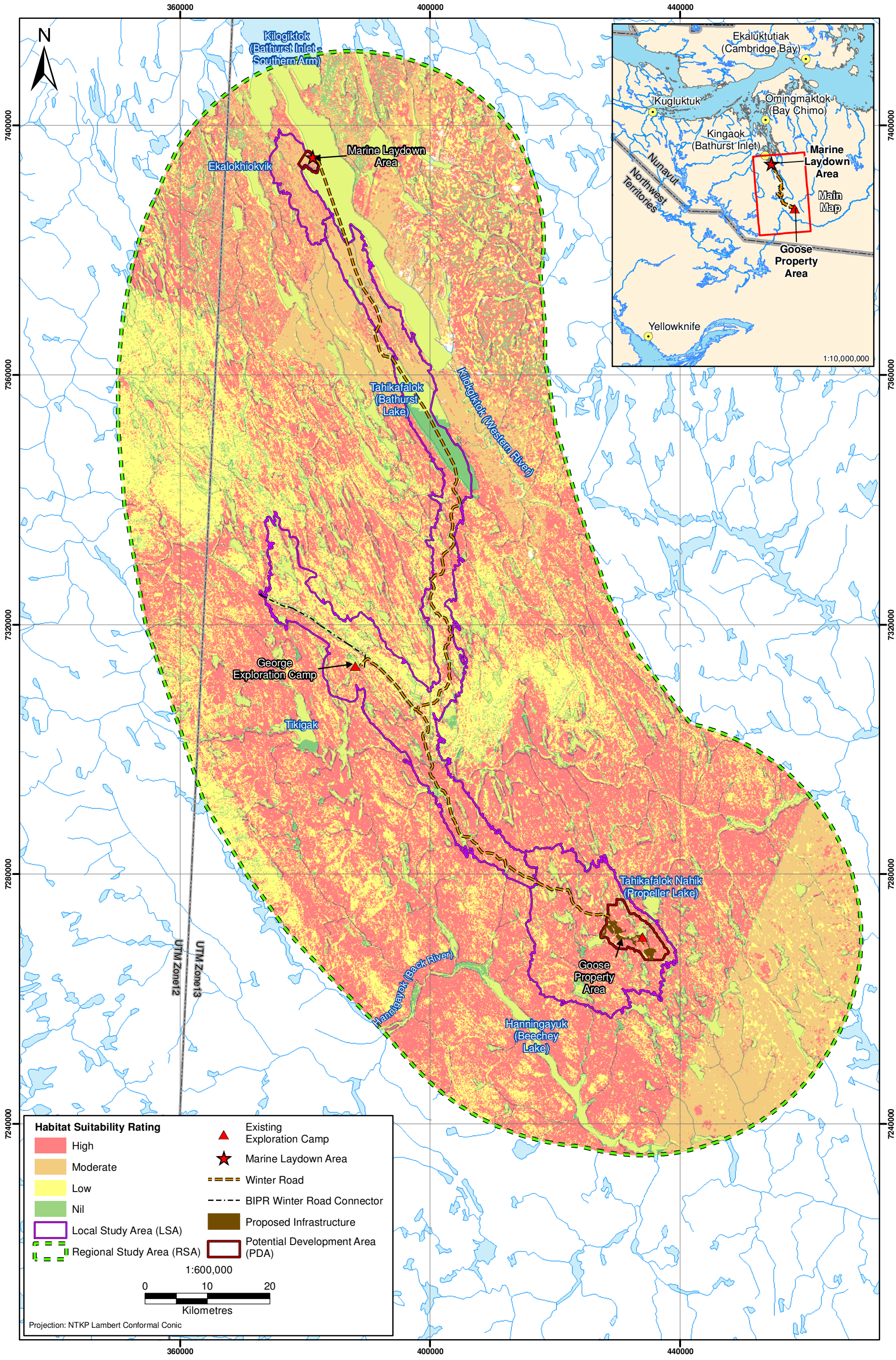

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Figure 5.1-12

Caribou: Fall Habitat in the Local Study Area and Regional Study Area

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Table 5.1-6. Seasonal Life Requisites of Caribou

Season	Date	Life Requisite	Habitat Preference
Calving	June 1 to ca. June 20	Reproduction and Living	Variable. Predator avoidance, lichen availability, and early vegetation growth is preferred.
Post-calving and Summer	ca. June 20 to July 15 (post-calving) July 16 to August 31 (summer)	Living	Caribou use eskers for insect and heat relief, lakes for predator avoidance, insect, and heat relief, eat green plants from riparian and sedge communities. Cows require high quality forage to replenish fat reserves.
Fall (Rut)	September 1 to October 31	Living, Reproduction, and Travel	Caribou travel to southern rutting areas selecting habitat for ease of travel, predator avoidance, and late season forage.

Table 5.1-7. Area and Proportion of Habitat within the LSA and RSA for Caribou

	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
Suitability Rating	Area (ha)[1]	% of LSA[2]	Area (ha)[1]	% of RSA[2]
Calving				
High	71,492.97	53	355,417.77	28
Moderate	30,436.22	22	300,905.11	24
Low	7,140.63	5	301,581.58	24
Nil	25,299.49	19	299,248.12	24
Post-calving and Summer				
High	25,850.80	19	343,578.60	27
Moderate	88,824.94	66	738,800.73	59
Low	19,556.98	15	107,137.87	8
Nil	136.58	1	67,635.37	5
Fall (rut)				
High	100,265.28	75	562,764.43	45
Moderate	9,795.05	7	178,261.57	14
Low	24,177.80	18	448,491.21	36
Nil	131.17	< 1	67,635.37	5

[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.
[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).

Resource Selection Function for Bathurst Caribou Herd

Recent evidence suggests that over-winter survival may be related to forage conditions on the summer range (Wenjun Chen et al. 2014). High leaf biomass, early start date and late end date of green leaf biomass, and high quality of leaf biomass in the summer range are generally believed to be beneficial to caribou growth and pregnancy rate during the summer-fall period and calf:cow ratio in the next year. By calculating a simple ratio vegetation index (SRVI) from broad scale advanced very high resolution radiometer data (AVHRR) over the summer range and correlating it to several demographic parameters of the Bathurst herd, W. Chen, Foy, et al. (2013) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate. Lag times were found to be one year for birth rate and calf survival rate, and two years for net productivity.

Given the vulnerability of calves during the post-calving period and the relationship between habitat quality and caribou demographics, industrial activity on the post-calving and summer ranges may contribute additional pressures on caribou. Understanding the relative contributions of natural and anthropogenic factors to population level changes in the Bathurst caribou herd is the goal of cumulative effects assessment, and fundamental to developing sound management practices to promote the long-term sustainability of the herd.

Resource Selection Functions (RSFs) provide a means to describe the inherently complex patterns of habitat use by the Bathurst herd across spatial and temporal scales. To do this, data relating habitat characteristics within the extent of historic caribou migration patterns were acquired. These characteristics include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The data are a compilation of original data and data derived from pre-existing datasets. Vector data was downloaded from online repositories and AVHRR satellite data products were provided by the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada. For each habitat characteristic, a spatial data layer was generated with coverage over the entire study area. Then, both caribou collar data points and a set of random points were overlain onto the data layers and extracted a value for each of the habitat characteristics for each of the data points. The motivation behind RSF modelling is to contrast environmental characteristics at locations where caribou were observed with characteristics at random points in the surrounding area. By comparing the habitat characteristics for these two datasets, models were developed which represent the best fit for the habitat use and thus identify habitat selection preferences using Akaike's Information Criterion (AIC_c). These models were then used to generate maps reflecting probability of habitat use over a relatively large spatial extent.

Methods

Resource Selection Functions (RSFs) provide a means to describe the inherently complex patterns of habitat use by the Bathurst herd across spatial and temporal scales. To do this data was acquired relating habitat characteristics within the extent of historic caribou migration patterns. These characteristics include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The data are a compilation of original data and data derived from pre-existing datasets. Vector data was downloaded from online repositories and AVHRR satellite data products were provided by W. Chen at the Canadian Centre for Remote Sensing under a data sharing agreement between Sabina and Natural Resources Canada.

For each habitat characteristic, a spatial data layer was generated with coverage over the entire study area. These were then overlaid on both caribou collar data points and a set of random points onto the data layers and extracted a value for each of the habitat characteristics for each of the data points. The motivation behind RSF modelling is to contrast environmental characteristics at locations where caribou were observed with characteristics at random points in the surrounding area. By comparing the habitat characteristics for these two datasets, models were developed which represent the best fit for the habitat use and thus identify habitat selection preferences using Akaike's Information Criterion (AIC_c). These models were then used to generate maps reflecting probability of habitat use over a relatively large spatial extent.

Study Area

Resource selection functions were generated for the post-calving (Figures 5.1-13a and 5.1-13b) and summer (Figures 5.1-13c and 5.1-13d) seasons. GPS collar data suggests that these seasons are the time periods when caribou distributions are in relatively close proximity or overlap with the Project. Bathurst caribou tend to calve to the northwest of the Project, and that range tends to be more resticted than other parts of the year.

GIS # **BAC-23-398a**

November 5, 2015

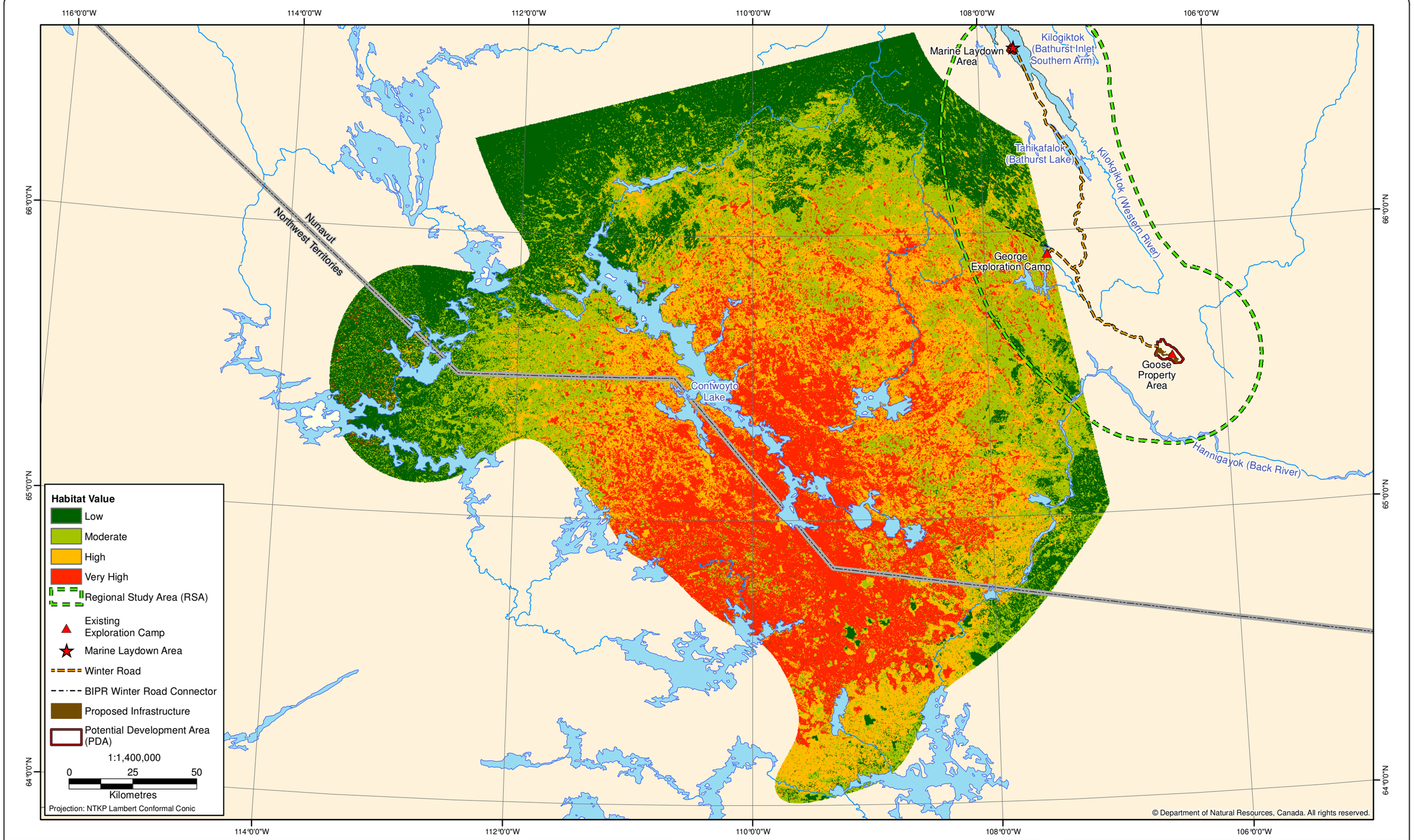

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Figure 5.1-13a

Caribou Habitat Values in the Post-calving Range Based on Resource Selection Modelling, 95% Kernel

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GIS # **BAC-23-398b**

November 5, 2015

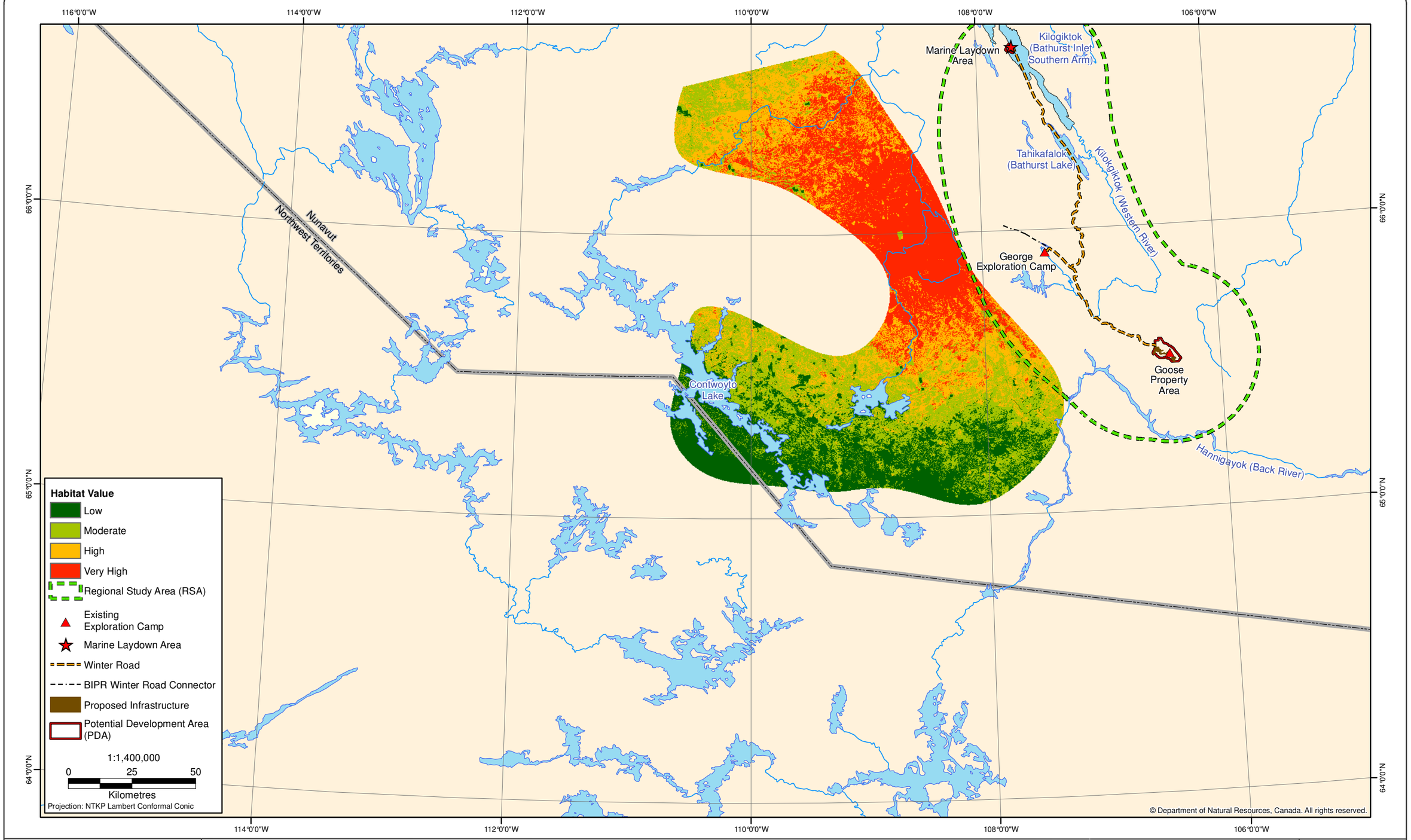

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Figure 5.1-13b

Caribou Habitat Values in the Post-calving Core Use Area Based on Resource Selection Modelling, 50% Kernel

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GIS # **BAC-23-398c**

November 5, 2015

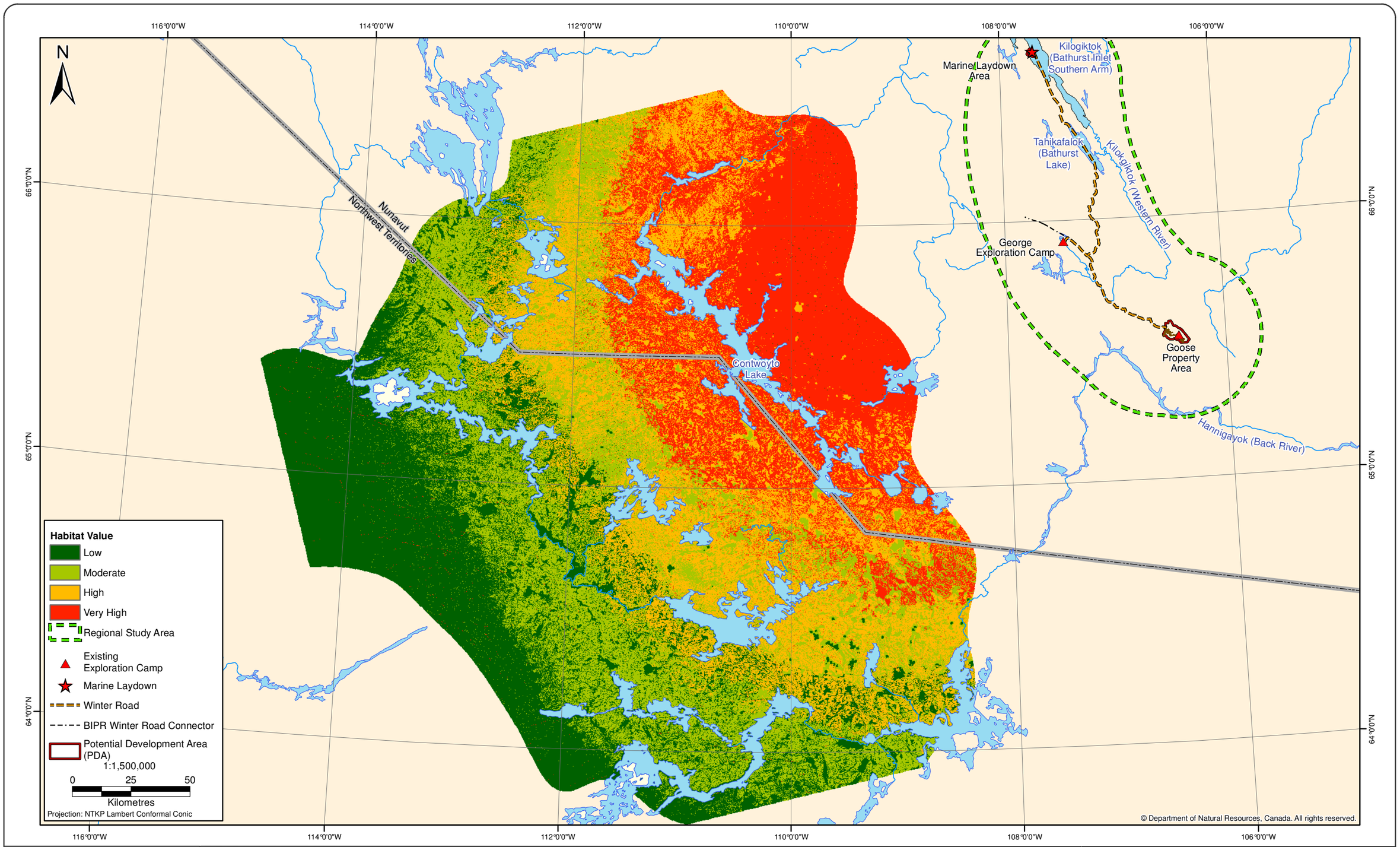

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Figure 5.1-13c

Caribou Habitat Values in the Summer Range Based on Resource Selection Modelling, 95% Kernel

Rescan an ERM company

GIS # **BAC-23-398d**

November 5, 2015

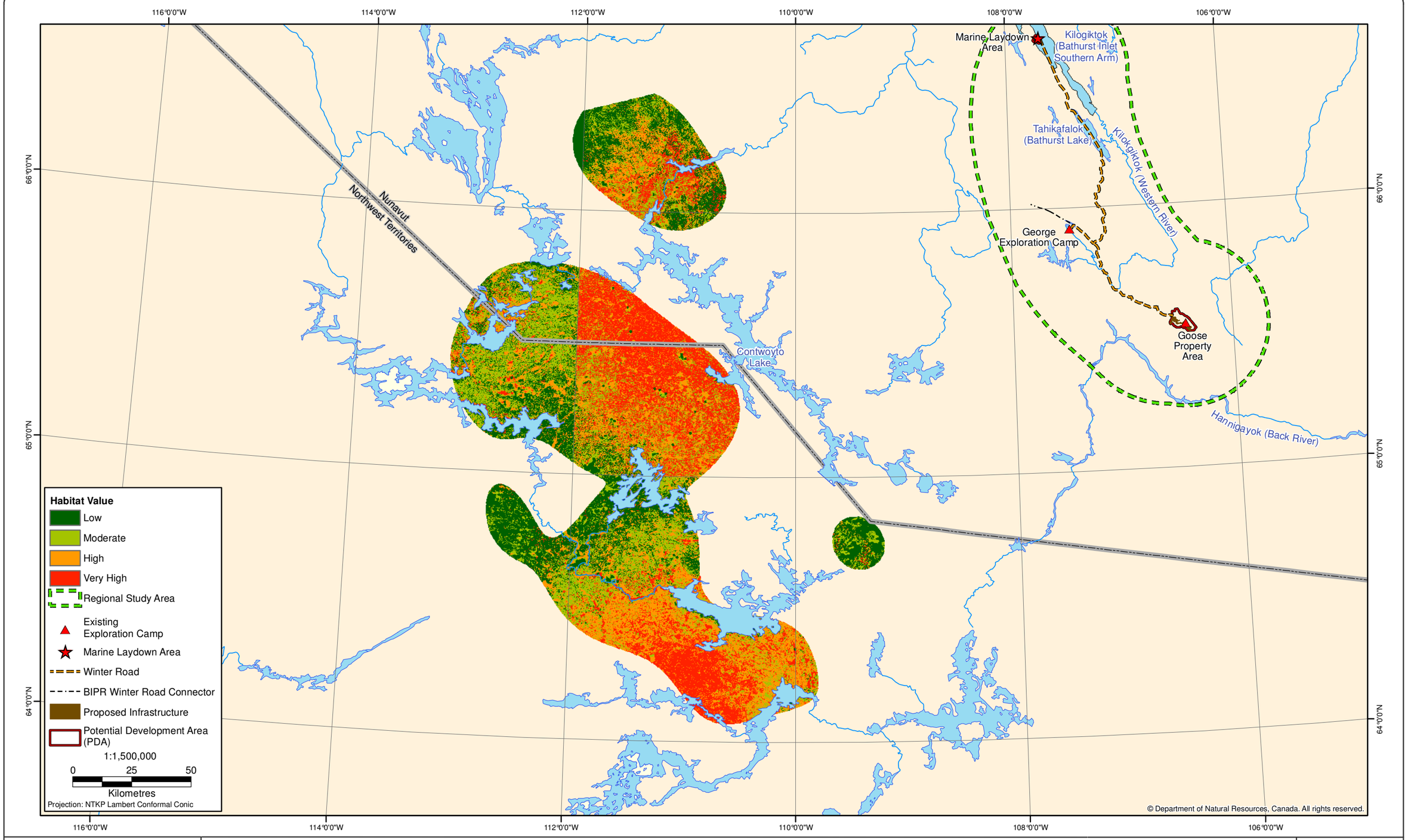

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Figure 5.1-13d

Caribou Habitat Values in the Summer Core Use Area Based on Resource Selection Modelling, 50% Kernel

Rescan an ERM company

Pooled GPS collar data since 1996 provided the maximum extent to bound the analyses, and can apply to future modelling exercises irrespective of year. Models were developed by pooling GPS collar data from all individuals and across years between 2004 and 2010. Assessing variability or across years was not a component of this modelling exercise. Rather, the objective was to develop a probability surface that was proportional to the likelihood of encountering caribou relative to mining activities and the distribution of habitat features, and based on the most complete recent data available.

A use-availability design was employed with a third order selection strategy (selection within a home range). The seasonal models were bounded in two ways. The first was defined by the 95% fixed kernel using all collar locations since 1996 to bound the maximum spatial extent available to caribou. The second was the 50% fixed kernel that was assumed to represent the core seasonal habitat range. Use is defined by the GPS collar location. Availability was determined by pairing five random locations for each use location (C. J. Johnson et al. 2006).

Model Inputs

Inputs to the RSF are predictor variables hypothesized to relate to species abundance or those identified as important characteristics in the literature. These variables include vegetation indices of productivity, land cover, topographic features, predation, and industrial development. The layers are a compilation of original data and data derived from pre-existing datasets. Most layers were comprised of multiple scenes or panels which were stitched together into a single image to provide coverage over the entire area of interest. The collar data points were overlaid onto the data layers and a unique value was extracted for each data point for each layer; therefore, each collar data point is associated with a value for each predictor variable. Patterns of selection or avoidance are defined relative to what is available to an animal. Availability is determined by a series of random points that are similarly assigned a value for each of the same predictor variables. The use of resources proportionately more than might be expected based on availability is termed selection. The use of resources less than expected based on what is available is termed avoidance.

RVI

In order to assess habitat quality and forage availability, vegetation productivity was quantified using a vegetation index. The simple ratio vegetation index (SRVI) utilizes the spectral signature of healthy vegetation, which is characterized by high near-infrared reflectance and comparatively lower red reflectance. The SRVI is calculated as:

$$SRVI = \rho_{NIR} / \rho_R$$

where ρ_{NIR} is the near-infrared reflectance and ρ_R is the red reflectance. Higher SRVI values correspond to pixels representing more dense, green vegetation while low values correspond to unvegetated or sparsely vegetated pixels.

SRVI maps were derived from Advanced Very High Resolution Radiometer (AVHRR) satellite imagery. AVHRR data has been widely used to monitor vegetation productivity and phenology due to its 1.1 km resolution and record dating back to the 1980s (Myneni et al. 1997; Tucker et al. 2001; Stow et al. 2007; Jia, Epstein, and Walker 2009; Beck and Goetz 2011). SRVI maps were generated from AVHRR imagery collected from 1996 to 2011 during post-calving and summer months (June to August). Image processing was carried out based upon methods described by Chen and others (W. Chen et al. 2009). To reduce errors associated with cloud and aerosol contaminated pixels, we set a cloud contamination threshold of 50% where pixels with cloud contamination probability of greater than 50% were removed (W. Chen, Foy, et al. 2013). Collar data points were matched with the AVHRR scene corresponding to the closest time period. In many cases, AVHRR data was not available on the day the collar location

was recorded due to removal of cloud contaminated pixels or as a result of the 10 day return interval of the AVHRR satellite. In these cases, collar data points were matched with SRVI values that corresponded to the nearest AVHRR time step at the pixel location.

LAND COVER

Though the SRVI provides information regarding the productivity of an area, it does not distinguish between different surface cover types that may influence caribou movements and habitat selection. As a result, land cover was also used as a predictor variable of caribou habitat use. Land cover information was generated from vectorized classification of Landsat satellite imagery collected in 2000. These land cover maps were generated by Agricultures and Agri-Food Canada (AAFC), Canada Center for Remote Sensing (CCRT), and Canadian Forest Service (CFS). Within the RSF study area, land cover for Nunavut and the northern regions of Northwest Territories was classified by the CCRT. Land cover in the forested regions of Northwest Territories was derived from forest cover mapping for the Earth Observation for Sustainable Development project (EOSD). Though a harmonized legend was created for the multiple data sources, some discrepancies and discontinuities exist due to differences in classification methods. A total of 12 broad land cover classes were generated from the above sources. These classes included:

- Barren/Non-vegetated;
- Sparsely vegetated;
- Bryoids;
- Tall Shrub;
- Short Shrub;
- Dwarf Shrub;
- Wetland;
- Tussock graminoid tundra;
- Moist to dry non-tussock graminoid tundra/dwarf shrub tundra;
- Forested (conifer);
- Forested (broadleaf);
- Forested (mixed).

TOPOGRAPHIC FEATURES

Topographic factors were also included that may influence the use of resources, including elevation, slope, and aspect. The elevation at each caribou observation was determined using digital elevation models (DEMs) from Canadian Digital Elevation Data. These were generated from 1:50,000 National Topographic Data Base maps and other available provincial and territorial data. Eighteen National Topographic Survey (NTS) map sheets were merged into a single DEM with spatial coverage over the area of interest and a spatial resolution ranging from 8 to 23 metres. On the merged DEM some seams are visible, particularly on lakes, as a result of differing data sources.

From the merged DEM we calculated slope, eastness, and northness using ArcGIS. Slope served as the basis for determining both eastness and northness which relate to slope aspect. Eastness was calculated as the sine of the aspect and northness the cosine of the aspect.

Preliminary analyses indicated that topographic features were not a significant component of resource use, likely due to the relatively uniform relief across the landscape; therefore topographic features were omitted from the final model iterations.

ESKER

Eskers were identified as a potentially important habitat feature due to their use as a travel corridor and for insect and heat relief. Eskers are included in the relief and forms CanVec vector data produced by Natural Resources Canada. From the esker delineation, a binary esker mask was generated using a 75 metre buffer. Regions within 75 metres of a mapped esker were classified to be esker related while areas further than 75 metres from mapped eskers were classified as non-esker features.

Preliminary analyses indicated zero use of eskers by caribou during the post-calving and summer periods (consistent with camera monitoring data); therefore, eskers were omitted from the final model iterations.

WATER

Proximity to water is used as a predictor variable because lakes may provide relief from heat and insects. The availability of water across the landscape was quantified using the position and spatial extent of waterbodies defined in the land cover map water class. For each collar data point, the distance to the nearest body of water and its surface area was calculated using a spatial join. At locations where the collar location falls within a mapped body of water, the distance to water is zero.

PREDATORS

Predation is considered an important component of caribou population dynamics. To incorporate predation risk as a predictor of caribou habitat use across the landscape, 4-class habitat suitability indices (HSI) were generated for both wolves and grizzly bears during each modelled season.

MINES

A development layer was created to encompass influence of mining activities including drilling, camp, and helicopter disturbances. Development within the study region was divided into operating mines, closed mines, and exploration camps, based on the assumption that each type of development is likely to influence the herd in different ways. At each collar data point, the distance to the nearest mine or camp was calculated for each of these development classes.

Results

During both the post-calving and summer periods, the region around Contwoyto Lake, Nose Lake, and the Mara and Hackett Rivers was identified as an area that is heavily used by caribou based on models that included habitat, RVI (an index of habitat productivity), distance to industrial activities, distance to water, and habitat quality ratings for predators (used as an index of predation risk). This result assumes that the current post-calving and summer distributions can be explained by pooled GPS collar data spanning 2004-2010, and that changes in land cover types are unlikely to have changed significantly since the land cover classification developed in the late 1990s. The selection surfaces are consistent with current GPS collar data as well as anecdotal evidence collected during regional monitoring programs at other mining operations (e.g., Ekati, Rescan 2013g). Information from TK indicates the Contwoyto Lake region as an important foraging area.

Across the post calving range (Figure 5.1-13a), caribou tended to avoid barren and sparsely vegetated cover types, as well as prostrate dwarf shrub and tussock graminoid tundra areas, relative to the availability of these cover types. In contrast, caribou tended to select tall shrub and forested habitats. Habitat suitability for predators, used as an indicator of potential predation risk, was included in the final model. There was evidence for selection of low quality wolf habitat and avoidance of low quality

grizzly bear habitat. There was zero use of high quality wolf habitat, which resulted in the removal of this parameter from the final model. In the post-calving core range (Figure 5.1-13b), caribou tended to select for highly productive areas, as indicated by the significant positive coefficient for RVI, and avoided prostrate dwarf shrub cover types.

Across the entire summer range (Figure 5.1-13c) caribou tended to select for areas with low lying vegetation relative to their availability across the landscape, such as barren and sparsely vegetated areas (which may include eskers) and shrub cover types. Caribou tended to avoid wetter areas, such as wetlands and moist non-tussock graminoid tundra, and forested cover types. In the core use area (50% UD; Figure 5.1-13d), caribou tended to avoid barren and bryoid cover types, low and dwarf shrub areas, and forested areas, but selected for sparsely vegetated (including eskers) cover types, tall shrub areas, and graminoid tundra cover types.

5.1.3 Beverly Caribou

5.1.3.1 Introduction

The Beverly herd (formerly known as the Ahiak and Beverly herds) were recognized as distinct herds in the 1980s (A. Gunn and D'Hont 2002). The calving grounds of the Ahiak herd extended over about 31,000 km^2 on the coast of the western Queen Maud Gulf, west of the Perry River in the Ahiak region. These are the largest calving grounds of any mainland barren-ground caribou herd in Nunavut and the Northwest Territories (Johnson, Nagy, and Williams 2008). The Beverly herd, calved to the south of the Ahiak herd near Garry Lake. Work by Nagy et al. (2011) has revealed that over many years beginning sometime prior to 2002, the Beverly calving herd has joined the Ahiak in the western Queen Maude Gulf calving area (Campbell et al. 2012). This combined herd is currently referred to as the Beverly herd by the Government of Nunavut (Campbell et al. 2012). Data from satellite collars indicates that some female caribou that calve on the coast of the western Queen Maud Gulf occur in the wildlife RSA during late summer, fall and winter and that the wildlife RSA is on the western edge of the distribution of these caribou. This herd is referred to as the Beverly herd in this assessment, except where data is presented from prior to 2002, where the two herds are referred to as Ahiak and Beverly herds.

5.1.3.2 Distribution and Migration Patterns

Data on the distribution and movements of Beverly caribou have been derived from Inuit TK (KIA 2012, 2014), aerial calving ground surveys in 1986, 1996 and 2002 (A. Gunn and Fournier 2000; A. Gunn and D'Hont 2002), satellite collar data from five cows between 1996 and 1998 (A. Gunn and Fournier 2000) and satellite collar data from 5 to 52 cows per year between 2001 and 2012 (GNWT ENR 2012). The following sections describe the Beverly herd's seasonal distribution and movements.

The Beverly herd winters over a broad area from Bathurst Inlet to northern Saskatchewan and migrates north to the Arctic coast on the Queen Maud Gulf for calving and summer foraging. The yearly distribution and movements of Beverly caribou can be classified into six distinct periods: winter, spring migration, calving, post-calving, summer, and fall migration (Table 5.1-8). The timing of migration and calving is thought to be similar to Bathurst caribou, although the calving period for Beverly females is thought to be about one week longer, ending around June 20th instead of June 15th (A. Gunn and Fournier 2000; Johnson, Nagy, and Williams 2008).

Table 5.1-8. Timing of Life History Stages of Beverly Caribou

Cycle Stage	Start Date	End Date
Spring Migration[1]	April 15	June 4
Calving[2]	June 5	June 20
Post-calving[4]	June 21	July 25
Summer[5]	July 26	August 31
Fall Migration[6]	September 1	October 31
Winter[7]	November 1	April 14

[1] Gunn, Fournier, and Nishi (2000).
[2] Gunn, Fournier, and Nishi (2000).
[3] Gunn, Fournier, and Nishi (2000); Gunn and D'Hont (2002); Johnson et al. (2008); Campbell et al. (2012)
[4] Five weeks post-calving, which includes post-calving and early summer periods defined in Gunn et al. (2008); Russell, Kofinas, and Griffith (2002).
[5] Gunn et al. (2008).
[6] Johnson et al. (2005b); includes rut period defined in Gunn et al. (2008).
[7] Includes late fall and winter periods defined in Gunn et al. (2008).

Spring Migration (April 15 to June 4)

During spring migration, Beverly female caribou migrate northwards from their wintering grounds to the calving grounds along Queen Maud Gulf. Satellite collar data indicate that some Beverly females are found in the wildlife RSA during winter and spring migration (Figure 5.1-14). Bulls and juvenile Beverly caribou follow the females north (A. Gunn and D'Hont 2002; Johnson, Nagy, and Williams 2008). Beverly caribou are segregated by age and gender on the calving grounds, with bulls occurring mostly on the eastern edge, females with cows in the middle, and non-parturient females and yearlings on the western edge (Campbell et al. 2012).

Calving (June 5 to 20)

Beverly caribou calve along the Queen Maud Gulf coast, on the east side of Bathurst Inlet, in the Queen Maud Gulf Migratory Bird Sanctuary (A. Gunn, Fournier, and Nishi 2000; A. Gunn and D'Hont 2002; A. D'Hont, GNWT ENR, unpublished data). In recent years, the calving grounds of the Beverly herd have overlapped the traditional (but not current) calving grounds of the Bathurst herd on the east side of Bathurst Inlet (A. Gunn and Fournier 2000; A. Gunn and D'Hont 2002). Beverly female caribou are not expected to occur in the wildlife RSA during calving, as their calving grounds are located north east of the wildlife RSA (Figure 5.1-15), but bulls and juveniles will likely occur there as indicated by aerial surveys (A. Gunn and Fournier 2000; D. E. Russell, Kofinas, and Griffith 2002).

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

Beverly cows and calves disperse south and southwest after calving (Figures 5.1-15). Relative to Bathurst cows, Beverly cows may spend more time on calving grounds during the post-calving period such that areas used for calving and after calving overlap (A. Gunn and Fournier 2000; A. Gunn and D'Hont 2002). This appears to be the result of river systems that caribou are reluctant to cross until water levels have receded (Campbell et al. 2012). Along with bulls and juveniles, Beverly cows and calves are expected to occur in the wildlife RSA during summer. The summer range of the Beverly herd overlaps the southern half of the wildlife RSA (Figure 5.1-16).

Fall Migration (September 1 to October 31)

During the fall, Beverly caribou continue move south from the summer range (Figure 5.1-16) towards the Thelon Game Sanctuary, located on the Northwest Territories/Nunavut border east of Great Slave

Lake, where the rut occurs (A. Gunn and Fournier 2000). A small number of collared caribou move through the southern portion of the wildlife RSA during the fall migration (Figure 5.1-16). Analysis of collar data supports these trends, with high kernel density of collar locations (i.e., high amounts of use) overlapping Lac de Gras for Bathurst caribou in the fall (Figure 5.1-16) and the eastern Thelon Wildlife Sanctuary for Beverly caribou (Figure 5.1-16).

Winter (November 1 to April 14)

After rutting, Beverly caribou disperse south or northwest (a smaller portion) for the winter (A. Gunn and Fournier 2000). Beverly caribou, like Bathurst caribou have a large and variable winter range. In most years for which there is satellite collar data, Beverly females wintered on the tundra; in 1997 and 2001 Beverly females wintered in the taiga as far south as Saskatchewan (A. Gunn and D'Hont 2002; A. Gunn, Russell, and Eamer 2011b). Beverly wintering grounds extend from Bathurst Inlet south to the area east of Great Slave Lake and the Saskatchewan border (Figure 5.1-14). The winter range of the Beverly herd overlaps that of the Bathurst herd. In some years, Beverly caribou were found in the southwestern portion of the wildlife RSA during winter; however, the core of the winter range does not overlap the wildlife RSA (Figure 5.1-14).

On the tundra, a key concern is that climate change may result in an increase in the number of rain-on-snow events, which can cause a hard crust to form on snow, sometimes making it more difficult for caribou to forage. Caribou, particularly Peary caribou, and muskox are thought to be susceptible to large-scale die-offs to starvation during arctic winters when ice layers form too thick for caribou and muskox to crater through the ice with their hoofs (reviewed in Jenkins et al. 2011). However, this hypothesis remains contentious; other factors like disease have yet to be tested for their role in die-offs of caribou and muskox in the arctic (Tyler 2010).

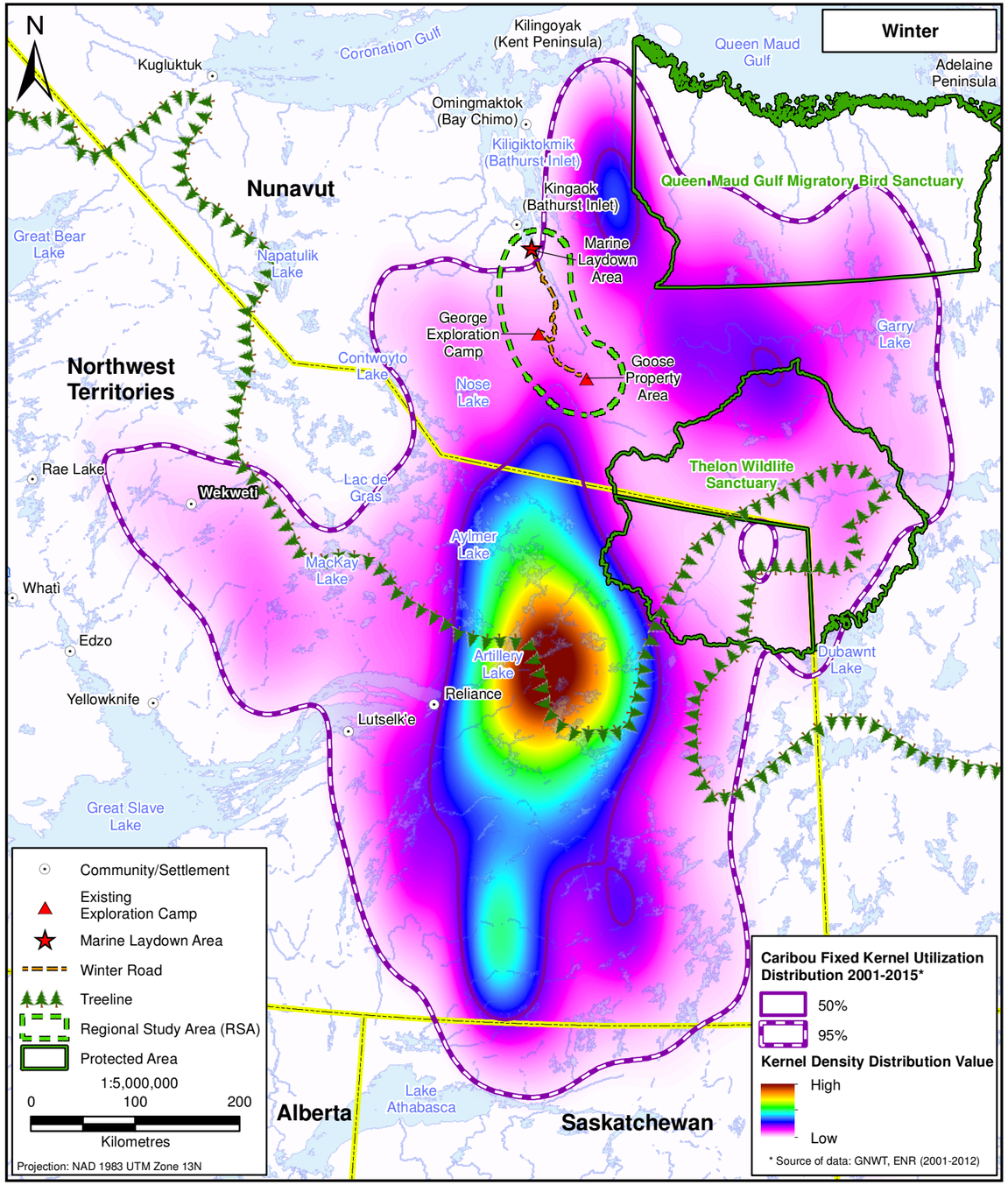
Beverly Caribou Distribution and Movements from Inuit TK

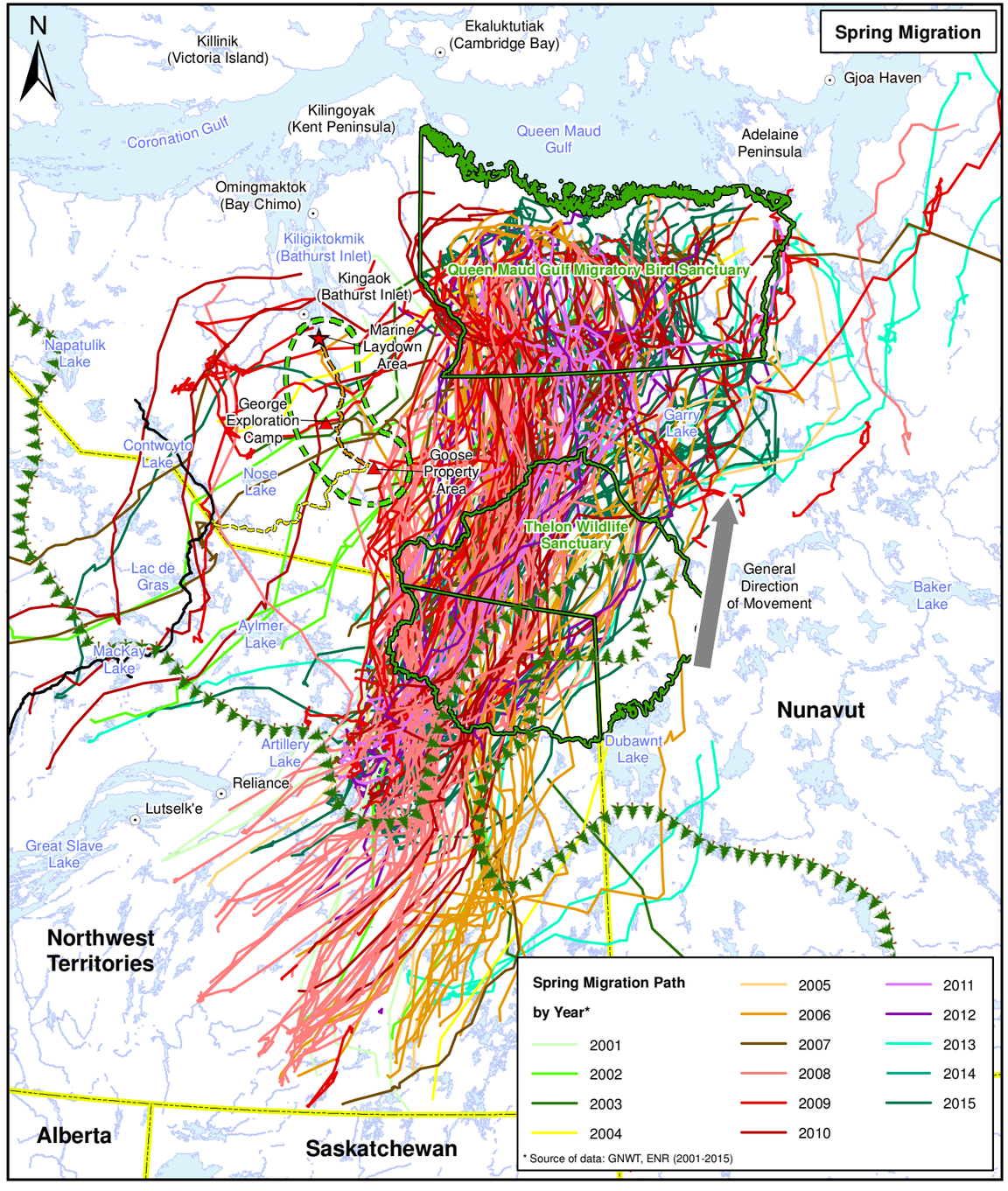
Inuit TK does not distinguish among caribou herds that occur on the mainland of Nunavut, but Dolphin and Union caribou were distinguished by their lighter color and were referred to as island caribou (KIA 2012, 2014). Membership to a particular herd can be inferred based on the location and timing of observations of mainland caribou recorded by Inuit TK. Inuit TK includes observations of large numbers of caribou migrating across Beechey Lake in historic times (KIA 2012, 2014). Based on the current migration route of the Beverly herd, it is likely that at least some of these caribou were of the Beverly herd.

Several key nadlok (caribou crossing places) were used along Beechey Lake, where Inuit were able to hunt enough caribou to support a large and important camp throughout the year (KIA 2012, 2014). Observations of mainland caribou inter-mixed with Dolphin and Union caribou in winter on either side of Bathurst Inlet may have been those of the Beverly herd. These results would indicate that the winter range of the tundra-wintering caribou, including some members of the Beverly herd, extended much further north in historic time than is indicated by recent collaring data (Nagy, Campbell, and Kelly 2012).

Summary of Beverly Herd Movements and Distribution

Beverly caribou overwinter in the boreal forest and move relatively quickly to calving grounds to the northeast of the wildlife RSA. Caribou cross through the southern portion of the wildlife RSA near Goose Camp during the spring migration. During post-calving, females and calves remain in the Queen Maud Gulf Migratory Bird Sanctuary east of the wildlife RSA. During the summer and into the fall, a small proportion of the Beverly herd range overlaps the wildlife RSA, particularly around the southern half before migrating south towards the treeline.





Sabina GOLD & SILVER CORP.

Range of Satellite-collared Beverly Caribou during Winter (1 November to 14 April) and Spring Migration (15 April to 4 June), 2001 to 2015

Figure 5.1-14

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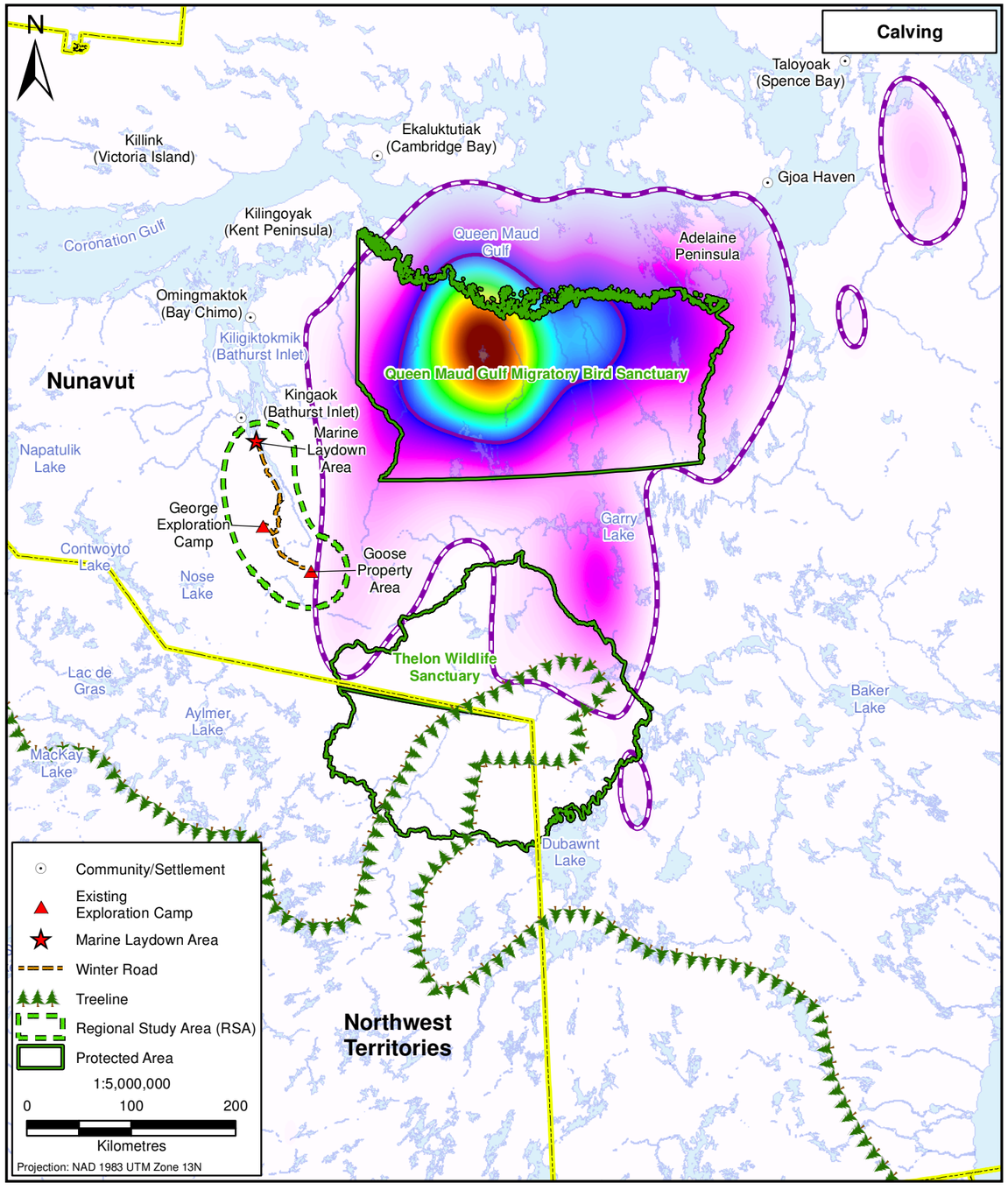

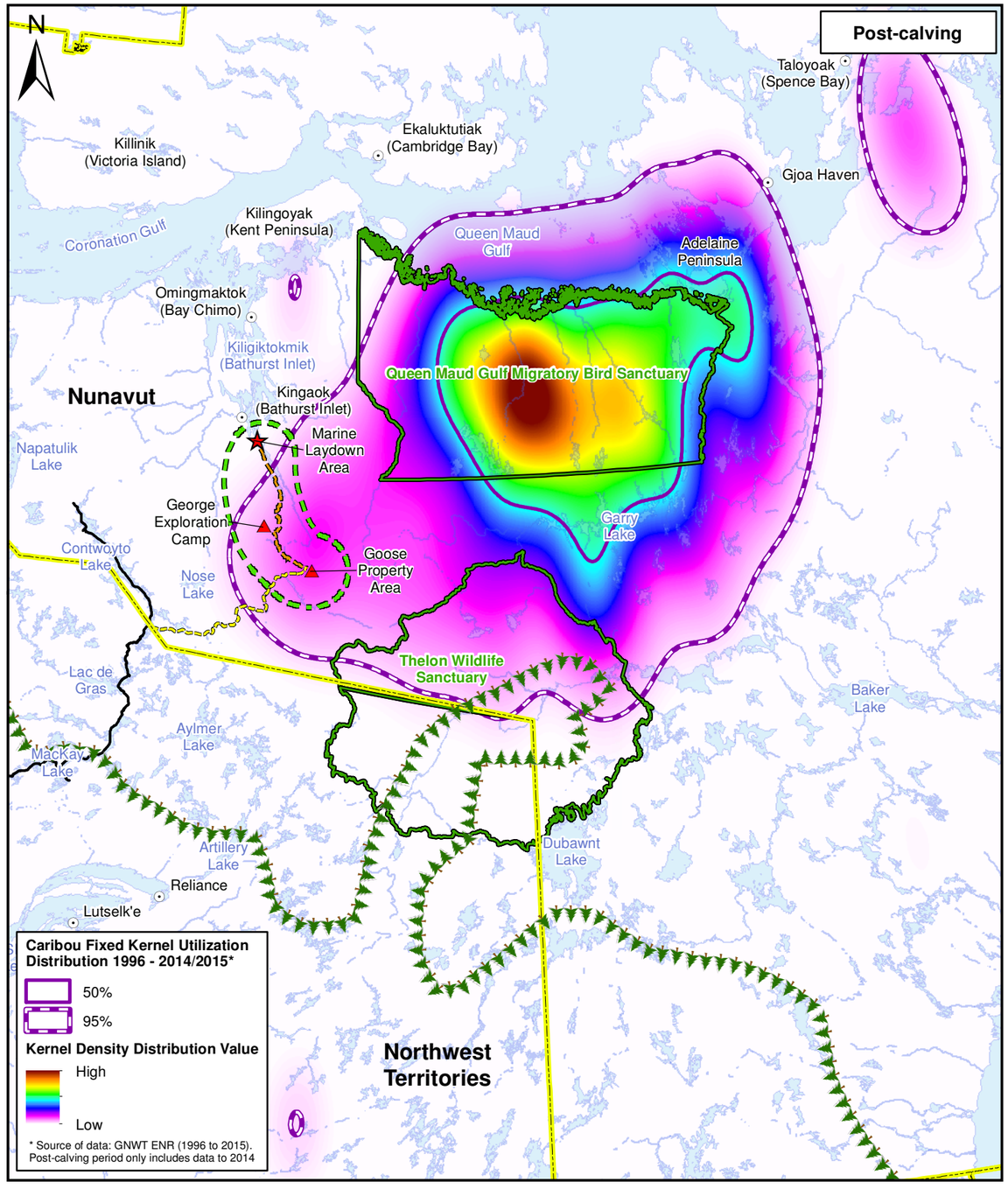

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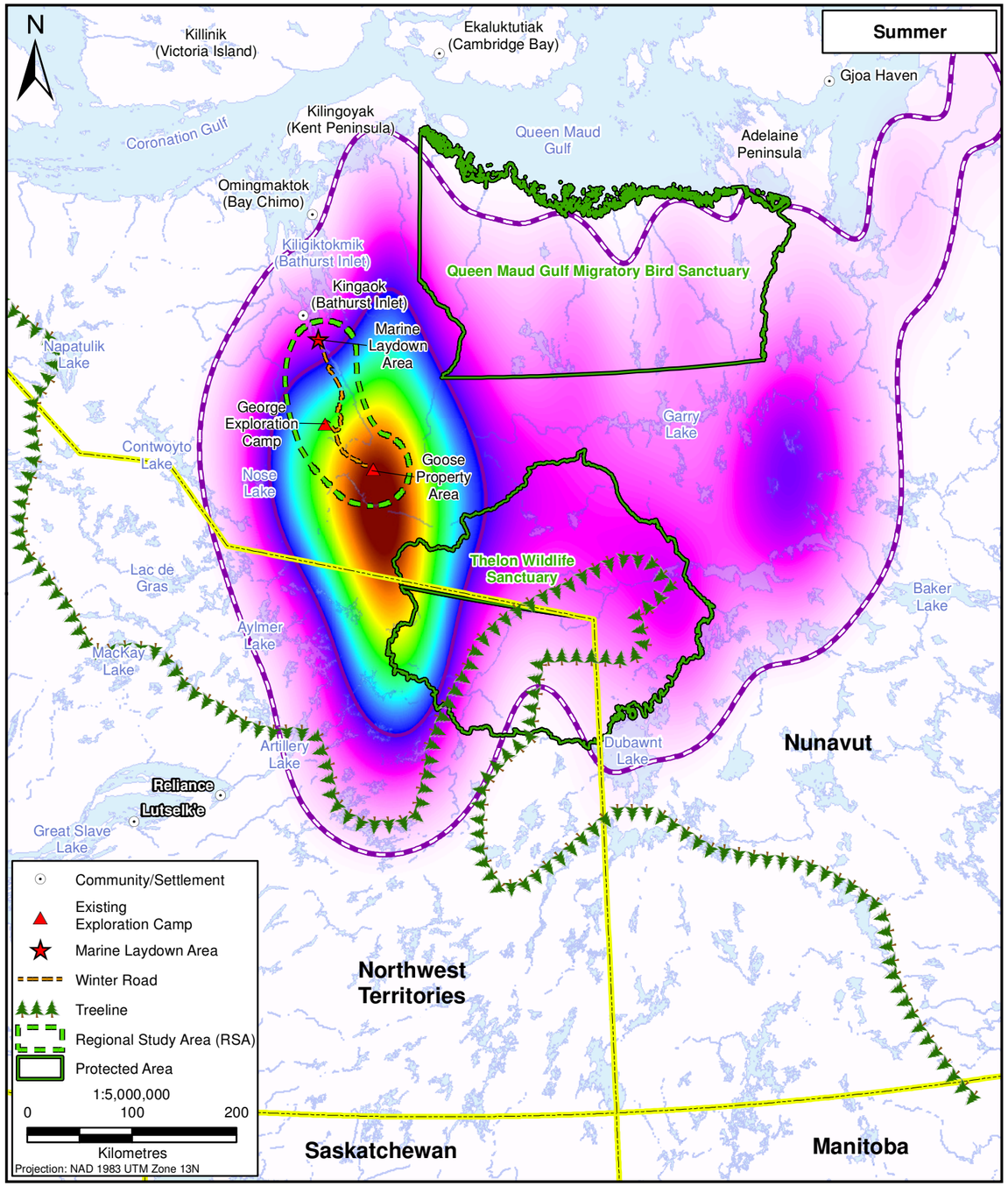
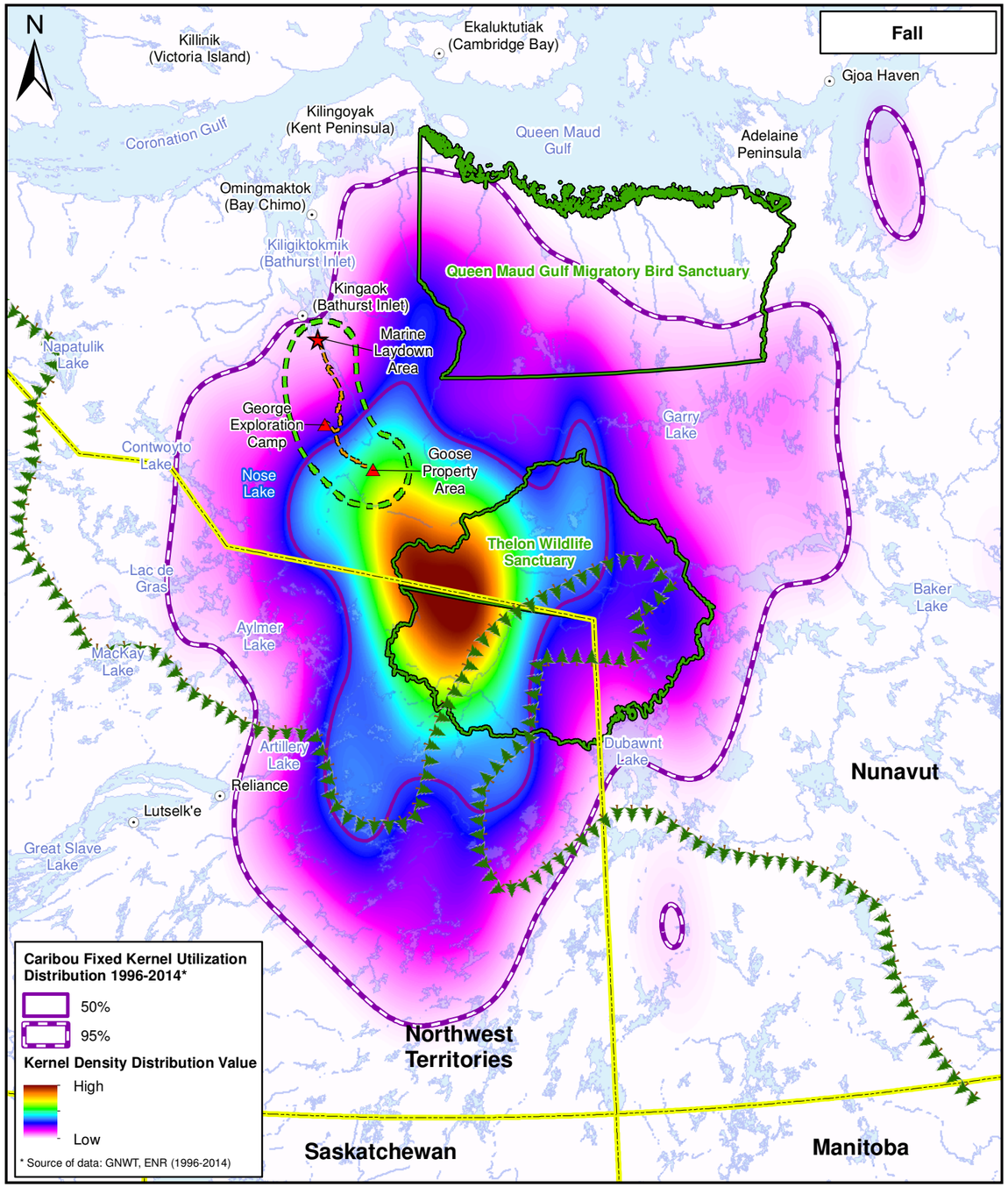
Range of Satellite-collared Beverly Caribou during Calving (5 June to 20 June) and Post-calving (21 June to 25 July), 2001 to 2014/2015

Figure 5.1-15

Rescan an ERM company





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Range of Satellite-collared Beverly Caribou during Summer (26 July to 31 August) and Fall (1 September to 31 October), 2001 to 2014

Figure 5.1-16

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5.1.3.3 Population Trends and Conservation

Based on aerial surveys of the calving grounds along the Queen Maud Gulf, the Beverly herd (at the time referred to as the Ahiak herd) increased from between 40,000 and 60,000 animals in 1986 to roughly 200,000 animals in 1996 (A. Gunn, Fournier, and Nishi 2000). In 2006, 123,000 caribou (mostly female) were estimated on the calving grounds, suggesting that the population increased again from 1996 to 2006 (A. Gunn, Russell, and Eamer 2011b). However, data from satellite-collared cows has revealed that the former Beverly herd, which calved south of the Ahiak herd near Garry Lake, has gradually shifted their calving to the area used by the Ahiak herd (Nagy et al. 2011). Thus, the apparent population increase of the Ahiak herd has been a result of the gradual shift of the Beverly herd to the Ahiak calving grounds (A. Gunn, Russell, and Eamer 2011b; Nagy et al. 2011). Aerial surveys conducted in June 2011 resulted in an estimated population size of 124,189 (± 13,996) caribou, of which 52,825 (± 2,638) were breeding females (Campbell et al. 2012). Note that these caribou are now collectively referred to as the Beverly herd. As a whole, it is likely that the Beverly herd has declined in abundance (Campbell et al. 2012).

Beverly caribou are harvested by people from the communities of Gjoa Haven, Omingmaktok, Cambridge Bay, and Lutsel K'e, and in winter by people from northern Saskatchewan when some of the herd overwinters there (A. Gunn, Russell, and Eamer 2011b). Harvest rates are not known.

5.1.3.4 Habitat Use and Diet

Habitat selection and diet of barren-ground caribou on the tundra is thought to be similar among herds (Gustine et al. 2012). Information for the habitat use of Bathurst and Beverly caribou herds is presented in Section 5.1.2.4 for the seasons where these herds are both on the tundra: spring migration, calving, post-calving, summer and fall migration. Unlike the Bathurst herd which overwinters below the tree line, a considerable proportion of the Beverly caribou overwinter on the tundra and are discussed separately below.

Detailed habitat mapping of habitat quality in the wildlife RSA for both Bathurst and Beverly caribou are described in Section 5.1.2.5; Habitat Suitability Modelling.

Winter (November 1 to April 14)

During winter, caribou are relatively sedentary, usually moving less than 2 km per day (Joly 2008). Key characteristics of high quality winter habitat for tundra-wintering caribou are low snow depth and abundant lichen, which comprises 10-60% of caribou diets during winter (reviewed in Ferguson, L. Gauthier, and F. Messier 2001; Joly, Chapin, and Klein 2010). Inuit TK includes observations of wintering caribou in areas where snow is relatively shallow, such as in rocky or elevated wind-swept areas where caribou could more easily crater for lichen (KIA 2012). Insufficient forage availability in winter can have a large impact on population dynamics of tundra-wintering caribou. Poor female body condition during winter can affect calf weights and survival, and thus population recruitment (Couturier et al. 2009). Because of the energetic demands of their growing foetuses, female caribou may choose riskier habitats that provide good forage relative to bulls (Joly 2008).

In years with rain-on-snow events, which can cause a hard icy crust to form on snow, caribou must expend added energy to crater with their hooves to access lichen and graminoids (S.G. Fancy and R.G. White 1985; J. Adamczewski et al. 1988; D. E. Russell, Martell, and Nixon. 1993). This can result in caribou having to move to upland areas (S.G. Fancy and R.G. White 1985), and to places where lichens may be less abundant, thus compounding energetic imbalances caused by icing. When lichen become over-grazed on wintering grounds, caribou emigrate to other areas (Ferguson, L. Gauthier, and F. Messier 2001).

Caribou, particularly arctic-wintering caribou, and muskox are thought to be susceptible to large-scale die-offs to starvation during arctic winters when ice layers form too thick for caribou to crater through the ice with their hoofs (reviewed in Jenkins et al. 2011). However, this hypothesis remains contentious; other factors like disease have yet to be tested for their role in die-offs of caribou in the arctic (Tyler 2010).

5.1.3.5 Baseline Data for Beverly Caribou Herd

The objectives of baseline studies were to highlight where the Beverly caribou herd is located during each season, to what degree these movements overlapped with the Project area, and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from government agencies and additional information was directly collected in the field. Four separate types of baseline studies were conducted, including:

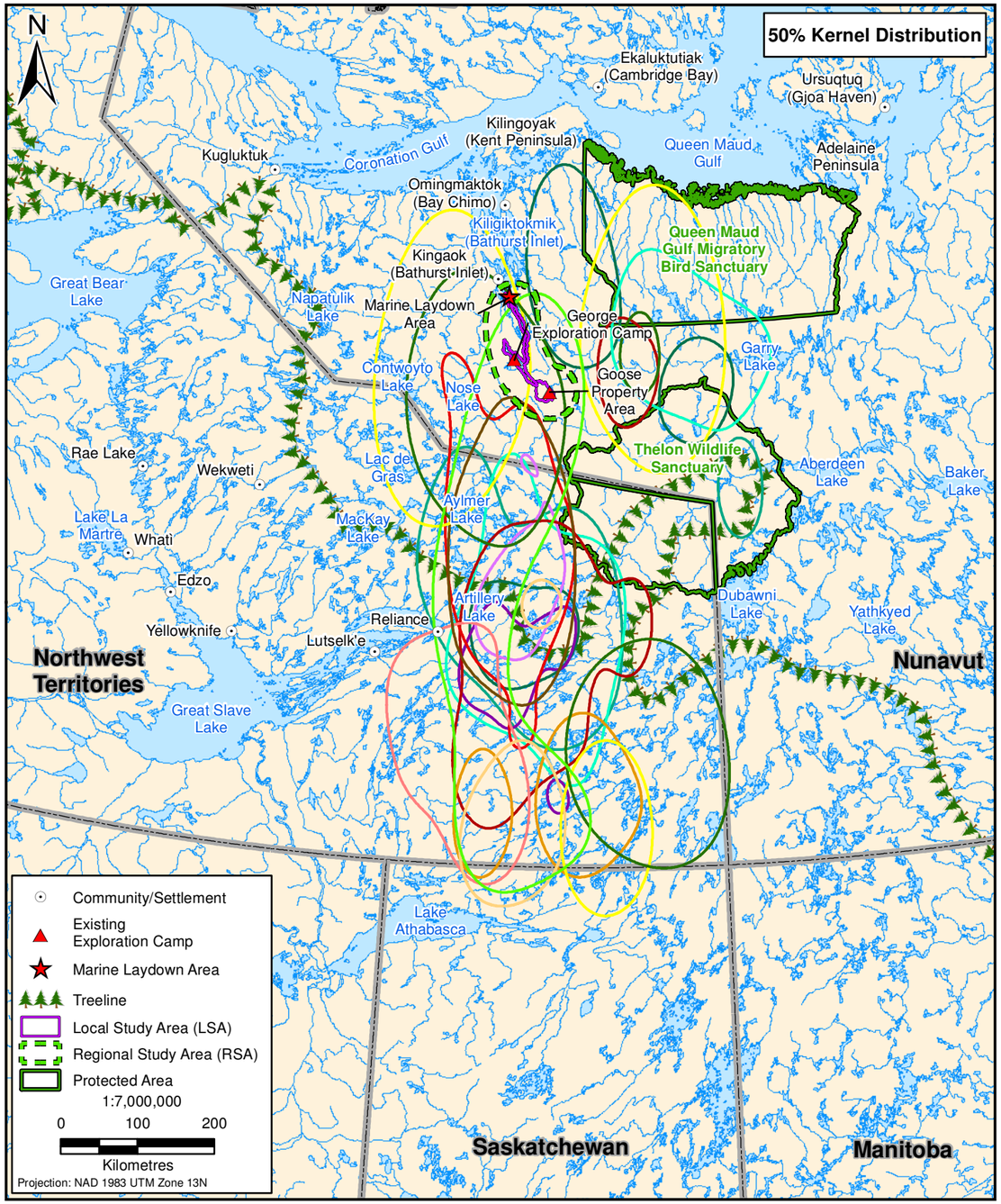
1. Analysis of satellite collar data (2001-2015) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered cameras (2012 to 2015) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features; and
4. Habitat suitability modelling to determine the location and abundance of various habitat types identified from literature review as important for caribou.

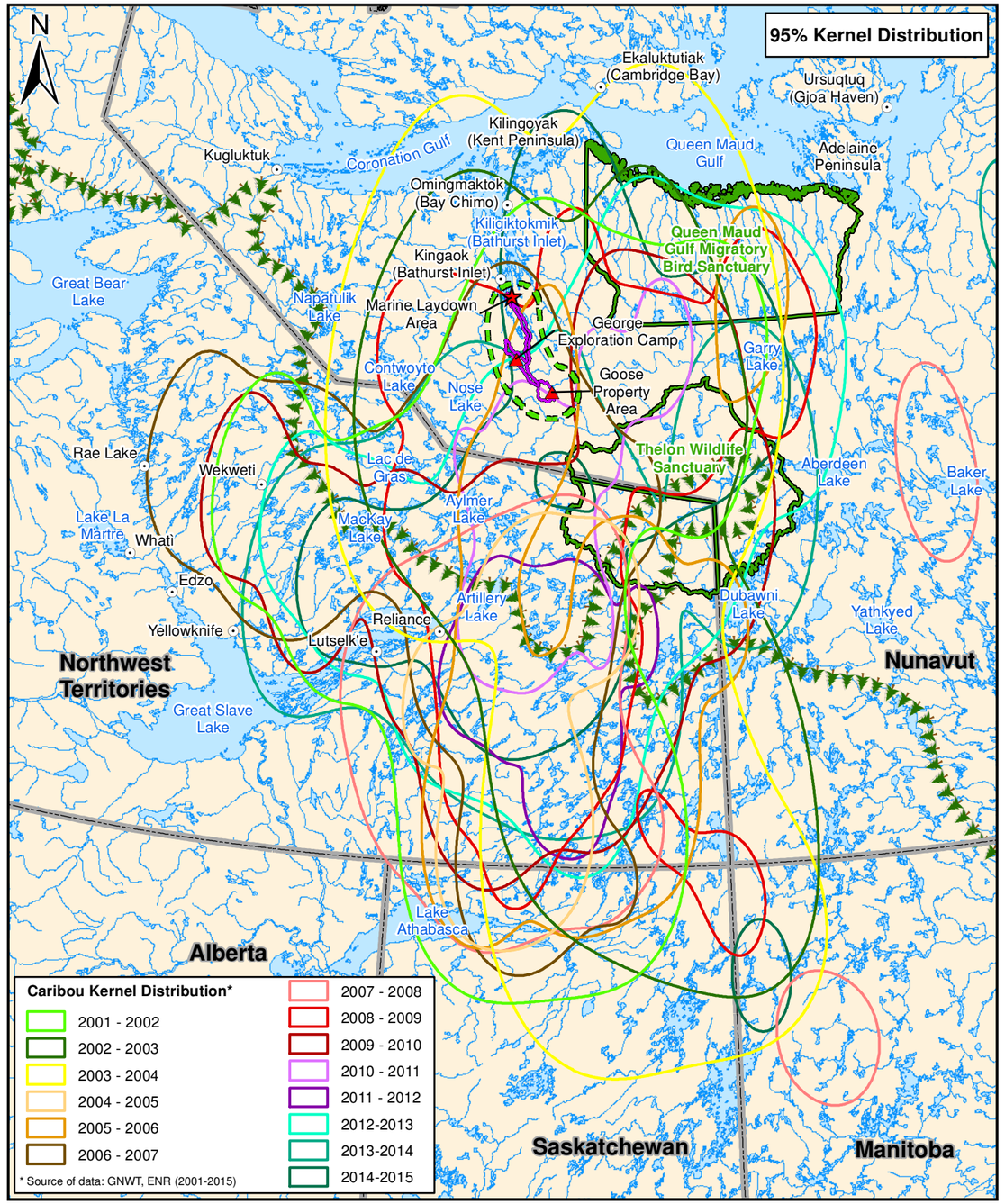
The results of these baseline studies are presented for both Bathurst and Beverly caribou in Section 5.1.2.5. Highlights of these data which pertain to the Beverly herd are summarized below.

Satellite Collar Data

The distribution of satellite collar data was mapped using 50% and 95% fixed kernel utilization distributions (UD) for the Beverly herd. Collars were active from five Beverly (then known as Ahiak) cows between 1996 and 1998 (A. Gunn and Fournier 2000) and satellite collar data from 5 to 52 cows per year between 2001 and 2015 (Table 5.1-9)(GNWT ENR 2012). Maps of the 50% and 95% UD for Beverly caribou are presented in Figures 5.1-17a-e. In March of 2015, collars were fitted to a group of male caribou for the Bathurst and Beverly herds.

Seasonal ranges (as defined by the 95% kernel UDs) for Beverly caribou overlap with the wildlife RSA in all seasons except during post-calving (Figure 5.1-17a to Figure 5.1-17g). Thus, Beverly caribou are expected to be found in the wildlife RSA throughout the year. Overall, collar data suggests that Beverly caribou are most commonly present around the Goose Property PDA in the summer (Figure 5.1-17e) from mid-July to the end of August (Rescan 2013e, Appendix V5-5C). The wildlife RSA overlaps the western range extent of the Beverly herd. Most notably, collared Beverly caribou were present within the wildlife RSA around the Goose Property PDA during the summer (July 16 to August 31). Collared Beverly caribou passed through the eastern edge of the wildlife RSA on their way to the calving grounds located north-east of the wildlife RSA during spring migration (May; Figure 5.1-17b).





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Yearly Distribution of Satellite-collared Beverly Caribou during Winter (1 November to 14 April), 2001 to 2015

Figure 5.1-17a

Rescan an ERM company

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November 5, 2015

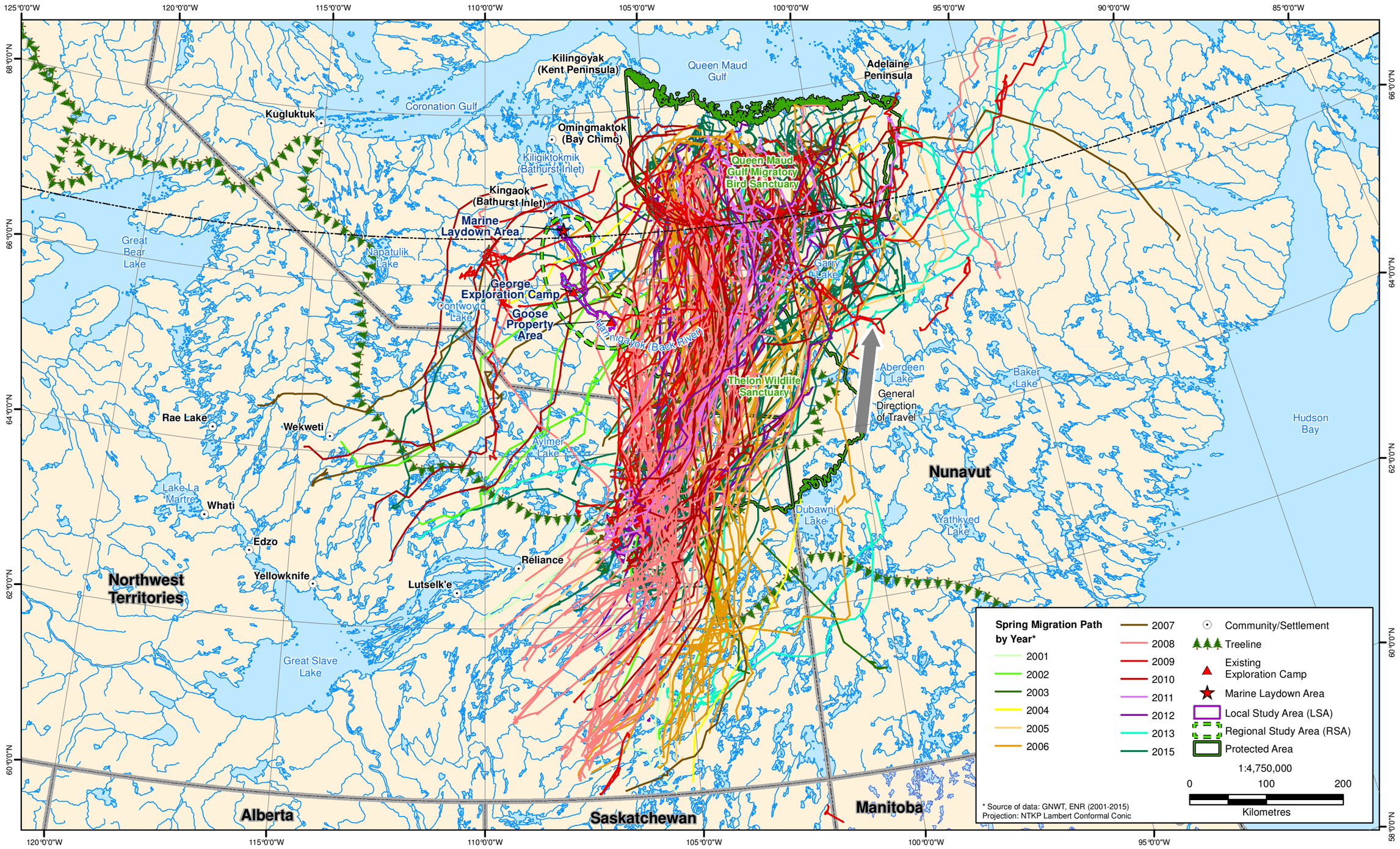

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Figure 5.1-17b

Yearly Spring Migration (15 April to 4 June) Paths of Satellite-collared Beverly Caribou, 2001 to 2015

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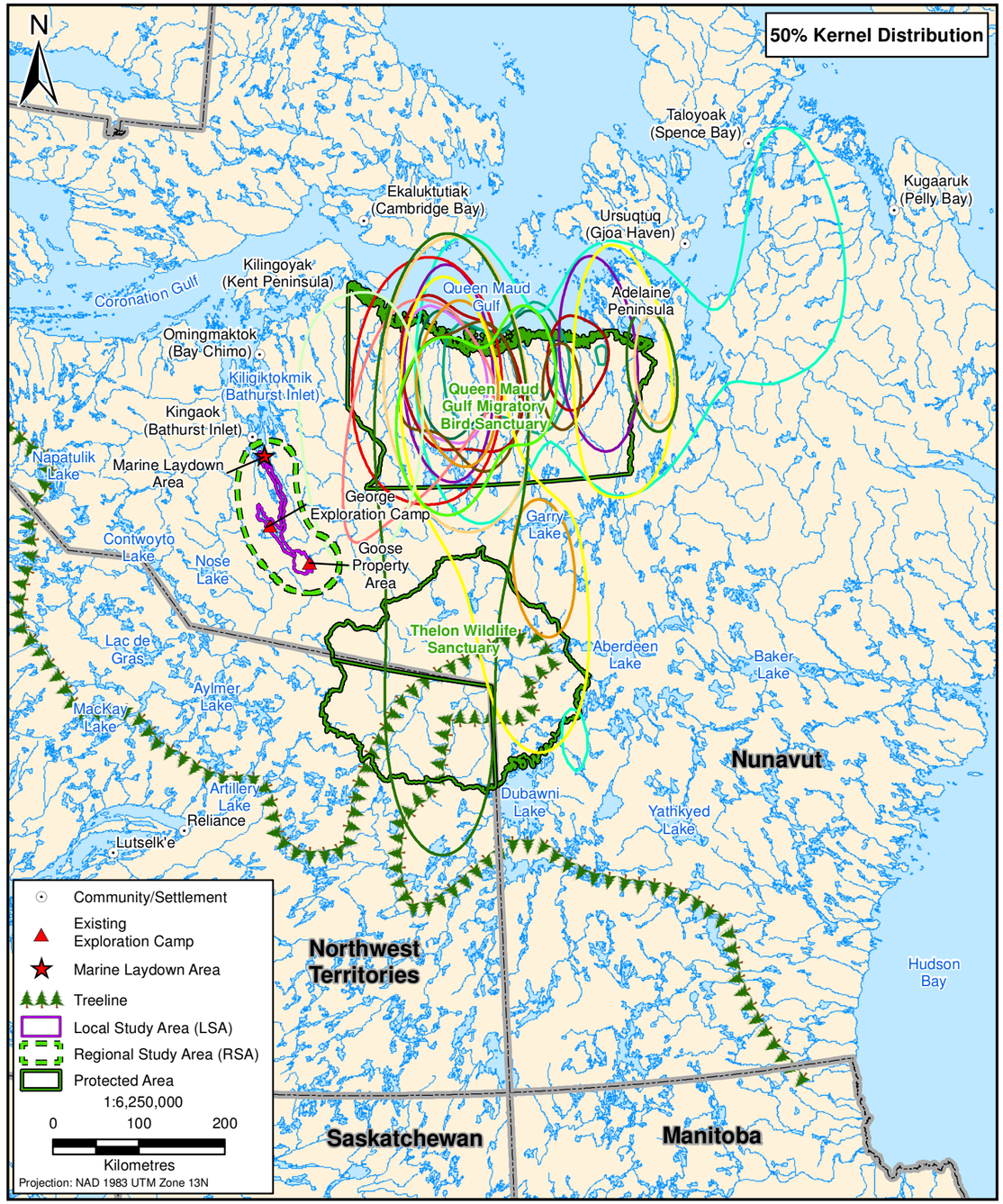

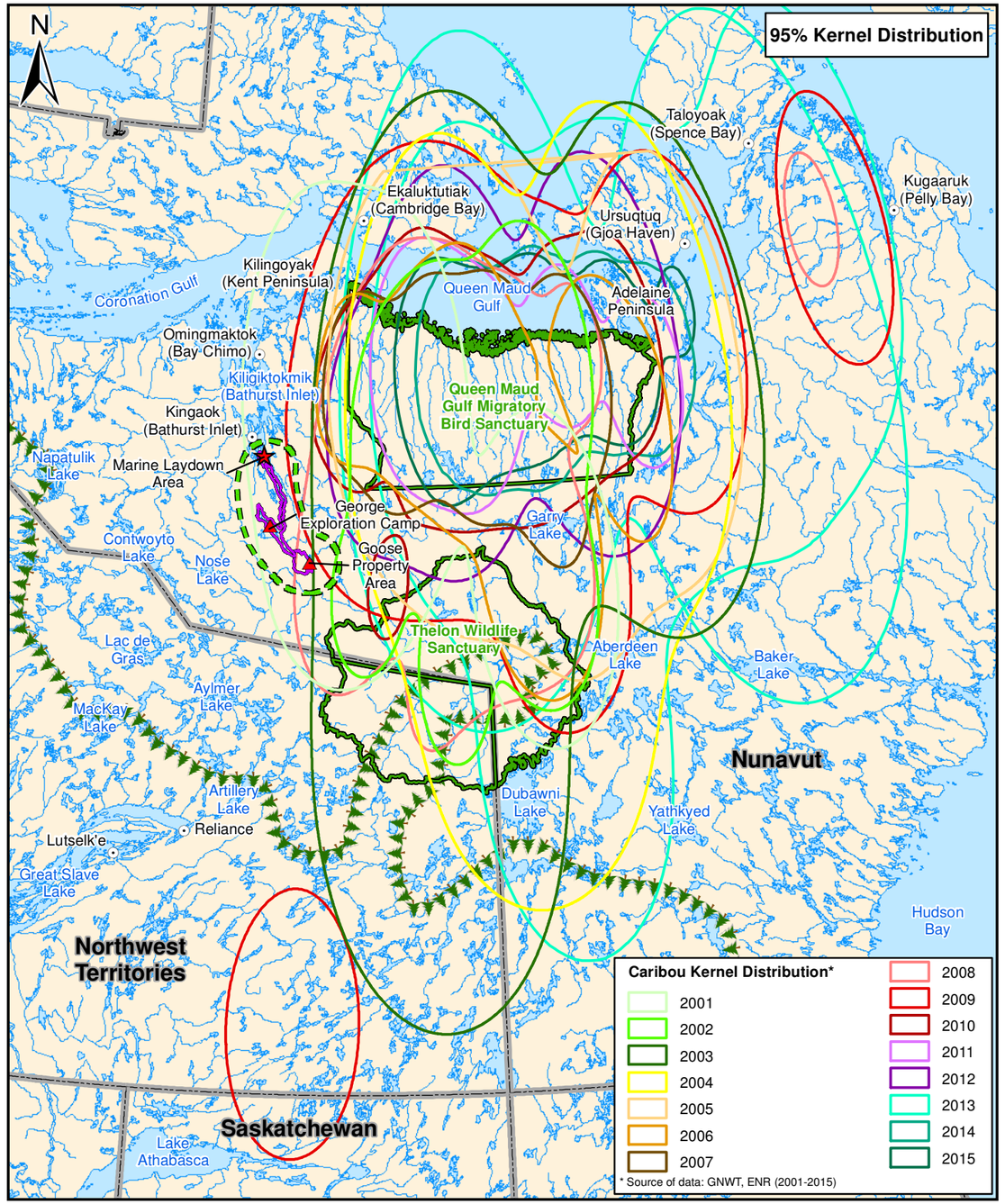

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Yearly Distribution of Satellite-collared Beverly Caribou during Calving (5 June to 20 June), 2001 to 2015

Figure 5.1-17c

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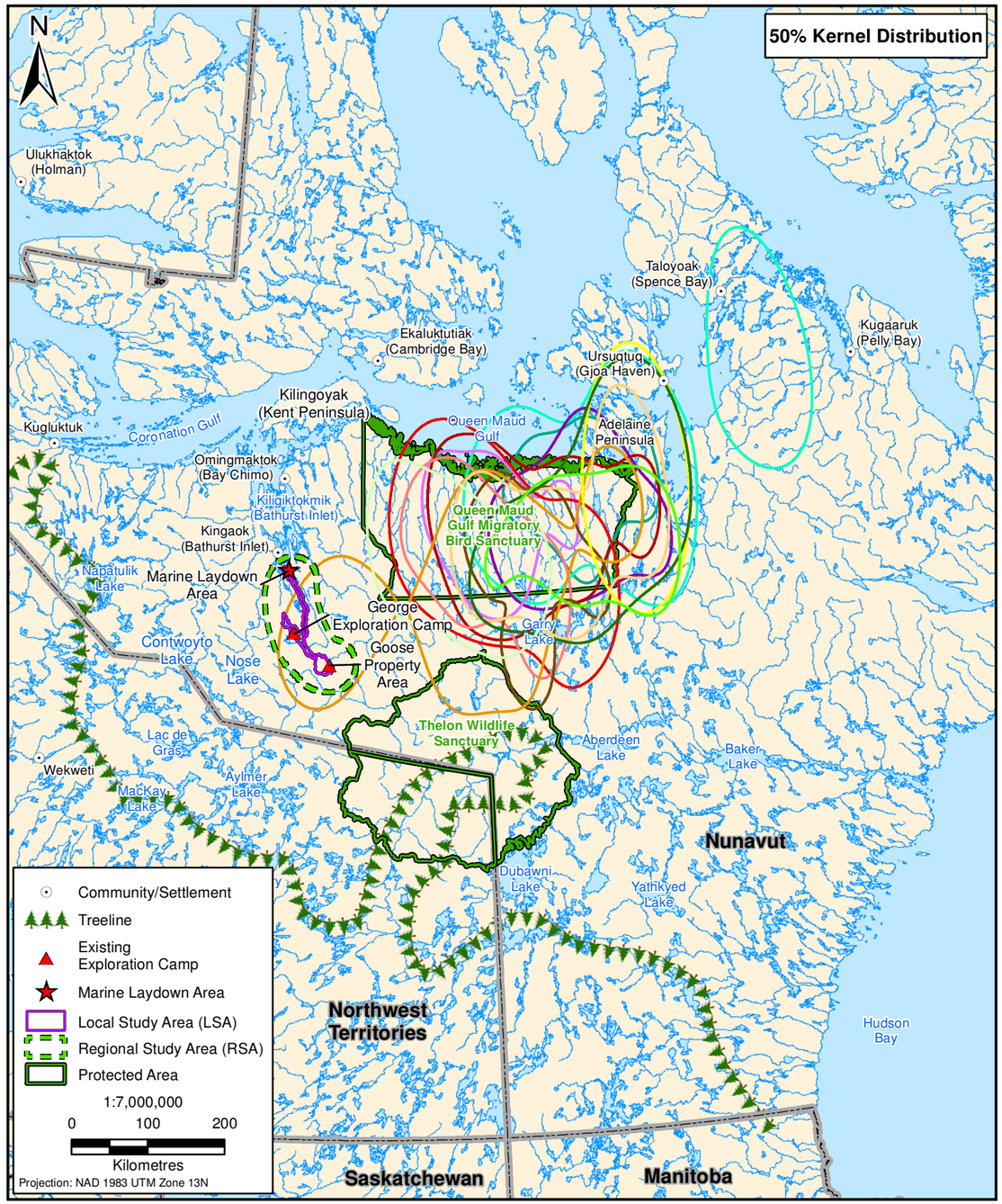

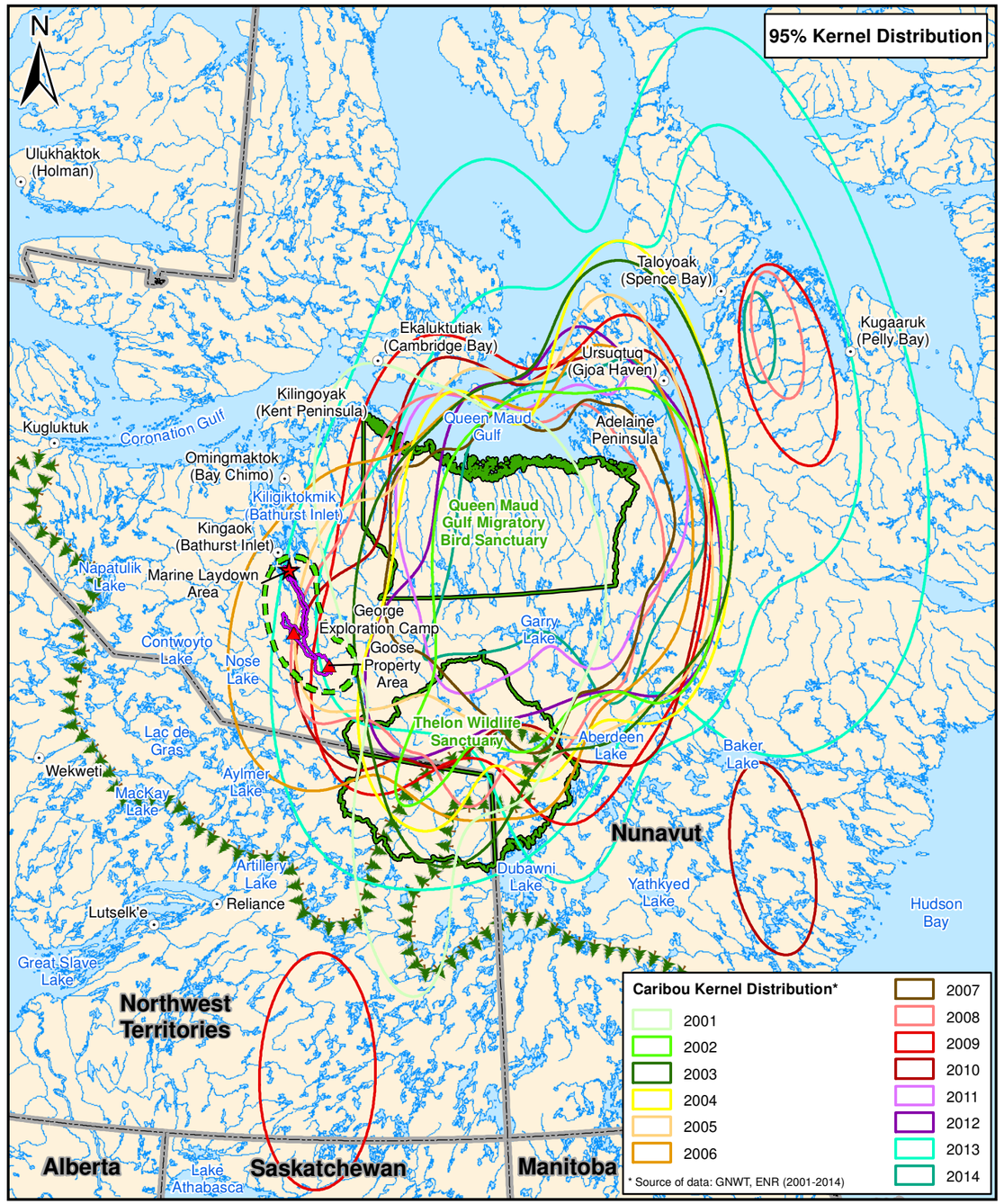

Sabina GOLD & SILVER CORP.

Yearly Distribution of Satellite-collared Beverly Caribou during Post-calving (21 June to 25 July), 2001 to 2014

Figure 5.1-17d

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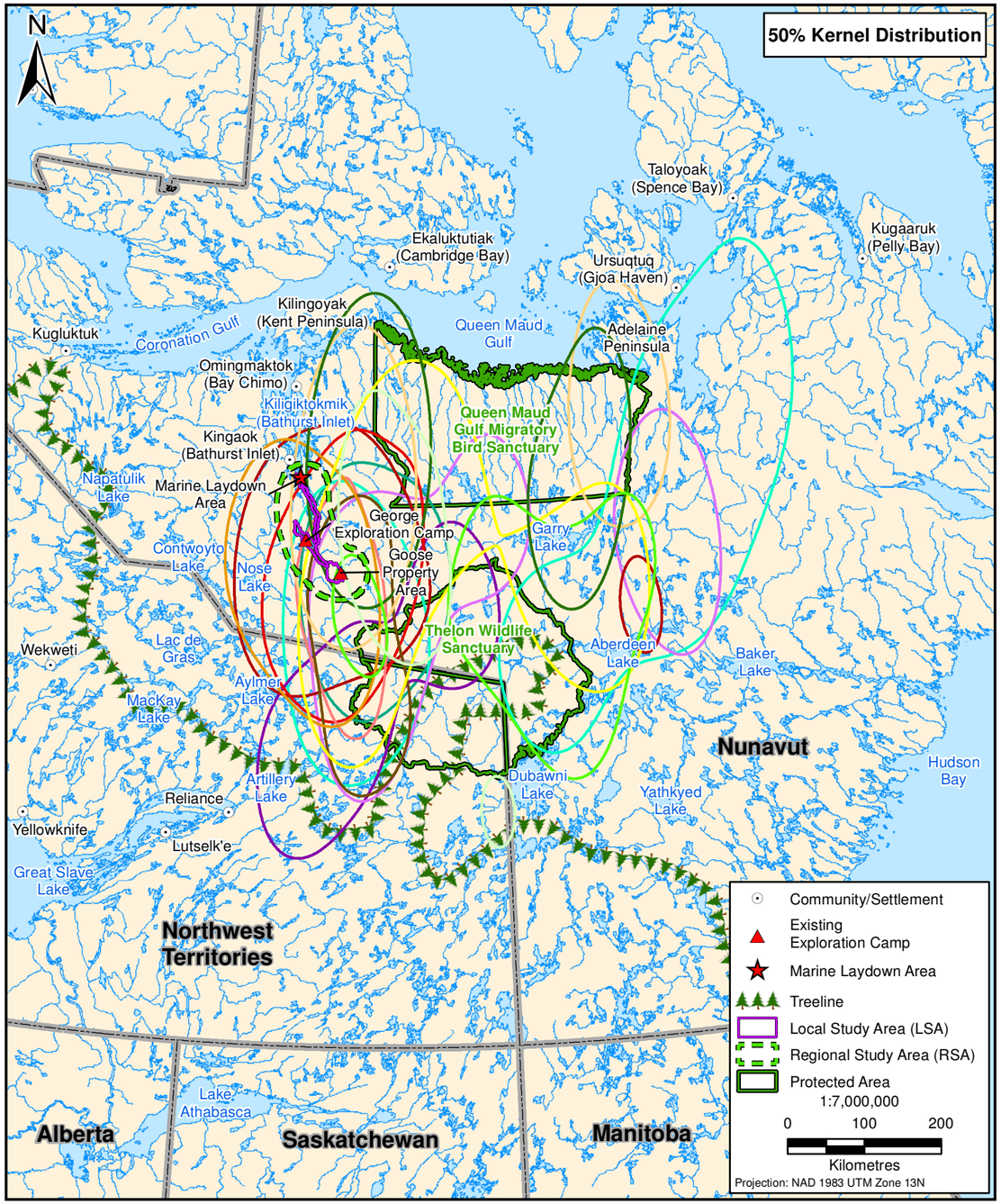

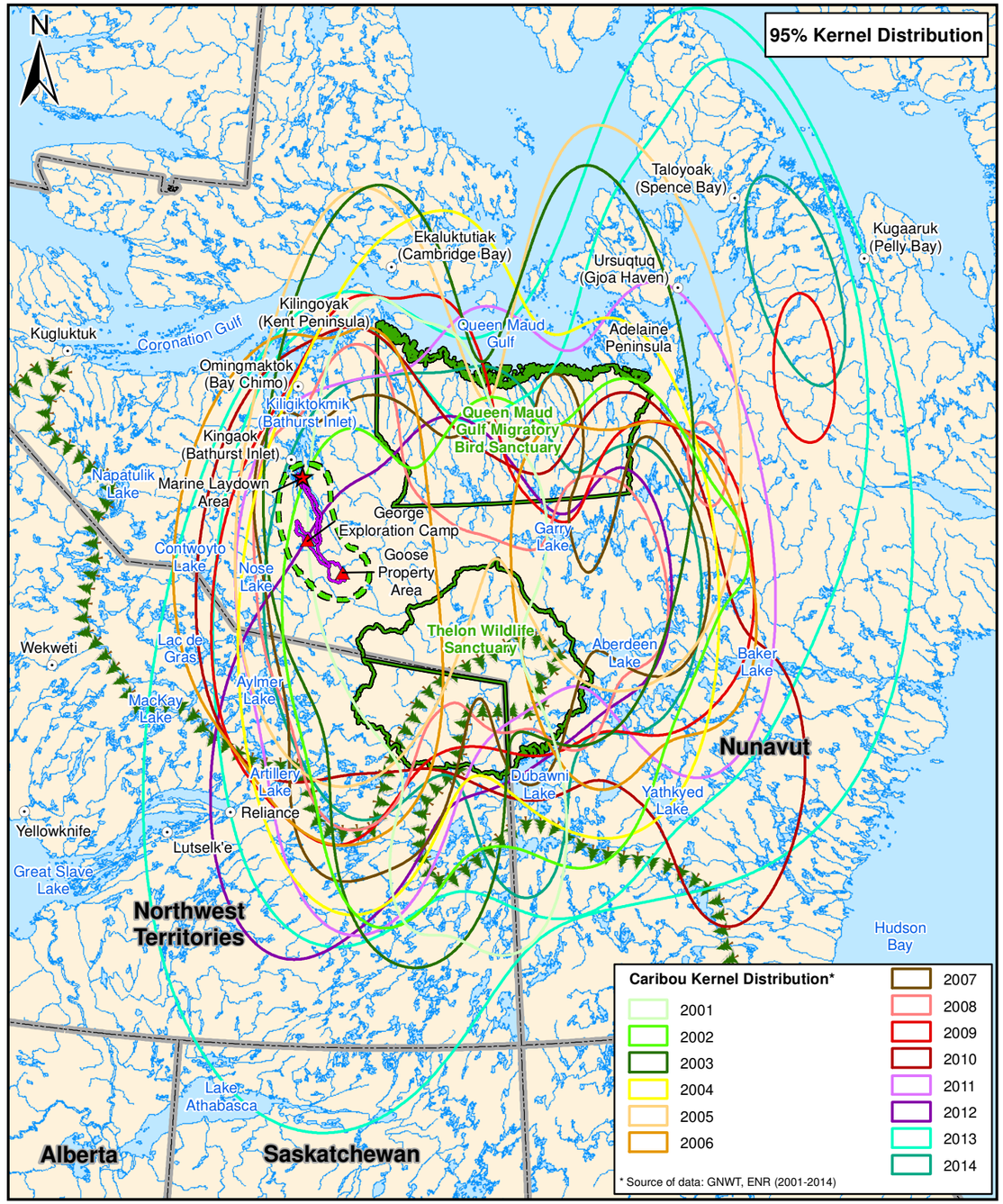

Sabina
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Yearly Distribution of Satellite-collared Beverly Caribou during Summer (26 July to 31 August), 2001 to 2014

Figure 5.1-17e

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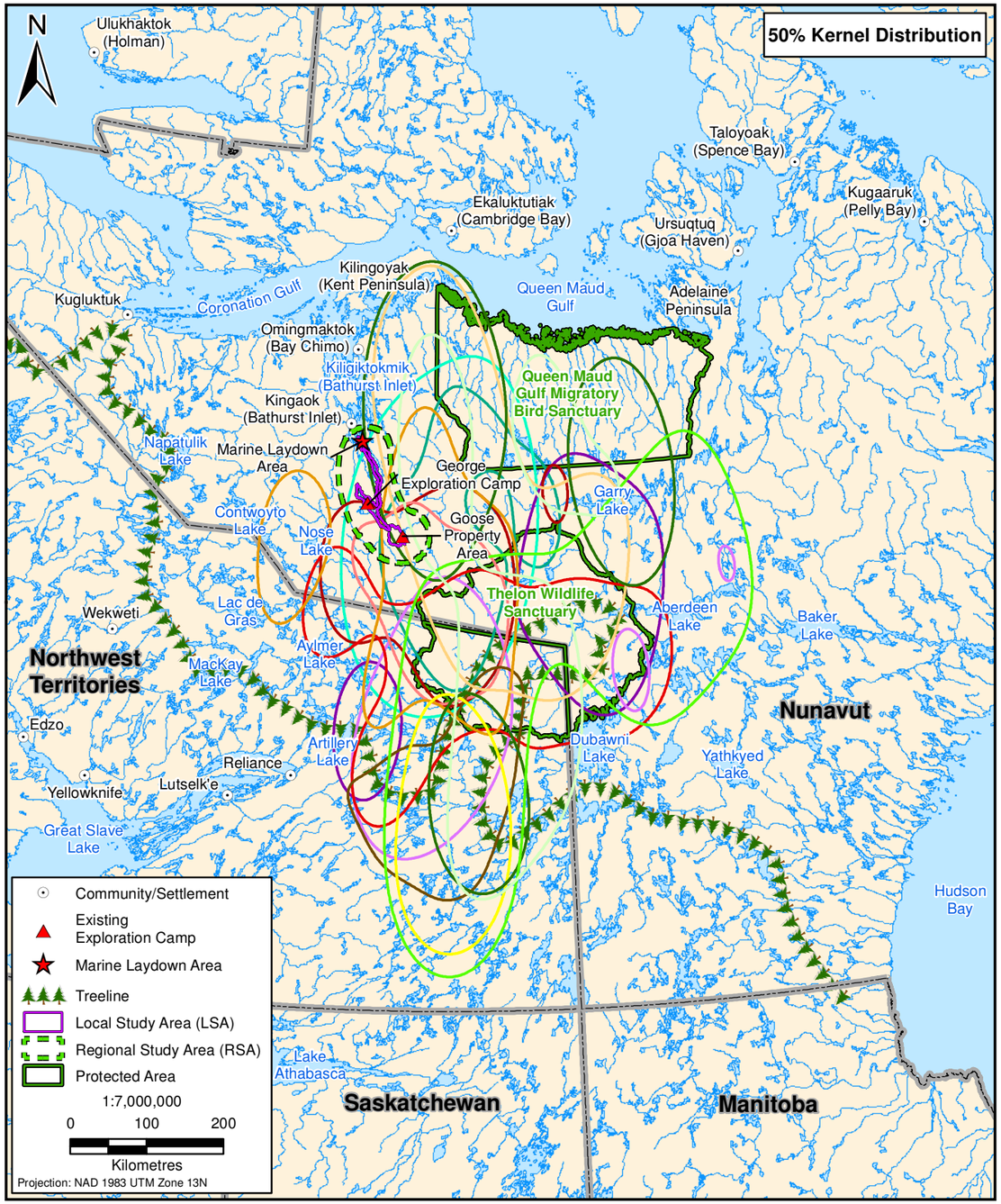
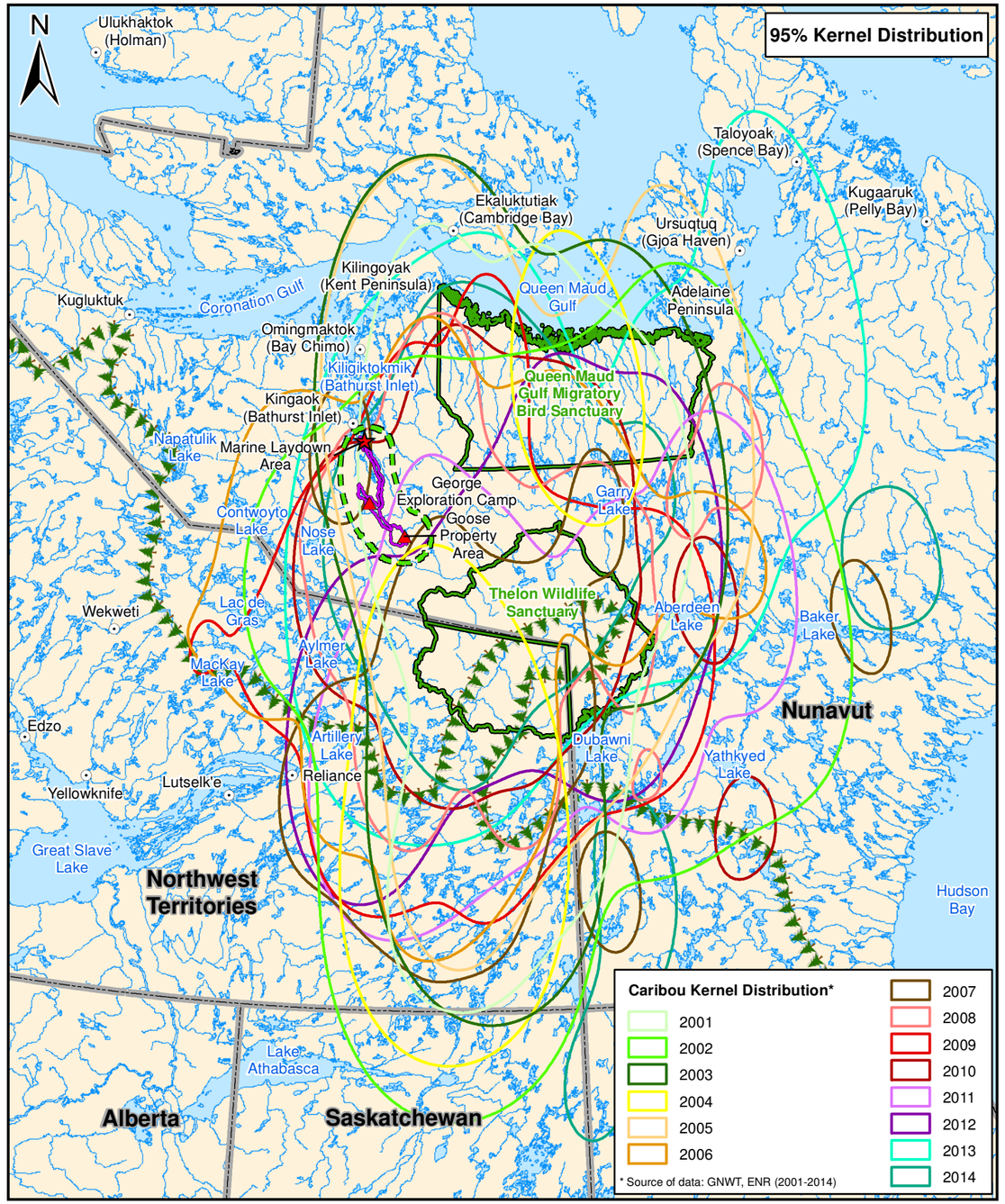
an ERM company





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Yearly Distribution of Satellite-collared Beverly Caribou during Fall (1 September to 31 October), 2001 to 2014

Figure 5.1-17f

Rescan an ERM company

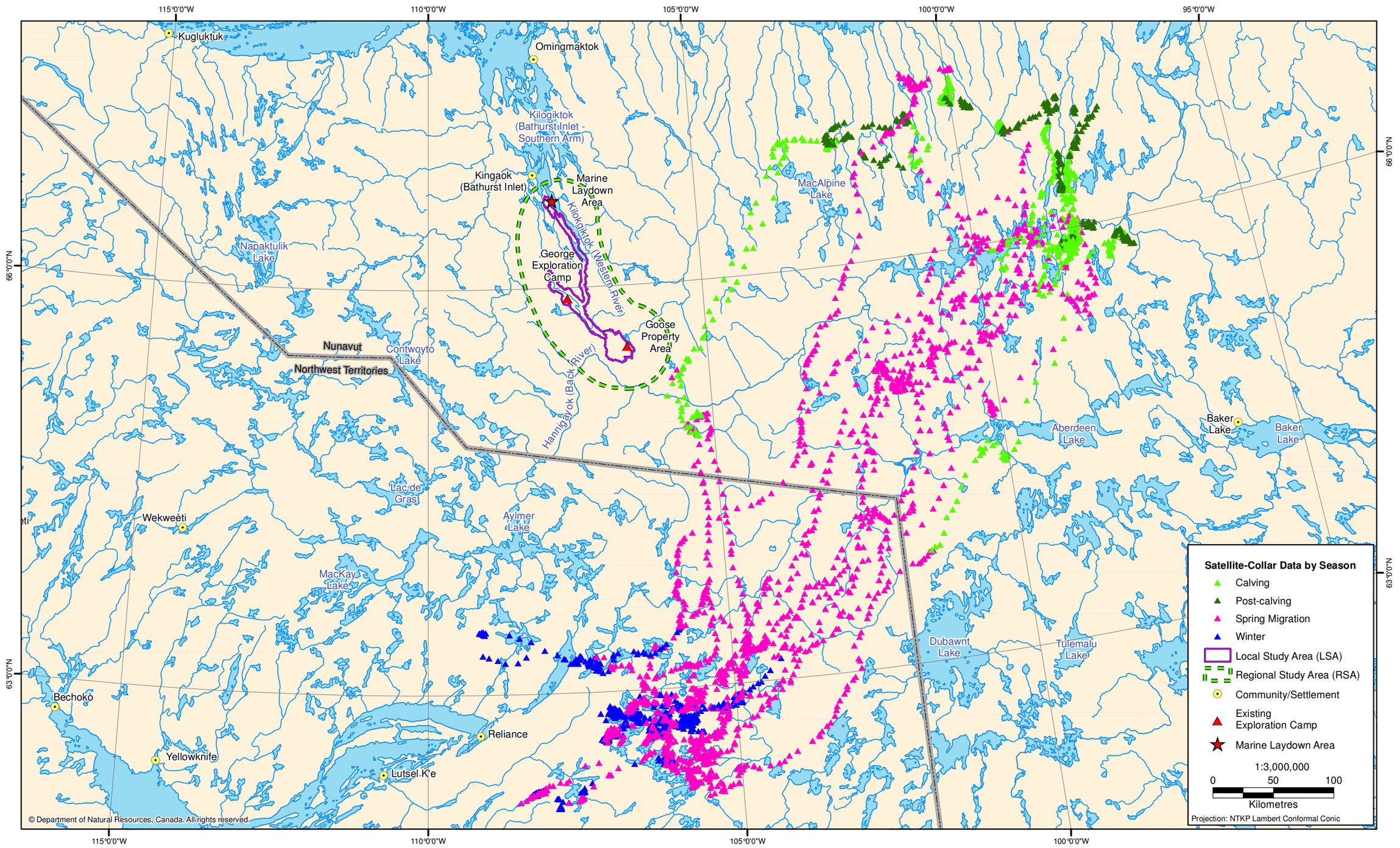

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Figure 5.1-17g

Locations of Collared Males from the Beverly Herd during Winter, Spring Migration, and Calving, 2015

Rescan an ERM company

Table 5.1-9. Average Number of Satellite-collared Beverly Caribou and Locational Data Points per Season from 1996 to 2015

Year	Average Number of Collared Caribou per Season	Average Number of Locational Data Points per Season
1996	4.3	31.5
1997	4.5	49.5
1998	n/a	n/a
1999	n/a	n/a
2000	n/a	n/a
2001	5.2	46.8
2002	7.0	80
2003	5. 7	74
2004	3.5	44.8
2005	6. 7	96.8
2006	17. 7	503.3
2007	27.8	1019. 7
2008	41.0	1574.8
2009	38.3	1808.5
2010	29. 7	1544.5
2011	16.3	944.3
2012	19.3	886.3
2013	16.8	738.5
2014	23. 7	1024. 7
2015*	34.8	1215.3
Average	17.7	699.9

Excludes 13 males that were collared in winter 2015, representing an average of 315 locational data points per season, from winter to post-calving periods.

The annual core use areas for collared Beverly caribou during calving span a large geographic area to the east of the RSA, from the east side of Bathurst Inlet west to the Adelaine Peninsula. The distribution of Beverly caribou overlapped the RSA during the calving period in only five of the last 13 years. The core use area for calving Beverly caribou in 2001 slightly overlapped the eastern edge of the RSA. Very small portions of the annual calving range (95% kernel UD) overlapped the eastern RSA in 2001, 2002, 2003, 2008, and 2009 (Figure 5.1-17b). The 2015 data from collared males suggests that males follow and lag behind females on their way to the calving grounds during spring migration, and typically remain south of calving grounds during the calving period, although this data is based on a limited number of collared individuals (13; Figure 5.1-17g).

Collared Beverly caribou are generally found to the east of the RSA during post-calving, in similar areas to those utilized for calving in the Queen Maud Gulf Migratory Bird Sanctuary. In 2006, the western extent of the core use area during post-calving for Beverly caribou overlapped the southern RSA, including the Goose Property PDA. The western extent of the post-calving ranges for Beverly caribou overlapped larger portions of the RSA including the Goose Property PDA and MLA in the mid to late 2000's (2005, 2006, 2008, 2009, 2010) and most recently, in 2013 (Figure 5.1-17d).

During summer, collared Beverly caribou generally spread to the southwest of their post-calving range towards the RSA. Annual core use areas have overlapped a portion of the RSA, particularly the southern

portion of the RSA at the Goose Property Area, in all years since 2001, and the western extents of their annual summer ranges have nearly encompassed the RSA since 2001 (Figure 5.1-17e).

Annual kernel UDs during the fall (which also includes both the fall migration and the fall rut) indicate that collared Beverly caribou are generally distributed to the east and south during this period (Figure 5.1-17f). Fall core use areas have overlapped the RSA in the 2000s (2003, 2006, 2008), and more recently, in 2010 and 2013. Northern extents of the annual fall ranges overlapped the RSA, including the Goose Property PDA and MLA in most of the last fifteen years, including most recently in 2014 (Figure 5.1-17f).

Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a, 2011a). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-3). Details of methods and results can be found in Section 5.1.2.5; Aerial Surveys.

Aerial surveys reported few caribou present in the wildlife RSA during the spring migration and very few during the calving periods; indicating that the calving areas for both Bathurst and Beverly caribou fall outside of the wildlife RSA. Groups of caribou were observed on the western side of the wildlife RSA during post-calving, which were consistent with the position of collared Bathurst herd. During the summer, caribou were observed, sometimes in large groups, in the southern area of the wildlife RSA, south of Goose PDA. The timing of these observations was consistent with the location of the Beverly herd in late summer.

Remote Cameras

Remote cameras were deployed within the RSA, in the Bathurst post-calving area west of the RSA, and within the Marine RSA; the number of cameras deployed varied by camera study year and by season (Table 5.1-5, Figures 5.1-9a-f).The methods and locations of these cameras is described in Section 5.1.2.5; Remote Cameras.

As with aerial surveys, cameras reported information on caribou distribution that was corroborated by the collar data and indicated that:

1. The few caribou observed in the wildlife RSA during the spring migration are likely Beverly caribou based on collar data (Figure 5.1-9b).
2. Very few caribou observed in the wildlife RSA during calving, and those that were observed tended to be located on the western edge of the wildlife RSA, in a similar location to the Bathurst collared males. This is consistent with the Beverly herd calving grounds being located to the east of the wildlife RSA throughout the entirety of the camera study (Figure 5.1-9c).
3. Following calving, peak numbers of caribou observed in the wildlife RSA during the post-calving period. The majority of caribou observed were recorded during the post-calving period, principally at the southern and western edge of the wildlife RSA. This is consistent with the Beverly caribou movements west from their calving ground to their summer range, as indicated from collar data (Figure 5.1-9d).
4. Majority of caribou observed in the wildlife RSA during the summer and early fall period were observed principally at the southern end of the wildlife RSA (Figure 5.1-9d and Figure 5.1-9e), are likely Beverly caribou (Figure 5.1-9d and Figure 5.1-9e). Calves were often recorded as part

of large groups that travelled past cameras, confirming the presence of post-calving groups of females, likely from the Beverly herd (Figure 5.1.9e).

5. Few caribou observed in the wildlife RSA during the winter period, with the exception of a small number of caribou observed principally at the southern end of the wildlife RSA and near the Goose Property Area are likely Beverly caribou based on collar data (Figure 5.1.9f).
6. Caribou generally observed in low numbers at the marine RSA in all seasons. Infrequent observations were made in the spring, likely of Beverly caribou, during northward migration towards their calving grounds (Figure 5.1-9a and Figure 5.1-9b). With the exception of two caribou individuals recorded in February 2015, no caribou observed in the marine RSA during the winter period. The two caribou recorded during the winter are likely from the Beverly herd, whose winter range has had variable overlap with portions of southern Bathurst Inlet in recent years (Figure 5.1-9f), but could also be Dolphin and Union caribou, because this herds winter range is thought to include habitat up to 100 km from the mainland coast (which includes the marine RSA).

Further details about the results of the remote camera study are described in Section 5.1.2.5; Remote Cameras.

Habitat Suitability Modelling

Habitat suitability modelling was conducted for the wildlife RSA for all caribou herds combined and is reported in Section 5.1.2.5: Habitat Suitability Modelling.

5.1.4 Dolphin and Union Caribou

5.1.4.1 Introduction

Dolphin and Union caribou are named after the Dolphin and Union strait on which they migrate during their annual spring and fall migrations between the mainland and Victoria Island. Dolphin and Union caribou are genetically distinct from Peary caribou and barren-ground caribou (COSEWIC 2004). The herd is federally listed as "Special Concern" on Schedule 1 of SARA. (COSEWIC 2004). Major threats to this herd have been identified as climate change, and winter shipping activity along the herd's migration route (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Climate change may shorten the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Since 1982, freeze-up has occurred 8-10 days later which may have affected the timing of fall migration (Poole et al. 2010). Concern has been raised about increased shipping activity which may break up the ice in Dease Strait or the Queen Maud Gulf, Dolphin and Union caribou migration may be blocked or animals may fall through the recently broken ice (COSEWIC 2004; Poole et al. 2010).

Caribou habitat is one of six main issues identified in the NLUP for environmental protection (NPC 2012a). In addition to calving areas, migration routes "especially at water crossings" have been identified as key aspects of caribou habitat. The plan stipulates that herds are vulnerable to ice breaking, and considerations for mitigation and management fall under Recommendation PSE-R3, which states "Project Proposals located in and/or near known caribou sea ice crossing areas should take into account impacts that may impede the ability of caribou to cross the ice." Water crossings are also considered (NPC 2012a).

Climate change has been identified as a major threat to some caribou herds, particularly to the Dolphin and Union herd which migrates from the mainland across sea ice to calve on Victoria Island (COSEWIC

2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Climate change may shorten the time interval caribou have on the mainland between the fall and spring migrations, since this movement is dependent on ice formation. Since 1982, freeze-up has occurred 8-10 days later which may have affected the timing of fall migration (Poole et al. 2010).

5.1.4.2 Distribution and Migration Patterns

Dolphin and Union caribou winter on the Nunavut mainland and migrate over the sea ice during the annual spring migration to their calving and summering grounds on Victoria Island, returning to the mainland during the fall migration (KIA 2012, 2014). The yearly distribution and movements of Dolphin and Union caribou can be classified into six distinct periods: winter, spring migration, calving, post-calving, summer, and fall migration (Table 5.1-10). The following sections discuss the demography and distribution of the Dolphin and Union caribou herd with emphasis on timing and migratory routes across sea ice.

Table 5.1-10. Timing of Life History Stages of Dolphin and Union Caribou

Cycle Stage	Start Date	End Date
Spring Migration	April 17[1]	June 29
Calving	June[2]	June[2]
Post-Calving and Summer	July 1[3]	October 19
Fall Migration	October 20[1]	December 8
Winter	December 8[4]	April 16

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

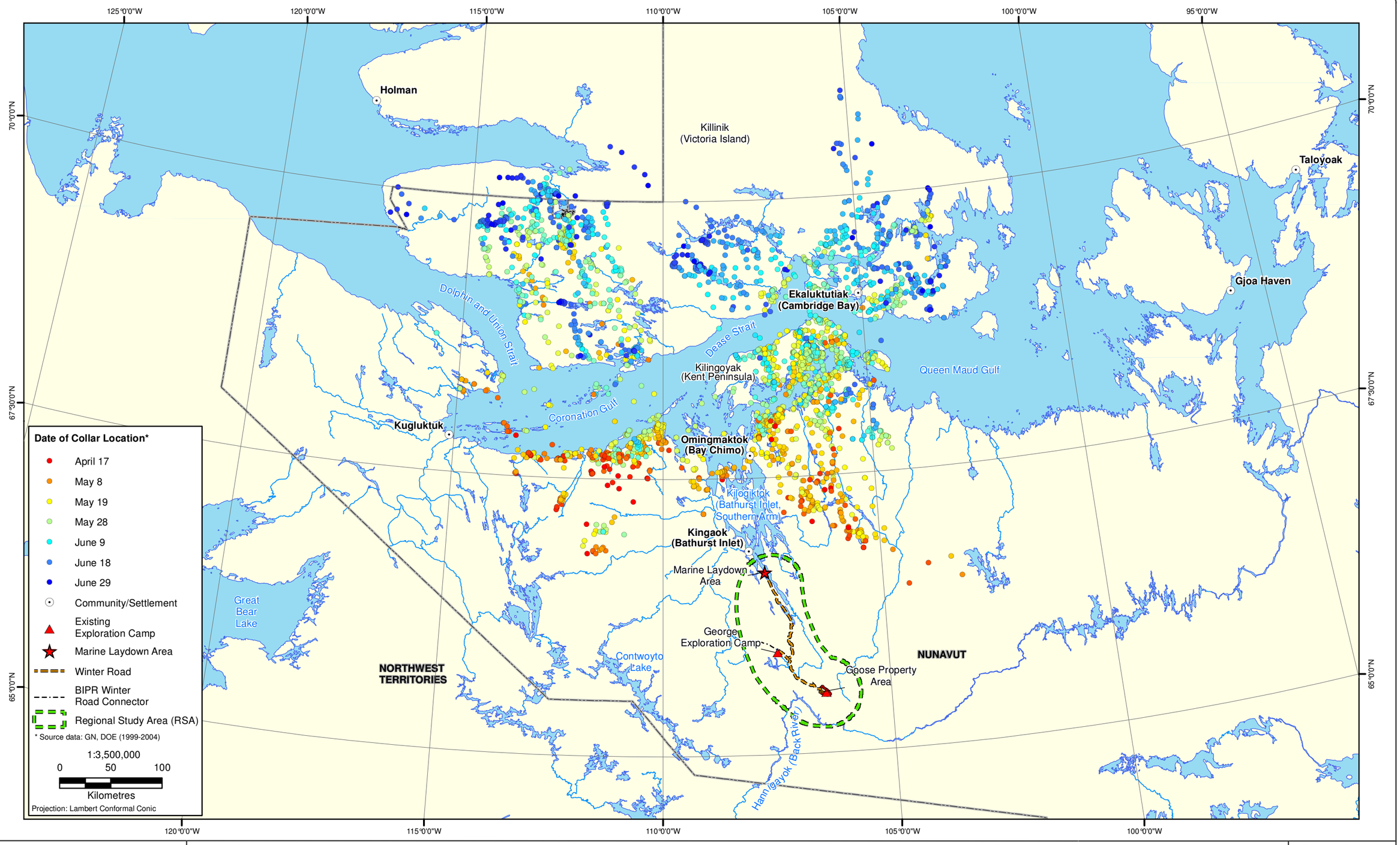
Spring Migration (April 17 to June 29)

The Dolphin and Union herd migrates from their wintering grounds on the northern coast of the mainland across the sea ice between April and June to its calving grounds that extend across the northwest portion of Victoria Island where they also spend the summer. During the spring migration, the majority of animals cross the sea ice northward from mid-May to late June (Figure 5.1-18a; Poole et al. 2010). Analysis of satellite collar data (1999-2004) from Dolphin and Union caribou indicates that spring migration occurs from between 17 April to 29 June (Figure 5.1-18a; M. Dumond, GN DOE, unpublished data).

The median date of crossing in the spring is 24 May; crossing initiation date is correlated with the timing of ice formation (Poole et al. 2010). The Kent Peninsula and islands in the Coronation and Queen Maud Gulf are important staging sites during crossing, especially during the north migration (A. Gunn et al. 1997; Poole et al. 2010). Satellite collar data do not show any locations of Dolphin and Union caribou within the wildlife RSA but some animals may have been observed during May, 2007 surveys at the northern extent of the survey area (M. Dumond, GN DOE, unpublished data).

Calving (June), Post-calving and Summer (July 1 to October 19)

Dolphin and Union caribou calve and summer on Victoria Island (Figure 5.1-17; COSEWIC 2004; Poole et al. 2010). Calving occurs in June (A. Gunn and Fournier 2000; Nishi 2000). There is overlap in dates for spring migration and calving because males and juveniles continue to migrate across the ocean after parturient and non-parturient females have arrived on Victoria Island.



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Locations of Satellite-collared Dolphin and Union Caribou during the Northward Spring Migration (17 April to 29 June), 1999 to 2004

Figure 5.1-18a

Rescan an ERM company

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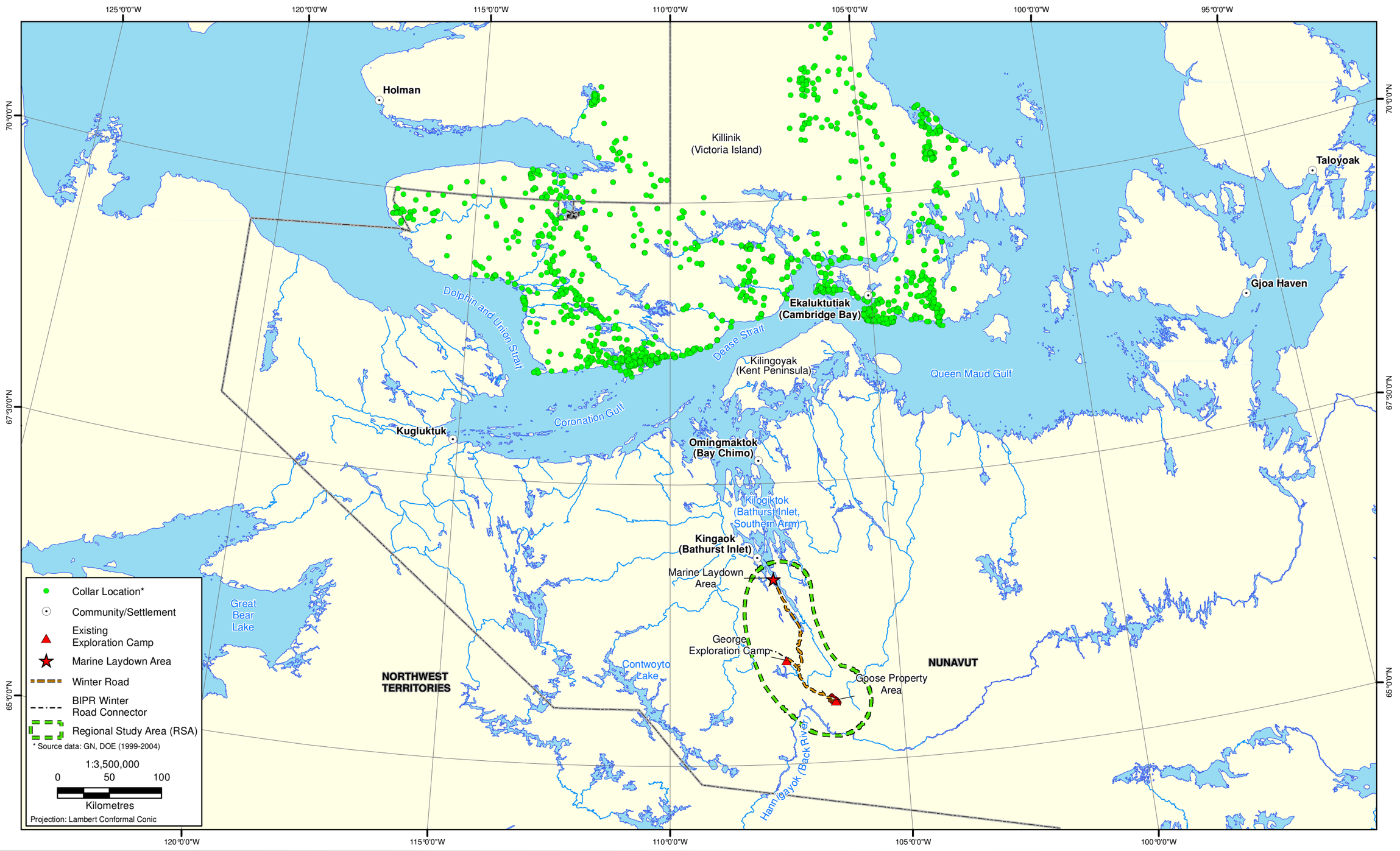
November 5, 2015



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Locations of Satellite-collared Dolphin and Union Caribou during Calving and Summer (30 June to 19 October), 1999 to 2004

Figure 5.1-18b

Rescan an ERM company

Fall Migration (October 20 to December 8)

In the fall, the herd migrates to the southern coast of Victoria Island for the rut, before migrating back across sea ice between October and late November to over-winter on the mainland. During the fall migration and after the rut and a staging period along the south coast of Victoria Island, the majority of animals cross the sea ice southward from late October to mid-November. Analysis of satellite collar data (1999-2004) from Dolphin and Union caribou indicates that fall migration occurs between 20 October and 8 December (Figure 5.1-18c; M. Dumond, GN DOE, unpublished data). Beginning as early as October 20, Dolphin and Union caribou migrate across the sea ice to over-winter on the mainland (Figure 5.1-18c). The duration of time that caribou are travelling across sea ice in early winter is shorter than the spring migration. Though caribou travelled on sea ice as late as December 8, the median date of crossing in the fall is November 1 (Poole et al. 2010) and most of the caribou have crossed the straight by November 28.

Winter (December 8 to April 16)

Dolphin and Union caribou winter on the Nunavut mainland (Figure 5.1-18d) along the Coronation Gulf, on the Kent Peninsula, and along the western extent of the Queen Maud Gulf (COSEWIC 2004; Poole et al. 2010). Inuit TK includes observations of some Dolphin and Union caribou over-wintering on Victoria Island prior to the 1950s, but not since then (KIA 2012). A minimal number of satellite-collared Dolphin and Union caribou have been found in the extreme northern tip of the wildlife RSA during winter suggesting that the majority of the wildlife RSA is south of the Dolphin and Union winter range (Figure 5.1-18d).

Dolphin and Union Caribou Distribution and Movements from Inuit TK

Inuit TK distinguishes Dolphin and Union from mainland caribou by their light color, and refers to the Dolphin and Union herd as island caribou (KIA 2012, 2014). Inuit TK includes observations of the historical distribution of the Dolphin and Union herd in winter, primarily in two concentrations on the east and west of Bathurst Inlet, which corresponds with their current winter distribution based on collar data. However, Inuit TK also includes observations of Dolphin and Union caribou as far south as Bathurst Lake during winter (KIA 2012), which has not been observed by western scientists in at least the last decade. Based on these observations, and the much larger historical size of the Dolphin and Union herd, it is possible that the winter range of the Dolphin and Union herd has contracted along with its population abundance. Inuit TK also includes regular observations of caribou along the shoreline of Bathurst Inlet throughout the year (KIA 2012, 2014). In late fall and winter, at least some of these observations were likely of members of the Dolphin and Union herd.

Summary of Dolphin and Union Herd Movements and Distribution

The Dolphin and Union caribou herd crosses Dease Strait and Queen Maud Gulf during the spring and fall migrations between Victoria Island and the mainland (COSEWIC 2004; Poole et al. 2010). Dolphin and Union caribou travel across the sea ice twice as fast during the south migration to the mainland in the fall than during the north spring migration (Poole et al. 2010). The herd moved across the ice over an average of 48 days in the spring and 23 days in the fall, corresponding to mean times to cross and mean travel rates of 4 days and 12 km/day in the spring, and 1.7 days and 23 km/day in the fall (Poole et al. 2010).

Caribou cannot cross south to the mainland until ice has formed, and cannot cross north to Victoria Island once the sea ice has melted. Ice-breaking in Dease Strait or the Queen Maud Gulf has the potential to disrupt caribou migrations or cause caribou mortality (COSEWIC 2004).

Dolphin and Union caribou are outside of the wildlife RSA, except during winter, when the southern edge of their distribution intersects the northern tip of the wildlife RSA. The remainder of the wildlife RSA is considered outside of the range of the Dolphin and Union caribou.

5.1.4.3 Population Trends and Conservation

In the early 1900s, the Dolphin and Union caribou herd was estimated at 100,000 animals (COSEWIC 2004). Overhunting and possibly also rain-on-snow events caused a population decline between 1900 and 1920 to the point where caribou were not observed migrating between Victoria Island and the mainland after about 1930 (A. Gunn 2005). Beginning in the 1970s, the herd size increased, and in the late 1980s caribou resumed migration between Victoria Island and the mainland (A. Gunn et al. 1997). In spring 1993, approximately 7,200 Dolphin and Union caribou were counted on the mainland prior to migrating over the ice in spring (A. Gunn et al. 1997). In 1997, the Dolphin and Union herd was estimated at 28,000 ± 3,350 animals (Nishi and Gunn 2004), about one-third of its historic size. A population estimate of 28,000 ± 2,500 in 2007 suggests the population size is stable or declining slightly, though still only a third of its historic size (M. Dumond, GN , unpublished data, cited from Poole et al. 2010; COSEWIC 2004). Inuit TK parallels these findings; Dolphin and Union caribou were rarely observed in the 1950s, but observations had become regular by the 1990s (KIA 2012).

A key hypothesis to explain population declines of tundra-wintering caribou and muskox, including the Dolphin and Union herd, is high mortality due to starvation during winters with severe ice conditions (COSEWIC 2004). Large die-offs of muskox and Peary caribou occurred during winter on islands in the Canadian Arctic, which has been attributed to rain-on-snow events that make it difficult for caribou to crater through snow to reach forage (A. Gunn, Dragon, and Boulanger 2002; F. L. Miller and Barry 2009).

While die-offs have been observed — scientists observed hundreds of caribou and muskox carcasses (A. Gunn, Dragon, and Boulanger 2002) — icing as the cause of the die-offs remains a hypothesis (Tyler 2010; Hansen et al. 2011). Data on icing is limited and accounts relating mortality to icing events have been mostly anecdotal (Tyler 2010). However, data from the Norwegian Arctic show low calf production following all but one winter with high ice cover (Stien et al. 2012), and strong correlation between icing and population size (Hansen et al. 2011).

Still relatively un-addressed by the scientific community, disease and parasites comprise a plausible alternative explanation for die-offs of tundra-wintering caribou. Parasites may also contribute to population decline — female Dolphin and Union caribou infected with high parasite loads had lower body condition and thus low probability of pregnancy (Hughes et al. 2009). Still another hypothesis is poisoning from naturally high heavy metals in vegetation.

Mortality during sea-ice crossings has been proposed as yet another explanation for population declines in the Dolphin and Union herd (Poole et al. 2010; Festa-Bianchet et al. 2011). Dolphin and Union caribou have been observed by hunters to die after breaking through newly-forming ice, and caribou have been observed with ice on their fur in December, possibly from falling through sea ice during southward migration (reviewed in Poole et al. 2010).

Caribou are of economic and cultural importance to the Inuit and other residents of Nunavut. Most northern communities, including Bathurst Inlet, Kugluktuk and Omingmaktok, harvest Bathurst, Dolphin and Union, and Bluenose East caribou (GNWT ENR 2012). Data from Inuit hunters indicates that between 1996 and 2001, the average number of caribou harvested annually by Inuit hunters (averaged by community) were: 93 in Bathurst Inlet (Bathurst Inlet Lodge 2007), 1,575 in Kugluktuk and 176 in the community of Omingmaktok (Priest and Usher 2004). These data include harvests of caribou from multiple herds.

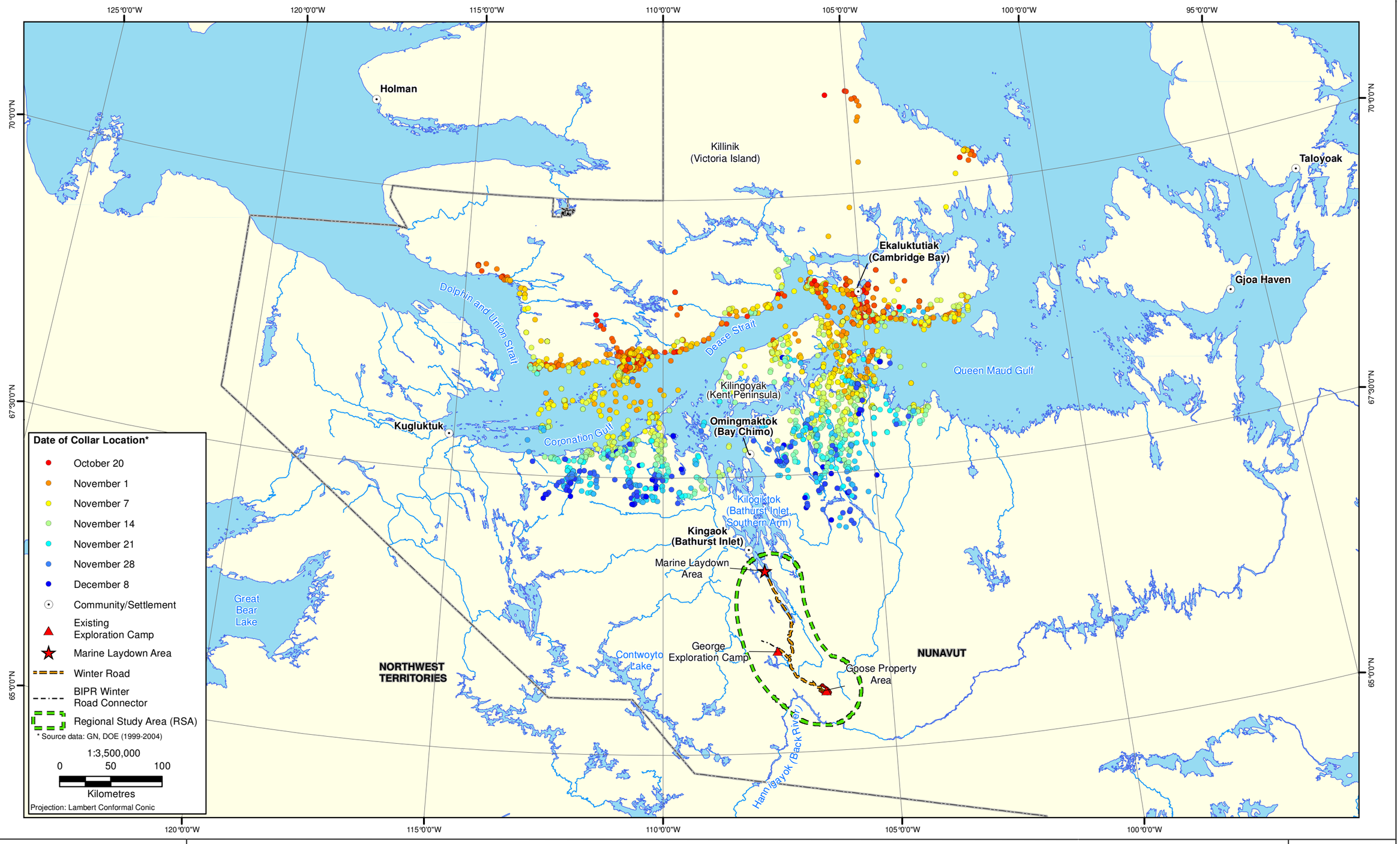

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Figure 5.1-18c

Locations of Satellite-collared Dolphin and Union Caribou during the Southward Fall Migration (20 October to 8 December), 1999 to 2004

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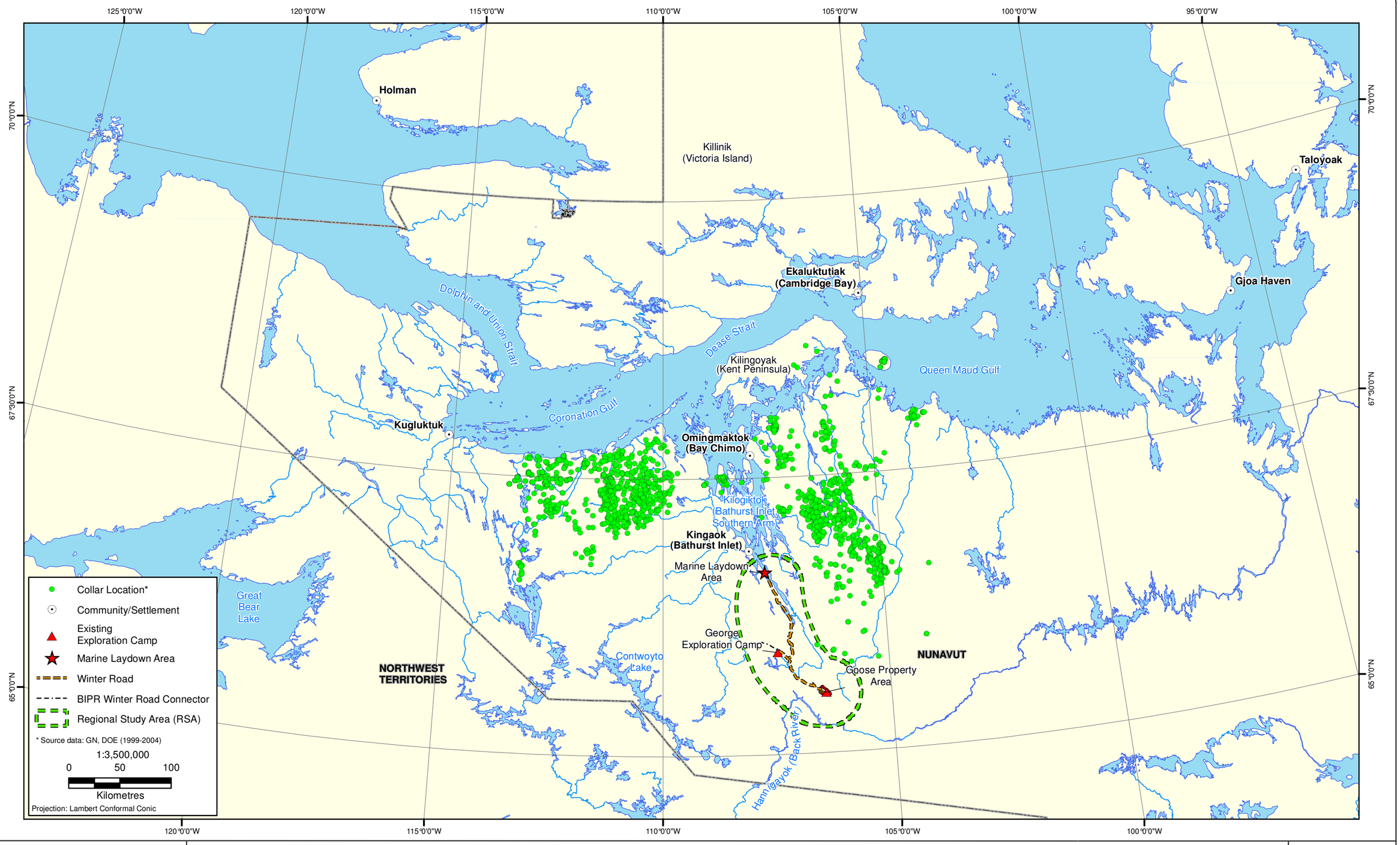

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Figure 5.1-18d

Locations of Satellite-collared Dolphin and Union Caribou during Winter (9 December to 16 April), 1999 to 2004

Rescan an ERM company

Subsistence harvest rates of the Dolphin and Union herd are not known, but thought to be about 10% of the population mainly from Kugluktuk (Coppermine), Omingmaktok (Bay Chimo), and Kingaok (Bathurst Inlet; Nishi and Gunn 2004; Poole et al. 2010).

5.1.4.4 Baseline Data for the Dolphin and Union Caribou Herd

The objectives of baseline studies were to highlight where the Dolphin and Union caribou herd is located during each season, to what degree these movements overlapped with the Project area, and how caribou use habitat within the wildlife RSA on a variety of scales. Several data sources are available from government agencies and other information was directly collected in the field. Four separate types of baseline studies were conducted, including:

1. Analysis of satellite collar data (1999-2004) to determine movement patterns and seasonal ranges;
2. Aerial surveys conducted in 2001, 2002, 2007, and 2010 in the wildlife RSA during key life history stages for caribou;
3. Remote motion-triggered cameras (2012 to 2015) for monitoring habitat use of certain habitat features and for determining detailed timing information for when caribou use these features; and
4. Habitat suitability modelling to determine the location and abundance of various habitat type identified from literature review as important for caribou.

The results of these baseline studies are presented for Bathurst and Beverly caribou in Section 5.1.2.5. Highlights of these data which pertain to the Dolphin and Union herd are summarized below.

Satellite Collar Data

Collaring programs for the Dolphin and Union herd began in the 1980s (A. Gunn, Fournier, and Nishi 2000), these collars were not global position system (GPS) collars and the number of animals collared was minimal. No collars on Dolphin and Union caribou have been functioning since 2006. The Dolphin and Union herd has a minimal chance to interact with habitat in the wildlife RSA, however; analysis of satellite collar data was carried out to ensure that no interaction between this herd and the MLA in Bathurst Inlet could occur. Collaring data used for these analyses included that obtained between 1999 and 2004.

The locations of satellite collar data were mapped for the Dolphin and Union herd. Maps of the 50% and 95% UD for Dolphin and Union caribou are presented in Figures 5.1-18a-d.

Collaring data for Dolphin and Union caribou indicate that this herd has potential to interact with the wildlife RSA during winter only.

Aerial Surveys

Aerial surveys were conducted in 2001, 2002, 2007, 2008 and 2010 in the wildlife RSA using standard census techniques for large mammals (Rescan 2002, 2007a, 2011a). The timing of surveys corresponded with the spring and early fall migration, calving, and post-calving periods for caribou (Table 5.1-3). Details of methods and results can be found in Section 5.1.2.5; Aerial Surveys.

Caribou were observed in the northern section of the wildlife RSA during aerial surveys conducted in March 2010 and during those conducted in May in 2002 (Rescan 2002), 2007 (Rescan 2007a), and 2010 (Rescan 2011a, Appendix V5-5E). While it is likely that these caribou represent Beverly herd caribou

during their spring migration to their calving grounds northeast of the wildlife RSA, there is some potential that these caribou are Dolphin and Union caribou on their migration north towards the sea ice.

Remote Cameras

Motion triggered cameras were deployed in winter 2014 at the Marine RSA to collect data on Dolphin and Union caribou (Table 5.1-5, Figure 5.1-9f). Cameras deployed in 2012-2013 were deployed in late May, long after the Dolphin and Union caribou have migrated north to their calving grounds on Victoria Island. Details on other remote cameras deployed within the RSA, in the Bathurst post-calving area west of the RSA, and within the Marine RSA; the number of cameras deployed varied by camera study year and by season (Table 5.1-5, Figures 5.1-9a-f).The methods and locations of these cameras is described in Section 5.1.2.5; Remote Cameras.

Caribou generally observed in low numbers at the marine RSA in all seasons, including winter. Two caribou were recorded during the winter (February 2015) at a camera located within the marine RSA. Based on collar data, these caribou are likely from the Beverly herd, whose winter range has overlapped portions of southern Bathurst Inlet in recent years, or the Dolphin and Union herd, whose winter range has overlapped the marine RSA in several years since 2001 (Figure 5.1-7a) (Rescan 2014a) (Rescan 2014a) (Rescan 2014a) (Rescan 2014a) (Rescan 2014a) . The winter range of Dolphin and Union caribou includes areas within 100 km of the coastline (which includes the marine RSA (Poole et al. 2010). The winter range for Bathurst caribou does not overlap the marine RSA, based on collar data.

Habitat Suitability Modelling

Habitat suitability modelling was conducted for the wildlife RSA for all caribou herds combined and is reported in Section 5.1.2.5; Habitat Suitability Modelling.

5.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

The following reports were reviewed for TK specific information related to caribou:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) (Appendix V3-3A of DEIS/FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014; KIA 2014) (Appendix V3-3C of FEIS);
- Back River Project: Existing and Publically Available Traditional Knowledge from Selected Aboriginal Groups in the Northwest Territories (Appendix V3-3B of DEIS/FEIS);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

Information regarding caribou knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot study communities. Additional TK was adapted from the *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014) (KIA 2014) and Inuit Traditional Knowledge of Sabina Gold &*

Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012).

Traditional knowledge, land user knowledge, and thoughts raised by the KIA and land users were incorporated into the effects assessment chapter in five primary ways:

1. Caribou were included as a VEC for a number of reasons (Section 5.3.2), including that they are a culturally and socially important species in the Project area.
2. Caribou distribution information from TK was incorporated in the existing environment and habitat suitability modelling report (Section 5.1.5) and effects assessment, including:
   - The location of the most prominent calving ranges for the Bathurst herd, both east and west of Bathurst Inlet indicative from TK.
   - The location of an additional less used calving area for the Bathurst herd, to the north of Nose Lake and around Beechey Lake as identified by TK.
   - The fact that the Bathurst herd calving grounds have changed frequently through time between their various traditional calving grounds.
   - The location of the Beverly calving ground.
   - The movement patterns of both Bathurst and Beverly caribou herds between their winter, calving, summer, and back to winter ranges.
   - The location of the Dolphin and Union herd calving ground.
   - Movement patterns of the Dolphin and Union herd on Bathurst Inlet and across the Dolphin and Union Straight.
   - The importance of Nose Lake and Contwoyto Lake for summering Bathurst Caribou.
3. Detailed habitat usage information for caribou, including:
   - The use of eskers and other elevated landforms during summer for ease of movement and relief from insects.
   - The use of wet foraging locations during the post-calving, including areas with cotton grass, as important forage for lactating females and newly weaned calves.
   - The use of lakeshores as travel corridors and for insect relief.
4. TK and landuser information were used to position the remote cameras at locations identified by TK as important to caribou. Elders and landusers also worked with Rescan biologists in the field to position and install cameras in high-quality foraging habitats and travel corridors.
5. TK information identified habitat loss and disturbance as concerns for caribou and these potential effects were subsequently added to the effects assessment for caribou.
6. TK, the KIA and landusers raised concerns about the effects of winter roads on caribou. Two potential effects were evaluated as a consequence: potential disruption of movement and effects of direct mortality in the effects assessment.
7. TK and landuser information was included in the preparation of management plans to reduce Project-related effects on caribou (Volume 10, Chapter 20).

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

5.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest locations and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

Note that as per the direction from the KIA in the TK report, the information in the report is considered of a confidential nature. Therefore details of mapped data and quotes from the document have not been directly transferred to the FEIS, and have instead been referred to indirectly as needed in the text.

5.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report (KIA 2012) and the *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014)* were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As a result of this process, caribou were selected as a VEC for the DEIS and FEIS.

5.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

5.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit and Aboriginal Groups in the Northwest Territories into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

5.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities. Specific comments are summarized in Section 5.3.1.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air quality: Volume 4, Chapter 1;
- Freshwater water quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and fish habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial wildlife: Volume 5, Chapter 6 (caribou), Chapter 7 (grizzly bear), Chapter 8 (muskox), Chapter 9 (wolverine and furbearers), Chapter 10 (migratory birds), and Chapter 11 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

5.3 VALUED COMPONENTS

5.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential interaction with the proposed Project;
- consultation with communities;

- available TK information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered and detailed in Chapter 1:

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

5.3.2 Valued Components Included in Assessment

Caribou have been identified as a VEC due to their importance to Inuit people, scientific studies, and their federal, territorial, and regional conservation status. Inuit TK, academic and monitoring studies have shown that under certain circumstances caribou are susceptible to a variety of development-related disturbances, and these may result in shifts in distribution and possibly also population declines (R. D. Cameron et al. 1992; Nellemann and Cameron 1998; Thorpe et al. 2001b; Dyer et al. 2002; C. J. Johnson et al. 2005b; Boulanger et al. 2011). For these reasons, caribou were included in this assessment.

Six caribou herds have been identified with geographic ranges that overlap elements of the wildlife terrestrial Regional Study Area (RSA) or the wildlife marine RSA. A description of these herds and the justification for their inclusion or exclusion from the assessment is listed in the following section.

The Bathurst herd occurs in the wildlife terrestrial RSA primarily during the post calving period, when the northern extent of their range overlaps the western and southern portion of the wildlife RSA (Figure 5.1-3). During this period, the caribou move from their calving areas between the Hood and Burnside Rivers and to their summer range surrounding and to the east of Contwoyto Lake (Section 5.1.2.2). The Bathurst herd has declined continuously since the late 1980s and declined quickly during the 2000s to < 10% of its size in the late 1980s. The Project Application Information Requirements (AIR) specified that the Bathurst herd be included in the DEIS and FEIS assessment and this herd is included as a VEC in this assessment.

The Beverly herd occurs in the wildlife terrestrial RSA during the summer, fall and winter (Figures 5.1-14 to 5.1-16). This herd calves and spends its post calving period in western Queen Maude Gulf and both its summer and winter on the tundra. The Beverly herd is composed of the Ahiak herd, which calved on Queen Maude Gulf and the Beverly herd which calved at Garry Lake, to the south of the Ahiak calving grounds. Starting sometime before 2002, the Beverly herd moved their calving to join the Ahiak caribou on their calving ground. The combined herds are now known collectively as the Beverly herd. Because of the number of seasons that this herd overlaps the wildlife RSA, it is included as a VEC in the effects assessment.

Dolphin and Union caribou are named after the Dolphin and Union strait on which they migrate during their annual spring and fall migrations between the mainland and Victoria Island (Figures 5.1-18a to 5.1-18d). Dolphin and Union caribou are genetically distinct from Peary caribou and barren-ground caribou (COSEWIC 2004). The herd is federally listed as "Special Concern" on Schedule 1 of SARA. (COSEWIC 2004). Major threats to this herd have been identified as climate change, and winter shipping activity along the herd's migration route (COSEWIC 2004). During migration, the caribou require ice thick enough to support their weight as they cross the Coronation Gulf, Dease Strait and the Queen Maud Gulf (COSEWIC 2004). Concern has been raised about increased shipping activity which may break up the ice in Dease Strait or the Queen Maud Gulf, Dolphin and Union caribou migration may be blocked or animals may fall through the recently broken ice (COSEWIC 2004; Poole et al. 2010). The herd range does not overlap with the wildlife terrestrial RSA, but it does overlap with the wildlife marine RSA with covers most of Bathurst Inlet. Shipping activity for the Project will occur only in the open water months, and so potential spatial or temporal overlap is not expected between the Project and this caribou herd, because caribou use the inlet as a migration corridor when the ice is frozen. Therefore, this herd was not included as a VEC in the effects assessment.

The Peary caribou herd may overlap the commercial Northwest Passage shipping route outside of the wildlife marine RSA only (outside of assessment area). Concerns have been raised for this herd about the potential effects of shipping if ice breaking is used — which may block movement patterns of this herd, or cause mortality when caribou break through thin ice (COSEWIC 2004). The Project is shipping during the open-water season only and will not, therefore, be ice breaking. Hence, the Project does not have a spatial-temporal overlap with this herd and they are not included in the assessment.

Three additional herds calve on the eastern edge of the Nunavut mainland: the Queen Maude Gulf herd, the Lorillard and Wager Bay herds whose distribution may overlap with the Project infrequently during the winter. The Queen Maud gulf herd calves on the eastern Queen Maude Gulf area, adjacent to the Beverly herd, while the Lorillard and Wager Bay herds calve to the south-east of the Queen Maude Gulf herd. These three herds overwinter on the tundra and in some years the extreme western edge of their winter distribution overlaps with the south-east portion of the wildlife RSA. For tundra-wintering caribou, this effects assessment discusses potential effects due to the Project with reference to the Beverly herd, which has a portion of its summer, fall and winter ranges overlapping with the wildlife RSA in most years. The Beverly herd is therefore used as a proxy for the Queen Maude Gulf, Lorillard and Wager Bay herds. Any effects that may occur for these three herds is assumed to be smaller than that for the Beverly herd, which has a longer duration, extent and frequency of overlap with the wildlife RSA. Hence, these three herds are not included in the effects assessment. If a significant effect were determined for the Beverly herd, then potential effects on these herds would be revisited.

The majority of caribou herds are declining across their circumpolar range (L. S. Vors and Boyce 2009). Researchers have proposed three key mechanisms causing declines in barren-ground caribou — high mortality rates of adult females from hunting and predation (J. Adamczewski et al. 2009; Boulanger et al. 2011), low survival through harsh winters (reviewed in Festa-Bianchet et al. 2011), and decreased birth rates and calf survival due to poor female body condition (Gaillard, Festa-Bianchet, and Yoccoz 1998; Griffith et al. 2002). These relationships may also be influenced by climatic oscillations or change, affecting forage availability (e.g., Joly, Klein, Verbyla, Rupp and III 2011). Project effects that result in stressors on the energy management of caribou and increase predation risk may affect caribou habitat selection, movement, and reproduction, and therefore population size.

5.4 SPATIAL AND TEMPORAL BOUNDARIES

5.4.1 Spatial Boundaries

The caribou effects assessment considered two study areas for wildlife inventory for the Project: a wildlife Local Study Area (LSA) and a wildlife Regional Study Area (RSA; Figure 5.4-1).

5.4.1.1 Local Study Area

The boundaries of the LSA for caribou were set to encompass the following:

- the Goose Potential Development Areas (PDAs), which contain all proposed Project infrastructure for the Goose Property Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose, and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Chapter 4, Section 4.4.1) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The wildlife LSA covers an area of approximately 134,369 ha (Figure 5.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

5.4.1.2 Regional Study Area

The wildlife RSA for caribou encompasses the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two potential development areas (Goose Property Area and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 5.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

5.4.2 Temporal Boundaries

The temporal boundaries used for the caribou effects assessment align with the time periods of the phases of the Project as presented in Table 5.4-1.

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October 27 2015

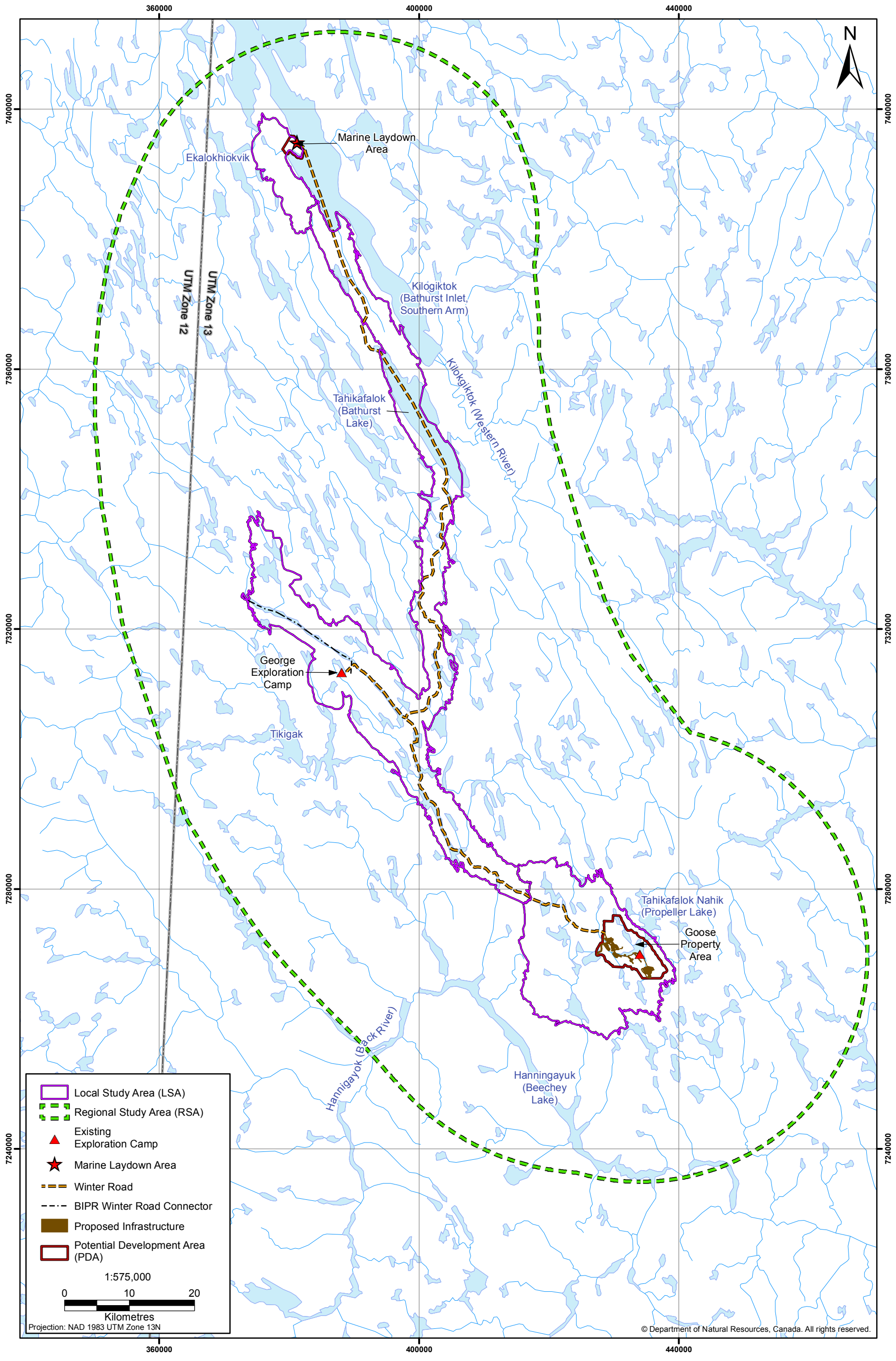

Figure 5.4-1

Local Study Area and Regional Study Area for Caribou

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Rescan an ERM company

Table 5.4-1. Temporal Boundaries - Project Phase Durations

Phase	Duration
Construction (including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post-Closure Monitoring	5 years
Other Potential Phases	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years
Exploration	Included in Construction and Operational phases

5.5 PROJECT EFFECTS ASSESSMENT

5.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on caribou as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and caribou;
2. Characterization of the potential effects that could result from these interactions;
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on caribou including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on caribou are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

5.5.1.1 Indicators Used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 5.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of ‘yes’ or ‘no’ where triggering of residual effects assessment occurred if the indicator value was ‘yes’ (e.g., indirect mortality to caribou was triggered as a residual effect if the Socio-economic assessment indicated an increase in access to the wildlife RSA).

Table 5.5-1. Criteria and Indicators Used to Characterize Potential Effects on Caribou

Potential Effect	Criteria	Indicator
Habitat Loss	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disturbance due to Noise	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disruption to Movement	Change in Population Health	Traffic timing, and traffic volume
Direct Mortality and Injury	Change in Population Health	Traffic timing, traffic volume, and vehicle speed
Indirect Mortality	Change in Population Health	Predicted increase in human access to wildlife RSA
Attraction	Change in Population Health	Attraction occurred at similar Projects in Nunavut and Northwest Territories
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on caribou

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

5.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 5.5-2).

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for caribou, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

Table 5.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects professional judgment and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

5.5.1.3 Overall Significance Ratings of Residual Effects

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 5.5-2) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 5.5-3). For example, a residual effect receives a rating of "Not Significant" typically if it is expected to be one of the following: negligible or low magnitude, confined to the LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

Table 5.5-3. Definitions of Significance Ratings for Residual Effects on Caribou

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

5.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the wildlife VEC caribou and the Project is provided in Volume 9, Chapter 1. Potential Project-related effects on caribou and caribou habitat have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, Inuit TK and land user knowledge, and a review of scientific literature of the effects of developments on caribou. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin Gold Mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Doris North mine (Rescan 2011b, 2013f). Interactions of caribou with Project components were evaluated to determine which of the following potential effects may occur (Table 5.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

Caribou use most parts of the tundra environment. Some areas of habitat will be lost within the Project footprint, here evaluated as a “Potential Development Area”, and some areas of habitat near infrastructure will be degraded during Project development. For these reasons, habitat loss was included and evaluated in this assessment.

Disturbances, including visual and auditory stimuli, can cause caribou to alter their regular behaviour patterns, resulting in avoidance of disturbed areas (McLaren and Green 1985). Therefore, the potential effects of disturbance and indirect habitat loss on caribou were included in this assessment.

Table 5.5-4. Potential Project-related Effects to Caribou in the Goose Property Area and the Marine Laydown Area

Potential Development Area	Project Component	Habitat Loss	Disturbance	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity
Goose Property Area									
	Open Pits (Main (Goose, Umwelt, Echo, and Llama)	X	X	X	X				X
	Haul and access roads	X	X	X	X	X			X
	Winter roads					X			X
	Stockpiles	X	X						X
	Waste rock storage areas	X	X	X				X	X
	Explosives storage areas	X							X
	Tailings Storage Facility	X	X				X	X	X
	Quarries	X	X						X
	Landfill	X	X				X		X
	Camp / Plant site	X	X	X	X	X	X	X	X
	Airstrip	X	X	X	X				X
	Other infrastructure (diversion channels, water intakes)	X							X
Marine Laydown Area									
	Camp	X	X				X	X	X
	Lightering Barge location	X	X					X	X
	Haul and access roads	X	X		X				X
	Winter roads					X			X
	Other infrastructure (interception ditch)	X							X

Caribou occupy large annual home ranges and make long migrations between seasonal habitats. Research on linear developments report that roads can alter the movements of caribou on the tundra. Roads have been described as a "semi-permeable barrier" to caribou movement (Dyer et al. 2002). The Goose PDA, the MLA, and the winter roads are therefore evaluated in this assessment for their potential to disrupt the movement on caribou.

Direct mortality and injury from vehicle strikes was also evaluated for caribou. The frequency of vehicle collisions is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). As some caribou overwinter on the tundra within the wildlife RSA when the all-weather site roads and winter road from the Goose PDA to the MLA are active, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed Project roads. Roads can increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Project infrastructure such as winter road alignments may act as attractants to caribou for ease of travel during the winter or as insect relief during summer. Caribou attracted to the site may interact more often with project vehicles or infrastructure. Thus, the effect of attraction is included as a potential effect in the assessment.

The potential for wildlife to be exposed to contaminants through ingestion of water or through the food chain was raised as a concern for caribou. For this reason, exposure to contaminants was included as a potential effect in the assessment, and was evaluated through a formal risk assessment conducted as part of the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). Results for exposure to contaminants for caribou are summarized in this chapter.

In response to concerns from regulators, the potential for the separate effects listed above to act synergistically on caribou energy budgets or stress levels and hence on the reproductive potential of caribou was also evaluated. For example, regulators have raised concerns that reduced energy intake due to habitat loss, disturbance from noise, and disruption to movements may result in physiological stress, lower feeding and increased movement rates which may result in reduced body condition and reproductive success. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

During the DEIS review phase, government regulators expressed concern that the range of the Bathurst caribou may shift over time. As a consequence, for each potential effect, an analysis and discussion is included for the scenario where the calving range of the Bathurst herd changes over time.

Each potential effect is identified for the Goose PDA, the MLA and each infrastructure/activity in Table 5.5-4.

5.5.2.1 Habitat Loss

As part of the development of the Project, infrastructure such as buildings, rock pads, the TSF, etc. will be built on the tundra. This section evaluates the loss of these areas as habitat for the Bathurst and Beverly caribou herds whose range overlaps or is close to the Project site. To minimize potential effects of habitat loss, the location of Project infrastructure was planned to avoid caribou sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. The potential for caribou to avoid the Project area

due to disturbance is described in Section 5.5.2.2, Disturbance. The potential for the Project to alter movement corridors of caribou is evaluated in Section 5.5.2.3, Disruption of Movement.

To enable flexibility in siting of Project infrastructure, loss and degradation of caribou habitat is assumed within the entire area of each of the two PDAs (Goose Property Area and the MLA). These areas greatly overestimate habitat loss because only 10% or less of the area within each PDA will be developed. Wherever possible, reclamation activities will be undertaken to restore habitat on an ongoing basis and Project infrastructure will be reclaimed following closure.

The operation of winter roads could result in alteration of vegetation due to soil compaction and could result in minor habitat degradation during the foraging season for caribou. However, the potential for soil compaction on the winter roads is anticipated to be relatively minor, and is not assessed further.

Calculation of Habitat Loss

Habitat loss for caribou was evaluated in two ways. The first method involved calculating the area of habitat loss due to the PDAs within the seasonal and annual home ranges for the Bathurst and Beverly caribou herds. The second method involved calculating the loss of high-quality habitat in the RSA to evaluate the loss of preferred vegetation for caribou due to the development of the Project.

Area of Habitat Loss within the ranges of Bathurst and Beverly Caribou

The location and areas of the Goose and MLA PDAs were compared to the seasonal and annual ranges of the Bathurst and Beverly herds to evaluate the total area that may be lost within these ranges due the Project. Seasonal and annual ranges are represented by fixed kernel utilization distributions (UDs) generated using all years of available collar data for each herd combined (Bathurst caribou, 1996 to 2015; Beverly caribou, 2001 to 2015; Section 5.1.2.5). Habitat loss is then expressed as the amount of habitat removed from the seasonal and annual home ranges of each herd wherever there is overlap between these ranges and the Project. The overall seasonal and annual ranges were represented by the 95% kernel distribution of collaring data. Core use areas for each season were calculated as the 50% kernel distribution of collaring data for each season.

During review of the DEIS, government regulators requested an analysis of potential effects to Bathurst caribou given the current low population status of the herd. Therefore, the location and area of the PDAs were also evaluated against 1) the herd range when the herd population was at a high, above 100,000 animals (1996 to 2006) and 2) the current low population scenario (2009-2015). The largest declines occurred during 2006, and so this year was used to separate the two scenarios (Section 5.1.2.3). Collar data from 2007 and 2008 were excluded from the analysis as they represent the time when the population was in a sharp decline and may represent a transitional range size. The population of the Bathurst herd was at a maximum during the 1980s, however distribution data during the post-calving and summer periods is not available because this time predates satellite collars.

Also during the DEIS review, government regulators requested an analysis to evaluate the potential effects of the Project on Bathurst caribou should the calving grounds shift to a new location. This analysis is also discussed in the following sections.

Area of High-Quality Habitat Lost in the RSA

This assessment evaluates the area of lost high-quality habitat within the RSA. This analysis is different from the analysis of the area of each herd range removed (above) because it focuses on habitat quality in the RSA – information that was not available for the entire herd range. Habitat suitability modeling was used to the produce a map of habitat quality for caribou in the RSA (Rescan 2013a, Appendix V5-5A). This mapping identified the vegetation groups that migratory caribou prefer and represents available habitat

for both the Bathurst and Beverly caribou herds within the RSA (as there is no distinct difference in preferred vegetation between most migratory caribou herds). Vegetation types were rated for caribou preference using information from Inuit TK and the scientific literature. It should be noted that this type of modeling cannot predict how often migratory caribou will use a site, only the forage quality at that site.

Habitat within the wildlife RSA was mapped for caribou based on a four class rating system (High, Moderate, Low, and Nil habitat). The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA using remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4). The availability of suitable habitat for caribou varies between seasons and is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 5.1). The same habitat suitability ratings were used for both Bathurst and Beverly herds.

Habitat loss and degradation for caribou was assessed conservatively by combining all seasonal habitats rated in the RSA (Section 5.1.2.5); this approach ensures that vegetation that may be preferred in different times of the year are all considered in the overall loss of habitat within the PDAs. The analysis evaluated the loss of "high-quality" habitat, which is a combination of habitat ranked as High or Moderate in the habitat models.

Evaluation of Habitat Loss for the Bathurst Caribou

An analysis conducted during baseline studies (Section 5.1.2.5) concluded that the calving, post calving and summer ranges have remained in the same location during the last 20 years when radio collar information has been available (1996-2015). The calving range has remained a constant size, despite the declines in the herd size, but the post-calving and summer ranges have contracted in size.

As a consequence, the analysis of habitat loss examines the location and area of the proposed Project compared to 1) the current low population, smaller seasonal herd ranges for the period 2009-2015, and 2) the high population, large seasonal herd ranges for the period 1996-2006.

Between 1990 and 1996, the Bathurst herd shifted its calving range from the east side of Bathurst Inlet to the west side of the Inlet (Section 5.1.2.2). The potential for habitat loss due to the Project is also examined for this, third scenario should the Bathurst herd shift the location of its calving range in the future. The results of these analyses are presented below.

Evaluating Habitat Loss in the Current Bathurst Range

The Bathurst caribou herd overwinters in the northern portion of the boreal forest (Section 5.1.2). Spring migration occurs in late May, when caribou travel north past Contwoyto Lake to the calving grounds. The majority of the herd migrates north to the west of the wildlife RSA. The calving grounds are located over 100 km to the north-west of the wildlife RSA between the Hood and Burnside Rivers. During the post-calving period, the Bathurst herd travels south-east, roughly parallel to the wildlife RSA. During this period, some Bathurst caribou can be found in the western portions of the wildlife RSA in late June. Caribou then spend the summer to the west and south of the wildlife RSA in the area surrounding Contwoyto Lake. During the late summer and fall, the Bathurst caribou move south, eventually crossing the tree line and returning to the winter range, south of the tree line.

The Goose PDA is approximately 5,427 ha while the MLA PDA occupies roughly 653 ha. The winter roads, when operational, will cover an area of approximately 3,397 ha. Therefore, the total area of the

Project is estimated at 6,080 ha during the snow-free period, and 9,477 ha while winter roads are active (December to April with active hauling during January through April; Table 5.5-5).

Table 5.5-5. Habitat Loss due to the Project within the Seasonal and Annual Ranges for the Bathurst Caribou Herd

Season	Area of Seasonal Range (ha)[2]	Area (ha) of Overlap with PDA: Seasonal Range (%)[1]		
		Goose	MLA	Winter Roads[1]
		5,427 ha	653 ha	3,397 ha
1) Population Low Scenario (2009 to 2015)				
Calving	888,977	0 (0%)	0 (0%)	n/a
Post-Calving	4,030,832	0 (0%)	0 (0%)	n/a
Summer	4,704,658	0 (0%)	0 (0%)	n/a
Fall	6,765,163	0 (0%)	0 (0%)	n/a
Winter	16,449,374	0 (0%)	0 (0%)	0 (0%)
Annual (All Seasons)	22,339,191	0 (0%)	0 (0%)	0 (0%)
2) Population High Scenario (1996 to 2006)				
Calving	1,552,949	0 (0%)	0 (0%)	n/a
Post-Calving	8,168,892	0 (0%)	0 (0%)	n/a[3]
Summer	11,335,569	0 (0%)	0 (0%)	n/a
Fall	21,094,216	0 (0%)	0 (0%)	n/a
Winter	37,853,722	0 (0%)	0 (0%)	0 (0%)
Annual (All Seasons)	46,011,271	0 (0%)	0 (0%)	0 (0%)[3]

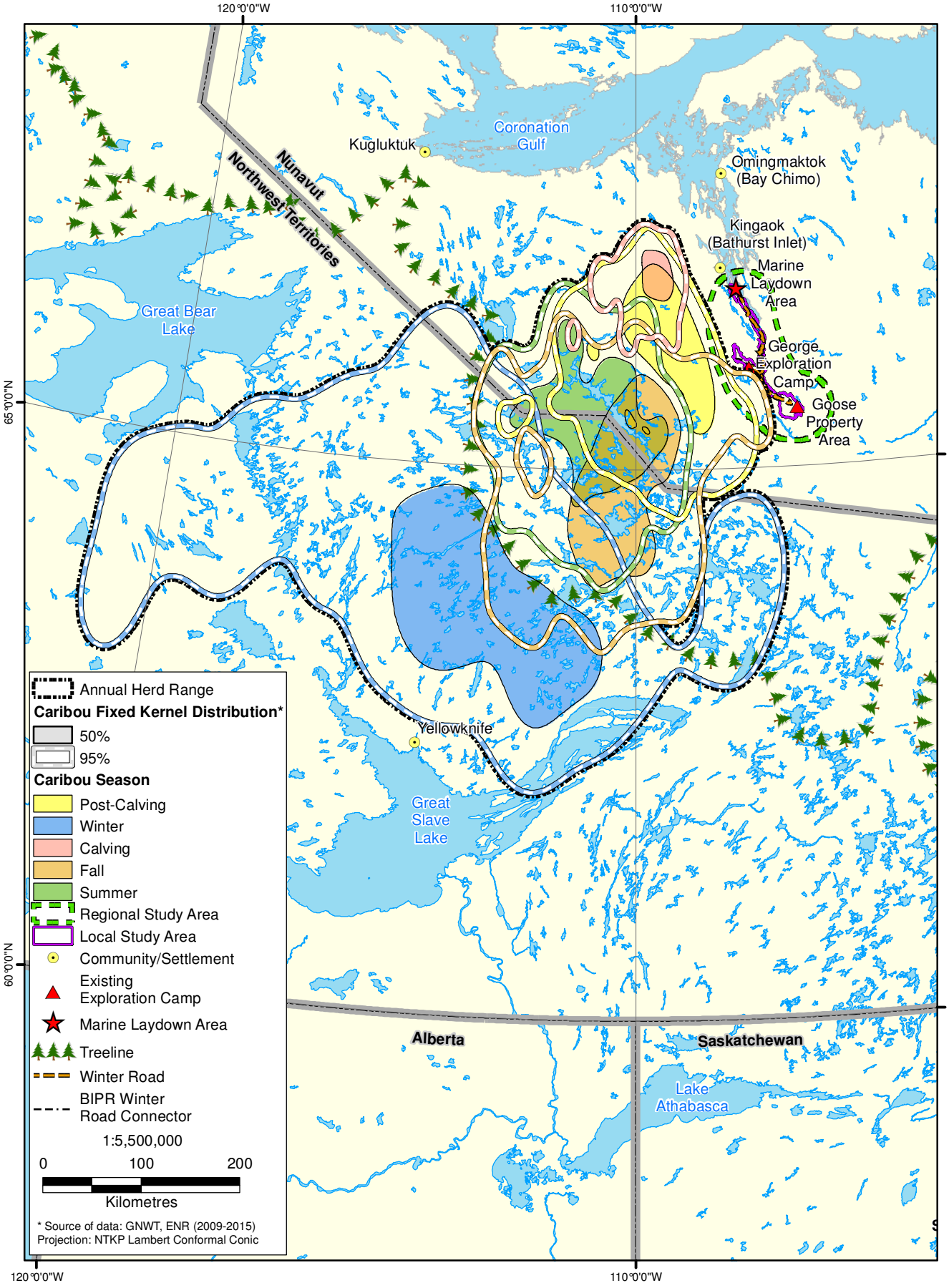
[1] Overlap with the Winter Road PDA is only calculated for the seasonal ranges where there would be temporal overlap with the operation of the winter road, which is the winter period. The area of overlap was also calculated for the annual range as a conservative estimate only when the Winter Road PDA overlapped the winter range of a herd.
[2] Seasonal Range is represented by the 95% kernel UD.
[3] A total of 2,941 ha overlaps the post-calving range (<0.1% of range) and annual range (<0.01% of range); however, this area will not be lost to Bathurst caribou as there is no temporal overlap between winter road operation and when Bathurst caribou would be present.

There is no overlap between the Goose and MLA PDAs and any seasonal ranges of Bathurst caribou when during the population low (2009-2015; Figure 5.5-1; Table 5.5-5). The seasonal ranges for Bathurst caribou based on data from 2009 to 2015, in comparison to the data from all years combined (Figures 5.5-2, 5.1-2, 5.1-3, 5.1-5, and 5.1-6), suggest that Bathurst caribou have shifted their overall use of habitat further to the west, and in the current context of the herd, interactions with any Project infrastructure are unlikely.

Under the current scenario of low population size (<100,000 animals), and reduced area of the post-calving and summer ranges, there is no overlap between the proposed Project PDAs and any seasonal range of the Bathurst caribou. Hence, no residual effect is predicted due to habitat loss for the Bathurst caribou under a scenario where the population remains low and the post-calving range remains at its current location and size.

Evaluating Habitat Loss for the Historic Bathurst Herd Range at a Population High

The seasonal ranges of Bathurst caribou during post-calving and summer were larger during the population high (i.e., above 100,000 individuals, 1996 to 2006) compared to the current low population condition (Section 5.1.2.2). Despite this, the proposed Project Goose and MLA PDAs do not overlap with the historic larger seasonal ranges in any season (Figure 5.5-3; Table 5.5-5).



Sabina GOLD & SILVER CORP.

Seasonal and Annual Herd Ranges for Bathurst Caribou in Relation to the Project PDAs, 2009 to 2015

Figure 5.5-1

Rescan an ERM company

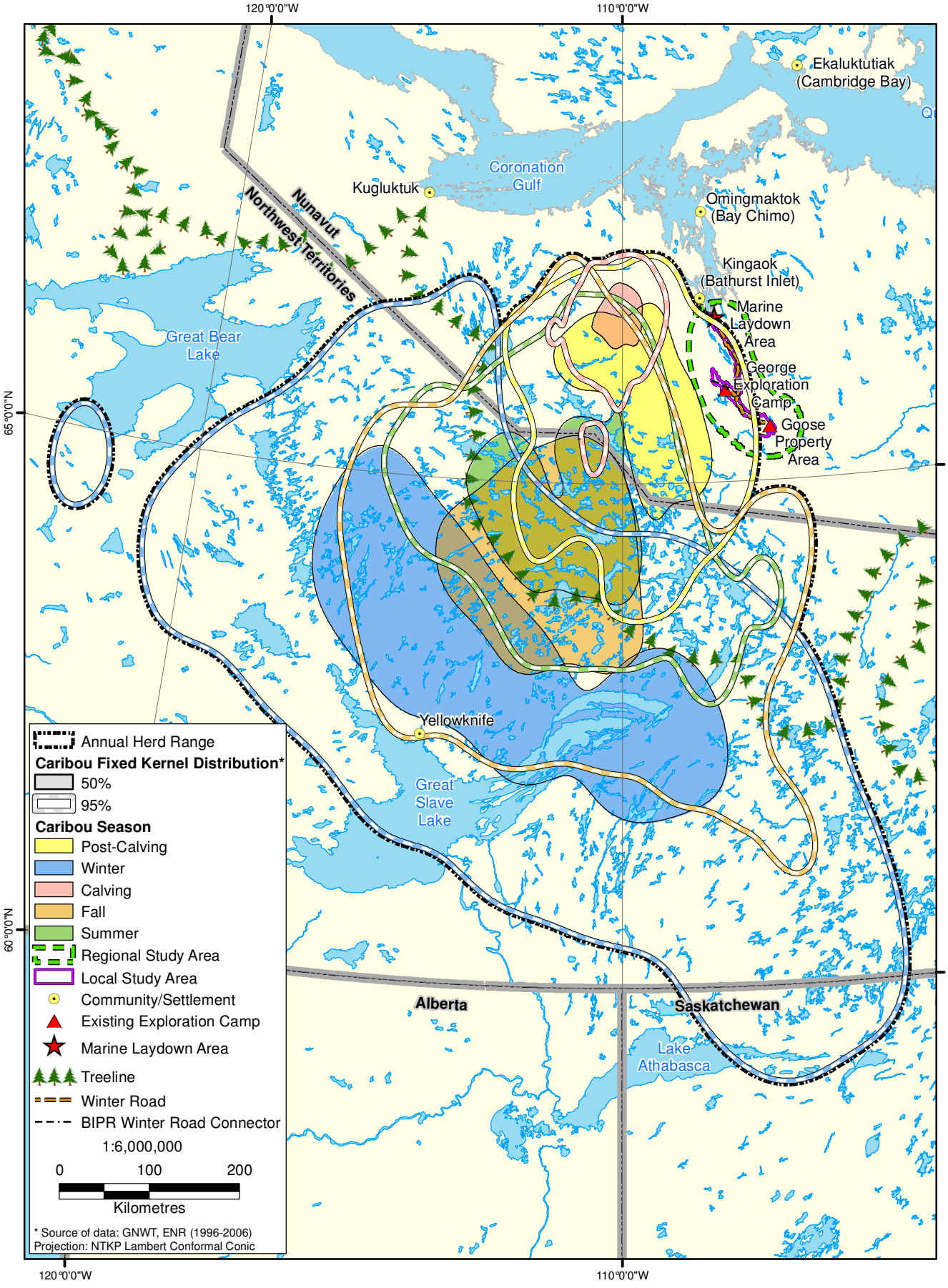


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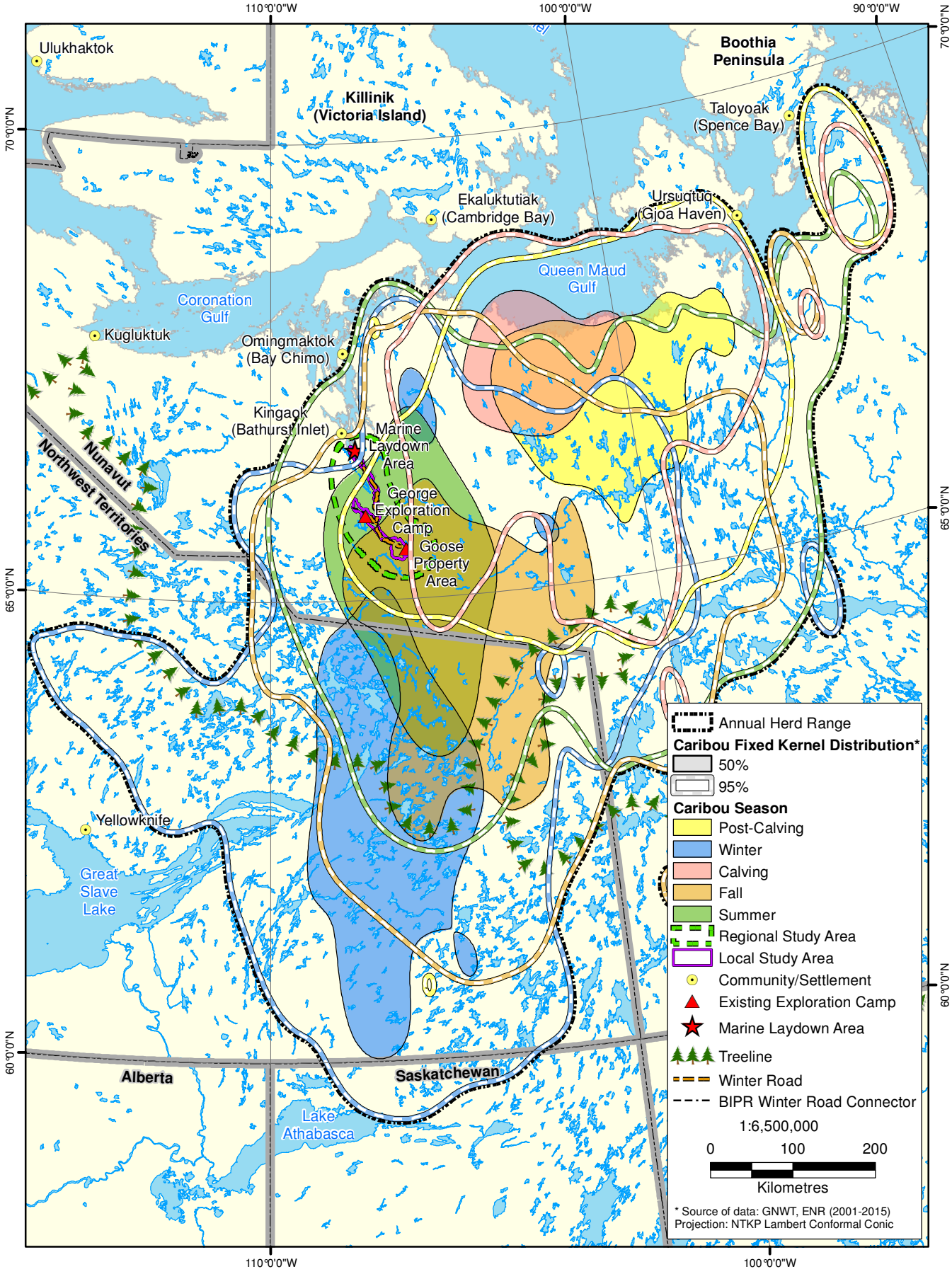
Figure 5.5-2

Seasonal and Annual Herd Ranges for Bathurst Caribou in Relation to the Project PDAs, 1996 to 2006

Rescan an ERM company



Sabina GOLD & SILVER CORP.

Seasonal and Annual Herd Ranges for Beverly Caribou in Relation to the Project PDAs, 2001 to 2015

Figure 5.5-3

Rescan an ERM company

The high-population post-calving and annual ranges range overlaps some areas of the proposed Winter Road PDA during some years; the total area of overlap constitutes 2,940 ha which represents less than 0.1% of the post-calving range and less than 0.01% of the annual range. However, this will not result in any habitat loss as caribou will be wintering to the south of the Project while winter roads are operational.

Under the historic scenario of higher population size (>100,000 animals), and larger post-calving and summer ranges, there is no overlap between the proposed Project PDAs and any seasonal range of the Bathurst caribou. Hence, no residual effect is predicted due to habitat loss for the Bathurst caribou under a scenario where the population returns to its former size and the various seasonal ranges return to their larger sizes.

Evaluating Habitat Loss if the Calving Range of the Bathurst Caribou Moves

During the DEIS review phase, government regulators requested an analysis to examine potential effects on Bathurst caribou should the calving range shift over time. As a consequence, this section evaluates the potential effects of the Project should the calving range of the Bathurst herd change in the future.

The calving range of the Bathurst caribou from 1996 to 2015 has been located between James River and Contwoyto Lake, approximately 100 to 150 km northwest of the wildlife RSA, with the most concentrated use taking place between the Hood and Burnside Rivers (Figure 5.1-3).

Results from aerial surveys and satellite collars indicate that the Bathurst caribou have calved both east and west of Bathurst Inlet over time. Urquhart (1981) compiled the historical evidence for the location of the Bathurst caribou between the 1930s to the 1970s, reporting that there was evidence of calving both east, west and south of Bathurst Inlet. Kelsall (1951 and 1953) reported calving both east and west of Bathurst Inlet, however the majority of calving was thought to be on the eastern side of the Inlet (Kelsall, 1955).

The first formal aerial surveys of the calving grounds were conducted in 1965 and 1966 and reported that calving occurred on the eastern side of Bathurst Inlet (Williams, 1966). Throughout the late 1960s and 1970s, calving and aerial surveys were conducted on the eastern side of Bathurst Inlet, although there were reports of additional calving west of the Inlet (M. Sutherland and Gunn 1996).

During the 1980s and early 1990s, calving appears to have occurred exclusively on the eastern side of Bathurst Inlet (A. Gunn, Poole, and Wierzchowski 2008). Between the aerial surveys conducted in 1990 and 1996, the Bathurst Caribou shifted their calving range from the east side of Bathurst Inlet to the west side of the Inlet, between the Hood and Burnside Rivers (A. Gunn et al. 2008). The calving range has remained centered in that location ever since based on aerial and satellite collaring data. The shift in calving grounds 1990-1996 occurred quickly, but the new location was within the historic calving grounds.

Inuit TK reports that the historic calving ground of the Bathurst caribou is both east and west of Bathurst Inlet (KIA 2012), which is consistent with scientific reports listed above for the period of 1930s to present. Inuit TK also identifies additional calving areas immediately to the north of Contwoyto and Nose Lakes (Thorpe et al. 2001b; KIA 2012) and surrounding Beechey Lake within the wildlife RSA (KIA 2012, 2014). This data can be interpreted in ways. These TK reports may be referencing the presence of females with calves at these lakes, which is consistent with scientific information 1996-present, which shows that females with calves are present at these lakes during the post-calving period. Alternatively, this TK information may represent calving in years when the conditions are not favourable (e.g. deep snow or ice) to make it to the calving grounds, and cows may drop their calves on route to their calving grounds. Typically, in the latter case, according to scientific information, cows would continue on to the calving

grounds with their calves a few days after they were born. Lastly, this TK information may represent historic calving grounds pre-dating modern aerial surveys in the 1960s.

The Project site (both the Goose and MLA PDAs) are outside of the historic calving grounds both east and west of Bathurst Inlet reported Inuit TK and by aerial surveys between the first formal aerial surveys in the 1960s to the present. In the event that the calving grounds were to move from their current position west of Bathurst Inlet, the most likely new location would be somewhere within the historic calving ground; a return to the historic calving grounds east of Bathurst Inlet (Figure 5.1-4).

If the calving grounds were to return to the east side of Bathurst Inlet, then the northern migration of the Bathurst caribou would likely return to its pre-1996 distribution, with caribou migrating north both east and west of Bathurst Inlet. Caribou migrating north on the west side of Bathurst Inlet to their historic calving ground east of the Inlet would likely cross the Inlet on the sea ice to reach the calving grounds. If this were the case, the number of caribou observed at the Project site during the spring migration would likely increase. Currently, the majority of the Bathurst spring migration occurs to the west of the RSA.

Under the scenario of a return to a calving ground east of Bathurst Inlet, it is unclear what the effect would be on the post-calving and summer range. Bathurst caribou could spend the summer east of Bathurst Inlet, or they may continue to use the area surrounding Contwoyto Lake as they currently do during that time. In either case, it is likely that there would be an increase in the number of Bathurst caribou observed in the RSA during the post-calving and summer periods as they travel south from the eastern calving ground to the wintering ground south of the treeline.

The Wildlife Mitigation and Monitoring Program (WMMP) Plan includes a program to account for possible shifts in the calving range of the Bathurst caribou (Volume 10, Chapter 20, Section 6.10; Mitigation and Management for Caribou). This program has two components:

1. Yearly monitoring of the location of the Bathurst caribou herd using satellite collars. Should this analysis report that the calving range has shifted, then future mitigation and management at the project can be planned for subsequent years. This includes possible shutdowns of the activities conducted on the Goose site should caribou calving surround the Goose PDA.
2. On-site monitoring for caribou by on-site caribou monitors during seasons when caribou are likely to occur at or near the Project site. Should this on-site monitoring report caribou, then staged management would be triggered, including alteration or cessation of activities for a) helicopters and aircraft, b) vehicles on the ice road, c) above-ground blasting, and d) vehicles on site roads.

Should any change occur in the location of the calving ground of the Bathurst caribou, then yearly satellite collar monitoring would identify the shift and mitigation would be planned. This mitigation could include planned staged reductions in activity, bringing caribou monitors to site for additional periods, and triggering of on-site monitoring and adaptive management described above.

Should the location of the Bathurst calving ground shift to the east side of Bathurst Inlet, then caribou may interact with the Goose PDA during the spring migration, post-calving, or summer seasons. During these seasons, both the Bathurst and Beverly caribou follow a common behaviour, moving generally south towards their fall and wintering grounds. If that were the case, then the Goose PDA could be considered to be within the new Bathurst post-calving and summer range. It is impossible to know what the size of the post-calving and summer ranges should the calving ground shift to the east of Bathurst Inlet. Measurements of summer range usage were not made prior to 1990, the last time that the calving ground was east of Bathurst Inlet. Using the average Bathurst herd seasonal ranges

based on current (2009-2015) and high population (1996-2006) scenarios, described above, as a possible range of post-calving and summer range sizes, the Goose PDA (5,427 ha) would represent the loss of 0.13% to 0.09% of the new "east calving scenario" post-calving range and 0.12% to 0.07% of the "east calving scenario" summer range, respectively. In this hypothetical case, habitat loss in the post-calving and summer range would be evaluated as a residual effect on this wildlife VEC. The likelihood that the calving range will shift away from its current location is difficult to predict. Gunn et al (1998) suggested that ranges shifts are due to nutrient depletion on the calving range as a result of overgrazing when the herd is at a high population size, as was the case when the last calving range shift occurred between 1990 and 1996. If this is the case, then it is unlikely that the current low population size of caribou can deplete vegetation resources on the calving range, and as such it is unlikely that the Bathurst herd will alter its calving grounds in the near future.

A second possible scenario exists, identified by Inuit TK, where the calving range of the Bathurst caribou shift to the areas north of Contwoyto and Nose Lakes and possibly surrounding Beechey Lake (as described above; Figure 5.1-4). This scenario is considered less likely, because it is unclear from the Inuit TK whether these areas represent observations of females with calves (which agrees with the current distribution of caribou using these areas in the post-calving and early summer periods), if they are calving areas that may be used in years when caribou are unable to make it to their current use calving areas, or if they are calving grounds in the same sense as the current calving ground west of Bathurst Inlet. There is no evidence from collaring or aerial surveys of caribou calving in these locations between the 1930s and present to corroborate this TK report.

Should the calving range shift to the areas near Contwoyto, Nose and Beechey Lakes, then the Goose PDA would be adjacent to, or possibly inside the calving range. The Goose PDA is >15 km from Beechey Lake. If this scenario occurred, then mitigation measures to track the calving grounds of the Bathurst caribou would detect this shift and appropriate mitigation would be planned for following years, including the potential to reduce or cease activities at the Goose PDA during the calving period. If this scenario were to occur, then it is predicted that despite mitigation, a residual effect of the Project would be anticipated. However, this scenario is considered less likely than the scenario described above where there is a shift to the east side of Bathurst Inlet, which conforms to both Inuit TK and scientific reports.

Summary of Habitat Loss for the Bathurst Herd

Three possible scenarios were evaluated for the potential for habitat loss for the Bathurst herd: 1) the current low population and smaller seasonal home ranges during 2009-2015, 2) the historic high population and larger seasonal home ranges during 1996-2006, and 3) the potential for a shift in the calving range, similar to that observed between 1990 and 1996.

The proposed Goose and MLA PDAs do not overlap the current (2009-2015) or historic (1996-2006) seasonal ranges of the Bathurst caribou and no residual effect is predicted for the effect of habitat loss.

Two options were assessed for a potential shift in calving range: 1) a more likely scenario where the calving range shifts to the east of Bathurst Inlet, and 2) a less likely scenario where the calving range shifts to the area surrounding Contwoyto and Nose Lakes and possibly and Beechey Lake. Should the calving range shift and return to the eastern side of Bathurst Inlet, then the Goose PDA may overlap the post-calving and/or summer ranges. Should the calving range shift to Contwoyto and Nose Lakes, then the Project would likely be outside of the herd range. If the calving area included Beechey Lake, then the Project could be adjacent to or inside the calving range. If the calving range shifts in future and the Goose PDA overlaps the herd range, then a residual effect would be predicted.

In conclusion, the proposed Project PDAs do not overlap the seasonal herd ranges of the Bathurst herd during the last 20 years for which seasonal distribution is available from satellite collars (1996-2015). However, if the calving range were to shift, then a residual effect could be encountered. Despite the fact that the proposed Project does not overlap the seasonal home ranges of the Bathurst herd, given the level of concern for this herd, the potential effect of habitat loss is rated as a residual effect following the precautionary principle.

Evaluation of Habitat Loss for the Beverly Caribou

Beverly caribou winter in areas both below and above the treeline, and some small proportion of caribou may be found within the wildlife RSA at this time (Section 5.1.3). In spring, Beverly caribou migrate relatively quickly to their calving grounds to the northeast of the wildlife RSA near the Queen Maud Gulf, and stay in the vicinity of the Queen Maud Gulf during post-calving. During the summer and fall (end of July to end of October), the wildlife RSA overlaps the western edge of the Beverly summer and fall ranges. The projected areas of habitat loss for the Beverly caribou herd due to the Project development are listed in Table 5.5-6 and described below. Areas of the seasonal ranges are based on the 95% kernel distribution of the collaring data as described in Section 5.1.3.2.

Calving: The calving range of the Beverly caribou herd is located approximately 200-300 km north-east of the Project site in the Queen Maude Gulf Bird Sanctuary, and has an area of 17,856,868 ha (Figure 5.5-3; Table 5.5-6). The Goose and MLA PDAs do not overlap the Beverly calving range. Winter roads are not active at this time of year.

Post-Calving: The post-calving range of the Beverly caribou is located in and surrounding the Queen Maude Gulf Bird Sanctuary and has an area of 22,675,438 ha (Figure 5.5-3; Table 5.5-5). The Goose PDA overlaps the western edge of the post-calving range of Beverly caribou, but the MLA does not, and winter roads are not active at this time of year (Figure 5.5-3). The area of habitat loss for Beverly caribou from the Goose PDA is 5,427 ha, which represents 0.02% of the post-calving range of the herd.

Summer: During summer, Beverly herd disperses south-west from the post-calving range and covers a large area of 33,999,052 ha. The summer range overlaps the wildlife RSA, including the Goose and MLA PDAs (Figure 5.5-3; Table 5.5-6). Winter roads are not active at this time of year. The area of habitat loss for Beverly caribou from the Goose and MLA PDA is 6,080 ha (0.01% of summer range).

Fall: During fall, the Beverly caribou disperse further south, to cover the area stretching from Great Slave Lake to Bathurst Inlet, and covering 34,091,423 ha. The fall range of the Beverly covers the wildlife RSA, including both the Goose and MLA PDAs (Figure 5.5-3; Table 5.5-6). Winter roads are not active during this time of year. The area of habitat loss for Beverly caribou from their fall range is 6,080 ha (<0.05% of fall range).

Winter: The winter range of Beverly caribou is similar to the fall range but larger in extent, covering 40,985,127 ha. The winter range for the Beverly covers the Goose PDA and part of Winter Road PDA. The MLA PDA falls outside of the winter range for Beverly caribou. The area lost from the winter range is 5,427 ha due to the Goose PDA and 3,140 ha from the winter road, for a total of 8,567 ha (0.01% of winter range).

Annual (All-Seasons): The size of the entire annual range of the Beverly herd is 60,663,348 ha. The annual range overlaps the wildlife RSA, including the Goose, MLA, and Winter Road PDAs (Figure 5.5-3; Table 5.5-6). The area of habitat loss for Beverly caribou from their annual range is 6,080 ha during the snow free season and 9,477 ha when winter roads are operational, both of which represent less than 0.05% of the annual range of Beverly caribou.

Table 5.5-6. Habitat Loss due to the Project for the Beverly Caribou Herd

Season	Area of Seasonal Range (ha)[2]	Area of PDA in Range (ha) (% of Range)		
		Goose PDA 5,427 ha	MLA PDA 653 ha	Winter Roads[1] 3,397 ha
Calving	17,856,868	0 (0%)	0 (0%)	n/a
Post-Calving	22,675,438	5,427 (0.02%)	0 (0%)	n/a
Summer	33,999,052	5,427 (0.02%)	653 (0.002%)	n/a
Fall	34,091,423	5,427 (0.02%)	653 (0.002%)	n/a
Winter	40,985,127	5,427 (0.01%)	0 (0%)	3,140 (0.01%)
Annual (All Seasons)	60,663,348	5,427 (0.01%)	653 (0.001%)	3,397 (0.01%)

[1] Overlap with the Winter Road PDA is only calculated for the seasonal ranges where there would be temporal overlap with the operation of the winter road, which is the winter period. The area of overlap was also calculated for the annual range as a conservative estimate only when the Winter Road PDA overlapped the winter range of a herd.
[2] Seasonal Range is represented by the 95% kernel UD.

Overall, the Project overlaps a small area (0.02%) of the range of the Beverly herd during any season. This proportion of area is small, however, due to the concern expressed by Aboriginal groups and government regulators for potential effects on caribou, the potential effect of habitat loss is rated as a residual effect.

A cumulative effects assessment of habitat loss from all industrial projects in the Beverly herd range is included in Section 5.6, Potential Cumulative Effects Assessment.

Evaluation of Loss of High-Quality Habitat

As part of baseline studies, habitat suitability maps were produced which mapped high quality habitat for caribou within the LSA and RSA. This high-quality habitat was defined by the vegetation communities present, and represents habitat available for all caribou that may use the area, which is expected to be primarily caribou Beverly herd. Vegetation communities preferred by caribou were identified using Inuit TK, the scientific literature, and professional judgement. Note that habitat suitability mapping identified only those habitats that caribou are thought to prefer, and did not evaluate the areas actually used by caribou (which are discussed in the proceeding sections).

As described in the proceeding sections, the total predicted habitat loss due to the development of the Project during the snow-free season is 6,080 ha, which is predicted to increase to 9,477 ha during the winter while winter roads are operational. In total, the PDAs represent 7.0% of the wildlife LSA and 0.8% of the wildlife RSA (Table 5.5-7).

The total amount of high-quality habitat (vegetation) that was mapped within the RSA was 1,087,291 (86% of the wildlife RSA), of which 5,399 ha is contained within the Goose and MLA PDAs (0.5% of available high-quality habitat in the wildlife RSA; Table 5.5-7). During the winter, some habitat may be temporarily lost when the winter roads are operational, which, in combination with habitat lost due to the Goose and MLA PDAs, represents 0.7% (7,355 ha) of the available habitat within the wildlife RSA. The temporary habitat loss due to the Winter Road PDA is only expected to affect Beverly caribou and only slightly as very few Beverly caribou are expected to occur near the Project during the winter (Section 5.1.3.2). The temporary loss of habitat within the Winter Road PDA will not affect Bathurst caribou as this herd is located well to the south of the Project and below the treeline during the winter.

Table 5.5-7. Habitat Loss and Degradation within the Project Development Areas (PDAs)

	Area Considered Lost to PDAs (ha)	Proportion of LSA (%)[1]	Proportion of RSA (%)[1]
By Project Area			
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.4	0.1
Winter Roads[2]	3,397	2.5	0.3
Total	6,080	4.5	0.5
Total Including Winter Roads	9,477	7.0	0.8
By Area of High-Quality Habitat			
Total High-quality Habitat	5,388 - 5,399*	4.7	0.5
Total High-quality Habitat (including loss of Winter Roads)	7,182 - 7,355*	6.3	0.7

[1] LSA = 134,369 ha, RSA = 1,262,005 ha
[2] Represents area of habitat loss during the winter the winter only period only; habitat degradation due to compaction during the snow free period is expected to be minor and is not assessed further.
** A small amount of high-quality habitat is mapped within the PDAs but is outside of the wildlife LSA. The range first presents the amount of high-quality habitat in the PDA that is within the wildlife LSA, and the second includes that in the PDAs and within the wildlife RSA.*

In all cases, the actual area lost will be much smaller as the design of the Project footprint is much smaller (10% or less of the PDAs) than the PDAs assessed as lost.

The determination of whether habitat loss is a residual effect was made in the proceeding sections, based on the area lost within the seasonal ranges of the caribou herds.

5.5.2.2 Disturbance

This section evaluates the potential effects of Project-related disturbance on caribou. In some cases caribou have been shown to avoid industrial developments, which may result in indirect habitat loss, depending on the seasonal usage of the habitat. For instance, if all habitats are equivalent and habitat area is not limiting then caribou choice of habitats further from industrial developments may not result in indirect habitat loss. However, if the population is at a food-mediated high and habitat is limiting, then disturbance may result in indirect habitat loss and effects on the population if the area lost is sufficiently large.

The potential effect of altered energetic balance due to disturbance is addressed in Section 5.5.2.8, Reduction in Reproductive Productivity.

There are several approaches that can be used to calculate and evaluate the potential effects of disturbance on wildlife populations. These methods have both pros and cons and are based on inferring mechanisms and resulting effects from other industrial sites or locations.

The first method is the “noise disturbance” approach. This approach assumes that of all of the potential disturbance effects of the Project, noise will travel the furthest from the Project site and can therefore be used to estimate the area where caribou will be disturbed. The advantage of this method is that the noise levels at industrial projects can be calculated with a relatively high degree of confidence. The disadvantage of this method is that caribou behavioural responses must be inferred from studies on disturbance from noise. Thresholds noise levels where wildlife species have been shown

to react negatively can be applied from the literature and averaged across multiple studies or by using similar ungulate species.

Behavioural responses are a common response by wildlife, where animals may be disturbed and either may lose time and energy foraging (Kraabel and Miller 1997; AMEC Americas Limited 2005) or functional loss of habitat as a result of avoidance of quality habitat (Gibeau et al. 2002). In some cases, caribou can become habituated to industrial noise. Resident caribou are reported by many Arctic exploration camps and active mine sites.

This section evaluates the potential effects of noise from continuous general Project noise (e.g. constant noise from camp infrastructure such as generators), instantaneous noise due to blasting, and intermittent aircraft noise. Noise modeling is used to produce a "noise map" of the Project site and compared to noise levels at which caribou and similar ungulates have behavioural reactions to noise. The areas where noise exceeds these thresholds are considered "disturbed" or "functionally lost" habitat.

The second method is the "zone of influence" approach. This approach takes the results of studies conducted at industrial sites and infers similar effects at the Project site. The advantage of this approach is its intuitive appeal. There are several disadvantages to this method, including the fact that few empirical studies have been conducted on caribou avoidance of industrial projects, necessitating comparisons with studies at different types of projects (e.g., large mines such as Ekati, pipelines and roads in Alaska) in different habitats (e.g., woodland and barrenland caribou), or in different circumstances (e.g., roads from which caribou are actively hunted).

As both of these approaches have advantages and disadvantages, this section uses both methods to evaluate the potential effects of disturbance on the Bathurst and Beverly caribou herds and compares the results of the two methods.

An analysis using the "zone of influence" approach is also carried out in the cumulative effects assessment, Section 5.6.4.2.

Calculating Disturbance to Caribou

Calculating Disturbance Due to Noise

The potential effect of disturbance due to noise on caribou was evaluated using the key indicator of indirect habitat loss due to noise avoidance. This assessment was achieved by using noise contours produced from the noise modelling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2). The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance. Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. The results of noise modelling were used to evaluate potential effects to caribou in two ways and mirrored the assessment of Habitat Loss (Section 55.2.1). The first method involved calculating the amount of habitat that may be disturbed due to noise within the seasonal ranges of Bathurst and Beverly caribou. The second method involved calculating the amount of high-quality habitat predicted to be disturbed by noise outside of the PDAs relative to that available within the RSA, in order to evaluate the additional areas where preferred vegetation exists outside of PDA that may be disturbed by noise. The methods for these analyses are described below.

Potential sources of sensory disturbance for caribou associated with Project activities include:

- Instantaneous noise from blasting;

- Continuous noise from Project activities (e.g., camp noise and vehicle traffic); and
- Intermittent noise generated from aircraft.

During Construction and Operations, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the open pits. Continuous Project noise includes rock crushing and stockpiling of materials for the TSF bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during all Project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required during Post-Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15). The results of noise modelling were generated during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be the worst case, which coincides with Year 3 of Operations at the Goose Property. The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other phases are expected to have less overall disturbance due to noise.

Threshold noise values for blasting, general Project noise, and aircraft noise were determined from the literature, above which caribou are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise “pressure” caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat (“functional habitat loss”; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally (“disturbed habitat”; 108 dB Lpeak). The threshold of 120 dB was selected to represent “functional habitat loss,” and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents “disturbed habitat” and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on caribou during Construction and Operations phases. Blasting noise models were conducted during peak noise levels for the Goose Property, which is Year 3 of Operations.

General Project-related, or equivalent noise levels, are presented as “A-weighted” decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The threshold for general Project noise was 45 dBA. This noise level value was selected based upon the criteria outlined in the Environment Code of Practice for Metal Mines (Environment Canada 2010), which recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas. Specifically, the sound pressure level from mining activities should not exceed 55 dBA during

the day and 45 dBA at night (Environment Canada 2010). Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in caribou habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). For the Goose Property, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013c).

To calculate the effects of noise disturbance on Bathurst and Beverly caribou herds, the amount of habitat mapped as functionally lost or disturbed due to noise outside of the PDAs (i.e., the area outside of the PDAs assessed as lost where noise will exceed threshold values listed above) was overlaid with the seasonal and annual distribution of Bathurst and Beverly caribou based on all available collar data (Figures 5.5-1 and 5.5-3). The amount of overlap within any of these seasonal ranges was then calculated. Comments were received from government regulators during review of the DEIS to evaluate effects to Bathurst caribou in relation to the current low population status of the herd and what effects could be should the population recover. Therefore, the areas modeled as functionally lost or disturbed due to noise were overlaid with two distributions of Bathurst caribou, one based on data from 2009 to 2015 (Figure 5.5-1) and second on data from 1996 to 2006 (Figure 5.5-2). As described in Section 5.5.2.1, data from 2009 to 2015 represent the time when the herd reached its current population low, and data from 1996 to 2006 span the period of time when collar data were available for the herd when the population was above 100,000 individuals and is intended to represent the scenario where the population recovers to a "population high" (Section 5.5.2.1). It is acknowledged that there is no available collar data for the period of time when the herd was at the highest known population (e.g., mid-1980s; Section 5.1.2.3), and that the collar data used to represent the population high actually spans the time period when the herd was in a slow decline from that recorded in the 1980s. However, these data were determined to be robust to evaluate the historic trends in habitat use of this herd while the population was at a relative high (>100,000 individuals).

The area of habitat that contains high-quality forage identified by habitat suitability mapping was also reported within the RSA.

Calculating Disturbance Using Avoidance Estimates

Caribou can avoid areas close to roads, resource development, infrastructure and human settlements (I. Vistnes and Nellemann 2008; Polfus, Hebblewhite, and Heinemeyer 2011). Avoidance of human activity and industrial developments has been documented to be most pronounced for maternal females (Ingunn Vistnes et al. 2001). It has been proposed that this avoidance behaviour could be an adaptation to reduce exposure to predators, often at the expense of foraging opportunities (S. G. Fancy and Whitten 1991; Bradshaw, Boutin, and Hebert 1997).

The results of studies on caribou avoidance are seldom consistent, likely due to the number of variables involved, including the sub-species of caribou (boreal vs. barren-ground), season, habitat quality, the type and intensity of disturbance, underlying distribution of habitat quality and other types of interrelated human activities. Researchers have reported considerable differences in the responses of different caribou groups. Some studies show that disturbed caribou (woodland) move rapidly away from the source of disturbance for 15 minutes following initial exposure, which can have significant

energetic consequences for northern ungulates when energy expenditure and forage availability in variable winter conditions is included in assessment (Skogland and Grovan 1988; Øritsland and Cuyler 1993). Other behavioral studies on barren-ground caribou report that caribou have shown a brief interruption in 'calm or neutral' behaviours (i.e. grazing, walking, standing), in response to stressors such as traffic, aircraft, and human presence) (ERM 2013). This difference in startle responses may be learned responses reflecting an individual animal's environment and history of being hunting, predation, and human interactions, or may be due to ingrained differences in these populations.

Caribou responses to disturbance also vary by season. For example, the effects to caribou due to noise from aircraft disturbance are most severe during calving, post-calving and winter seasons (G.W. Calef, DeBock, and Lortie 1976; Maier et al. 1998; Scott A. Wolfe, Griffith, and Gray Wolfe 2000) when caribou are most energetically stressed due to natural factors. This effect is most prevalent for calves and pregnant females and can negatively affect calf survival (Harrington and Veitch 1992).

It has been hypothesized that caribou may avoid mines due to noise, human presence, or altered habitat in a Zone of Influence (ZOI). As a measure of disturbance, it has been argued that ZOI buffers are especially important when used to measure cumulative effects, mitigate impacts or inform population models (Sorensen et al. 2008). However, differences in how ZOI is calculated and how the underlying mechanisms are identified can lead to controversies about biologically meaningful buffer widths, significance, and the type of response measures (A. Gunn, Russell, and Eamer 2011a). It is unlikely that caribou respond to development in a strictly linear fashion. Rather, disturbance is likely apparent out to a certain distance or threshold, beyond which sensory effects no longer apply. Recently, there have been calls for a consistent approach to monitor avoidance that can be applied across scales for species that are affected by human development (Francesco Ficetola and Denoël 2009; Polfus, Hebblewhite, and Heinemeyer 2011).

Several studies have assessed ZOIs around industrial developments and a wide range of ZOIs have been reported for various herds of caribou and types of human development activities (reviewed in Scott A. Wolfe, Griffith, and Gray Wolfe 2000; C. J. Johnson et al. 2005b; Weir et al. 2007; Boulanger et al. 2012; Chris J. Johnson, Johnson, and Russell 2014). Inconsistent conclusions across avoidance studies make avoidance by tundra caribou difficult to predict. Some studies show that caribou avoidance extends over relatively large distances – from 4 km up to 30 km (J. R. Dau and R. D. Cameron 1986; R. D. Cameron et al. 1992; Helle and Särkelä 1993; Nellemann and Cameron 1996, 1998; Dyer et al. 2001; Nellemann et al. 2001; Ingunn Vistnes and Nellemann 2001; Ingunn Vistnes et al. 2001; Nellemann et al. 2003a; I. Vistnes, Nellemann, Jordhoy, et al. 2004; R. D. Cameron et al. 2005; C. J. Johnson et al. 2005b; Boulanger et al. 2012). These studies are incongruent with other studies that show no avoidance by caribou beyond a few hundred meters (Cronin et al. 1998; Lynn E. Noel et al. 1998; Noel, Parker, and Cronin 2004; Noel et al. 2006; Reimers and Colman 2006; Reimers et al. 2007).

In barren-ground caribou, the most common ZOI reported in the literature is between 4 to 6 km (reviewed in Scott A. Wolfe, Griffith, and Gray Wolfe 2000). However, in the Bathurst herd, Johnson et al (2005b) reported a large area of avoidance near mines and communities (up to 30 km) with the avoidance response varying seasonally. Boulanger et al (2012) reported a zone of influence of 14 km and 11 km respectively around two diamond mines in Northwest Territories. These studies, suggest that caribou may avoid operating mines at a distance beyond which they can hear direct disturbance effects such as noise. Boulanger (2012) reported a correlation between the reported ZOI and modeled dust deposition and hypothesized that caribou may be avoiding the mine complex due to dust deposition. However, this mechanism remains untested. However, it was noted in this study that the ZOI was related to the amount of mining activity and industrial development size, as a ZOI of 3 - 4 km was evident when the construction of the Ekati mine occurred on its own prior to construction of the Diavik mine, and was increased to a ZOI of 11 - 14 km when both mines were in operations with a total of

seven open pits (Boulanger et al. 2012). The scale of the cumulative footprint of both diamond mines was approximately 40 km^2 which is much larger than reported for the studies that found a ZOI ranging between 1–10 km.

Similarly, different ZOIs have been reported for woodland caribou (Dyer et al. 2001; L.S. Vors et al. 2007; Leblond et al. 2011; Polfus, Hebblewhite, and Heinemeyer 2011). In woodland caribou, Johnson et al (2015) reports variable ZOIs with infrastructure type. For example a ZOI of 1.75 km was modelled for roads, 2.5 km for seismic and pipelines, 4.25 km for oil and gas features, 5.5 km for cutblocks, 8.0 km for burns, and 3.0 km for coal mines (C.J. Johnson, Ehlers, and Seip 2015). In another study of woodland caribou, a ZOI of 4 to 6 km around a gold mine was found, but the effect varied seasonally (Weir et al. 2007).

Variability in the magnitude of the effect could also influence ZOI for caribou. For example, caribou respond negatively to traffic likely because they perceive the noise, lights, vehicles, and people associated with traffic as a predation risk (A. Frid and Lawrence M. Dill 2002). Much of the variation in calculated ZOI is likely due to differences between the monitoring sites or the experience of individual caribou. For example, the reaction of caribou to an all-season road with high speed limits that is open to hunters is likely to be very different from the reaction of caribou to a closed resource road with low enforced speed limits and no history of hunting.

Data from behaviour monitoring studies of caribou exposed to disturbance events are often incongruous with calculated ZOIs. Monitoring studies of caribou activity budgets at the Ekati Diamond Mine found that although caribou responded to blasting 60% of the time within 1 km of the blast, the response was low; animals were alert but typically did not move (BHPB 1999). The behavioural response of caribou to traffic varies with vehicle speed and distance – most strong reactions have been observed when vehicles were within 100 m of caribou, but caribou more than 300 m away did not react (Horejsi 1981; Murphy and Curatolo 1984). Responses are typically short in duration. For example, although most (86%) of 34 caribou ran or trotted away from a truck, the duration of response was less than one minute on each occasion (Horejsi 1981).

Seasonal differences in avoidance of infrastructure by caribou may be due to a number of factors. For example, it has been argued that sensory disturbance from development has substantially fewer effects on caribou relative to the stress these animals may face during periods of high insect harassment (Bergerud, Sluttich, and Camps 2008), and caribou may be more tolerant to human activity during insect harassment from late June to August (L.A. Witter et al. 2012) then at other times. When insect harassment increases during the summer, caribou have been observed using developed areas such as roads (Murphy and Curatolo 1987) and well pads (Pollard et al. 1996; Lynn E. Noel et al. 1998) and in the shade of elevated pipelines (Pollard et al. 1996; Lynn E. Noel et al. 1998) to find relief from insects. During the winter, avoidance of roads by caribou have been noted and found to depend on traffic activity levels ((Cumming and Hyer. 1998; Nellemann et al. 2001). During sensitive times such as calving, females with calves have been found to avoid developed areas up to 5 km (R. D. Cameron et al. 2005).

Studies on woodland caribou have reported a variety of distances by which caribou may avoid industrial infrastructure and roads. Most studies in the literature conducted at the regional level indicate that caribou and reindeer avoid or reduce their use around human development activities to a distance ranging between 1 – 10 km (Murphy and Curatolo 1987; Scott A. Wolfe et al. 2000; Nellemann et al. 2001; Mahoney and Schaefer 2002; R. D. Cameron et al. 2005; Joly, Nellemann, and Vistnes 2006; Weir et al. 2007; I. Vistnes and Nellemann 2008; Polfus, Hebblewhite, and Heinemeyer 2011). The most common value for avoidance of industrial mine sites reported in the literature ranges between 2 and 4 km and tends to vary depending on the footprint and magnitude of mining activities, as reported for

woodland caribou at a large open-pit gold mine in newfoundland (4 km; Weir et al. 2007), at small placer mines in northwestern BC (2 km; Polfus, Hebblewhite, and Heinemeyer 2011), and for Quintette herd caribou at coal mines (3 km; C.J. Johnson, Ehlers, and Seip 2015).

For the purposes of the Back River Project FEIS, two ZOIs were chosen to assess the effect of disturbance due to the mine; a 4 km ZOI was chosen as the size and type of the mine (approximately 10% the size of the Ekati-Diavik complex) was similar to several studies where a ZOI ranging between 2 to 4 km. A 14 km ZOI was also chosen as a conservative approach, because the 14 km ZOI was reported for Bathurst caribou on their summer range (Boulanger et al. 2012); the same herd of caribou to interact with the western side of the Project RSA.

To assess the amount of habitat loss associated with these buffers, a 4, and 14 km buffer was placed around the Project Footprint. The total amount of habitat and the total amount of high-quality habitat, based on habitat suitability mapping results, was calculated within these buffers and compared to the amount of habitat available within the summer range, herd range and RSA to report the potential proportional amount of high-quality seasonal habitat functionally lost to disturbance.

Results of Noise Calculation Approach

The noise produced by blasting at the Goose PDA, general Project noise produced at the Goose PDA, and the aircraft noise produced at both PDAs was calculated. In general, both blasting noise and general Project noise exceeded the thresholds where wildlife will react to noise over a relatively small area, generally contained within the PDAs. Of interest, aircraft was the largest producer of modeled noise that exceeded wildlife thresholds (Table 5.5-8). Overall, the areas modeled as disturbed due to noise account for 11% of the wildlife LSA and approximately 1% of the wildlife RSA (Table 5.5-8).

Blasting Noise

A total of 9 ha that falls outside the Goose PDAs is predicted to be functionally lost from the noise modeling above an Lpeak of 120 dB, and 316 ha is modeled with an Lpeak above 108 dB outside of the Goose PDA. No blasting noise above 120 dB Lpeak overlaps with the Winter Road PDA, but a small portion of habitat (23 ha) occurs where the modeled contour for 108dB Lpeak overlaps the Winter Road PDA. Thus, during the winter, a total of 293 ha outside of the Goose and Winter Road PDA is modeled above an Lpeak of 108 dB. All blasting noise above 120 dB Lpeak is completely contained within the 108 db Lpeak contour; therefore, only 307 ha outside of the area modeled as functionally lost (≥120 dB Lpeak) will be disturbed by blasting noise above 108 db Lpeak during the snow free period, which will be reduced to 284 ha when winter roads are operational. Blasting noise, considered independently (i.e., habitat functionally lost due to blasting above 120 dB Lpeak and additional area outside of 120 dB Lpeak disturbed by blasting noise above 108 dB Lpeak) and cumulatively (i.e., all habitat disturbed by blasting noise above 108 db Lpeak which includes 120 dB Lpeak), accounts for less than 1% of the wildlife LSA and less than 0.1% of the wildlife RSA in both the snow-free period and when winter roads are operational.

General Project Noise

The majority of sensory disturbance due to general Project noise modeled as above 45 dBA will be associated with the development and operation of the TSF, processing plant, roads and camps. Traffic noise was modeled along the winter road alignments; the results indicated that traffic noise will dissipate to 45 dBA at less than 50 from the road alignment (Volume 4, Chapter 2). The Winter Road PDA is assumed to be a 200 m wide corridor (Volume 2). Therefore, all traffic noise above 45 dBA along winter roads will be contained within the Winter Road PDA already assessed as lost (Section 5.5.2.1) and no additional disturbance outside of the Winter Road PDA is expected.

The total amount of area modeled as affected by elevated noise levels due to general Project noise (outside of the PDAs already considered to be lost; Section 5.5.2.1) is 1,212 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 1,708 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs; Table 5.5-8). All noise attributable to blasting above 108 dB Lpeak, which is an intermittent noise source, will occur entirely within the area modeled as disturbed by continuous general Project noise above 45 dBA. Therefore, wildlife can experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap when winter roads are not operational, and in 293 ha of habitat when winter roads are operational.

Table 5.5-8. Areas of the LSA and RSA Exceeding Thresholds for Noise Disturbance

	Area Considered Lost to PDAs	Area Modeled as Disturbed by Noise (ha)[1]				Total Area Modeled above Noise Thresholds[2]	% of LSA	% of RSA
		Blasting ≥120 dB	Blasting ≥108 dB	General Project Noise ≥ 45 dBA	Aircraft Noise ≥ 80 dBA			
By Project Area								
Goose Property Area	5,427	9	316[a]	1,212[b]	1,824			
Marine Laydown Area	653	-	-	-	12,367[c]			
Winter Roads	3,397	-	-	-	-			
Total	**6,080**	**9**	**316**	**1,212**	**14,191**	**15,388**	**11.5**	**1.2**
Total Including Winter Roads	**9,477**	**9**	**293**	**1,078**	**14,084**	**15,147**	**11.3**	**1.2**

[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Appendix V4-2B) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 5.5.2.1).
[2] Total Area considers cumulative overlap in noise contours, and also where noise profiles overlap the Winter Road PDA
[a] A total of 23 ha of habitat disturbed by blasting noise at 108 dB overlaps the Winter Road PDA exiting the Goose Property Area
[b] A total of 134 ha of habitat disturbed by general project noise at 45 dBA overlaps the Winter Road PDA exiting the Goose Property Area
[c] A total of 107 ha of habitat disturbed by aircraft noise at the MLA overlaps the Winter Road PDA in Bathurst Inlet; therefore, only 12,260 ha of habitat will be disturbed by aircraft noise during the winter while winter roads are operational

Aircraft Noise

The total amount of area modeled as affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 7.5.2.1) is 14,191 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 14,084 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs); in both cases (with and without winter roads), the percentage of habitat modeled as affected by aircraft noise within the wildlife LSA and wildlife RSA is the same, at 10.5% of the wildlife LSA and 1.1 of the wildlife RSA.

Sensory disturbance modeled due to aircraft noise is greater near the MLA relative to the Goose PDA, as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. However, it should be noted that much of the habitat modeled as disturbed by aircraft noise at the MLA is over marine habitat in Bathurst Inlet. Thus, during the snow-free periods, only 2,273 ha of terrestrial habitat along the shorelines is modeled as receiving elevated noise levels, which is equivalent to 0.2% of the wildlife RSA. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area modeled as disturbed by

continuous general Project noise above 45 dBA, thus representing the area where wildlife may encounter multiple types of Project noise.

Results of Zone of Influence Approach

The area covered by the 4 km ZOI totals 27,352 ha, which is roughly 2.1% of the wildlife RSA (Table 5.5-9). The area covered by the 14 km ZOI totals 182,617 ha, which is equivalent to 14.5% of the wildlife RSA. The 4 km ZOI produces results on the same scale as analysis using Project noise, with the 4 km buffer roughly 2 times larger than the area modeled as disturbed from Project noise. The 14 km ZOI is roughly 14 times greater than the area modeled as disturbed from Project noise (see above section).

Table 5.5-9. Areas Modeled within Zones of Influence Surrounding the Project

	Areas Modeled within Zones of Influence (ZOIs)			
Project Area	**4 km ZOI (ha)**	**% RSA**	**14 km ZOI (ha)**	**% RSA**
Goose Property Area	18,155	1.4	106,552	8.4
Marine Laydown Area	9,197	0.7	76,065	6.0
Total	27,352	2.2	182,617	14.5
Total Including Winter Roads	27,272	2.2	182,276	14.4

Evaluating Effects of Disturbance on Bathurst Caribou

The potential effects of disturbance on the Bathurst caribou herd were evaluated using two methods – calculating the likely area where caribou would be affected by noise, and calculating a buffer area based on literature values. These analyses indicated that there is no overlap between the Bathurst range and the potentially disturbed area due to the Project in any season. The results of these analyses are presented in Table 5.5-9 and below.

Calving: The calving range is located 100-150 km north-west of the Project site. The results of disturbance modeling using both noise and ZOI approaches indicated no overlap with the Bathurst calving range using the 2009 -2015 and 1996 – 2006 data (Table 5.5-10).

Post-Calving: The post-calving range is located to the south-west of the Project. Using data from 2009 to 2015 when the population was at a low, the post-calving area was 4,030,832 ha. When the herd was at a population high (>100,000 individuals), represented by data from 1996 to 2006, the area of the post-calving range was 8,168,892 ha, roughly twice the size of the post-calving range based on the 2009 - 2015 data. The eastern edge of the post-calving range in both cases overlaps the western portion of the wildlife RSA but does not overlap the Goose or MLA PDAs (Section 5.5.2.1).

The results of disturbance modeling using both noise and ZOI approaches indicated no overlap with the Bathurst post-calving range in the current population low (2009 – 2015). There was some overlap during the time when the population was higher (1996 – 2006), including 55 ha of area modeled within noise contours (<0.01% of post-calving range), 1,029 ha within the 4 km ZOI (<0.1% of post-calving range), and 32,521 ha within the 14 km ZOI (0.4% of post-calving range; Table 5.5-10).

Summer: The summer range is located south and south-west of the Project; the area of the summer range varied from 4,704,658 ha using data from 2009 – 2015, and 11,335,569 ha using data from 1996 – 2006 (Table 5.5-9). The results of disturbance modeling using both noise and ZOI approaches indicated no overlap with the Bathurst summer range, using both the 2009 – 2015 and 1996 – 2006 data.

Fall: The fall range is located south of the Project; the area of the fall range varied from 6,765,163 ha using data from 2009 – 2015, and 21,094,216 ha using data from 1996 – 2006. The results of disturbance modeling using both noise and ZOI approaches indicated no overlap with the Bathurst fall range, using the 2009 – 2015 and 1996 – 2006 data (Table 5.5-10).

Winter: The winter range is located south of the Project below the treeline. Using data from 2009 to 2015 when the population was at a low, the winter range was 16,449,374 ha. When the herd was at a population high (>100,000 individuals), represented by data from 1996 to 2006, the area of the winter range was 37,853,722 ha, over twice the size of the winter range based on the 2009 - 2015 data. The results of disturbance modeling using both noise and ZOI approaches indicated no overlap with the Bathurst winter range, using the 2009 – 2015 and 1996 – 2006 data (Table 5.5-10).

Annual Range: The annual range of the Bathurst herd varied between 22,339,191 ha based on data from 2009 – 2015, and 46,011,271 ha based on data from 1996 – 2006 (Table 5.5-9). There was no overlap between the modeled noise contours and ZOIs and any seasonal ranges based on data from 2009 – 2015, and thus there is no disturbance features (i.e., modeled noise, ZOIs) that overlap the 2009 – 2015 annual range of Bathurst caribou. The post-calving range based on data from 1996 – 2006 overlapped modeled noise contours and the ZOIs, and thus the same amount of area will be contained within the overall annual range for that same time period. The proportion of the annual herd range that overlaps the noise contours and the ZOIs represents less than 0.1% of the 1996 – 2016 annual range of Bathurst caribou (Table 5.5-10).

Overall, the modelled noise contours and ZOIs do not overlap the range of the Bathurst herd during any season in the current population low context (2009 – 2015); however, there was overlap with modeled Project noise and ZOIs when the herd size was higher (1996 – 2006) during the post-calving period, which represents less than 0.5% of the post-calving and 0.1% of the annual range of Bathurst caribou during that time. No residual effect is predicted given the herd range for the current low population size. However, should the herd recover, it may expand its range again and overlap the disturbed area. As a consequence, given the level of concern for this herd, a residual effect is predicted following the precautionary approach.

A cumulative effects assessment of disturbance from all industrial projects in the Bathurst herd range is included in Section 5.6, Potential Cumulative Effects Assessment.

Evaluating Disturbance if the Calving Range of the Bathurst Caribou Moves

During the DEIS review phase, government regulators requested an analysis to examine potential effects on Bathurst caribou should the calving range shift over time. As a consequence, this section evaluates the potential effects of the Project should the calving range of the Bathurst herd change in the future.

Section 5.5.2.1 includes a detailed history of the scientific and Inuit TK information on the historic range of the Bathurst caribou calving range. This review evaluated two scenarios. A likely scenario entailed the Bathurst caribou returning to their calving grounds east of Bathurst Inlet that both scientific and TK information agree they occupied until recently (they were last surveyed there in 1990). A less likely scenario was identified where the calving range shifted to the areas surrounding Contwoyto, Nose and Beechey Lakes. TK identified these areas as historic calving ranges but it was unclear from TK information whether these were sightings of females with calves, or a calving ground in the scientific sense of the term.

The Wildlife Mitigation and Monitoring Program (WMMP) Plan includes a program to account for possible shifts in the calving range of the Bathurst caribou (Vol 10, Chapter 20, Section 6.10; Mitigation and Management for Caribou). This program has two components:

1. Yearly monitoring of the location of the Bathurst caribou herd using satellite collars. Should this analysis report that the calving range has shifted, and then future mitigation and management at the project can be planned for subsequent years. This includes possible shutdowns of the Goose site should caribou calving surround the PDA site.
2. On-site monitoring for caribou by on-site caribou monitors during seasons when caribou are likely to occur at the Project site. Should this on-site monitoring report caribou, then staged management would be triggered, including alteration or cessation of activities for a) helicopters and aircraft, b) vehicles on the ice road, c) above-ground blasting, and d) vehicles on site roads.

Should the location of the Bathurst calving ground shift to the east side of Bathurst Inlet, then it is possible that increased numbers of Bathurst caribou would be observed during the spring migration and summer/fall seasons. If this were the case, then the caribou program of the WMMP would: a) identify the shift from satellite collar data and plan mitigation for following years, and b) on-site monitors would trigger short term mitigation (cessation of certain activities) to limit potential disturbances.

Should the location of the Bathurst calving ground shift to the areas surrounding Contwoyto, Nose and Beechey Lakes and overlap or be adjacent to the Goose PDA, then the caribou program of the WMMP would: a) identify the shift from satellite collar data and plan mitigation for following years (including planned reductions or cessations of Project activities), and b) on-site monitors would trigger short term mitigation (cessation of certain activities) to limit potential disturbances during other seasons.

Under the scenario of the calving ground moving east of Bathurst Inlet and the post-calving and summer ranges occur over the Goose PDA, then disturbance could affect 0.5 to 0.2% of the post-caving range, and 0.4 to 0.2% of the summer range (using the post-calving and summer ranges of the Bathurst herd based on data from 2009 – 2015 and 1996 – 2006 as possible sizes of these ranges in the current low population and population high context, respectively, and using a 4 km ZOI).

The second, less likely scenario, involved the calving grounds moving over the area of Contwoyto and Nose Lakes and possibly and Beechey Lake. Contwoyto and Nose Lakes are greater than 100 km from the Goose PDA, while Beechey Lake is approximately 20 km from the Goose PDA. Should the calving range move to Contwoyto and Nose Lake, no further interaction between Project ZOIs and Bathurst caribou would be expected. If the calving range moved to Beechey Lake, then depending on the distribution of animals, some could be affected within the Project ZOI. If that were the case, mitigation measures would be triggered to reduce potential effects by planned curtailment or cessation of Project activities during the calving period. For more information see the WMMP (Volume 10, Chapter 20).

Under these scenarios, with mitigation, a residual effect on Bathurst caribou would be predicted.

Evaluating Effects of Disturbance on Beverly Caribou

Calving: The calving range of the Beverly caribou is located in and surrounding the Queen Maude Gulf Bird Sanctuary and has an area of 17,856,868 ha (no habitat was predicted to be lost from the Beverly calving range due to the PDAs; Section 5.5.2.1; Table 5.5-11). The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly calving range. Relatively small amounts of the calving range overlapped modeled noise contours (238 ha; <0.01% of range). Larger

amounts of the calving range overlapped modeled ZOIs, including 1,625 ha within the 4 km ZOI (0.01% of range) and 29,265 within the 14 km ZOI (0.2% of range).

Note that this analysis is likely an overestimate of the degree of overlap between the ZOI and the calving range. The calving range calculated in the environmental setting appears to include animals from the spring migration and consequently includes an area to the south-west of the acknowledged calving ground in the Queen Maude Gulf.

Post-Calving: The post-calving range of the Beverly caribou is located in and surrounding the Queen Maude Gulf Bird Sanctuary and is predicted to have an area of 22,670,011 ha (Section 5.5.2.1; Table 5.5-11). The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly post-calving range. Overall, the amount of overlap with the modeled noise counters, 4 km ZOI, and 14 km ZOI approaches 0.01%, 0.08%, and 0.5% of the total post-calving range, respectively.

Summer: During summer, Beverly herd disperses south-west from the post-calving range; the summer range is predicted to cover 33,992,972 ha (Section 5.5.2.1; Table 5.5-11). The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly summer range. Overall, the amount of overlap with the modeled noise contours, 4 km ZOI, and 14 Km ZOI approaches 0.05, 0.08, and 0.5% of the total summer range, respectively.

Fall: the Beverly caribou disperse further south, to cover the area stretching from Great Slave Lake to Bathurst Inlet; the fall range is predicted to have an area of 34,085,343 ha (Section 5.5.2.1; Table 5.5-11). The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly fall range. Overall, the amount of overlap with the modeled noise contours, 4 km ZOI, and 14 km ZOI is roughly 0.05, 0.08, and 0.5% of the total fall range, respectively.

Winter: The winter range of Beverly caribou is similar to the fall range, covering 40,976,560 ha. The winter range for the Beverly covers the Goose PDA and part of Winter Road PDA. The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly winter range. Overall, the amount of overlap with the modeled noise contours, 4 km ZOI, and 14 km ZOI is roughly 0.03, 0.05, and 0.3 of the total winter range, respectively.

Annual Range: The annual range of the Beverly herd is 60,653,871 ha. The results of disturbance modeling using both noise and ZOI approaches indicated overlap with the Beverly annual range. Overall, the amount of overlap with the modeled noise contours, 4 km ZOI, and 14 km ZOI is roughly 0.01, 0.04, and 0.3% of the total annual range, respectively.

Overall, the effects of disturbance due to the Project overlaps a small area (<0.1%) of the range of the Beverly herd during any season. This proportion of area is small; however, due to the concern expressed by Aboriginal groups and government regulators for potential effects on caribou, the potential effect of habitat loss is rated as a residual effect.

A cumulative effects assessment of disturbance from all industrial projects in the Beverly herd range is included in Section 5.6, Potential Cumulative Effects Assessment.

Table 5.5-10. Areas Modelled as Affected by Disturbance in the Bathurst Caribou Range

Season	Area of Seasonal Range Remaining (ha)[1]	Calculation Method Area (ha) and (%) of range		
		Calculated Noise	4 Km ZOI	14 Km ZOI
1) Population Low Scenario (2009 to 2015)				
Calving	888,977	0 (0%)	0 (0%)	0 (0%)
Post-Calving	4,030,832	0 (0%)	0 (0%)	0 (0%)
Summer	4,704,658	0 (0%)	0 (0%)	0 (0%)
Fall	6,765,163	0 (0%)	0 (0%)	0 (0%)
Winter	16,449,374	0 (0%)	0 (0%)	0 (0%)
Annual (All Seasons)	22,339,191	0 (0%)	0 (0%)	0 (0%)
2) Population High Scenario (1996 to 2006)				
Calving	1,552,949	0 (0%)	0 (0%)	0 (0%)
Post-Calving	8,168,892	55 (<0.01%)	1,029 (0.01%)	32,521 (0.4%)
Summer	11,335,569	0 (0%)	0 (0%)	0 (0%)
Fall	21,094,216	0 (0%)	0 (0%)	0 (0%)
Winter	37,853,722	0 (0%)	0 (0%)	0 (0%)
Annual (All Seasons)	46,011,271	55 (<0.01%)	1,029 (<0.01%)	32,521 (0.07%)

[1] Overlap with the Winter Road PDA is only calculated for the seasonal ranges where there would be temporal overlap with the operation of the winter road, which is the winter period. The area of overlap was also calculated for the annual range as a conservative estimate when the Winter Road PDA overlapped the winter range of a herd.
[2] Seasonal Range is represented by the 95% kernel UD. The area presented is the area remaining after accounting for habitat loss due to the PDAs calculated in Section 5.5.2.1. Removal of the Winter Road PDA is only considered for the seasonal ranges where there would be temporal overlap with the operation of the winter road, which is the winter period. Temporary loss of habitat due to winter roads was also calculated for the annual range as a conservative estimate when the Winter Road PDA overlapped the winter range of a herd.

Table 5.5-11. Areas Modelled as Affected by Disturbance in the Beverly Caribou Range

Seasonal Range	Area	Calculation Method Area (ha) and (%) of range		
		Calculated Noise	4 Km ZOI	14 Km ZOI
Calving	17,856,868	238 (<0.01%)	1,625 (0.01%)	29,265 (0.2%)
Post-Calving	22,670,011	3,021 (0.01%)	18,155 (0.08%)	106,552 (0.5%)
Summer	33,992,972	15,612 (0.05%)	27,352 (0.08%)	182,616 (0.5%)
Fall	34,085,343	15,612 (0.05%)	27,352 (0.08%)	182,616 (0.5%)
Winter	40,976,560	4,827 (0.01%)	18,075 (0.04%)	118,076 (0.3%)
Entire Range[3]	60,653,871	15,612 - 15,479 (0.03%)	27,352 - 27,272 (0.05%)	182,616 - 182,276 (0.3%)

[1] Overlap with the Winter Road PDA is only calculated for the seasonal ranges where there would be temporal overlap with the operation of the winter road, which is the winter period. The area of overlap was also calculated for the annual range as a conservative estimate.
[2] Seasonal Range is represented by the 95% kernel UD. The area presented is the area remaining after accounting for habitat loss due to the PDAs calculated in Section 5.5.2.1.
[3] Range in numbers first indicates the amount of habitat within modeled noise and ZOI during the snow-free period when winter roads are not active, and second, that within noise contours and ZOIs including the loss of winter roads.

Evaluation of Disturbance to High-Quality Habitat

A breakdown of the percentage of high-quality habitat within modeled noise contours outside of the PDAs can be found in Table 5.5-11. The percentage of high-quality habitat modeled as disturbed across all noise sources combined outside of the PDAs is minimal (<2% of the wildlife LSA; <0.5% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife LSA and RSA, both for the snow free period and during the winter while winter roads are operational (Figure 5.5-4; Table 5.5-12).

Table 5.5-12. High-Quality Habitat Mapped within Noise Contours outside of the Project Development Areas

		Area Modeled as Disturbed by Noise (ha)[1]						
	Area Considered Lost to PDAs	Blasting ≥120 dB	Blasting ≥108 dB	General Project Noise ≥ 45 dBA	Aircraft Noise ≥ 80 dBA	Total Area Modeled above Noise Thresholds[2]	% of LSA[3]	% of RSA[3]
Total High-quality Habitat	5,388 - 5,399	9	279	1,052	1,200 - 3,551	2,238 - 4,588	1.7	0.4
Total High-quality Habitat (including loss of Winter Roads)	7,182 - 7,355	9	267	967	1,200 - 3,551	2,153 - 4,504	1.6	0.4

[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Appendix V4-2B) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 5.5.2.1).
[2] Total Area considers cumulative overlap in noise contours, and also where noise profiles overlap the Winter Road PDA
[3] Percentage of high-quality habitat within the wildlife LSA and RSA
Note: wherever a range is presented, the first number presents the area of high-quality habitat that overlaps the PDAs and modelled noise contours within the wildlife LSA, and the second presents that within the wildlife RSA.

A breakdown of the percentage of high-quality habitat within the two ZOIs (4 and 14 km) outside of the PDAs can be found in Table 5.5-12. The percentage of high-quality habitat modeled as disturbed across the 4 km ZOI outside of the PDAs is small, occupying 1% of the wildlife RSA during the snow free season and when winter roads are operational. Larger amounts of high-quality habitat were within the 14 km ZOI scenario, roughly 13% of the wildlife RSA, both during the snow free season and when winter roads are operational (Table 5.5-13).

Table 5.5-13. High-Quality Habitat Mapped within ZOIs outside of the Project Development Areas

	Area Considered Lost to PDAs	4km Zone of Influence (ZOI)		14km Zone of Influence	
		Area (ha)	% of RSA[1]	Area (ha)	% of RSA[1]
Total High-quality Habitat	5,388 - 5,399	13,441	1	135,445	13
Total High-quality Habitat (including loss of Winter Roads)	7,182 - 7,355	13,382	1	135,104	13

[1] Percentage of high-quality habitat available within the wildlife RSA after accounting for loss of PDAs.

The determination of whether disturbance is a residual effect was made in the proceeding sections, based on the area disturbed due to Nosie and within ZOIs that overlap seasonal ranges of the caribou herds.

5.5.2.3 Disruption to Movement

Disruption to movement of caribou is evaluated for: 1) linear corridors such as roads which may impede movement and, 2) point sources of disturbance that may affect known caribou movement corridors.

The Project will use two types of roads; 1) a 160 km winter road (December to April) from the Marine Laydown Area MLA to the Goose MLA, and 2) short stretches of all-season road within the Goose MLA that connect the various buildings, the pits, waste rock storage, and the TSF. The primary road for the Project will be the winter road, thus, this section focuses on evaluating the effects of this road on caribou.

Roads with vehicular traffic have been described as a "semi-permeable barrier" to caribou movement (Dyer et al. 2002), with permeability depending on the amount and frequency of traffic. This section evaluates the potential effects of the physical structure of the winter road itself and of the influence of traffic on this road on caribou movement.

There is very little evidence to suggest that roads on the tundra without traffic act as barriers to caribou movement. Winter roads are constructed by piling and flattening snow on the tundra and frozen lakes, and pumping water on top in order to make a compact and even surface. The majority of winter roads are constructed over frozen lakes for ease of maintenance. Thus, winter roads do not require berms or height for maintenance, and don't deter wildlife from crossing them. Worldwide, there are few data suggesting that roads without traffic deter caribou from crossing them, or have effects on migration routes (S. A. Wolfe, Griffith, and Wolfe 2000; Dyer et al. 2002). Thus, it is unlikely that the proposed winter road, without traffic, will pose a barrier to caribou movement.

In the oil fields of Alaska, traffic was the most important factor affecting crossing of road-pipeline corridors (reviewed in Lawhead et al. 2006). Caribou crossed roads without traffic and elevated pipelines as frequently as control sites, but crossed a pipeline with nearby road traffic less than half the time relative to roads with no traffic (J. A. Curatolo and Murphy 1986). A traffic rate of 20 vehicles per hour was the likely cause of a low crossing rate for two large caribou groups trying to cross a pipeline road in Alaska (Smith and Cameron 1985). Crossing success of a pipeline was significantly reduced when traffic averaged 32 vehicles per hour (Murphy and Curatolo 1984). Traffic volumes on the Project winter roads are estimated to be very low. The estimated active hauling window of the winter roads is 100 days between January and April. Traffic volumes will be on average 19 one way truck trips per day during Construction. Assuming transits are evenly spaced across the 16 hour operating period for trucks within a day, the traffic volume translates to roughly 1 vehicle passing along any one point of the winter road per hour. During Operations, the traffic volume will increase to an average of 40 one way truck trips per day, with between two to three trucks passing any one point of winter road per hour. Although migrating caribou move relatively quickly through the EKATI and Diavik diamond mine developments, which includes a 29 km all-weather road, preliminary data suggests that the frequency of caribou crossing this road may correlate with traffic volume (Rescan 2012a, Appendix V5-5D). Similarly, roads in Alberta were not a barrier to caribou movement unless traffic was present (Dyer et al. 2002).

Unless habituated to road traffic, caribou likely perceive road traffic as a predation risk which varies with vehicle speed and distance. In some cases, caribou may not run away from traffic, but instead may display heightened vigilance. Reactions of caribou to traffic may vary with group size, group composition (i.e., presence of calves), and insect activity (reviewed in S. A. Wolfe, Griffith, and Wolfe 2000). Large groups may be more sensitive to traffic than small groups (J. A. Curatolo and Murphy 1986; S. A. Wolfe, Griffith, and Wolfe 2000), cows and cows with calves appear more sensitive to traffic than bulls (Horejsi 1981; S. A. Wolfe, Griffith, and Wolfe 2000), and insect-harassed caribou cross roads more frequently (J. A. Curatolo and Murphy 1986).

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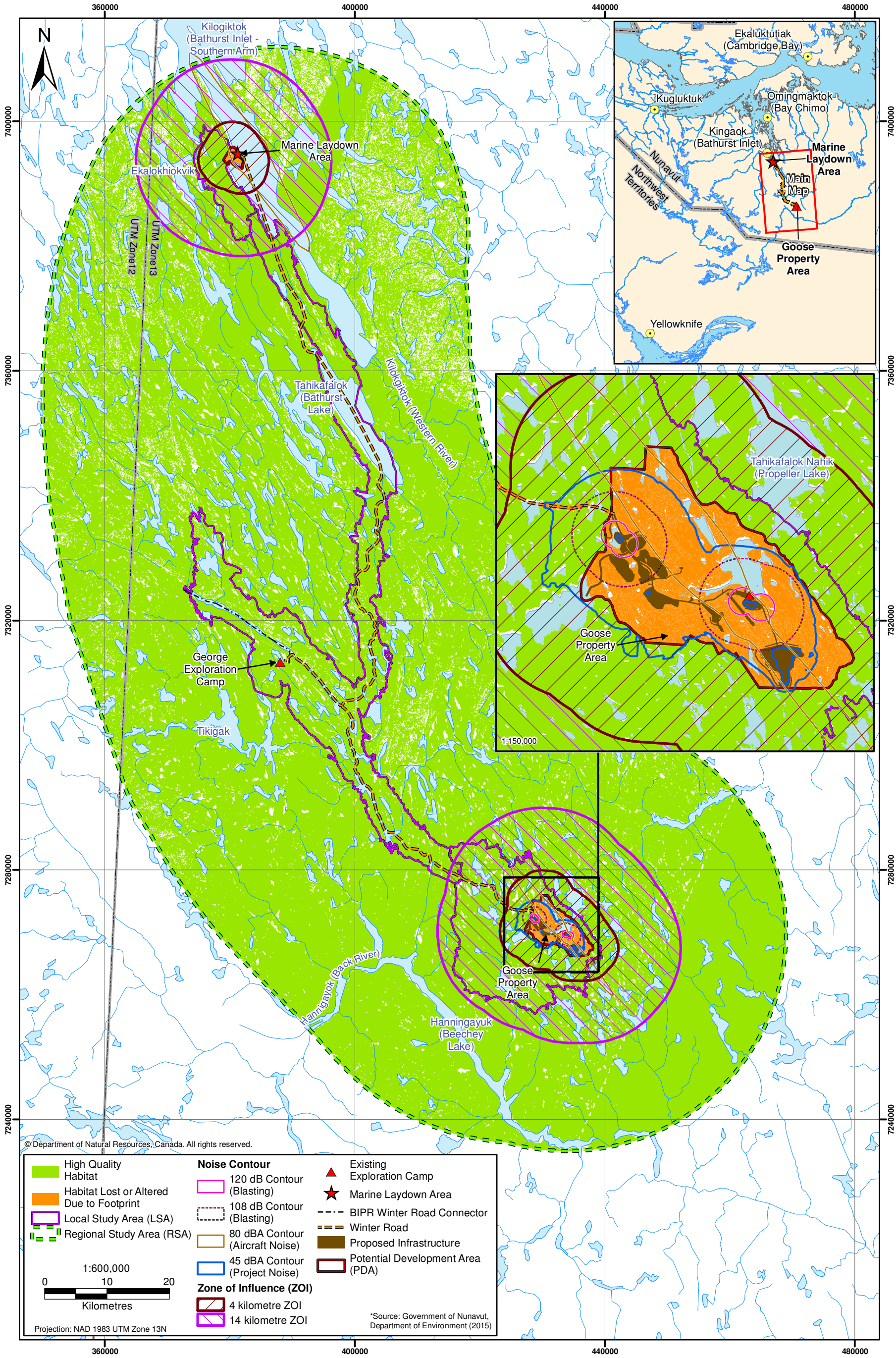
November 06 2015



Sabina GOLD & SILVER CORP.

Caribou High-quality Habitat Disturbed Within Noise Contours and 4 and 14 km Zones of Influence

Figure 5.5-4

Rescan an ERM company

Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If a development site were located on a movement corridor, then the development could disrupt the movement of wildlife, including caribou. This section evaluates whether the Project PDAs are located on or adjacent to movement corridors for caribou identified from Inuit TK, satellite collaring data, and aerial and camera baseline surveys.

Potential Project infrastructure and activities that were evaluated for the potential disruption to movement of caribou include the Goose and MLA PDAs. Disruption to movement may begin during the Construction phase of the Project when infrastructure are built and continue throughout the Operational and Reclamation/Closure phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Calculation of Disruption to Movement

Disruption to movement due to Project-related activities was evaluated for caribou by the following key indicators: 1) the comparison of traffic timing and volume on the haul roads, and 2) whether the Project interacts with any identified caribou migratory routes or crossing points, as reported by Inuit TK, satellite collaring data, or aerial and camera baseline surveys.

Evaluation of Disruption to Movement

Bathurst Caribou

The winter road from Goose PDA to the MLA PDA will be active between December and April with active hauling occurring in January through April, when the Bathurst caribou are wintering below treeline and not within or near the Project RSA. Therefore, potential effects of the ice road on movement of Bathurst caribou are not considered further in this assessment.

Several points where caribou cross lakes and rivers during the open water season were identified for caribou from Inuit TK and baseline studies. Baseline studies were designed using motion-triggered cameras to examine crossing points identified by Inuit TK and land users. Local Inuit elders worked with biologists in the field to identify the best locations for camera setup to capture these crossing points. Cameras recorded use of several crossing locations in the wildlife RSA and to the west of the wildlife RSA (Section 5.1.2.5; Rescan 2013e, Appendix V5-5C; 2014a). The closest crossing point to any Project infrastructure was the crossing point at the east edge of Beechey Lake, which is >15 km to the south of the Goose PDA. Caribou were observed at this location during late summer and were likely Beverly caribou. Although less likely based on satellite collaring data, Bathurst caribou may also use this location during the post-calving period. Baseline surveys using cameras also identified several locations 20-100 km west of the RSA where aggregations of caribou were observed during the post-calving period (Section 5.1.2.5; Rescan 2013e, Appendix V5-5C; 2014a). These caribou likely belonged to the Bathurst herd.

No effect of the Project is expected at these location because 1) there is no direct overlap between Project infrastructure and these crossing locations (Section 5.5.2.1), and 2) they are located sufficiently far away from the Project (>15 km) that no Project-related disturbance is expected (see Section 5.5.2.2).

Thus, a residual effect of disruption to movement of Bathurst caribou is not anticipated, and is not assessed further for this herd.

Evaluating Disruption of Movement if the Calving Range of the Bathurst Caribou Moves

During the DEIS review phase, government regulators requested an analysis to examine potential effects on Bathurst caribou should the calving range shift over time. As a consequence, this section evaluates the potential effects of disruption of movement should the calving range of the Bathurst herd change in the future.

As described above, the ice road between the Goose and MLA PDAs is only active when the Bathurst caribou are on their wintering grounds below treeline. In addition, the Project PDAs do not interact with any movement corridors or crossing locations identified from Inuit TK or baseline surveys. Therefore, the Project is not expected to impede the movement of Bathurst caribou and no residual effect is predicted.

Beverly Caribou

Baseline surveys and GPS collar data indicate that Beverly caribou occur in the southern portion of the wildlife RSA in the winter season. The northern extent of the Beverly winter range occurs on the southern portion of the wildlife RSA, and approximately 0.01% of the winter range of Beverly caribou (based on a 95% kernel distribution of collared caribou between 2001 and 2015) overlaps the Winter Road PDA that connects the Goose PDA and the MLA PDA.

Mitigation and management of the road to reduce potential effects of the road as a barrier to movement will include: 1) low speed limits to reduce disturbance to caribou (60 km/h), 2) reduced speed limits when caribou are within 250 m of the road (40 km/h), and 3) vehicles will give caribou the right of way if caribou are attempting to cross the road or are using the road as a movement corridor. To ensure caribou movement is not impeded by accumulated snow along the road, snow banks and snowdrifts will be managed if these reach heights deemed to impair the ability of drivers to see wildlife and for wildlife to cross the road.

Potential effects on the Beverly herd will be reduced by several factors. First, the road will not be active during spring or fall migration, when caribou must move to new habitats. Winter is the season when caribou movement rates are lowest (Section 5.1.3.2), so the rate of caribou crossing the road is expected to be relatively low. Second, a small proportion of the Beverly winter range will interact with the winter road, so few animals are expected to attempt to cross the road. Only 0.01% of Beverly winter range overlaps the Winter Road PDA (Section 5.5.2.1). Third, mitigation measures will further minimize the effect of disruption to movement. Thus, the construction and use of the winter road is not anticipated to result in a residual effect.

Crossing points identified by Inuit TK and camera studies conducted within the Project area included one crossing location on the east end of Beechey Lake. This site was identified as a hunting camp by TK and cameras reported caribou crossing south across the river during late August and early September. These animals were likely Beverly caribou due to the timing of their observations. This crossing location is >15 km from the Goose PDA and will not be directly or indirectly affected by Project disturbance.

Thus, a residual effect of disruption to movement of Beverly caribou is not anticipated, and is not assessed further.

5.5.2.4 Direct Mortality and Injury

This section describes and evaluates the potential for caribou to suffer mortality or injury due to the Project. Potential industrial activities that are considered include vehicle strikes. The potential for indirect mortality due to increased access and increased hunting is evaluated in Section 5.5.2.5.

Calculation of Direct Mortality and Injury

To assess the likelihood of significance of caribou mortality and injury resulting from interaction between caribou and the Project, three indicators were used to assess whether a residual effect was likely including: 1) traffic timing (time of year of traffic relative to when caribou are present in the wildlife RSA), 2) traffic volume, and 3) vehicle speed. The latter two indicators were used if caribou were present during the period of road construction and use (December through April). Academic literature and monitoring reports from other industrial projects in Nunavut and Northwest Territories (Ekati, Diavik, and Hope Bay), and from GN DOE was also reviewed, and estimates of wildlife mortality rates due to activities at these projects were summarized.

Evaluation of Direct Mortality and Injury

Bathurst Caribou

The primary Project road is the winter road that connects the Goose PDA with the MLA PDA, planned to be operational for the period between December and April. The Bathurst caribou herd are on their winter ranges below treeline at this time and will not interact with the Project roads. Thus, no residual effect of direct mortality is anticipated for Bathurst herd.

Effective and sustained mitigation and monitoring of waste management and camp infrastructure and compliance with the Sabina policies of wildlife management are predicted to result in limited attraction or avoidance of the Project by predators such as wolves, wolverine or grizzly bears. These activities will also reduce/prevent the potential for the creation of problem animals that must be destroyed (See Chapters 6 and 8). With no local or regional population-level effect predicted for predators, no altered predator-prey interactions are predicted for Bathurst caribou due to the Project.

Evaluating Direct Mortality if the Calving Range of the Bathurst Caribou Moves

During the DEIS review phase, government regulators requested an analysis to examine potential effects on Bathurst caribou should the calving range shift over time. As described above, the winter road between the Goose and MLA PDAs is only active when the Bathurst caribou are on their wintering grounds below treeline. If, the wintering grounds of the Bathurst herd were to change and be found within the RSA with changes to the calving grounds, on-site traffic management (described in Section 5.5.2.3) will reduce the potential for any vehicle-wildlife collisions and no residual effect is predicted.

As noted above, there is no expected no local or regional population-level effect predicted for predators due to the Project (See Chapters 6 and 8). Therefore, no altered predator-prey interactions are predicted for Bathurst caribou due to the Project.

Beverly Caribou

Beverly caribou may be present in the wildlife RSA in the winter when the winter roads are constructed and used (December through April). During this time of year, the road will be used for hauling supplies, equipment and fuel to and from the Project PDAs. Traffic levels on the road are expected to be on average 19 one way truck trips per day during Construction. Assuming transits are evenly spaced across the 16 hour operating period for trucks within a day, the traffic volume translates to roughly 1 vehicle passing along any one point of the winter road per hour. During Operations, the traffic volume will increase to an average of 40 one way truck trips per day, with between two to three trucks passing any one point of winter road per hour. The northern extent of the Beverly winter range occurs on the southern portion of the wildlife RSA. Approximately, 0.01% of the Beverly winter range (based on a 95% kernel distribution of satellite collared caribou between 2001 and 2015) overlaps with the winter road

between the Goose PDA and MLA PDA is located. Winter is the season when caribou movement rates are lowest (Section 5.1.3.2), so the rate of caribou crossing the road is expected to be relatively low.

Mitigation and management of the road to reduce any effects of the road as a barrier to movement will also reduce the effects of direct mortality as a result of vehicle strikes and will include: 1) low speed limits to reduce disturbance to caribou (60 km/h), 2) reduced speed limits when caribou are within 250 m of the road (40 km/h), and 3) vehicles will give caribou the right of way if caribou are attempting to cross the road or are using the road as a movement corridor. To ensure caribou movement is not impeded by accumulated snow along the road, snow banks and snowdrifts will be managed if these reach heights deemed to impair the ability of drivers to see wildlife and for wildlife to cross the road.

During the 18 years of operation of the Tibbitt to Contwoyto Lake Winter Road, supplying the diamond and gold mines in NWT, only five caribou mortalities have been reported (Golder 2014). The Hope Bay Project, which was in construction and operations for several years after 2009 has had no reports of caribou mortalities or injuries due to vehicle collisions (ERM 2015a). No direct caribou mortality or injury from vehicles strikes has been documented at the Ekati Diamond Mine, an active mine located approximately 250 km south of the RSA, and within the spring and fall migration pathway of Bathurst Caribou, since full operations began in 1997 (ERM 2015b).

The winter range of Beverly caribou overlaps the southern wildlife RSA and approximately 0.01% of the winter range overlaps a portion of the Winter Road PDA, indicating that few caribou of this herd will occur in the RSA during the winter period when the winter road will be active. Thus, there will be few caribou crossing this winter road. Combined with the vehicle mitigation which has proven effective at other, similar industrial sites (such as the Ekati Diamond Mine and the Hope Bay mine), mortality from vehicle collisions on the winter road is not anticipated to result in a residual effect.

Effective and sustained mitigation and monitoring of waste management and camp infrastructure and compliance with the Sabina policies of wildlife management are predicted to result limited attraction or avoidance of the Project by predators such as wolves, wolverine or grizzly bears. These activities will also reduce/prevent the potential for the creation of problem animals that must be destroyed (See Chapters 6 and 8). With no local or regional population-level effect predicted for predators, no altered predator-prey interactions are predicted for Beverly caribou due to the Project.

5.5.2.5 Indirect Mortality

Indirect mortality to caribou was evaluated for the potential to increase hunting of caribou due to new road development and access. The socio-economic assessment (Volume 8, Chapter 3) reports that an increase in human immigration and hunting is unlikely in the Back River wildlife RSA.

Mitigation measures are in place to prevent public access to Project roads (Section 7.5.3 and Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees on site. Thus, construction and operation of the road is not expected to cause an increase in caribou mortality due to facilitation of hunter access (i.e., indirect mortality) and is therefore is not anticipated to result in a residual effect on caribou.

Hunting is prohibited at similar industrial sites in Northwest Territories such as the Ekati Diamond Mine and Snap Lake Mine, which have been in operations for several years. Indirect mortality due to hunting has not been reported at these sites (ERM 2015b; Golder 2015). Minimal hunting activities have been documented along the winter access road to Gahcho Kué Project (11 occurrences in 2014; Golder

2015), located approximately 280 km northeast of the city of Yellowknife. However the same hunting pressures are not expected at the Project because the Gahcho Kué Project is connected to Yellowknife by the Tibbett-to-Contwoyto Winter Road, making it more accessible to hunters, whereas the Project is not connected to any villages or cities via the winter road.

The potential for indirect mortality would not change if the calving range of Bathurst caribou shifted over time as increased access to the herd for hunting would not change relative to the current position of the calving grounds, thus would not result in additional mortality due to hunting. Therefore, no residual effects of indirect mortality are expected.

5.5.2.6 Attraction

This section describes and evaluates the likelihood that Bathurst and Beverly caribou will be attracted to the Goose or MLA PDAs for relief from insect harassment. Use of the PDAs for insect relief would be limited to late June through August, when caribou are harassed by insects. The attraction of Beverly herd caribou to winter roads as movement corridor is also assessed for the winter season only (December through April) when winter roads will be constructed and operational.

In the central Arctic, caribou travel along eskers, frozen lakes, ridges and high points, probably because these are places where snow is relatively shallow, and thus presents an easier route for travel (Thorpe et al. 2001b; C. J. Johnson et al. 2005b). Caribou of the Porcupine herd in the western Arctic have been reported to use roads for travel, particularly when the roads paralleled migration routes (Banfield 1974). Caribou have also been documented crossing roads and using roads as movement corridors at the Ekati Diamond Mine in the Northwest Territories (BHP Billiton 2007).

Evaluation of Attraction

Bathurst Caribou

Baseline studies conducted for the Project and satellite collaring data from 1996 to 2015 indicate that the Bathurst caribou do not currently occupy the Project PDAs during any season and so are unlikely to interact with the PDAs in future. During their annual migration, Bathurst caribou are closest to the Project site during the post-calving season (June 16 to July 20) when they have been observed to the west of the RSA and at low densities inside the western portion of the RSA. The post-calving season is not a period when insect harassment is prevalent; hence caribou are unlikely to be attracted to the Project roads or infrastructure within the PDAs at that time for insect relief. Thus, the effect of PDAs as attractants to caribou for insect relief is not anticipated to result in a residual effect to Bathurst caribou.

Should the calving range of the Bathurst caribou shift to the east of Bathurst Inlet, then there is possibility that this herd may be observed at the Goose PDA during the summer, when caribou could be attracted to infrastructure for insect relief. However, the likelihood of this effect is small and no residual effect is predicted. Should the calving range overlap the Project site, it is unlikely that caribou would be attracted to the site for insect relief because the calving period is too early in the season for insect harassment.

Beverly Caribou

Beverly caribou occur within the wildlife RSA during the summer season (July 21 to August 31) when insect harassment is an issue and may be attracted to project infrastructure for insect relief. However, the southern RSA has extensive areas of rocky bluffs, eskers and lakeshores which will also serve as insect relief for caribou. It is unlikely that Beverly caribou will be attracted to the PDAs when there are many alternate areas for insect relief that do not have human presence and noise. Should any Beverly

caribou use the site for insect relief, standard traffic management will ensure that no vehicle-caribou collisions occur (see Section 5.5.2.4).

Baseline studies indicated that Beverly caribou will occur in the wildlife RSA at low numbers during the winter, when the winter roads are active. The northern edge of the winter range intersects the southern portion of the wildlife RSA, with approximately 0.01% of the Beverly winter range overlapping the Winter Road PDA. Should any Beverly caribou be attracted to the winter road as a movement corridor, standard traffic management will ensure that no vehicle-caribou collisions occur (see Section 5.5.2.4).

Overall, attraction of Beverly caribou to PDAs and winter roads is not anticipated to occur and is not expected to result in a residual effect.

5.5.2.7 Exposure to Contaminants

Exposure to contaminants in caribou due to the Project was evaluated in the Country Foods Effects Assessment (Volume 8, Chapter 5) and in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in soils and surface waters, and evaluation of predicted future vegetation concentrations (upon which caribou forage), relative to baseline, were either less than one (which means future concentrations are predicted to be less than soil or water quality guidelines), or are predicted to be within the range of baseline. Therefore, risks to caribou are considered to be negligible. Thus, a residual effect due to exposure to contaminants in caribou is not anticipated, and is not considered further in the assessment.

5.5.2.8 Reduction in Reproductive Productivity

This section evaluates the potential for Project-related effects to alter the reproductive productivity (number of calves) of caribou populations in a two-step process. First, the potential factors that are thought to affect reproductive productivity are reviewed from the scientific literature and TK. Second, each of these factors is assessed for potential interactions with predicted Project-related effects evaluated in Sections 5.5.2.1 through 5.5.2.7.

Several potential factors are thought to affect reproductive productivity in barren-ground caribou. These factors include:

1. forage availability;
2. annual variation in food quality;
3. disease and parasites;
4. insect harassment;
5. predation;
6. fire in the winter range;
7. harvesting;
8. climate change, and;
9. industrial development.

Caribou populations are thought to be driven by both density-dependent and density-independent factors (Solberg et al. 2001; J. Tews, M.A.D. Ferguson, and L. fahrig 2007; Joly, Klein, Verbyla, Rupp and Chapin 2011). Density dependent factors include those variables that restrict population growth when the density of the population increases (J. Tews, M.A.D. Ferguson, and L. fahrig 2007).

Density dependent factors can regulate the size of wildlife populations. For instance, as a population increases, the food available per animal typically declines, which can result in reduced female body condition and reproductive rate. Density independent factors may alter the size of caribou populations, but act across a spectrum of population sizes. Density independent factors include variables that have the same proportional effect on population regardless of population densities (J. Tews, M.A.D. Ferguson, and L. fahrig 2007).

Food Availability and Quality

Food availability for caribou can be both a density dependent and a density independent effect for caribou. The area and abundance of forage can be considered as responding to density dependent effects. Seasonal alterations in forage quality can be considered a density independent effect and is discussed in the Section "Weather-Dependent Food Quality".

Food availability, as defined by the area of foraging habitat and the quality of forage in that area, has been cited as one of the most important criteria for influencing the distribution and abundance of migratory tundra-dwelling caribou (Reimers 1983; Post and Klein 1999; Bergerud, Sluttich, and Camps 2008). Habitat selection by caribou is primarily dictated by their nutritional requirements and the distribution and availability of suitable forage (G. W. Calef 1981; J. H. Russell 1998).

Forage abundance, as indicated by dietary digestible biomass, is an important driver of caribou movement patterns (Avgar, Street, and Fryxell 2015) and barren-ground caribou migrate large distances each year to take advantage of the most nutritious sources of vegetation available. The loss of areas of high-quality habitat could result in higher densities of caribou in the remaining habitat and consequent density-dependent effects (W. J. Sutherland 1996).

Female caribou who have access to more or better quality forage have larger masses, and maternal mass has been positively correlated to body condition of calves at birth (Taillon, Brodeur, and Festa-Bianchet 2012). The effect of maternal mass on calf condition is greatest at weaning and depends on the quantity and quality of forage and milk (Taillon, Brodeur, and Festa-Bianchet 2012). Poor body condition of juveniles could persist to adulthood (Forchhammer et al. 2002; Gaillard et al. 2003) thereby reducing reproductive success (Forchhammer et al. 2002) and delay age at first reproduction (Langvatn et al. 1996; Festa-Bianchet, Gaillard, and Jorgenson 1998). Hence, as the area or quality of foraging areas declines, so does calf body condition, and thus reproductive productivity.

When caribou populations reach a large size, they can deplete the available forage in their seasonal habitats, resulting in density-dependent population limitation (a food-mediated high), population declines or range shifts as caribou go in search of new habitat. Grazing and trampling of vegetation by large numbers of caribou can decrease the amount of available vegetation thus affecting the quality of the range (Klein 1968; Moser, Iii, and Thomson 1979; Morneau and Payette 1989; Arsenault et al. 1997; Joly, Bente, and Dau 2007). This in turn could result in decreased growth, poor body condition and increased vulnerability of caribou to predation, and overwinter survival.

The historical cumulative effect of overgrazing on caribou calving, summer or winter ranges can be shown to result in periodic range shifts and large population fluctuations. Further migrations that caribou may have to take to find abundant forage as a result of range shifts could lead to additional energetic expense, and in combination with other stressors (i.e. predation, hunting pressure, industrial development and climate change) these increases in energetic cost could be detrimental to caribou populations (Joly, Bente, and Dau 2007; Joly, Chapin, and Klein 2010). Recovery of depleted seasonal ranges could take decades and may be prolonged due to continuous grazing and damage to forage due to trampling during migration to and from their seasonal ranges as well as by changes in climate and by

wildfire frequency on the winter range (Joly, Jandt, and Klein 2009; Klein and Shulski 2009; Joly, Chapin, and Klein 2010).

The definition of high-quality habitat and the potential effects of limiting high-quality habitat change with the seasons and the location of caribou in their yearly migration. The following sections describe high-quality habitat for each season and review the available research for the effects of altering the abundance of each habitat.

Calving

During the calving period, caribou in the central Canadian Arctic are known to select flat, open terrain areas that support abundant lichen and green vegetation with a diversity of vegetation types (Griffith et al. 2001). During this time, caribou forage primarily on lichens (Griffith et al. 2001) prior to shifting to relatively protein-rich spring vegetation which includes sedges, mosses, grasses, and shrubs as they become available. During these periods, caribou prefer the lichen veneer, riparian shrub and birch seep habitats (Griffith et al. 2001; C. J. Johnson et al. 2005b).

Barren-ground herds of caribou traditionally show strong fidelity to their calving grounds. However, shifts in caving grounds have occurred for some herds, including the Bathurst herd of caribou where calving grounds have shifted between the east and west sides of the Bathurst Inlet (A. Gunn et al. 2008). Several hypotheses have been suggested to account for these shifts in calving ranges including the theory that as caribou numbers increase, caribou may shift their calving grounds due to increased number of female caribou and calves over-grazing the calving and summer ranges thus. Caribou may consequently move their calving areas to new areas with higher biomass (A. Gunn et al. 2008). The George River herd has also shifted its calving ground toward the treeline during an increase in the herds between 1978 and 1992. These shifts were attributed to overgrazing as cows expanded into areas not recently used (Bergerud, Sluttich, and Camps 2008).

Post-Calving and Summer

Throughout post-calving and summer, barren-ground caribou require habitat that provides nutritious forage associated with dense green leaf biomass areas consisting of willows, grasses, sedge, and other green vegetation (Griffith et al. 2001; Thorpe et al. 2001a) which provides high protein content (McNeil et al. 2005). The post-calving and summer season is a time when calves are growing and, in the late summer, when animals are fattening-up for the winter.

In recent years, researchers have examined the effects of forage availability during summer on reproductive productivity by investigating how yearly variation in vegetation quality affects female body weight and calf survival. Body weight of caribou is reported to be largely determined by the summer foraging conditions (Reimers 1997; Colman et al. 2003a).

Researchers have also reported density-dependent effects on summer forage, where large herds reduced the available forage in their summer range. In northern Quebec, significant differences in body condition and subsequent demographic parameters were found between the Riviere George and Riviere aux Feuilles herds related to density-dependent habitat conditions on the respective summer ranges (Crete and Huot 1993).

Fall

In fall, barren ground caribou herds require habitats that have abundant forage but also facilitate travel to wintering grounds. Caribou will continue to consume green, summer forage, and switch to lichen veneer as green forage becomes less available (C. J. Johnson et al. 2005b). Caribou breed during the fall rut but implantation of the fertilized egg is delayed and can be aborted if animal condition is

poor during winter. Birth mass is also positively related to fall population productivity and (Couturier et al. 2009) and juvenile mass at the onset of winter is thought to be a determinant of survival to 1 year (Gaillard et al. 1998; Hewison and Gaillard 2001; Taillon, Brodeur, and Festa-Bianchet 2012). Hence, high quality forage may be important to caribou productivity during the fall.

Winter

Energetic stress is highest in female caribou during lactation and winter. Female caribou give birth at a time when they are protein deficient, because their primary winter food—lichen—is protein poor (Parker, Barboza, and Stephenson 2005). Consequently, females require abundant forage rich in protein during the post-calving period, in order to restore protein reserves and meet the protein demands of lactation (Barboza and Parker 2008; Parker, Barboza, and Gillingham 2009). In winter, female caribou must maintain sufficiently high fat reserves to avoid using protein reserves that are necessary for foetal growth and survival (Post and Klein 1999; Barboza and Parker 2008).

On their winter range, large, migratory herds of barren-ground caribou both require abundant lichen biomass for overwinter diet and affect lichen availability (Moser, Iii, and Thomson 1979; Arsenault et al. 1997; Joly, Chapin, and Klein 2010). Grazing and trampling of vegetation by large numbers of caribou on their winter range can decrease the amount of available lichens thus affecting the quality of winter range (Klein 1968; Moser, Iii, and Thomson 1979; Morneau and Payette 1989; Arsenault et al. 1997; Joly, Bente, and Dau 2007). For example, in the northern portion of the current winter range of Western Arctic Herd of caribou in Alaska, lichens, which were once abundant, have been reduced by a third within one decade (Joly, Chapin, and Klein 2010). This reduction in lichen biomass could push winter range lichen abundance below desired thresholds for the herd (Jouko Kumpula, Colpaert, and Nieminen 2000). Once lichens are depleted on their winter range areas, caribou may expand or shift their distribution to find new areas with high lichen abundance (Ferguson, L. Gauthier, and F. Messier 2001; Joly, Bente, and Dau 2007; Klein and Shulski 2009; Joly, Chapin, and Klein 2010).

Annual Variation in Food Quality

Several studies have linked seasonal forage quality to caribou productivity, particularly on the summer and winter ranges. Access to high quality summer forage has been shown to account for over 50% of the variation in calf:cow ratio in late winter (Wenjun Chen et al. 2014). These results suggest that high quality summer forage facilitates better body condition of calves, which in turn can survive overwintering when nutritional forage is limiting. However, a separate study found that compensatory growth in smaller individuals occurred during winter months (see below), not summer, for young caribou (Dale et al. 2008). During years with poor summer weather, cows may face limiting forage availability and prioritize maternal energetics over calf growth and survival during poor condition years to preserve the ability for reproductive success in the future (Stopher et al 2008).

In Alaska, the condition of cows and calves of the Porcupine herd at the end of June predicts their condition during the autumn breeding season. If animals are in poor condition in fall, then pregnancy rate is reduced, age of first reproduction may be delayed, and winter mortality will increase (D. E. Russell and McNeil 2005).

Access to lichens in winter can be affected by snow depth and hardness (Collins and Smith 1991) and thaw-freeze events can cause inaccessibility to lichens by creating an ice layer. For example, catastrophic die-offs of the Peary herd caribou have occurred as a result of severe ground icing events (COSEWIC 2004). Thus, caribou select their winter range by balancing the amount of lichen available with the snow conditions present (Anne Gunn et al. 2009) and search out areas where they can easily dig through snow to access lichens (Steve G. Fancy and Robert G. White 1985). Several studies have demonstrated that winter nutrition is linked with adult survival, timing of parturition, neonatal

survival, and postpartum mass (Espmark 1980; Skogland 1983, 1984; J. Z. Adamczewski et al. 1987; Cameron et al. 1993; Cameron and Hoef 1994).

A study on late-winter barren-ground caribou have indicated that levels of hormones indicating nutritional stress were detected in areas of low habitat quality an physiological stress was greatest for pregnant cows with increased demands during winter gestation periods (Joly, Wasser, and Booth 2015). In addition, relationships between caribou activity levels and snow depth suggest demonstrate that caribou need to expend additional energy when foraging for food in areas with deep snow cover or ice (Mosser et al. 2014), potentially creating a larger energy deficit during this time. Greater snow depths reduce the ability for caribou to move across the landscape(Avgar et al. 2013) to find better sources of food availability, which in turn is energetically costly (Steve G. Fancy and Robert G. White 1985).

Disease and Parasites

Disease and parasites can act in both a density dependent and independent manner. As populations of caribou increase, transmission rates of disease and parasites can increase, resulting in a density dependent effect. Disease and parasite numbers can also respond to climate shifts and stochastic effects in a density independent manner, as discussed in the section on the effects of climate change below.

Disease plays a role in wildlife population dynamics and in concert with other factors can influence population dynamics (Bradley and Altizer 2005; S. Kutz et al. 2009). Disease can also act as a burden to caribou through increased energetic costs as a result of immune response (Anne Gunn and R. Justin Irvine 2003; Åsbakk et al. 2005).

To date, there are significant gaps in the understanding of the effects of disease on caribou herds in the Arctic (Curry et al. 2011). Recently in the Bathurst herd, *Mycobacterium avium* subspecies *paratuberculosis* (MAP) which is the causative agent of Johne's disease has been positively detected by fecal culture and PCR in 1.8% of the samples collected (Forde et al. 2012). In addition, local hunters of the Dolphin and Union herd caribou have reported more animals in poor physical condition with signs of disease relative to previous years (Dumond and Lee 2013). In addition, there is concern that caribou may carry diseases that may be transmissible between animals and humans (e.g. Brucellosis and toxoplasmosis) and may be a potential health risk for harvesters who may consume raw or undercooked meat (Mcdonald et al. 1990; Lévesque et al. 2007; Glynn and Lynn 2008).

Vectors of disease to caribou can include insect parasites such biting flies (Glover, Swendrowski, and Cawthorn 1990; Lefebvre et al. 1997; Dubey et al. 2004) that are a burden on caribou in terms of resources required for larval growth and development (Nilssen 1997) and blood loss (Syroechkovskii 1995). Several species of gastrointestinal parasites have been documented in barren-ground caribou belonging to the Beverly herd (Fruetel and Lankester 1989). In the Dolphin and Union herd, a positive relationship with nematode burden and body condition and a decrease in back fat and decreased pregnancy was associated with increased warble flies in female caribou over 2 years of age (Hughes et al. 2009).

Toxoplasma gondii is a parasite that occurs in a number of warm-blooded animals and has been documented in caribou herds from Nunavut and Northwest Territories including in the Bathurst, Beverly and Dolphin and Union herds (S. J. Kutz et al. 2001). Clinical disease resulting from *T. gondii* has not been documented in free-ranging caribou (S. J. Kutz et al. 2001), however, in experimental clinical trials with captive reindeer, acute, severe, fatal hemorrhagic enteritis occurred in one animal (Oksanen et al. 1996). Infections of *Besnoitia tarandi*, a tissue dwelling parasite, have been reported in caribou across the arctic and subarctic (Leighton and Gajadhar 2001). Infected caribou show

decreased mobility and resistance to movement similar to domestic cattle and horses (Heerden et al. 1993; Renaud 2004), which can increase susceptibility to predation and consequently decrease survival rates, especially during times of nutritional stress over winter. In addition, the negative effects of parasites may be greatest when multiple parasite species are present, during periods of unfavourable environmental or range conditions (Helle and Tarvainen 1984; Albon et al. 2002; Slansky 2007; Careau, Thomas, and Humphries 2010).

Parasites can also affect the condition, fecundity, survival or grazing behaviours of caribou (Anne Gunn and R. Justin Irvine 2003; Irvine 2006) by having a negative impact on foraging, herding behaviour and movement during summer (Folstad et al. 1991; Hagemoen and Reimers 2002; Fauchald et al. 2007). This is discussed further in the insect harassment section. Pregnancy rates and calf survival are important for recovery of herds and may be negatively affected by parasites (J. Adamczewski et al. 2009). In response to parasitism caribou make tradeoffs in energetic and nutrient allocation between reproduction and survival (Albon et al. 2002; Burns, Goodwin, and Ostfeld 2005). Health of adult caribou can compensate for the effects of parasitism even with energetic costs associated with immune responses (Scheer 2008). However, calves experiencing their first exposure to parasites lack antibodies against parasites (Åsbakk et al. 2005), and may be more vulnerable to the energetic costs associated with parasites while concurrently facing significant costs of growth and development (Helle and Tarvainen 1984; Albon et al. 2002; Hawlena et al. 2006; Slansky 2007; Careau, Thomas, and Humphries 2010). Increased mortality of calves during the winter may be associated with high parasite infestations during warm summers that favour insect activity (Klein 1991). Calves exposed to high parasitism who survive over winter may experience fitness consequences that continue into adulthood (Klein 1991).

Predation

Predation is thought to be a density dependent effect for caribou for a certain range of caribou population sizes. From low to medium population sizes, wolf predation has been hypothesized to have a regulatory effect on caribou populations leading to stable low population size known as a “predator pit”. However, at higher caribou populations, the effect of wolf predation plateaus due to intra-specific competition for wolf territories, and caribou populations can continue to increase until they are limited by forage supply.

Research suggests that when caribou numbers increase and caribou expand their summer range, more caribou come within the hunting rages of denning wolves which in turn can increase wolf pup survival, ultimately increasing the population of wolves (D. C. Heard and Williams 1992) and predation pressure on caribou. Similarly wolf populations can collapse when abundance and distribution of caribou is low, thus providing a feedback loop whereby the caribou population can recover.

However, other prey species, such as moose on the caribou winter range, may support wolf numbers and reduce any numerical or functional responses of wolves to changes in caribou numbers. This can theoretically lead to high predator densities, even at low densities of caribou resulting in increased proportion of predation on caribou at low population sizes, an inverse density dependent effect (Bergerud and Elliot 1986; Seip 1991).

In addition to population regulation, wolf predation also influences habitat choice for caribou on large migratory scales. For example, even though food quality on the calving grounds has been demonstrated to be less than more southerly areas where bulls tend to forage during the spring, northerly calving grounds are chosen by pregnant female caribou as the trade-off because there is a decreased pressure from predation in these areas, where calf survival may be greater as a result (Bergerud and Ballard 1988; Bergerud, Ferguson, and Butler 1990; S. G. Fancy and Whitten 1991; R. D. Cameron et al. 1992; Douglas C. Heard and Ouellet 1994). Wolf densities on Bathurst herd calving grounds were

approximately 22% of that on the winter range. Wolves are generally limited to more southerly areas relative to these calving grounds at this time where the soil is suitable for successfully digging dens for pupping (D. C. Heard and Williams 1992; Walton et al. 2001; McLoughlin et al. 2004). Thus, a seasonal relationship exists between predation and other factors that can influence caribou population dynamics. The seasonal influence of predation risk to caribou has been documented in other studies assessing the distribution and movements of herbivores and areas of high predation risk (C. J. Johnson et al. 2002; Fortin et al. 2005; Hebblewhite and Merrill 2007; Briand et al. 2009; Gervazi et al. 2013). Broad-scale association between the distribution and movements of wolves and caribou on the Bathurst herd's annual range also was noted by Walton et al. (2001). These studies suggest that caribou may modify their behaviour in response to seasonal and temporal variability of predation.

Insect Harassment

On the post-calving and summer range, barren-ground caribou are harassed by biting and parasitic insects including mosquitoes, black flies, and oestrid flies (Colman et al. 2003a). Insect harassment can be considered a density independent effect, since it occurs across a spectrum of herd sizes.

Insects are abundant on warm days when wind speeds are low (Boulanger et al. 2004) especially for the two weeks spanning late June or early July (Thorpe et al. 2001a). Insect harassment during the post-calving and summer season can cause caribou to alter their habitat selection and seek shelter in windy, elevated areas such as eskers, or riparian communities and shores of lakes, rivers and the ocean (R. G. White et al. 1975; Downes, Theberge, and Smith 1986; Murphy and Curatolo 1987; D. E. Russell, Martell, and Nixon 1993; Thorpe et al. 2001a; Hagemoen and Reimers 2002; A. Gunn and R.J. Irvine 2003). Often these areas are devoid or limited in suitable forage relative to surrounding areas (R.D. Boertje 1981; D. E. Russell, Martell, and Nixon 1993; Skarin et al. 2004). In addition, caribou have often been seen swimming in lakes to escape the heat and insects.

As insect harassment increases, caribou travel rates typically increase and feeding declines (Bergerud, Sluttich, and Camps 2008). Thus, insect harassment can interfere with foraging behaviour, and increase energy expenditures and can create a negative energy balance, by increasing time involved with energetically costly behaviours (D. E. Russell, Martell, and Nixon 1993; Toupin, Huot, and Manseau 1996; Colman et al. 2003a). Evidence suggests that harassment by insects may be the most important causal link between warm summer temperatures and low body condition of caribou (reviewed in Weladji, Holand, and Almøy 2003).

Female lactating cows and calves are particularly vulnerable to the effects, of insect harassment (S.G. Fancy 1986; Hovey et al. 1989; D. E. Russell, Martell, and Nixon 1993). If nutritional assimilation has not been met during the post-calving and summer foraging season, it can lead to lower body mass (Helle and Tarvainen 1984; Helle and Kojola 1994; Weladji, Holand, and Almøy 2003) and caribou may fail to breed in the autumn (Thomas 1982) or potentially risk winter starvation (Bergerud 1996; Gerhart et al. 1996), ultimately leading to lower survival rates and reproductive success (Festa-Bianchet, Gaillard, and Jorgenson 1998). As insect harassment can cause calf-cow separation leading to vulnerability of calves to predation, and can contribute to over-heating if caribou run for long periods to avoid insects (Mörschel and Klein 1997; Thorpe et al. 2001a).

Fire

Fire is a factor that can affect forage availability on the winter range of barren-ground caribou. As such, fire can have both density dependent and independent effects on caribou populations. Fire can reduce the overall amount of habitat available in the winter range and theoretically limit the maximum population size of caribou as a consequence. In addition, fire can increase the patchiness of the winter

range, increasing energy expenditure for caribou, who must transit between patches of good quality habitat, a density independent effect.

Forest fires can reduce the amount of forage available to caribou (Scotter 1970) and can increase energetic expenditure of caribou as a result of potential foraging time lost and additional movements made to find appropriate forage (Festa-Bianchet et al. 2011). For example, in a study assessing the abundance of forage lichens on burned versus unburned plots, researchers reported four times the number of forage lichens on unburned plots relative to burned plots within the current winter range of WAH caribou (Joly, Chapin, and Klein 2010). Thus, it was hypothesized that caribou avoid burned habitat as a result of limited lichen forage availability (Joly, Bente, and Dau 2007; T. A. Anderson and Johnson 2014). Small fires are thought to have relatively little impact to caribou herd foraging and movements; larger fires or those that run perpendicular to the migratory routes of barren-ground caribou are thought to have considerable impact to the energetic cost of relocating to new areas (Payette et al. 2004). In addition, in poor years, decline of lichen availability on the winter range as a result of fire can exacerbate stress experience on the summer range (J. Kumpula, Colpaert, and Nieminen 1998; BCMPC 2004) and additive seasonal stress could result in poor body condition, resulting in poor recruitment and increased vulnerability to predation and mortality.

While the effects of fire on winter range are thought to negatively affect caribou energetics, fire may also rejuvenate winter habitat and ensure productive habitat availability in future generations (BCMPC 2004). However, regeneration of forage such as lichens can take several decades to return to their former abundance (Racine et al. 2004; Dunford et al. 2006; Holt, McCune, and Neitlich 2008; Jandt et al. 2008). Thus, the influence of forest fires on caribou population dynamics may contribute to natural decadal variations in caribou abundance.

Harvesting

Wildlife harvest is an important means of providing sustenance for Aboriginal peoples (Thorpe et al. 2001a). Hunting can regulate caribou populations and declines reported in several herds of caribou have been attributed to the influence of subsistence and commercial hunting (Boulanger and Gunn 2007). From a management perspective, caribou harvest management has been of the upmost importance to population management (The Bathurst Caribou Management Planning Committee 2004).

Until recently, the allowable harvest of Bathurst herd caribou did not change based on the size of the caribou population (Nesbitt and Adamczewski 2009; Festa-Bianchet et al. 2011). As the population of the herd declined during the 1990s and 2000s, the number of animals removed remained relatively constant. This resulted in a 10 fold increase in the proportion of allowable harvest of caribou belonging to the Bathurst herd between 1996 and 2009 (Nesbitt and Adamczewski 2009). Harvest can play a stronger role in the decline of caribou herd population sizes in the later phases of decline as the proportion of the herd removed annually increases (Bergerud, Sluttich, and Camps 2008). Thus, hunting may have serious impacts to caribou populations when populations are in a declining phase. In 2010, at the recommendation of the Wek'èezhii Renewable Resources Board, the NWT Government introduced a ban on hunting on the winter range of the Bathurst herd to limit the number of caribou hunted during the time when caribou are most limited by their environment (Nesbitt and Adamczewski 2009; Anne Gunn et al. 2014).

Caribou populations are sensitive to even small changes in the mortality of adult females (Gaillard et al. 2000). Using an estimate of 3,000 – 5,000 cows and 1,000 – 2,000 bulls harvested per year from the Bathurst herd in recent years, harvest is assumed to have a limited impact on the population of the herd, until after year 2000, after which the proportional harvest mortality increased (Boulanger et al. 2011). Boulanger et al. (2011) reported that a similar rate of change in mortality could be induced by a

constant harvest rate at lower population sizes. Further, if harvest rates were additive to predation and other natural sources of mortality, they could potentially cause a negative trend in adult female survival rate (Boulanger et al. 2011).

Hunting alone does not invariably a cause of decline because migratory tundra caribou have declined and recovered in the past, despite Aboriginal hunting (Zalatan, Gunn, and Henry 2006). Hunting may become a threat to a population when technological changes modify the feedback between caribou abundance and hunting effort, or when a population is already declining as a result of other causes (Zalatan, Gunn, and Henry 2006). Changes in hunting technologies such as snowmobiles and aircraft to access herds, and access to wintering areas from winter roads, has increased hunting efficiency even when the herd size declines. For examples, the small Harp Lake herd of caribou in northeastern Quebec disappeared in the late 1970s coinciding with the time when snowmobiles were introduced, increasing hunting rates in the area (Bergerud, Sluttich, and Camps 2008). In addition, a reduced rate of increase in the Riviere-aux Feuilles herd in Quebec coincided with increased hunting by Nunamiut in the late 1800s and early 1900s when rifles were introduced.

While initial declines in the Bathurst caribou numbers may have been a consequence of natural population cycles, biologists have proposed that relatively high winter mortality rates of females to hunting probably resulted in accelerated declines, especially between 2006 and 2009 (J. Adamczewski et al. 2009; Boulanger et al. 2011).

Climate Change

Climate change has been recognized locally and globally as a major threat to maintaining sustainable ecosystems and to the persistence of sensitive species (Pounds et al. 2006). In the Arctic, the effects of climate change are projected to be substantial (ACIA 2005). However, the effects of climate change on various species remains uncertain as several positive and negative effects to species may result (Hulme 2005), the magnitude and direction of these effects are not always clear (ACIA 2005), and magnitude and direction of effects may change over time depending on environmental conditions (J. Tews, M.A.D. Ferguson, and L. fahrig 2007).

Links between ungulate population fluctuations and large-scale climatic patterns, such as the Arctic Oscillation, have been widely documented (e.g. Post and Stenseth 1999; Forchhammer et al. 2002; Zalatan 2006; Joly, Klein, Verbyla, Rupp and Chapin 2011; L. White 2013). Local Inuit have noted a decline in some barren-ground caribou herds as a result of freezing rain conditions. Although on its own, climate change is thought to be a density independent factor that can drive caribou population dynamics, climate may affect both density dependent and density independent factors that control caribou populations. Climate variability can affect the availability or quality of forage (Lenart et al. 2002; J. Tews, M.A.D. Ferguson, and L. fahrig 2007), disease and parasite dynamics (Hueffer, O'Hara, and Follmann 2011), insect harassment (Leslie A. Witter et al. 2012), predation (reviewed in L. White 2013), and fire (Joly, Duffy, and Rupp 2012). Thus, the effects that climate change may have on density dependent and independent factors which can affect population dynamics in caribou are discussed in the following sections.

Effects of Climate Change on Food Availability and Quality

Climate variation and subsequent effects on forage plants have the potential to influence the population dynamics of caribou through 1) effects on the availability of their food supply, and 2) extreme weather events.

Climate change may reduce the quantity of summer forage by low air temperature and low precipitation. In the long term, shrubland and taiga forest could eventually displace arctic tundra as

the growing environment becomes favorable for such species in a process referred to as "shrubification". This could, in turn, adversely affect caribou populations by creating competition for food sources with other browsing ungulates, especially during the winter months.

Alternatively, extensions in the growing season could result in a positive effect from a future climate scenario (ACIA 2005). The abundance and quality of forage are influenced by climate. Increased vegetation biomass could provide caribou with additional forage and result in better overall body condition of caribou to better withstand harsh winters. In a simulation modelling exercise, an increase in biomass strongly decreased population die-off because caribou were less prone to starvation (J. Tews, M.A.D. Ferguson, and L Fahrig 2007).

Climate change may also affect food availability through more frequent extreme climate events. For example, over the last four decades, the Peary caribou herd have experienced significant die-offs as a result of four extreme climatic events, where unusual winter weather caused ice to coat vegetation on the tundra, and thicker-than-usual snow cover makes forage inaccessible leading to malnutrition and starvation (F.L. Miller, Russell, and Gunn 1977; F.L. Miller 1991; A Gunn and Dragon 2002; Frank L. Miller and Gunn 2003; J. Tews, M.A.D. Ferguson, and L. fahrig 2007; Joerg Tews, Michael A. D. Ferguson, and Lenore Fahrig 2007). Reduced food intake can influence pregnancy and calving rates of females. Extreme weather events such as late spring snowfall or late snowmelt can influence access to food and result in lower calf weights or delayed parturition (time of calving), which influences survival of young (Skogland 1984; J. Z. Adamczewski et al. 1987; Cameron et al. 1993).

Predicted future climate change could result in an increase in frequency and severity of such climatic events (2007; Joerg Tews, Michael A. D. Ferguson, and Lenore Fahrig 2007) predicted a 100% increase in the frequency of population die-offs with a 25% increase in forage inaccessibility due to extreme climate events caused by climate change.

Effects of Climate Change on Disease and Parasitism

Climate change may influence disease and parasitism in caribou in the Arctic. A recent study has suggested that accelerated climate change in the northern latitudes may affect the populations of disease vectors and consequently the abundance and distribution of ungulate populations. An increase in temperature during the growing season (post-calving and summer) is predicted to result in an increase in the distribution and number of insects and parasites and ultimately disease in barren-ground caribou populations (Joly, Klein, Verbyla, Rupp and Chapin 2011).

Changes in the prevalence and severity of some diseases has already been documented over the past decade, and has been attributed to climate change (Harvell et al. 2009; Baker-Austin et al. 2013; Garrett et al. 2013; Burge et al. 2014). In caribou, changes in the life-cycle and infection rate of *O. gruehneri*, have been documented (Hoar, Ruckstuhl, and Kutz 2012; Molnar et al. 2013). Results of these studies have indicated that caribou may be at increased risk of infection from *O. gruehneri* as a result of increased minimum temperatures and an extended growing season which may enhance the development and transmission of *O. gruehneri* (Hoar, Ruckstuhl, and Kutz 2012; Molnar et al. 2013) of a shift to two peaks of annual transmission. However, climate change may not always benefit parasitic transmission, and increases in the magnitude and extent of maximum temperatures may negatively impact parasite development and transmission (Hoar, Ruckstuhl, and Kutz 2012).

Disease dynamics will also likely be influenced by climate-induced shifts in phenology and species movements (I. C. Chen et al. 2011). As climate warms, and the terrain changes, many species may move towards higher latitudes (Hickling et al. 2006), bringing with them novel groups of pathogens or disrupting established host-parasite interactions (Morgan et al. 2004). Alternatively, changes in current

host behaviours may alter disease in a population. For barren-ground caribou, migration is considered an important parasite avoidance strategy (Hoar, Ruckstuhl, and Kutz 2012), whereby hosts can escape pathogens that may accumulate in the environment or by culling sick animals undertaking strenuous journeys thereby decreasing the risk of transmission to others (Altizer, Bartel, and Han 2011). For animals that use seasonal habitats, diminishing migration behaviours could increase the transmission of infectious disease (Hoar, Ruckstuhl, and Kutz 2012) which is a concern for caribou herds, such as Dolphin and Union and Peary caribou that migrate over sea ice as climate change diminishes the ice (Post et al. 2013).

Effect of Climate Change on Predation of Caribou

Direct and indirect effects of climate change (adverse weather) could increase vulnerability to predation and influence caribou population size (R.D. Boertje, Valkenburg, and McNay 1996; L. White 2013). Climate change may have an effect on precipitation, thus affecting snow depth. An increase in snow depth could lead to a decrease in forage accessibility, and make escaping predators more difficult (Zalatan 2006). In addition decreases in available forage and potential increases in extreme weather events may decrease energy intake and a caribou's ability to evade predation.

Effects of Climate Change on Insect Harassment

Accelerated climate change is predicted in the Arctic, with warming temperatures and it is anticipated that insect harassment on caribou will be intensified with an earlier onset and longer timeframe of insect harassment experienced by caribou (Brotton and Wall 1997; Callaghan et al. 2004). However, few studies have assessed how abundance and activity of different parasitic insects will be affected by changing environmental conditions in the Arctic, thus making it difficult to predict the extent to which climate change will affect the distribution and productivity of caribou populations (A. Gunn and Skogland 1997; Whitfield and Russell 2005).

Insect presence is correlated to temperature (Danks 2004; Quinlan, Douglas, and Smol 2005) and insect harassment may be the most important causal link resulting in reduced caribou body condition during warm summer temperatures (Weladji, Holand, and Almøy 2003). In those studies that have assessed insect abundance and activity at differing temperature regimes, a positive relationship between temperature and insect abundance of mosquitoes, black flies and oestrid flies were generally reported (reviewed in Witter 2010). However, in many cases upper temperature threshold limits were not tested in these studies (reviewed in Witter 2010) and it is possible that high temperatures could suppress insect activity (D. E. Russell, Martell, and Nixon 1993; Hagemoen and Reimers 2002).

Alternatively, increased cloud cover could decrease caribou harassment by insects (D. E. Russell, Martell, and Nixon 1993; Helle and Kojola 1994; Mörschel and Klein 1997), which in turn would allow for more foraging opportunity by caribou. Therefore cool, cloudy summers are more favorable for caribou than clear, hot summers. Other environmental factors such as wind (D. E. Russell, Martell, and Nixon 1993; Toupin, Huot, and Manseau 1996; J. R. Anderson, Nilssen, and Hemmingsen 2001; Hagemoen and Reimers 2002; Weladji, Holand, and Almøy 2003), barometric pressure (Davies 1952; Rowley and Graham 1968), solar irradiation (J. R. Anderson and Nilssen 1996; Weladji, Holand, and Almøy 2003; Danks 2004), time of day (J. R. Anderson and Nilssen 1998; J. R. Anderson, Nilssen, and Hemmingsen 2001; Hagemoen and Reimers 2002), and water temperature (Sommerman, Sailer, and Esselbough 1955; Corbet and Danks 1973; Merritt, Ross, and Larson 1982; Currie 1997), may also affect insect abundance and activity and may differentially change with climate warming.

Effect of Climate Change on Fire

The frequency of forest fires in the caribou winter range below treeline is largely determined by decadal changes in climate such as the Arctic Oscillation (Overland and Wang 2005). Assuming that

current climatic trends continue (IPCC 2007), an increase in fire activity across northern landscapes will further reduce the availability of forested taiga for wintering caribou (Joly, Duffy, and Rupp 2012; Gustine et al. 2014). Larger and more abundant burns, in addition to fewer older and lichen-rich stands, could significantly reduce the area or connectivity of high-quality habitat on the winter range (Cornelissen et al. 2001; Olthof et al. 2008; Joly, Duffy, and Rupp 2012).

Changes in ecosystems, including fire regime, could have profound effects on the distribution and abundance of caribou (J. Tews, M.A.D. Ferguson, and L. fahrig 2007; Tyler 2010; Joly, Klein, Verbyla, Rupp and Chapin 2011). A reduction in the availability or quality of winter range could lead to density-dependent effects of winter forage restriction including reduction in recruitment and body size of adult females (Skogland 1986), as well as altered distribution patterns (Joly et al. 2003; Joly, Bente, and Dau 2007; Joly, M.J., and Jandt 2007; Joly, Chapin, and Klein 2010; Gustine et al. 2014).

Industrial Development

This section reviews the effects of industrial developments on caribou populations and productivity.

Evidence suggests that industrial developments such as forestry, oil and gas, and mining can affect caribou populations, particularly for woodland caribou and in the forested winter ranges of barren-ground caribou (Nellemann et al. 2003a; C. J. Johnson et al. 2005b; R.R. Wilson, Liebezeit, and Loya 2013; Joly, Wasser, and Booth 2015). The effects of industrial developments in forested habitats are both more prevalent and have a broader suite of potential effects than similar projects in barren-ground environments.

Likely the largest impact of developments in forested habitats is the creation of new all-season roads and linear corridors for seismic testing and transmission line rights of way. The density of all-season roads is often considered the primary metric of habitat quality for wildlife in forested environments. All season roads typically have higher speed limits than comparable ice roads and may attract ungulates to the road, through the application of road salt and maintenance of an early seral plant community. These factors can increase the chance of direct mortality to caribou through collisions with vehicles.

All season roads and seismic lines also allow hunting in areas previously inaccessible to hunters. Linear corridors such as roads and seismic lines can also increase the chances of predation where improved sight lines increase the chances of wolves detecting and catching caribou, although most research on linear corridors and predation has been done on boreal caribou.

Researchers have reported that caribou will avoid all season roads and industrial sites in forested habitats (reviewed in Section 5.5.2.2; Disturbance). However, it is unclear which factor is driving this avoidance – the roads themselves, disturbance due to traffic, or risk of mortality from hunting or predation.

Correlations between increased probability of predation of caribou and proportion of recent disturbances have been reported (Leblond et al. 2013) suggesting that caribou have learned behaviours and can alter their behaviours to avoid predation. Adaptive strategies made by female caribou with calves, such as avoidance of linear developments to curtail increased predation risk have been reported (e.g. in areas with high road density) and have resulted in decreased predation of calves relative to females that have not learned to avoid linear developments (Leclerc, Dussault, and St-Laurent 2014). Increases to energetic costs in caribou can result in changes to caribou behaviour, impaired reproduction and parental investment (A. Frid and L.M. Dill 2002) as when caribou are at

increased predation risk, as it may be more beneficial to reduce probably of death than continue fitness-enhancing activities such as grazing, parental care, or mating.

Industrial activities in barren-ground habitats that are supplied by winter roads are thought to have a reduced number of effects on caribou. Effects due to all-season roads are largely removed in barren-ground habitats, thereby reducing or eliminating potential effects of direct mortality from vehicle-wildlife collisions, creating sight-lines for predators, and increased hunting.

Industrial sites and their on-site all-season roads will remove areas of barren-ground caribou, although these areas are typically small compared to the large ranges of migratory caribou. Hence, concern has focused on the remaining potential effects that caribou may be disturbed by industrial activities, resulting in indirect habitat loss, disruption of migration routes, and stress.

Indirect habitat loss has been measured for a variety of industrial sites in both forested and barren-ground habitats (reviewed in Section 5.5.2.2; Disturbance) and has been calculated for the Project using a variety of methods (Section 5.5.2.2). Disruption of movement along migratory routes for caribou was examined in Section 5.5.2.3 by evaluating the location of the Project relative to known movement corridors and bottlenecks, such as crossing points on lakes and rivers.

To evaluate the effects of indirect habitat loss on caribou populations, researchers have attempted to translate the short and medium-term effects of avoidance of industrial sites to individual energetics. Increased movement or decreased feeding opportunities while avoiding a development site can affect the energy balance of an individual caribou.

Energetic modelling has been used to evaluate the energetic gains and losses to a variety of wildlife species, including caribou. However, these models depend on a large list of energetic values associated biological measurements such as measures of loss and gain of fat and protein (Taillon, Brodeur, and Festa-Bianchet 2012), allocation of resources to fetal growth (Barboza and Parker 2008) and milk production (Taillon *et al.,* 2013) combined with herd productivity (Taillon *et al.,* 2013).

Early versions of energetic modelling used in the late 1970s and 1980s were based on energy balance models that attempted to balance energy input with expenditure. Energy balance models were used to assess whether several herds in Prudhoe Bay were nutritionally limited (Russell (1976), the Denali herd in interior Alaska (R. D. Boertje 1985) and the George River herd (Bergerud, Sluttich, and Camps 2008). These models are limited as forecasting tools because they cannot evaluate the influence of multiple variables and potential projects over time frames sufficiently long to be relevant.

Energy balance models have been largely replace by energetic simulation models that can incorporate a larger number of variables and determine the energetic costs of various parameters (such as insect harassment) and include other biological factors (such as foraging strategies. Simulation models can also include a suite of variables such as climate change and industrial development that can affect caribou forage, activity and diet (Murphy et al., 2000; Russell, 2011). These models can therefore be used to assess cumulative effects of these variables on caribou populations (A. Gunn et al. 2013).

Initial energetic simulation models were created for female caribou at Prudhoe Bay (Russell 1976) to assess energetic costs of insect harassment while taking into account foraging strategies. Since then, these models have been used for several caribou herds including the Porcupine herd to simulate energetics of female caribou driven by environmental variables (D. E. Russell, Martell, and Nixon 1993) and a subsequent updated model to account for expenditures associated with maintenance and deposition of body reserves, gestation and lactation (D. E. Russell, White, and Daniel 2005), and integration of nutritional components to determine responses to climate change (Griffith et al. 2002);

Kruse et al., 2004) and effects of climate change (Russell et al. 1996), energy consequences of low flying fighter jet aircraft on the Delta caribou herd in central Alaska (Luick et al. 1996), effects of road and pipeline and climate change to the energetics of Central Arctic herd in Alaska (Murphy et al. 2000); summer range assessment of the George River herd (Manseau 1996), and a full integration of variables including the application of a Resource Selection Function (RSF) model to assess effects of a development and cumulative effects on the Bathurst herd on their summer range (A. Gunn, Russell, and Eamer 2011b). Models of this type often require extensive datasets that are herd specific (Russell 2014).

Recently, models have been further advanced to include protein nutrition in addition to energetics (White et al. 2013). These models have been used to assess the potential effects on the recovery of the North Baffin caribou herd on Baffin Island near the proposed Mary River iron mine (Russell, 2011) and potential effects on the Qamanirjuaq caribou herd in near Baker Lake for the Kiggavik Project (AREVA Resources 2014).

These models have a number of weaknesses that limit their applicability in forecasting effects. Primary among these is that the output of these models is dependent on the quality of the input data. While true of most models, energetics models are particularly sensitive to incomplete data sets. These protein energetics models require a large amount of data to run (White et al. 2014), much of which is unknown for any one caribou herd and must be estimated or inferred. Second, the degree to which caribou may be able to compensate for energy expenditures by increased foraging or adjustments to movement patterns has been largely unexplored.

There remains considerable debate over the true short-term effects of industrial developments on caribou. Several different zones of influence have been reported in the literature. The energetic effects of a ZOI, where caribou are displaced from one area of tundra habitat to another, have yet to be shown conclusively. Finally, it is not clear whether the effects of a project ZOI, should it occur, would be density dependent or independent on a population. Indirect habitat loss may not have any effect on a population that is not at a high population size and therefore not food-limited.

Effects of the Project on Bathurst Herd Caribou Productivity

The proceeding sections described the potential factors which are thought to influence caribou productivity. This section evaluates potential interactions between Project-related effects and those factors that may alter caribou productivity in Table 5.5-14.

Table 5.5-14. Potential Project Effects on Factors Affecting Reproductive Productivity in Bathurst Caribou

Factor Affecting Reproductive Productivity	Potential Interaction	Evaluation of Potential Project Interactions
Forage availability	--	No interaction expected.
Annual variation in food quality	--	No interaction expected.
Disease and parasites	--	No interaction expected.
Insect harassment	--	No interaction expected.
Predation	--	No interaction expected.
Fire in the winter range	--	No interaction expected.
Harvesting	--	No interaction expected.
Climate change	--	No interaction expected.

Forage availability: The Project falls outside of the Bathurst herd range in all seasons in all years 1996-2015 when the herd has been at a low population level. Hence, no interaction is predicted between the removal of habitat within the Goose or MLA PDAs and forage availability for the Bathurst caribou.

However, when the herd was at a high population size, the post calving and summer ranges were larger. At that time, the outer edge of the modeled noise profile for aircraft takeoffs and the 4 and 14 km ZOI for the Goose PDA overlapped with the eastern edge of the post calving range for the Bathurst caribou. Section 5.5.2.2 describes that between <0.1% to 0.4% of post-calving range may be affected by disturbance, based on the method used to calculate disturbance.

It is likely that the effect of disturbance on caribou will be at the lower end of this scale. The upper value was calculated from a 14 km ZOI reported for the Ekati and Diavik mining complex which is over 10 times larger than the proposed Project.

While it is not expected that there will be any measurable effect on caribou reproductive productivity under the current population level, this potential effect is rated as a residual effect following the precautionary principle.

Annual variation in food quality: See above.

Disease and parasites: The Project will not affect the forage availability of the Bathurst caribou (see above) and there is no expected direct interaction between the Project and the likelihood that Bathurst caribou will be subject to diseases and parasites.

Insect harassment: The Project is outside of the current range of the Bathurst caribou (see above). The Project will not alter the amount of insects available to harass caribou. Since the Project is outside of the Bathurst Range, caribou will be able to use Project structures for insect relief (see Section 5.5.2.6, Attraction).

Predation: The Project is outside of the current range of the Bathurst caribou (see above). The Project will not construct any all-season roads in forested areas and so increased predation due to new sight lines along roads will not occur.

Fire in the winter range: The Project is outside of the winter range and will not alter the fire frequency or magnitude in the winter range.

Harvesting: The Project access roads are winter only and do not connect to a populated area. All Project roads will be closed to non-Project personnel. The Project will have a no hunting policy for all on-site personnel. No effect is predicted on harvest levels due to the Project (see Section 5.5.2.5, Indirect Mortality)

Climate change: The Project is outside of the current range of the Bathurst caribou (see above).

Recovery of the Herd

Under the current low population size of the Bathurst caribou during the past ten years, the proposed Project does not overlap the range of the Bathurst caribou. As a consequence, the Project is not predicted to have any effects on the Bathurst caribou at the current low population size, and consequently in the herd's recovery.

Evidence from satellite collars in 1996 and 2003, indicate that when the Bathurst caribou were at a population high, that the eastern edge of the herd range overlapped the Goose PDA during some years. Hence, any effects of the Project on the removal of habitat or disturbance to caribou would only occur at the population high when the caribou herd is more robust and able to absorb effects of disturbance.

Shifts in the Calving Range

The effects assessment evaluated what the potential Project effects would be on Bathurst caribou if the calving range shifted over time (Section 5.5.2.1). The calving range for the Bathurst herd has remained consistently between the Hood and Burnside Rivers for the last 20 years. Assuming that the calving range moved in the first place due to over-grazing of vegetation on the calving range, it is unlikely that calving range will shift in the near future at the current low population levels.

Two potential scenarios were evaluated for shifting calving range; a more likely scenario where the calving range returns to the east side of Bathurst Inlet and a less likely scenario where the calving range shifts to the areas surrounding Contwoyto, Nose and Beechey Lakes. If the calving range were to return to the east side of Bathurst Inlet, then the Goose PDA may occur in the post-calving or summer range for the Bathurst caribou. This would result in the removal of 0.4 to 0.2% ha of this summer range. In the less likely scenario that the calving range moves to the areas surrounding Contwoyto, Nose and Beechey Lakes, then the Project could be in or adjacent to the new calving range.

The Wildlife Mitigation and Monitoring Program (WMMP) Plan includes a program to account for possible shifts in the calving range of the Bathurst caribou (Volume 10, Chapter 20, Section 6.10; Mitigation and Management for Caribou). This program has two components:

1. Yearly monitoring of the location of the Bathurst caribou herd using satellite collars. Should this analysis report that the calving range has shifted, then future mitigation and management at the project can be planned for subsequent years. This includes possible shutdowns of the activities conducted on the Goose site should caribou calving surround the Goose PDA.
2. On-site monitoring for caribou by on-site caribou monitors during seasons when caribou are likely to occur at or near the Project site. Should this on-site monitoring report caribou, then staged management would be triggered, including alteration or cessation of activities for a) helicopters and aircraft, b) vehicles on the ice road, c) above-ground blasting, and d) vehicles on site roads.

With mitigation, shifts in the calving range to either the east side of Bathurst Inlet or the area surrounding Contwoyto, Nose and Beechey Lakes are expected to result in residual effects on caribou, albeit small. In these circumstances, a small, but residual effect of reduction in reproductive productivity is also predicted.

Effects of the Project on Beverly Herd Caribou Productivity

The proceeding sections described the potential factors which are thought to influence caribou productivity. This section evaluates potential interactions between Project-related effects and those factors that may alter caribou productivity in Table 5.5-15.

Forage availability: The footprint of the Goose PDA falls within the range of the Beverly herd, resulting in the removal of <0.01% of post calving and fall ranges and 0.02% of the summer range. As a consequence, a small, but residual effect on habitat loss and disturbance to caribou was predicted in Sections 5.5.2.1 and 5.5.2.2.

Table 5.5-15. Potential Project Effects on Factors Affecting Reproductive Productivity in Beverly Caribou

Factor Affecting Reproductive Productivity	Potential Interaction	Evaluation of Potential Project Interactions
Forage availability	X	The Goose PDA footprint and modeled zone of influence overlap the summer range of the Beverly caribou herd.
Annual variation in food quality	X	The Goose PDA footprint and modeled zone of influence overlap the summer range of the Beverly caribou herd.
Disease and parasites	--	No interaction expected.
Insect harassment	--	No interaction expected.
Predation	--	No interaction expected.
Fire in the winter range	--	No interaction expected.
Harvesting	--	No interaction expected.
Climate change	--	No interaction expected.

Direct and indirect habitat loss within the summer range could be considered a density dependent effect, altering the amount of forage available and thus the possible maximum population size of the herd. If this were the case, then effects of the Project on reproductive productivity would only be apparent at a summer food-regulated population high. Alternatively, disturbance effects could operate on the energetics of caribou across a spectrum of population sizes, resulting in a small, but residual effect on reproductive productivity.

Annual variation in food quality: With the proposed Project located in the summer range of the Beverly caribou, the construction of the footprint and a possible zone of influence of the Project would result in direct and indirect habitat for this herd. There is some evidence that year to year summer forage quality can influence overwinter calf survival. This may indicate that the area of forage is not limiting for caribou. Alternatively, decreases in the area of summer forage may only be felt during years of poor habitat quality. Regardless of which option is more correct, a small, but residual effect on reproductive productivity.

Disease and parasites: There is no expected direct interaction between the Project and the likelihood that Bathurst caribou will be subject to diseases and parasites.

Insect harassment: The Beverly caribou may experience a small positive effect of using the Project structures for insect relief (see Section 5.5.2.6, Attraction).

Predation: The Project will not construct any all-season roads in forested areas and so increased predation due to new sight lines along roads will not occur.

Fire in the winter range: The Project is outside of the forested portion of the winter range for the Beverly herd and will not alter the fire frequency or magnitude in the winter range.

Harvesting: The Project access roads are winter only and do not connect to a populated area. All Project roads will be closed to non-Project personnel. The Project will have a no hunting policy for all on-site personnel. No effect is predicted on harvest levels due to the Project (see Section 5.5.2.5, Indirect Mortality)

Climate change: The Project is within the summer range of the Beverly herd. Any effects of climate change on the summer herd may act to increase or offset predicted effects of direct and indirect habitat loss in this area. For instance, if summer forage quality increases due to a longer growing season, then project effects on this habitat would be offset. However, if climate change led to a decrease in the quality of the summer range, for instance through increased shrub growth, then the two effects could act synergistically.

As a consequence of the overlap of the Project with the summer range of the Beverly caribou and the reports that forage quality on the summer range may alter overwinter calf survival, a small, but residual effect of the Project on reproductive productivity is predicted for the Beverly caribou herd.

5.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10 Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including caribou. In addition, a number of other mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on caribou was predicted to result from habitat loss, disturbance, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to caribou. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

5.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to caribou may include the following:

- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as caribou calving grounds and caribou high use areas (Volume 10, Chapter 20);
- infrastructure designed to minimize the Project footprint to reduce habitat loss for caribou (Project Description; Volume 2, Chapter 2);
- consideration of the location of the stockpiles and windbreaks to minimize dustfall, to reduce habitat degradation for caribou (Volume 10, Chapter 17);
- infrastructure, waste rock storage areas, and the TSF at the Goose Property confined to the local watersheds where the deposits are located, thereby minimizing the Project footprint to reduce habitat loss for caribou (Project Description; Volume 2, Chapter 2).
- open-water season shipping only (no ice-breaking) to avoid loss of ice for migration of the Dolphin-Union herd that migrates across the ice (Project Description; Volume 2, Chapter 2); and
- winter only road access corridors proposed (no all-weather roads for re-supply routes), to minimize direct habitat loss, and habitat degradation due to dust deposition for caribou (Project Description; Volume 2, Chapter 2).

5.5.3.2 Mitigation for Disturbance

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement for Wildlife program (Volume 10, Chapter 20).

A comprehensive mitigation plan for caribou is described in the WMMP (Volume 10, Chapter 20, Section 6.10), which includes details on monitoring and mitigation triggered by caribou observations, including:

- monitoring for caribou using satellite collars, incidental observations and dedicated environmental technicians;
- Triggers for actions will be dependent on how sensitive caribou are in each season and the number of animals. During low sensitivity season, a trigger will require caribou to be closer to the Project and in larger groups to trigger mitigation. In sensitive seasons, the opposite will be true – smaller groups at greater distances will trigger the same mitigation actions;
- should the calving ground of the Bathurst herd shift to overlap the Project site, planned reductions or cessation of Project activities will be conducted the following year;
- should caribou be observed by helicopter pilots, pilots will avoid caribou and report to the sighting to the Environment Team;
- should a drive observe a caribou, the drive will slow down if caribou are near the road, or stop and wait should caribou be on the road or attempting to cross the road; and
- should caribou be observed near the mine site during a sensitive season, then staged reductions in outdoor activities will occur, including vehicle stoppages, halting above ground blasting, and aircraft movement.

Additional wildlife specific measures to minimize the effect of disturbance to caribou may include:

- pre-construction ground clearing conducted outside of sensitive periods for caribou (i.e., spring migration [Beverly herd], post-calving [Bathurst herd]) where possible, to reduce disturbance to caribou;
- winter roads designed to minimize the distance travelled which will reduce the overall noise generated associated with construction and operation (Project Description; Volume 2, Chapter 2);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to caribou (Volume 10, Chapter 18);
- Ground-based observations for caribou conducted prior to blasting during the calving and post-calving periods if incidental observations from helicopters indicate that caribou are in the area (Volume 10, Chapter 20);
- above ground blasting scheduled outside of the peak periods of Bathurst caribou presence in the project area, where possible (Volume 10, Chapter 20);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to caribou (Volume 10, Chapter 18);

- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to caribou habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- Helicopters will remain above prescribed flight altitudes when possible, as recommended in the draft caribou protection measure guidelines. Landing and takeoff will only be conducted when herds of caribou are not present in the immediate area (Volume 10, Chapter 20);
- Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

5.5.3.3 Mitigation for Disruption to Movement

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to caribou:

- winter access roads only, when the majority of caribou are not in the wildlife RSA to minimize disruption of movement for caribou (Volume 10, Chapter 20); and
- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce disruption of movement to wildlife (Volume 10, Chapter 20).

5.5.3.4 Mitigation for Direct Mortality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the WMMP Plan (Volume 10, Chapter 20), and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to caribou may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to caribou;
- caribou will be given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20);
- Stopping trucks when groups of caribou are crossing the road to allow small groups (< 10) or individual wildlife standing on the road to move off the road unalarmed (Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

5.5.3.5 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management

Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to caribou may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project staff and contractors while on site and enforced to prevent an increase in mortality to caribou (Volume 10, Chapter 23).

5.5.3.6 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of attraction to the Project to caribou and other wildlife are described in the Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), and the Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to caribou:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20); and
- a protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers (Volume 10, Chapter 20).

5.5.3.7 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to caribou.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including caribou from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD Cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);

- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10 Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

5.5.4 Characterization of Residual Effects

In Section 5.5.2, eight potential Project effects on caribou were evaluated for their potential to result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Three of these effects were identified as residual effects: 1) habitat loss, 2) disturbance, and as a consequence of these two effects 3) reduction in reproductive productivity. The significance of residual effects are evaluated here for these three effects. Each residual effect is described in this section in terms of eight descriptors (see Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. The magnitude of the residual effect was evaluated by using the information in Table 5.5-2. Table 5.5-3 provides a description of the significance ratings used for residual effects.

5.5.4.1 Habitat Loss

The total area of the Goose and MLA PDAs is equivalent to 6,080 ha during the snow free period, and 9,477 ha while winter roads are active. These PDAs were then compared to the seasonal ranges of the Bathurst and Beverly caribou herds.

Bathurst Caribou

The proposed project infrastructure will not overlap with 1) the current (2009-2015) seasonal ranges of the Bathurst caribou herd while this herd is at a low population size, or 2) the historic seasonal ranges when the herd was larger (>100,000 individuals). Therefore, there is no predicted habitat loss for the herd across their range in their current condition, and also in the scenario should the herd recover.

It is possible that the herd may shift calving grounds to the east side of Bathurst Inlet, as has been documented in the past. Two options were assessed for a potential shift in calving range: 1) a more likely scenario where the calving range shifts to the east of Bathurst Inlet, and 2) a less likely scenario where the calving range shifts to the area surrounding Contwoyto and Nose Lakes and possibly and Beechey Lake. Should the calving range shift and return to the eastern side of Bathurst Inlet where it was from at least the 1930s until 1990, then the Goose PDA may overlap the post-calving and/or summer ranges. Should the calving range shift to Contwoyto and Nose Lakes, then the Project would likely be outside of the herd range. If the calving area included Beechey Lake, then the Project could be adjacent to or inside the calving range. If the calving range shifts in future and the Goose PDA overlaps the herd range, then a residual effect would be predicted.

In conclusion, the proposed Project PDAs do not overlap the seasonal herd ranges of the Bathurst herd during the last 20 years for which seasonal distribution is available from satellite collars (1996-2015).

However, if the calving range were to shift, then a residual effect could be encountered. Despite the fact that the proposed Project does not overlap the seasonal home ranges of the Bathurst herd, given the level of concern for this herd, the potential effect of habitat loss was rated as a residual effect following the precautionary principle.

Should the Bathurst caribou herd remain in the current calving range, which it has occupied for at least the last 20 years, then no effect of habitat loss is predicted because there is no interaction with the Project PDAs. The direction of this effect would be neutral, the magnitude negligible and the duration long term. The PDAs would be continuously outside of the seasonal ranges. The geographic extent would be the footprint, the effect would be reversible and the probability is likely. The confidence in this assessment is high because all of the different forms of baseline data agree that there is no overlap with the 95% herd range (collar data, aerial survey, cameras and incidental observations). The effect of habitat loss on the Bathurst caribou herd under the current and future recovery scenarios is not significant.

Should the calving range shift and return to the east side of Bathurst Inlet where it was from at least the 1930s until 1990, the extent of habitat loss would be the PDA, the frequency would be sporadic, and duration would be long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas within the PDAs will not be affected and may return to baseline conditions. The probability of the effect occurring is unlikely since this herd is at a low population size and is unlikely to deplete the vegetation resources on its current calving ground. Confidence in this assessment is medium. Overall, the potential effect of removing an area of habitat in the Bathurst herd range should this herd change its calving ground is deemed not significant.

Beverly Caribou

The seasonal ranges for Beverly caribou overlapped the Goose and MLA PDAs during the post-calving, summer, fall and winter periods; the winter range also overlapped the Winter Road PDA. In all cases, the area removed due the PDAs from these seasonal ranges totals approximately 0.01% of the seasonal range sizes. When the proportion of habitat loss within these ranges is compared to quantities thresholds for magnitude (Table 5.5-1), the magnitude is considered low.

The extent of the effect of habitat loss is footprint, the frequency is sporadic, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas within the PDAs will not be affected and may return to baseline conditions. The probability of the effect occurring likely, as a small but measureable amount of habitat from seasonal ranges of Beverly caribou will be lost due to the PDAs. The confidence of the effect occurring is considered high, although confidence in the area and proportion of habitat removed from these ranges is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose and MLA PDAs will not be developed, and operation of the winter roads will only cause temporary habitat loss during the winter season only. The residual effect of habitat loss for Beverly caribou is concluded to be Not Significant.

5.5.4.2 Disturbance

Disturbance to Bathurst and Beverly caribou were evaluated by overlaying the seasonal ranges with the results of noise modelled conducted for the Project and also two zone of influence (ZOI; 4 and 14 km ZOIs). The total area where noise is predicted to exceed thresholds for instantaneous blasting noise, continuous Project noise, and intermittent aircraft noise outside the PDAs totals 15,388 ha during the

snow-free period, and 15,147 ha during the winter when winter roads are operational. The total area of the 4 km ZOI was 27,352 ha, while the total area of the 14 km ZOI was 182,617 ha.

Bathurst Caribou

The seasonal ranges of the Bathurst herd in its current condition (population low; data from 2009 to 2015) does not overlap the areas modelled as above noise thresholds or either of the 4 or 14 km ZOIs associated with the Goose and MLA PDAs. There was minor overlap with noise contours and ZOIs in the scenario should the herd recover to >100,000 individuals (data from 1996 to 2006), but only during the post-calving period. This accounted for 55 ha of overlap with areas disturbed by Project noise above thresholds, 1,029 ha of overlap with the 4 km ZOI, and 32,521 ha of overlap with the 14 km ZOI. These areas of overlap represent 0.1 to 0.4% less of the post-calving range. Thus, using the quantities thresholds for magnitude (Table 5.5-1), the magnitude is considered Negligible.

The duration would be long term, the frequency continuous, the extent would be local, and the effect reversible at closure. The probability of this effect is likely and the confidence is high, resulting in a not significant effect.

Should the calving range of the Bathurst herd shift then areas of habitat may be affected by disturbance. The extent of the effect of disturbance is local for the noise modelling approach as most noise exceeding thresholds is contained within the wildlife LSA, though the extent is regional for the ZOI approach as the 14 km ZOI extends beyond the wildlife LSA into the wildlife RSA. In total, the extent is considered local. The frequency for the noise modelling approach is expected to be continuous for general Project noise and sporadic for other sources of Project noise (e.g., blasting and aircraft); the frequency is assumed to be continuous for the ZOI approach as the zones of influence are predicted start during construction of a development and last throughout operations until closure. In total, the frequency is considered continuous. The duration is considered medium as the effect of disturbance is expected to subside at closure. The effect is considered to be reversible as, following closure, disturbance effects will subside and thus it is expected that there is will be no overlap Project noise and ZOIs of the Project with the post-calving range. The probability of the effect occurring is unlikely, since there is no reason to believe that the Bathurst caribou will shift their calving range in the near future. The confidence in the assessment is medium because this herd has shifted its calving range in the past. The residual effect of disturbance on Bathurst caribou is assessed as Not Significant.

Beverly Caribou

The seasonal ranges of the Beverly herd overlapped the areas modelled as above noise thresholds and the 4 or 14 km ZOIs associated with the Goose and MLA in most seasons (post-calving, summer, fall, and winter). Across seasons, the amount of overlap with overlap with areas disturbed by Project noise above thresholds ranged from 238 ha to 15,612 ha, represented roughly <0.01% to 0.05% of the total size of these ranges. The amount of overlap with the 4 km ZOI ranged from 1,625 ha to 27,352 ha, represented roughly 0.01% to 0.08% of the total size of these ranges. In the 14 km scenario, the amount of overlap ranged from 29,265 ha to 182,616 ha, represented roughly 0.2% to 0.5% of the total size of these ranges. Thus, using the quantities thresholds for magnitude (Table 5.5-1), the magnitude is considered low.

The extent of the effect of disturbance is local for the noise modelling approach as most noise exceeding thresholds is contained within the wildlife LSA, though the extent is regional for the ZOI approach as the 14 km ZOI extends beyond the wildlife LSA into the wildlife RSA. In total, the extent is considered local. The frequency for the noise modelling approach is expected to be continuous for general Project noise and sporadic for other sources of Project noise (e.g., blasting and aircraft); the frequency is assumed to be continuous for the ZOI approach as the zones of influence are predicted

start during construction of a development and last throughout operations until closure. In total, the frequency is considered continuous. The duration is considered medium as the effect of disturbance is expected to subside at closure. The effect is considered to be reversible as, following closure, disturbance effects will subside and thus it is expected that there is will be no overlap Project noise and ZOIs of the Project with the ranges of Beverly caribou. The probability of the effect occurring is likely, as a small but measureable amount of habitat from seasonal ranges of Beverly caribou are expected to overlap areas where noise exceeds thresholds and the ZOIs associated with the Project. The confidence in the assessment is high, as caribou are known to be sensitive to blasting activities related to mining and zones of influence are well studied in the scientific literature. The residual effect of disturbance on Beverly caribou is assessed as Not Significant.

5.5.4.3 Reduction in Reproductive Productivity

The potential effect of reduction in reproductive productivity was included in the assessment in order to evaluate the potential for small direct effects to combine and act synergistically on caribou, and result in a change in the ability of caribou cows to produce young. The residual effects of the Project on caribou include habitat loss, and disturbance. These effects combined could result in a reduction in reproductive productivity in caribou. Section 5.5.2.8 reviewed the primary determinants of reproductive productivity and examined how potential Project effects could interact with the factors to alter productivity. Two potential interactions were found, habitat loss and disturbance. These potential effects were also considered as residual effects in the effects assessment. The following sections evaluate the significance of the potential effect of reduction in reproductive productivity on the Bathurst and Beverly caribou herds.

Bathurst Caribou

Should the Bathurst caribou herd continue to use its current calving ground, the potential effects of habitat loss and disturbance were rated as a negligible magnitude because there is currently no overlap between the proposed Project PDAs at either low or high population sizes. As a consequence, it is anticipated that effects on reproductive productivity would also be negligible. The duration would be long term, the frequency continuous, the extent would be local, and the effect reversible at closure. The probability of this effect is likely and the confidence is high, resulting in a not significant effect.

The effects assessment also evaluated the potential for the Bathurst caribou herd to shift its calving ground (likely to the east of Bathurst Inlet where it was from at least 1930 to 1990) and predicted low magnitude effects of habitat loss and disturbance. As a consequence, the potential effect of reduction in reproductive productivity is also rated with a low magnitude effect.

The duration of the effect is expected to be medium as habitat loss may be permanent and the effect of disturbance will last until Project-related activities cease. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the mine is closed. The geographic extent of this residual effect is anticipated to be regional.

However, the likelihood that a reduction in reproductive productivity on caribou will occur is uncertain. The confidence in the effect rating is medium as it is unknown how the residual effects of the Project on reproduction of caribou may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the residual effect of reduction of reproductive productivity is concluded to be Not Significant.

Beverly Caribou

The Beverly caribou herd overlaps the Project site, resulting in the loss of 0.01% of the herd's range and disturbance of an additional 0.01% to 0.08% of the range. This assumes that the noise modeling approach or the 4 km ZOI are more likely than the 14 km ZOI approach, which was based on a mine that is over 10 times larger than the Proposed Project. Under these circumstances, low magnitude effects were predicted for habitat loss and disturbance and are likewise predicted for reduction in reproductive productivity.

The duration of the effect is expected to be medium as habitat loss may be permanent and the effect of disturbance will last until Project-related activities cease. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the mine is closed. The geographic extent of this residual effect is anticipated to be regional.

However, the likelihood that a reduction in reproductive productivity on caribou will occur is uncertain. The confidence in the effect rating is medium as it is unknown how the residual effects of the Project on reproduction of caribou may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the residual effect of reduction of reproductive productivity is concluded to be Not Significant.

5.5.5 Significance of Residual Effects

The effects assessment for caribou identified three residual effects as follows:

- habitat loss, rated Not Significant;
- disturbance, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Habitat loss and disturbance due to the Project leading to avoidance of habitat is anticipated to result in a small effect on the population of Bathurst and Beverly caribou herds as the total amount of habitat lost or altered due to disturbance is small relative to the size of the seasonal ranges for Bathurst and Beverly caribou herds. The calving range for Bathurst and Beverly caribou is outside the RSA. The Bathurst caribou shifted their calving range from the east side of Bathurst Inlet to the west side of the Inlet, between the Hood and Burnside Rivers between 1990 and 1996 and the calving range has remained centered in that location ever since. Thus, these effects will not significantly result in a decline in the caribou populations in the region. A summary of residual effects on caribou and overall significance ratings are presented in Table 5.5-16. Contingent on the implementation of mitigation measures outlined in the WMMP Plan (Volume 10, Chapter 20), the combined significance of residual effects for caribou is predicted to be **Not Significant**.

Table 5.5-16. Summary of Residual Effects on Caribou and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*
Bathurst – current calving area									
Habitat Loss	Neutral	Negligible	Long	Continuous	Footprint	Reversible	Likely	High	N
Disturbance	Neutral	Negligible	Long	Continuous	Local	Reversible	Likely	High	N
Reduction in Reproductive Productivity	Neutral	Negligible	Long	Continuous	Local	Reversible	Likely	High	N
Bathurst – change in calving area									
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Unlikely	Medium	N
Disturbance	Negative	Low	Medium	Continuous	Local	Reversible	Unlikely	Medium	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Continuous	Regional	Reversible	Unlikely	Medium	N
Beverly									
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	Medium	N
Disturbance	Negative	Low	Medium	Continuous	Local	Reversible	Likely	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Continuous	Regional	Reversible	Unlikely	Medium	N

As a consequence of the proposed Project being outside of the seasonal ranges of the Bathurst caribou herd, there is no predicted removal of or disturbance to the habitat for this herd, either at the current low population size (2009-2015) or at the historic high population (1996-2006). As a consequence, it is not predicted that there will be any effect of the Project on the recovery of the Bathurst caribou herd to its former herd size.

As part of the DEIS review, the GNWT requested that the potential effects on the Bathurst herd be evaluated in terms of the timeframes relevant for Aboriginal peoples. As stated above, with the proposed Project PDAs outside of the current and historic caribou seasonal ranges, no effects on these ranges and on the reproductive productivity of the herd are predicted. As a consequence, there is no predicted effect of the Project on the recovery of the herd to its former size. This recovery period can be considered the timeframe relevant to Aboriginal peoples, who are currently unable to harvest caribou from this herd in any meaningful numbers. The proposed Project will not alter this recovery timeframe.

5.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

5.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The cumulative effect assessment (CEA) follows the methodology detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for characterizing potential effects were the same as those used for characterizing Project-related effects (Section 5.5.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 5.5.1) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for caribou.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 5.5.1). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for caribou and not the wildlife RSA.

5.6.1.1 Spatial Boundary

The cumulative effects assessment for caribou considers several spatial boundaries based on the seasonal ranges of these herds when they may come into contact with Project-related activities due to the Back River Project. The potential cumulative effects of habitat loss and disturbance were also considered on the annual herd ranges for Bathurst and Beverly herd caribou for completeness.

Bathurst Caribou

The spatial boundary for the Bathurst caribou is based on the combined post-calving and summer seasonal range of this herd (Section 5.1.2.5). Effects of other projects or anthropogenic activities that occur within the combined post-calving and summer ranges, and within the annual home range for the Bathurst caribou herd are considered in the cumulative effects assessment on this herd (Figure 5.6-1).

Recent research by the Canadian Centre for Remote Sensing has examined the food availability on the post-calving and summer range of the Bathurst herd. This research suggests that the forage availability on the post-calving and summer range may drive natural population change for the Bathurst herd (W. Chen, Russellb, et al. 2013; Wenjun Chen et al. 2014). In years with poor biomass availability, the overwinter survival of calves the following winter is reduced and the growth rate of the herd declines or is negative (Chen et al. 2014).

In order to examine the potential cumulative effects of habitat removal, disturbance and resulting potential cumulative effects on reproductive productivity, the cumulative effects area was set to encompass the combined post-calving and summer range of the Bathurst herd (Figure 5.6-1). This area comprises approximately 8,100,050 hectares. With evidence that forage availability on the post-calving and summer range is driving the population growth rate of the Bathurst herd (Wenjun Chen et al. 2014), this area was used to evaluate cumulative effects. If a larger area is chosen, more projects would be included, but the effects of projects (e.g., the proportion of habitat removed or affected) on the larger assessment area would be diluted due to a proportionally larger area examined.

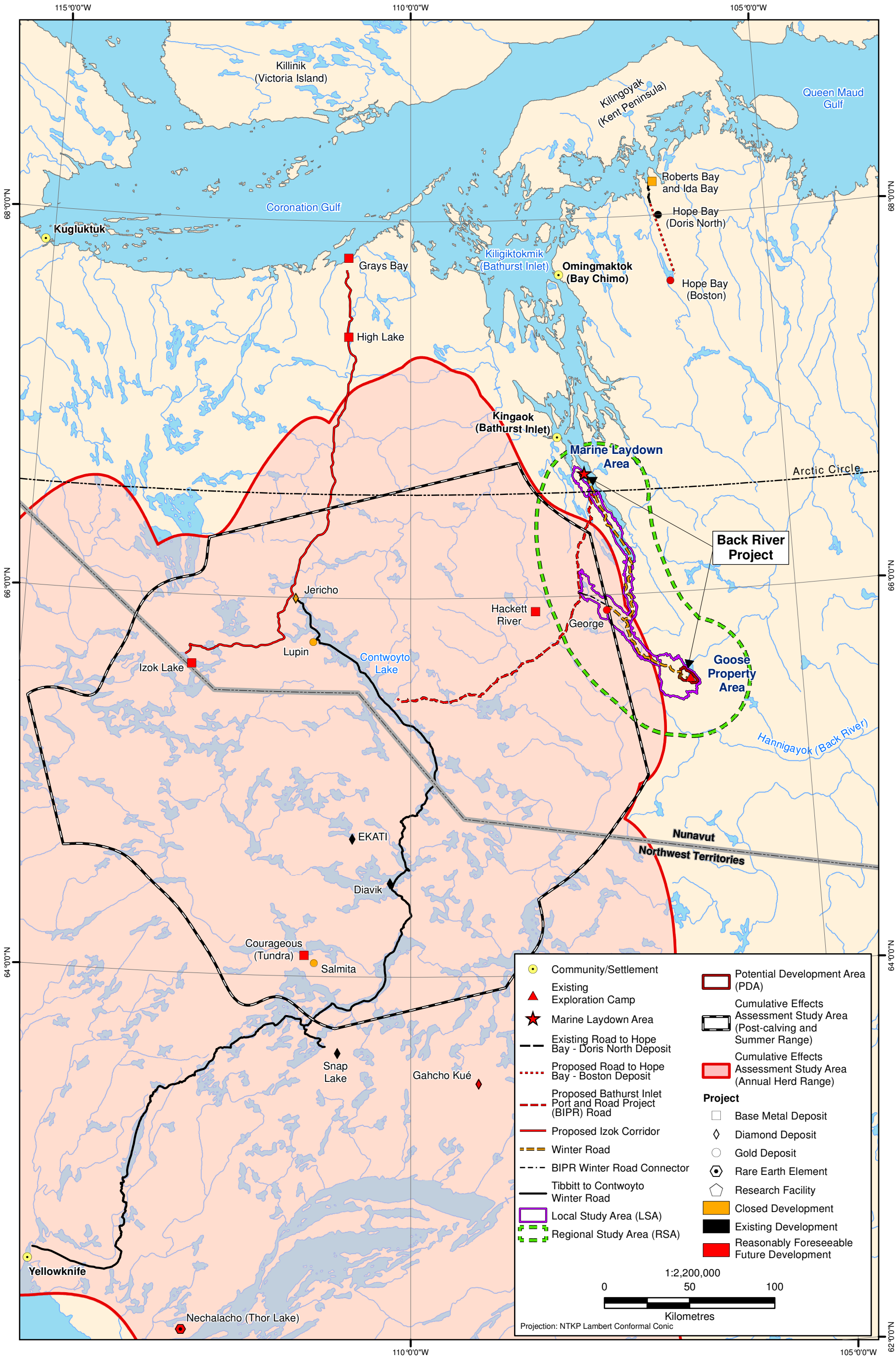
In order to conduct a comprehensive approach to the Cumulative Effects Assessment, the potential cumulative effects of habitat loss, and disturbance were also assessed on the entire annual range of the Bathurst caribou herd. This range was delineated by creating a polygon of the outer contour of the combined seasonal 95% kernel UD polygons developed for the Bathurst herd based on collaring data collected between 1996 and 2015. This area comprises approximately 30,526,670 hectares and includes projects that occur on the winter grounds of Bathurst caribou (Figure 5.6-1).

Beverly Caribou

The spatial boundary for the Beverly caribou is based on the summer, winter, and annual home ranges of this herd (Section 5.1.3). Effects of any other projects or anthropogenic activities that occur within the seasonal ranges for the Beverly caribou herd are considered in the cumulative effects assessment on this herd (Figure 5.6-2).

GIS # BAC-23-380d

November 06 2015



Sabina GOLD & SILVER CORP.

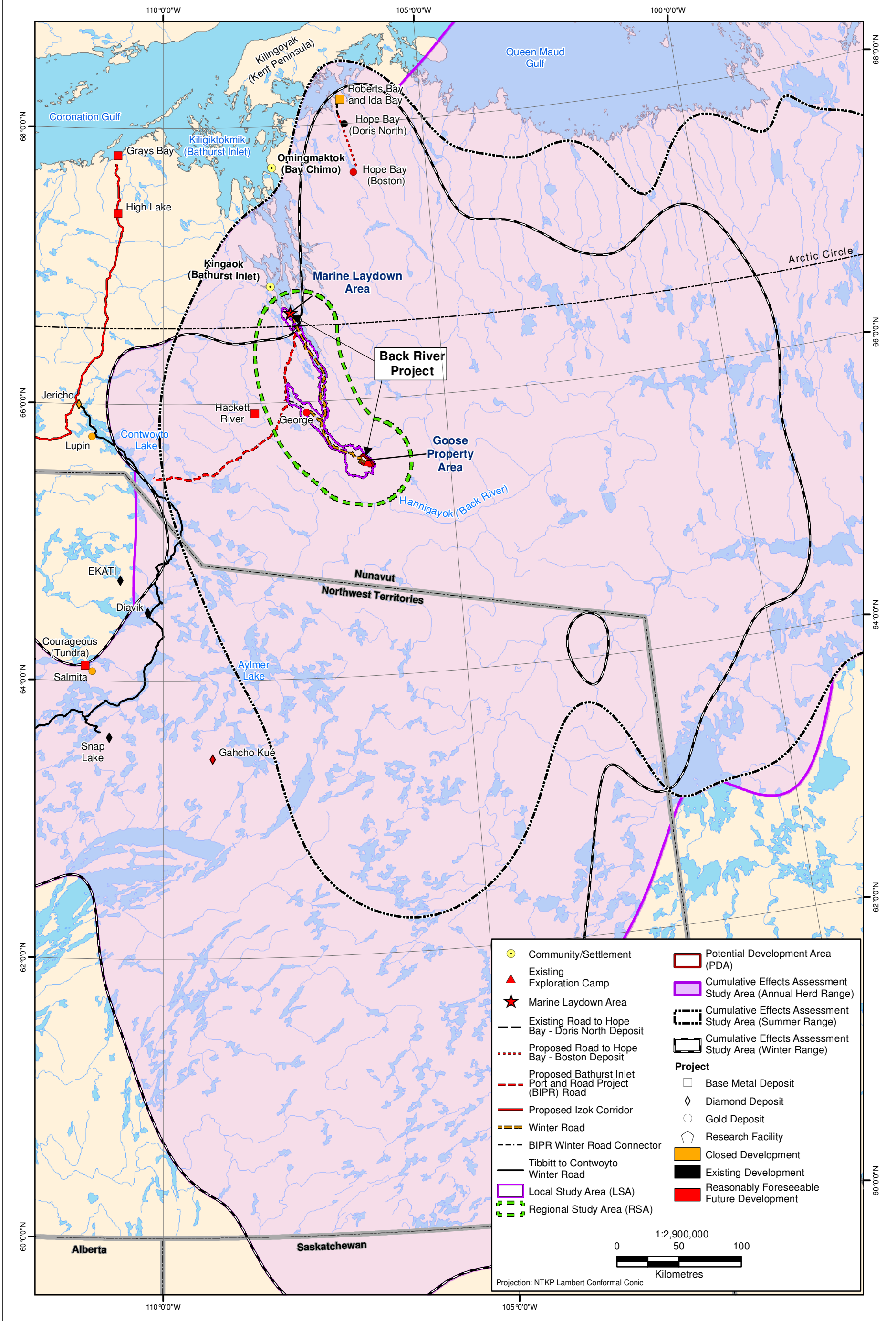
Figure 5.6-1

Spatial Boundary for Bathurst Caribou Cumulative Effects Assessment

Rescan an ERM company

GIS # BAC-23-380e

November 06 2015



Sabina GOLD & SILVER CORP.

Figure 5.6-2

Spatial Boundary for Beverly Caribou Cumulative Effects Assessment

Rescan an ERM company

For the cumulative effects assessment, the information on the importance of the Bathurst herd post-calving and summer range is used to define the Beverly herd CEA spatial boundary. With evidence that forage availability on the post-calving and summer range may drive the population growth rate of caribou, through overwinter survival of calves, it is important to rate the effects of the Project against this area. However, as, the post-calving range for the Beverly herd is outside of the Project RSA and located in the same area as the calving range for Beverly caribou, and no closed, existing, or foreseeable future developments are located within the post-calving range for Beverly herd caribou, only the summer range for Beverly herd caribou is used to define the Beverly herd CEA boundary during the foraging season.

The summer range of Beverly caribou for the cumulative effects assessment was based on 95% kennel UD area defined by satellite collaring data collected from 2001 to 2015 (Figure 5.6-2). It should be noted that this area is likely an overestimate of the summer range as some of the collaring data does not distinguish between the former Beverly herd and Ahiak herd caribou. This summer range CEA area comprises 33,999,052 hectares.

The winter range of Beverly caribou was chosen as a second boundary for the cumulative effects assessment of Beverly caribou. The residual effects due to the Back River Project may be greater during the winter, when the winter roads are active, relative to the summer foraging period and Beverly caribou may interact with the Project during the winter in some years. Thus, to assess the potential cumulative impacts of winter activities from all Projects within the winter range of caribou, the winter range was assessed separately.

Similar to the summer range of Beverly caribou, the winter range was delineated based on collaring data collected between 2001 and 2015 (Figure 5.6-2). As noted above, this area is likely an overestimate, as some of the the collaring data does not distinguish between the Beverly herd and Ahiak herd caribou. This area comprises 40,985,127 hectares.

While the Back River Project also overlaps with the fall range for Beverly caribou, the fall range is contained within the summer and winter ranges for Beverly caribou. The cumulative effects on the summer range would approximate those on the fall range as the habitat quality on summer range is more critical to that on the fall range indicative from the literature that suggests that forage quality on the summer range drives the overwinter survival of calves. No additional past, current, or future foreseeable projects are included on the fall range relative to the summer range, and the fall range represents a larger area relative to the summer range. The inclusion of this additional area contained on the fall range for Beverly caribou would dilute the cumulative effects of all projects considered within the summer range. Thus, the assessment of effects of these projects on the summer range is more conservative to that on the fall range as they approximate a worst case scenario.

In order to conduct a comprehensive approach to the Cumulative Effects Assessment, the potential cumulative effects of habitat loss, and disturbance were also assessed on the entire annual range of the Beverly caribou herd. The annual home range of Beverly caribou is based on a buffer approximating the 95% kernel distribution across the last fifteen years (2001 to 2015). This area comprises approximately 60,663,348 hectares and includes Projects that occur on both the summer and winter grounds of Beverly caribou (Figure 5.6-2).

5.6.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

5.6.2 Potential Interactions of Residual Effects with Other Projects

Three residual Project-related effects were identified during the caribou effects assessment: habitat loss; disturbance due to noise; and reduction in reproductive productivity. These effects were primarily found for the Beverly caribou herd as there was no overlap between the seasonal ranges of the Bathurst herd and the Back River Project infrastructure during the current herd scenario and past herd scenario (prior to 2006). However, due to the status of this herd and the concern for this herd from Aboriginal groups and government regulators, the potential effect of habitat loss, disturbance and reduction to reproductive productivity for Bathurst caribou was carried forward as a residual and is assessed in this cumulative effects assessment. Several additional projects or anthropogenic activities may contribute cumulatively to residual effects if they occur within the seasonal ranges for Bathurst and Beverly caribou that interact with the Back River Project.

Figures 5.6-1 displays the past, present, and foreseeable future developments that could interact with Bathurst caribou in the CEA boundaries for herd. Ten additional projects have been identified within the combined post-calving and summer CEA spatial boundary for Bathurst herd caribou including four past developments which are now closed (Jericho Mine, Lupin Mine, Tundra Mine, and Salmita Mine), two existing developments (Ekati and Diavik Mines), and five reasonably foreseeable future projects (George, BIPR, Hackett River, Izok Corridor, and Courageous Lake projects) in addition to the Back River Project. Within the annual range of the Bathurst caribou, two existing developments were identified (Snap Lake and the Tibbitt to Contwoyto Lake Winter Road), plus three additional future foreseeable projects, the Gahcho Kué, NICO, and Nechalacho (Thor Lake) projects. A description of the type of potential cumulative effect due to all projects combined for Bathurst caribou is listed in Table 5.6-1.

Figures 5.6-2 displays the past, present, and foreseeable future developments that could interact with Beverly caribou in the CEA boundaries for herd. Five projects, in addition to the Back River Project have been identified within the summer CEA boundary for Beverly caribou including one past development (Roberts Bay and Ida Bay project), one existing development (Doris North Project) and four future foreseeable projects (George, BIPR, Hackett River, and Hope Bay [Phase 2]). For the winter CEA boundary for Beverly caribou, projects have been identified in addition to the Back River Project including three past developments (Roberts Bay and Ida Bay, Salmita, and Tundra projects) five existing development (Diavik, Doris North, Ekati, Snap Lake, and the Tibbitt to Contwoyto Winter Road [TCWR]), and six reasonably foreseeable projects (BIPR, Courageous Lake, Gahcho Kué, George, Hackett River, and Hope Bay [Phase 2] projects). On the annual range for Beverly caribou, no additional past, existing or future foreseeable projects occur. A description of the type of potential cumulative effect due to all projects combined for Beverly caribou is listed in Table 5.6-1.

5.6.2.1 Habitat Loss

The Project effects assessment rated the residual effect of habitat loss from the Back River Project as Not Significant, with a low magnitude for both the Bathurst herd caribou during the post-calving and summer periods and for the Beverly herd caribou during the summer, fall, and winter seasons.

Calculation of Habitat Loss

Cumulative habitat loss was calculated in three ways for the Bathurst herd and two ways for the Beverly herd:

1. The total area removed by all projects, compared to the area of the CEA study areas (Bathurst and Beverly);
2. The area likely degraded by dust surrounding each project (Bathurst and Beverly); and
3. The area of high-use habitat, as calculated by a resource selection function for the Bathurst herd.

Table 5.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Caribou in the Area

Herd	Residual Effect from Back River Project	Rating based on Project Effect Assessment	Cumulative Assessment Area	Other Project or Activity			Type of Potential Cumulative Effect
				Past	Existing	Reasonably Foreseeable Future	
Bathurst herd							
	Habitat Loss	Low	Post-calving and Summer	Jericho, Lupin, Tundra, Salmita	Diavik, Ekati	BIPR[1], Courageous Lake, George, Hackett River, Izok Corridor	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
			Annual Range[3]	No additional Projects	TCWR[2] Snap Lake	Gahcho Kué Nechalacho (Thor Lake) NICO	
	Disturbance	Low	Post-calving and Summer	n/a	Diavik, Ekati	BIPR[1], Courageous Lake, George, Hackett River, Izok Corridor	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance
			Annual Range[3]	n/a	TCWR[2] Snap Lake	Gahcho Kué Nechalacho (Thor Lake) NICO	
	Reduction in Reproductive Productivity	Low	Post-calving and Summer	Jericho, Lupin, Tundra, Salmita	Diavik, Ekati	BIPR[1], Courageous Lake, George, Hackett River, Izok Corridor	Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects
			Annual Range[3]	No additional Projects	TCWR[2] Snap Lake	Gahcho Kué Nechalacho (Thor Lake) NICO	

(continued)

Table 5.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Caribou in the Area (continued)

Herd	Residual Effect from Back River Project	Rating based on Project Effect Assessment	Cumulative Assessment Area	Other Project or Activity			Type of Potential Cumulative Effect
				Past	Existing	Reasonably Foreseeable Future	
Beverly Herd							
	Habitat Loss	Low	Summer Range	Roberts Bay and Ida Bay	Doris North	BIPR[1], George, Hackett River, Hope Bay (Phase 2)	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
			Winter Range	Roberts Bay and Ida Bay, Tundra, Salmita	Diavik, Doris North, Ekati, Snap Lake, TCWR[2]	BIPR[1], Courageous Lake, Gahcho Kué, George, Hackett River, Hope Bay (Phase 2)	
			Annual Range[3]	No additional Projects	No additional Projects	No additional Projects	
	Disturbance	Low	Summer Range	n/a	Doris North	BIPR[1], George, Hackett River, Hope Bay (Phase 2)	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance
			Winter Range	n/a	Diavik, Doris North, Ekati, Snap Lake, TCWR[2]	BIPR[1], Courageous Lake, Gahcho Kué, George, Hackett River, Hope Bay (Phase 2)	
			Annual Range[3]	n/a	No additional Projects	No additional Projects	

(continued)

Table 5.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Caribou in the Area (completed)

Herd	Residual Effect from Back River Project	Rating based on Project Effect Assessment	Cumulative Assessment Area	Other Project or Activity			Type of Potential Cumulative Effect
				Past	Existing	Reasonably Foreseeable Future	
Beverly Herd (cont'd)							
	Reduction in Reproductive Productivity	Low	Summer Range	Roberts Bay and Ida Bay	Doris North	BIPR[1], George, Hackett River, Hope Bay (Phase 2)	Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects
			Winter Range	Roberts Bay and Ida Bay, Tundra, Salmita	Doris North, Diavik, Ekati, Snap Lake, TCWR[2]	BIPR[1], Courageous Lake, Gahcho Kué, George, Hackett River, Hope Bay (Phase 2)	
			Annual Range[3]	No additional Projects	No additional Projects	No additional Projects	

[1] *BIPR = Bathurst Inlet Port and Road Project*
[2] *TCWR = Tibbit to Contwoyto Winter Road*
[3] *Projects that may interact with the Bathurst herd or Beverly caribou on annual range in addition to seasonal CEA boundaries*

The amount of habitat removed ("area removed") was estimated from the generalized footprints of all projects and road corridors in the combined post-calving and summer CEA boundary for Bathurst herd caribou and the separate summer and winter CEA boundaries for Beverly herd caribou and used as a key indicator to determine potential cumulative effects. The fall boundary for Beverly herd caribou was not included in the cumulative effects assessment as habitat loss during the summer season would represent a worst case scenario during the entire foraging season (post-calving through fall). The Beverly herd winter cumulative effects assessment includes the calculation of potential effects due to the winter roads. Winter roads are not anticipated to result in an effect during the foraging season, thus are not assessed in these seasons. For all existing and future foreseeable projects, habitat within 100 m of footprints were considered degraded due to dust (Walker and Everett 1987; Rescan 2012b). Habitat loss for the Back River Project was calculated within the PDAs which already includes a dust-disturbance area, thus no additional area was calculated for dust for the Back River Project.

The selection of a study area to determine which projects to evaluate and compare the area of habitat removed for the Bathurst herd used the post-calving and summer ranges, defined as the study area for a Resource Selection Function conducted for the herd (Section 5.1.2.5). For Beverly herd caribou, an RSF model was not available for the summer and winter ranges, and since detailed habitat mapping does not exist for the entire summer or winter CEA boundaries for Beverly herd caribou, it was assumed that these CEA boundaries contain approximately the same proportion of high quality habitat as the wildlife RSA for each season. The percentage of high-quality habitat in the wildlife RSA during the summer season was equivalent to 85.8%. Habitat quality was not estimated for the winter season in the wildlife RSA, thus, the habitat quality for the calving season was used as it represents the season where lichens would be most important to caribou (similar to winter) and is equivalent to 52.0%, although this may be an overestimate of the amount of high-quality habitat during the winter season as some lichens may be unavailable (e.g. due to snow conditions). The total area of lost habitat from these calculations was compared to the area of the seasonal ranges used for the CEA assessment.

Evaluation of Habitat Loss

Bathurst Herd

A number of closed projects including Jericho Mine, Lupin Mine, Salmita Mine and Tundra Mine have already removed some habitat within the combined post-calving and summer CEA boundary for Bathurst herd caribou. Other existing developments including the Ekati Mine and Diavik Mine overlap with the post-calving and summer CEA boundary for Bathurst herd. The proposed George, BIPR, Hackett River, Izok Corridor, and Courageous Lake projects have the potential to overlap with the combined post-calving and summer CEA boundary for Bathurst herd caribou.

On the annual range of Bathurst caribou, two existing projects (Snap Lake and the Tibbitt to Contwoyto Lake Winter Road), and three additional reasonably future foreseeable projects including the Gahcho Kué, NICO and Nechalacho projects, were also evaluated.

The combined post-calving and summer CEA boundary for Bathurst caribou is 8,100,050 ha. Within this CEA boundary (post-calving/summer range) for Bathurst herd caribou, the cumulative effects assessment identified 10,541 ha of removed habitat, and 13,652 ha of degraded habitat (Table 5.6-2). These areas equate to a total of 23,049 ha (0.3% of Bathurst CEA boundary) after accounting for overlap between projects. The Back River Project will not contribute to the cumulative habitat loss for Bathurst caribou (Table 5.6-2). While the proportion of habitat loss within the post-calving and summer CEA boundary for Bathurst herd caribou is minimal, a residual effect, albeit small, is predicted.

Table 5.6-2. Cumulative Habitat Loss in the Bathurst Caribou CEA Boundary

Range	Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Post-calving and Summer Range					
	Back River Project[3]	0	n/a	0	n/a
	Past Developments				
	Jericho Mine	242	n/a	242	n/a
	Lupin Mine	796	n/a	796	n/a
	Salmita	10	n/a	10	n/a
	Tundra	96	n/a	96	n/a
	Existing Developments				
	Diavik Mine	988	421	1,409	n/a
	Ekati Mine	3,221	2,058	5,279	n/a
	Reasonably Foreseeable Future Developments				
	BIPR[4]	504	4,112	4,616	n/a
	Courageous Lake	2,207	843	3,050	n/a
	George	172	239	411	n/a
	Hackett River	1,454	2,056	3,510	n/a
	Izok Corridor Project[5]	851	3,923	4,774	n/a
	Cumulative Areas				
	Total Area	10,541	13,652	23,049	n/a
	Total Area Accounting for Overlap[6]	10,541	13,652	23,049	n/a
	% CEA Boundary	0.13	0.17	0.28	n/a
Annual Range					
	Back River Project[3]	0	n/a	0	n/a
	Past Developments				
	Jericho Mine	242	n/a	242	n/a
	Lupin Mine	796	n/a	796	n/a
	Salmita	10	n/a	10	n/a
	Tundra	96	n/a	96	n/a
	Existing Developments				
	Diavik Mine	988	421	1,409	1,409
	Ekati Mine	3,221	2,058	5,279	5,283
	Snap Lake	118	78	186	186
	TCWR[4]				941
	Reasonably Foreseeable Future Developments				
	BIPR[4]	521	4,241	4,762	4,762
	Courageous Lake	2,207	843	3,050	3,050
	Gahcho Kué	1,805	322	2,126	2,290
	George	172	239	411	411

(continued)

Table 5.6-2. Cumulative Habitat Loss in the Bathurst Caribou CEA Boundary (completed)

Range	Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Annual Range *(cont'd)*					
	Hackett River	1,454	2,056	3,510	3,510
	Izok Corridor Project[5]	1,006	5,475	6,481	6,571
	NICO	456	1,044	1,501	1,501
	Nechalacho (Thor Lake)	190	371	561	561
	Cumulative Areas				
	Total Area	13,282	17,147	30,420	30,476
	Total Area Accounting for Overlap[6]	13,282	17,147	30,420	30,473
	% CEA Boundary	0.04	0.06	0.10	0.10

[1] Bathurst Post-calving and Summer Cumulative Effects Assessment boundary approximates 8,100,050 hectares, while the Annual Range boundary is approximately 30,526,670 ha.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area. Winter road calculations were excluded from post-calving and summer ranges but included under the Annual herd range.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
4 TCWR = Tibbitt to Contwoyto Lake Winter Road, BIPR = Bathurst Inlet Port and Road Project
[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.
[6] Represents the total area of habitat loss and degradation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degradation, these were dissolved to provide a total accounting for overlap.

Habitat loss was also evaluated for the annual herd range, which is 30,526,670 ha. Habitat loss totals 13,282 ha of removed habitat and 17,147 ha of degraded habitat for a total of 30,473 ha (0.10% of the annual range for Bathurst herd caribou) after accounting for overlap between projects (Table 5.6-2). Again, the Back River Project is not expected to contribute to cumulative habitat loss within the annual range of Bathurst caribou (Table 5.6-2). The proportion of habitat loss within the total annual range for Bathurst caribou was smaller (0.1% of the annual range) relative to that in the combined post-calving and summer range (0.3%), therefore the combined post-calving and summer range was used as a conservative approach for assessing the overall effects of cumulative habitat loss on Bathurst caribou.

Inuit TK indicates that the Contwoyto Lake and Nose Lake regions have been important post-calving and summer ranges for the Bathurst herd since before development and prior to the deployment of radio collars on the Bathurst herd. The RSF model, which provides a spatial surface that indicates the likelihood of detecting caribou across the landscape, indicates that these areas continue to be important to the Bathurst herd during the post-calving and summer periods (Figures 5.1-13a, 5.1-13b, 5.1-13c, and 5.1-13b). The designation of habitat value is arbitrary and based on calculated probabilities of detections (low = 0 – 0.25; moderate 0.26 – 0.50; high = 0.51 – 0.75; very high > 0.75). A portion of the Back River wildlife RSA overlaps the eastern edge of the post-calving range, which is comprised or primarily low and moderate value habitat (i.e., lower detection rates relative to the rest of the range).

Other projects in the region have the potential to influence post-calving and summer habitat conditions and subsequent distribution and habitat use by caribou. Current ranges and habitat use are likely integrated over time by conditions on the landscape. The Ekati and Diavik diamond mines are the only operators in the region, and occur at the southern edge of an area of high value habitat (i.e.,

probability of detection > 0.75) during post-calving, and in the centre of moderate and high value habitat during summer, but falls outside the core use areas during both seasons. Amongst potential future developments, the neighboring Hackett River project is found within both the post-calving range and the post-calving core use area (i.e., in the Mara River and Hackett River movement corridors), but not in the summer range or summer core use area. The Courageous Lake project does not occur in the post-calving range or post-calving core use area. Both the Courageous Lake and Izok projects are located in low to moderate value habitat relative to the entire summer range, and only Izok is located in moderate valued core summer habitat (relative to the rest of the core use area).

Beverly Herd

Summer: The summer range CEA boundary for Beverly caribou is 33,999,052 ha. Within this area the cumulative effects assessment identified 11,602 ha of lost habitat, and 8,579 ha of degraded habitat, for a total of total of 20,181 ha (Table 5.6-3) and 0.06% of the summer CEA boundary for Beverly caribou. The Back River Project will contribute 6,080 ha (30%) of the total area of habitat loss within the summer CEA boundary for Beverly caribou and is equivalent to < 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10% or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

Table 5.6-3. Cumulative Habitat Loss in the Beverly Caribou CEA Boundary

Range[1]	Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Summer Range					
	Back River Project[3]	6,080	n/a	6,080	n/a
	Past Developments				
	Roberts Bay and Ida Bay	3	n/a	3	n/a
	Existing Developments				
	Doris North	279	532	811	n/a
	Reasonably Foreseeable Future Developments				
	BIPR[4]	625	4,685	5,310	n/a
	George	172	239	411	n/a
	Hackett River	1,454	2,056	3,510	n/a
	Hope Bay (Phase 2)	2,989	1,066	4,055	n/a
	Cumulative Areas				
	Total Area	11,602	8,579	20,181	n/a
	Total Area Accounting for Overlap[5]	11,602	8,579	20,181	n/a
	% CEA Boundary	0.03	0.03	0.06	n/a
Winter Range					
	Back River Project[3]	5,427	n/a	5,427	8,567
	Past Developments				
	Roberts Bay and Ida Bay	3	n/a	3	3
	Salmita	10	n/a	10	10
	Tundra	96	n/a	96	96

(continued)

Table 5.6-3. Cumulative Habitat Loss in the Beverly Caribou CEA Boundary (continued)

Range[1]	Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Winter Range *(cont'd)*					
	Existing Developments				
	Diavik Mine	988	421	1,409	1,409
	Doris North	279	532	811	811
	Ekati Mine	312	402	714	719
	Snap Lake	118	78	186	186
	TCWR[4]	n/a	n/a	0	684
	Reasonably Foreseeable Future Developments				
	BIPR[4]	643	4,808	5,451	5,451
	Courageous Lake	2,099	796	2,895	2,895
	Gahcho Kué	1,805	322	2,126	2,290
	George	172	239	411	411
	Hackett River	1,454	2,056	3,510	3,510
	Hope Bay (Phase 2)	2,989	1,066	4,055	4,055
	Cumulative Areas				
	Total Area	11,780	7,359	19,128	23,121
	Total Area Accounting for Overlap[5]	11,780	7,359	19,128	23,118
	% CEA Boundary	0.03	0.02	0.05	0.06
Annual Range					
	Back River Project[3]	6,080	n/a	6,080	9,477
	Past Developments				
	Roberts Bay and Ida Bay	3	n/a	3	3
	Salmita	10	n/a	10	10
	Tundra	96	n/a	96	96
	Existing Developments				
	Diavik Mine	988	421	1,409	1,409
	Doris North	279	532	811	811
	Ekati Mine	359	587	945	950
	Snap Lake	118	78	186	186
	TCWR[4]	n/a*	n/a	n/a	728
	Reasonably Foreseeable Future Developments				
	BIPR[4]	656	4,919	5,576	5,576
	Courageous Lake	2,099	796	2,895	2,895
	Gahcho Kue	1,805	322	2,126	2,290
	George	172	239	411	411
	Hackett River	1,454	2,056	3,510	3,510
	Hope Bay (Phase 2)	2,989	1,066	4,055	4,055

(continued)

Table 5.6-3. Cumulative Habitat Loss in the Beverly Caribou CEA Boundary (completed)

Range[1]	Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Annual Range *(cont'd)*					
	Cumulative Areas				
	Total Area	17,107	11,016	28,113	32,407
	Total Area Accounting for Overlap[5]	17,107	11,016	28,113	32,404
	% CEA Boundary	0.03	0.02	0.05	0.05

[1] Beverly Summer, Winter, and Annual Cumulative Effects Assessment boundary approximates 33,999,052 ha, 40,985,127 ha, and 60,663,348 ha, respectively
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area. Winter road calculations were excluded from summer ranges but included under the winter and annual herd range.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] TCWR = Tibbitt to Contwoyto Lake Winter Road, BIPR = Bathurst Inlet Port and Road Project
[5] Represents the total area of habitat loss and degradation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degradation, these were dissolved to provide a total accounting for overlap.

Winter: The winter CEA boundary for Beverly caribou is 40,985,127 ha. Within this area 11,780 ha of habitat has been or may be lost, and 7,359 ha of degraded habitat (Table 5.6-3). These areas equate to a total of 19,128 ha after accounting for overlap between projects which is equal to approximately 0.05% of the winter CEA boundary for Beverly caribou. Additional areas will be temporarily lost when winter roads are operational, and this accounts for 23,121 ha (0.06% of CEA boundary). The Back River Project will contribute to 5,427 ha of habitat loss and degradation during the snow-free period (28% of the total lost area), and 8,567 ha when winter roads are operational (37% of the total lost area), both of which represent less than 0.1% of the winter CEA boundary for Beverly caribou. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10% or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

Annual Beverly Herd Range: As a comprehensive approach, a check was conducted to confirm that the proposed seasonal cumulative effects areas for Beverly caribou provided a conservative assessment of the effects of industrial development. The proportion of area affected by industry on the seasonal CEA areas was compared to the total area affected by all projects within the total annual range (using all seasons combined) for the Beverly herd. The total annual range for Beverly caribou is approximately 60,663,348 ha. Within the total annual range, the cumulative effects of habitat loss due to all projects on this range is 17,107 ha of removed habitat and 11,016 ha of degraded habitat for a total of 28,113 ha (0.05% of the annual range for Beverly herd caribou) after accounting for overlap between projects (Table 5.6-3). Additional areas will be temporarily lost when winter roads are operational, and this accounts for 32,404 ha (0.05% of CEA boundary).

The proportion of habitat loss within the total annual range for Beverly caribou was similar to that recorded within the summer and winter ranges, but no new projects are located within the annual range that are not already considered within the summer and winter ranges. Thus, the summer and winter ranges were used as a conservative approach to assessing the overall effects of cumulative habitat loss for Beverly caribou.

While the proportion of habitat lost in the summer and winter CEA boundaries for Beverly caribou is small, a residual effect is anticipated.

5.6.2.2 Disturbance

The effect of disturbance to caribou was rated as not significant for the Bathurst herd. Due to the status of the Bathurst herd and the concern for this herd from Aboriginal groups and government regulators, the potential effect of disturbance resulting in functional habitat loss was carried forward as a residual and is assessed in this cumulative effects assessment for Bathurst caribou.

The effect of disturbance for the Beverly herd caribou as a result of the Back River Project was rated as not significant in the effects assessment. A background on the potential effects of disturbance to caribou is presented in Section 5.5.2.2. In the CEA, the potential effect of disturbance was evaluated for Bathurst caribou during the post-calving (June 16 to July 20) and summer (July 21 to August 31) seasons, and for the Beverly herd caribou during the summer/fall seasons (July 20 to October 31) and winter season (November 1 to April 15) when these herds may interact with the Back River Project.

Potential cumulative effects from existing and proposed projects within the seasonal CEA boundaries for Bathurst caribou and Beverly caribou were assessed (Section 5.6.2). Closed projects were excluded from the analysis as they are not anticipated to generate noise or have sufficient anthropogenic activity to result in disturbance to caribou. Cumulative effects due to disturbance from other projects are predicted to increase the effects of disturbance on Bathurst and Beverly caribou. Disturbance could be considered an energetic cost to caribou that are trying to feed, since they may avoid or increase their movement rate through areas that may be influenced by visual or auditory effects by mines or mining-related activities (including road use). Disturbances to caribou may also result in indirect habitat loss or functionally lost habitat due to avoidance by caribou as a result of noise stimulation and anthropogenic activities.

Calculation of Disturbance

To evaluate the effects of disturbance on Bathurst and Beverly caribou, the area in which caribou may be affected by disturbance was calculated and used as a key indicator of this potential effect.

A zone of influence (ZOI) approach was taken to evaluate the cumulative effect of disturbance on the VEC. A ZOI represents the area where caribou may avoid industrial developments or features due to noise, human presence, or altered habitat within a particular distance of that development or feature. The results of noise modeling produced in Volume 2, Chapter 4 and literature values were used to develop ZOIs for all project features occurring with the CEA boundaries for Bathurst and Beverly caribou. The cumulative effects of disturbance on Bathurst and Beverly caribou were evaluated using the ZOI approach in two ways:

1. The area where disturbance may occur around active mines, all season roads and winter roads, compared to the caribou seasonal CEA areas and annual ranges for both Bathurst and Beverly caribou;
   - for all-season roads, a 1.5 km buffer was used, and winter roads were assigned a 200 m buffer; and
   - for mines, two scenarios were evaluated — a 4 km buffer and a 14 km buffer — to encompass the variability in caribou responses reported in the literature.
2. The area of high use, calculated from a resource selection function, for the Bathurst herd compared to the Bathurst combined post-calving and summer CEA area;

The ZOI of 4 km was applied to all existing and reasonably foreseeable future developments and associated infrastructure areas (e.g., port facilities). This value was chosen based on literature values reported for caribou zones of influences surrounding industrial developments (see Section 5.5.2.2 for further details).

However, some studies show that caribou avoidance of industrial developments extends over relatively large distances — from 4 km up to 30 km (J. R. Dau and R. D. Cameron 1986; R. D. Cameron et al. 1992; Helle and Särkelä 1993; Nellemann and Cameron 1996, 1998; Dyer et al. 2001; Nellemann et al. 2001; UNEP et al. 2001; Ingunn Vistnes and Nellemann 2001; I. Vistnes et al. 2001; Nellemann et al. 2003b; I. Vistnes, Nellemann, Jordhøy, et al. 2004; R. D. Cameron et al. 2005; C. J. Johnson et al. 2005b; Boulanger et al. 2012). These studies are incongruent with other studies that show no avoidance by caribou beyond a few hundred meters (Cronin et al. 1998; L. E. Noel et al. 1998; Noel, Parker, and Cronin 2004; Noel, Parker, and Cronin 2006; Reimers and Colman 2006; Reimers et al. 2007). A study at the EKATI-Diavik mine complex reported that caribou avoided the mine by approximately 14 km (Boulanger et al. 2012) and it was hypothesized that caribou may be avoiding the mine complex due to dust deposition. Thus, a 14 km buffer was also used around all mining projects to calculate a very conservative scenario.

All-weather roads for all existing and reasonably foreseeable future developments were assigned a ZOI of 1.5 km. Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km.

Winter roads for all existing and reasonably foreseeable future developments were assigned a ZOI of 200 m. The results of noise modelling produced in Rescan (2013c) indicated that traffic along winter roads would attenuate to 45 dBA at roughly 200 m from vehicle traffic and activities on these roads. No ZOI was applied to winter roads associated with the Back River Project as the results of noise modeling produced in Volume 2, Chapter 4 indicated that traffic noise above 45 dBA will be completely contained within the footprint of the Winter Road PDA, and no additional disturbance outside of the PDA was expected (Section 5.5.2.2). Buffers on winter roads are applied to the Beverly winter and annual cumulative assessment only.

ZOIs for project features overlap one another. For example, ZOIs associated with all-weather roads at a development area will overlap the 4 and 14 ZOIs for that certain development, and ZOIs for all-weather roads connecting to existing winter road networks will overlap the ZOIs for those winter roads. Thus, a priority was assigned to each ZOI to account for overlaps in features. The ZOIs for developments took precedence over all other ZOIs, as it was assumed that the physical presence of the development, noise (in some cases continuous noises such as generators), and other associated activities, would cause more potential disturbance than roads which will have more infrequent disturbance during hauling periods. All-weather roads ZOIs took precedence over ZOIs for winter roads on account of the smaller predicted area of habitat above noise thresholds around winter roads relative to all-weather roads.

In some cases, ZOIs for certain projects overlap one another. In these cases, the amount of overlap was calculated and removed from the total disturbance within ZOIs to avoid double-counting areas where ZOIs overlap.

The total area of disturbance due to all projects was compared to the total area of the seasonal and annual CEA boundaries for Bathurst and Beverly herd caribou. It is important to note that caribou are not predicted to be completely excluded from the areas within the ZOIs surrounding projects. The ZOI is

indicative of an area of reduced caribou occupancy relative to natural occupancy rates in surrounding areas. Based on aerial survey data collected between 1998 and 2008 surrounding Ekati and Diavik mine sites, Boulanger et al. (2012) found that caribou were detected 4.2 times more at distances > 14.0 km from the mine sites compared with areas immediately surrounding the mine, and that detection increased between the mine site and the 14 km ZOI. Thus, they estimated that a 76% reduction of caribou habitat occurs within a 14 km ZOI surrounding the mines. Therefore, the 4 km and 14 km ZOI buffers likely overestimate the amount of habitat lost as a result of disturbance. If within these buffers for other projects, an effective loss of 24% is assumed (e.g., the area within 4 km and 14 km is multiplied by 0.24), then the effective reduction in in caribou habitat within that area would be 76% lower than reported. Thus, results for the two mine buffer scenarios (4 km and 14 km) during construction and operation scenarios are presented as total areas and adjusted areas based on a reduced occupancy approach.

Access to high quality forage is thought to be a key driver of caribou population demographics (Section 5.1.2.5). Given the vulnerability of calves during the post-calving period and the relationship between habitat quality on the post-calving and summer range and caribou demographics, industrial activity on the post-calving and summer ranges may contribute additional pressures on caribou. By calculating a simple ratio vegetation index (SRVI) from broad scale advanced very high resolution radiometer data (AVHRR) over the summer range and correlating it to several demographic parameters of the Bathurst herd, W. Chen, Foy, et al. (2013) demonstrated that productivity on the summer range explains a significant portion of the variation in caribou birth rate (86%), net productivity (56%), and calf survival rate (52%), but not cow survival rate. Based on these analyses, moderate to high SRVI values likely provide a reliable index of high quality forage, which are well correlated with the population dynamics of the Bathurst herd.

To provide an additional measure to evaluate potential cumulative effects of disturbance on the Bathurst herd, the amount of high quality forage within 4 km and 14 km ZOI was calculated as a proportion of the amount available within the combined post-calving and summer ranges. To identify high productivity areas, SRVI was calculated for two representative images from the post-calving and summer time periods. The representative images were the same as those used for the RSF modelling with the post-calving image acquired on June 21, 2006 and the summer image acquired on August 1, 2006. High productivity habitat was identified using a 5-class classification scheme based on natural breaks in the SRVI histogram. The top two classes, above 3.1 for post-calving and 3.0 for summer, were defined as high productivity areas, and thus high quality forage for caribou.

Evaluation of Disturbance

Bathurst Herd

Post-calving and Summer Range: The Bathurst herd combined post-calving and summer range, used for the cumulative effects assessment is approximately 8,100,050 ha. The area of habitat disturbed within the ZOI for each project and scenario is depicted on Figure 5.6-3 and is reported in Table 5.6-4; results of the 4 km and 14 km ZOI scenarios including adjustments for reduced occupancy and proportion of high-quality habitat are presented in Table 5.6-5.

In the scenario using the 4 km buffer around mine infrastructure, the zone of influence around projects would cover 238,427 ha or 2.9% of the total combined post-calving and summer range for Bathurst herd caribou. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 794,834 ha, or 9.8% of the CEA boundary. Within these areas, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-5 for a total of 0.7% to 2.3% reduction in caribou habitat.

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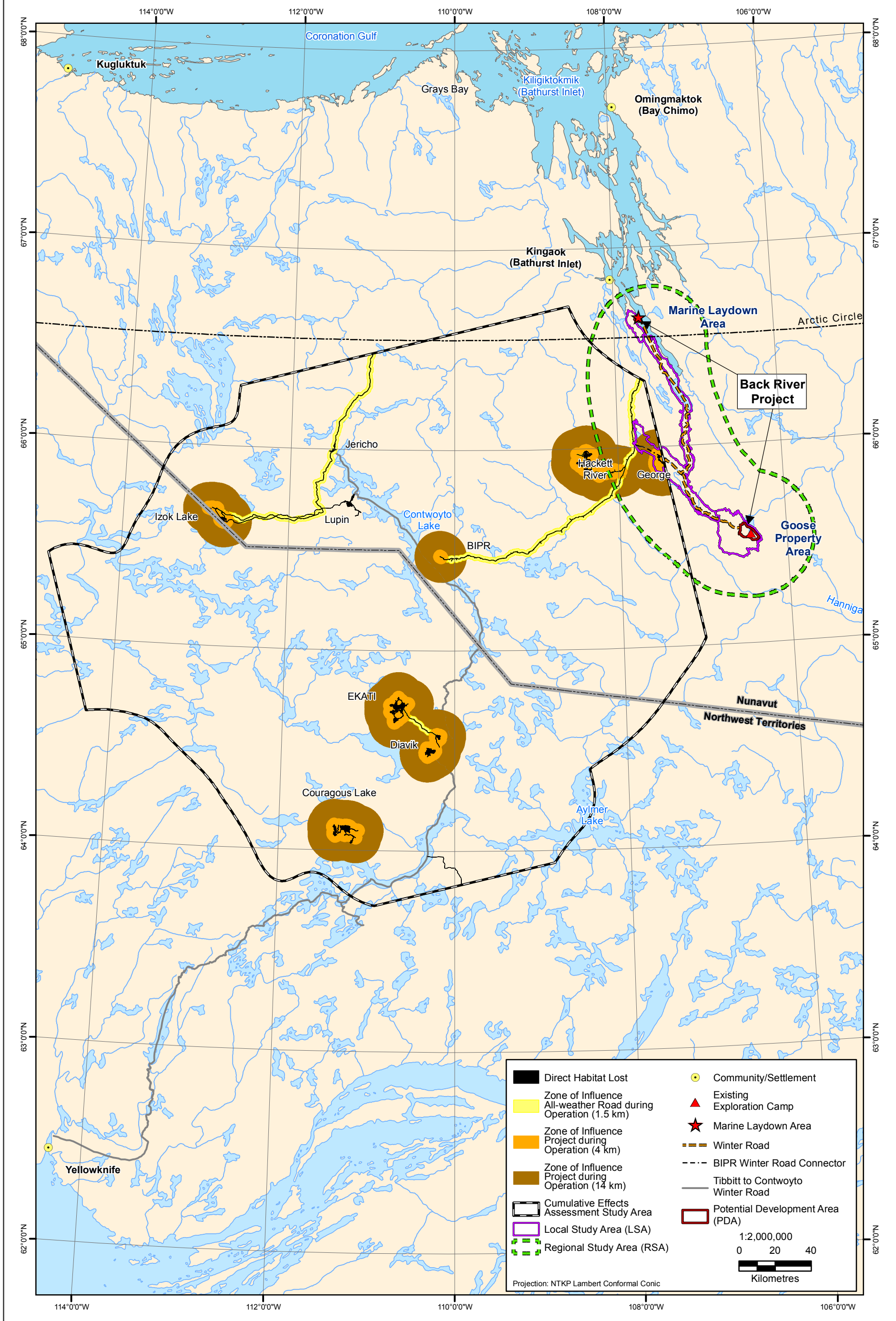

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Habitat Lost or Altered due to All Project Footprints and Disturbances in the Bathurst Caribou Post-calving and Summer Range Cumulative Effects Assessment Boundary

Figure 5.6-3

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Table 5.6-4. Zone of Influence due to Disturbance in the Bathurst Caribou CEA Boundary

Range[1]	Project	Areas of Habitat within ZOIs (ha)[2]				Total 4 km Mine ZOI		Total 14 km Mine ZOI	
		Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Mine (14 km)	Without Winter Roads	With Winter Roads	Without Winter Roads	With Winter Roads
Post-calving and Summer Range									
	Back River Project[3]	n/a	n/a	0	0	0	n/a	0	n/a
	Existing Developments								
	Diavik Mine	n/a	n/a	11,725	73,406	11,725	n/a	73,406	n/a
	Ekati Mine	n/a	4,030	32,879	167,831	36,909	n/a	171,860	n/a
	Reasonably Foreseeable Future Developments								
	BIPR[4]	n/a	50,440	5,689	59,396	56,129	n/a	109,837	n/a
	Courageous Lake	n/a	n/a	23,079	116,635	23,079	n/a	116,635	n/a
	George	n/a	n/a	15,080	77,165	15,080	n/a	77,165	n/a
	Hackett River	n/a	0	36,096	148,683	36,096	n/a	148,683	n/a
	Izok Corridor Project[5]	n/a	44,618	16,649	97,871	61,267	n/a	142,489	n/a
	Cumulative Areas								
	Total Area	n/a	99,088	141,198	740,985	240,286	n/a	840,073	n/a
	Total Area Accounting for Overlap[6]	n/a	99,088	139,339	695,747	238,427	n/a	794,834	n/a
	% CEA Boundary	n/a	1.2	1.7	8.6	2.9	n/a	9.8	n/a
Annual Range									
	Back River Project[3]	n/a	n/a	0	1,289	0	0	1,289	0
	Existing Developments								
	Diavik Mine	n/a	n/a	11,725	73,406	11,725	11,786	73,406	73,406
	Ekati Mine	61	4,030	32,879	167,831	36,909	38,238	171,860	171,921
	Snap Lake	1,329	n/a	7,654	70,743	7,654	8,983	70,743	72,072
	TCWR[4]	24,850	n/a	n/a	n/a	n/a	24,850	n/a	24,850
	Reasonably Foreseeable Future Developments								
	BIPR[4]	n/a	52,069	5,689	59,396	57,757	59,161	111,465	111,465
	Courageous Lake	1,404	n/a	23,079	116,635	23,079	27,383	116,635	118,039

(continued)

Table 5.6-4. Zone of Influence due to Disturbance in the Bathurst Caribou CEA Boundary (completed)

Range[1]	Project	Areas of Habitat within ZOIs (ha)[2]				Total 4 km Mine ZOI		Total 14 km Mine ZOI	
		Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Mine (14 km)	Without Winter Roads	With Winter Roads	Without Winter Roads	With Winter Roads
Annual Range *(cont'd)*									
	Gahcho Kué	4,303	n/a	14,110	91,575	14,110	14,110	91,575	95,879
	George	n/a	n/a	20,348	104,118	20,348	20,348	104,118	104,118
	Hackett River	n/a	0	36,096	148,683	36,096	38,544	148,683	148,683
	Izok Corridor Project[5]	2,447	65,910	16,649	97,871	82,559	82,559	163,780	166,228
	NICO	n/a	9,190	12,837	83,821	22,026	22,026	93,011	93,011
	Nechalacho (Thor Lake)	n/a	n/a	12,754	87,383	12,754	12,754	87,383	87,383
	Cumulative Areas								
	Total Area	34,395	131,198	193,820	1,102,750	325,018	335,892	1,233,948	1,268,342
	Total Area Accounting for Overlap[6]	34,395	131,198	191,960	1,057,511	325,018	335,892	1,232,659	1,223,104
	% of CEA Boundary	0.1	0.4	0.6	3.5	1.1	1.1	4.0	4.0

[1] *Bathurst Post-calving and Summer Cumulative Effects Assessment boundary approximates 8,100,050 hectares, while the Annual Range boundary is approximately 30,526,670 ha*

[2] *Disturbance includes total area in ZOI and does not take into account habitat suitability within the area.*

[3] *Habitat within ZOIs of the Goose Property and MLA PDAs.*

[4] *TCWR = Tibbitt to Contwoyto Lake Winter Road, BIPR = Bathurst Inlet Port and Road Project*

[5] *Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.*

[6] *Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.*

Table 5.6-5. Results of the 4 km and 14 km Scenarios for Bathurst Caribou Zone of Influence due to Disturbance

Range	Scenario[1]	ZOI (ha) and % of Range	Adjusted Area[2] (ha) and % of Range	Post-Calving High Quality Forage and % in Range[3]	Summer High Quality Forage and % in Range[3]
Post-calving and Summer					
	Scenario 1 (4 km Mine)	238,427 (2.9)	57,222 (0.7)	66,195 (0.8)	75,085 (0.9)
	Scenario 2 (14 km Mine)	794,834 (9.8)	190,760 (2.3)	232,394 (2.9)	243,735 (3.0)
Annual Herd Range					
	Scenario 1 (4 km Mine)	325,018 (1.1)	78,004 (0.3)	-	-
	Scenario 2 (14 km Mine)	1,232,659 (4.0)	295,838 (1.0)	-	-

[1]: Scenario 1 uses a 4 km buffer around mine infrastructure; Scenario 2 uses a 14 km buffer around mine infrastructure.
[2]: Adjusted area is calculated by assuming a 24% loss of habitat within the zone of influence.
[5]: Total area of high quality forage available in CEA boundary is 8,100,050 ha.

The Back River Project is not anticipated to contribute to any of the disturbed habitat on the post-calving and summer range in either of the ZOI scenarios (4 km or 14 km scenario).

Annual Herd Range: The proportion of area affected by disturbance due to industry was also calculated for the in the annual range for the Bathurst herd, which is 30,526,670 ha. The area of habitat disturbed within the ZOI for each project and scenario is depicted on Figure 5.6-4 and reported in Table 5.6-4; the results of the two scenarios accounting for reduced occupancy are presented in Table 5.6-5.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects would cover 325,018 ha or 1.1% of the annual range for Bathurst herd caribou. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 1,232,659 ha, or 4.0% of the annual range for Bathurst caribou. Additional areas will be temporarily disturbed when winter roads are operational in the annual range of Bathurst caribou, but the overall proportion of habitat within ZOIs relative to the CEA boundary remain the same inclusive of the 200 m ZOI around winter roads, at 1.1% of the annual range under the 4 km scenario and 4.0% of the annual range under the 14 km scenario. ZOIs from the Back River Project are only expected to overlap the annual range of Bathurst caribou under the 14 km ZOI scenario, no overlap was predicted using the 4 km ZOI scenario (Table 5.6-4).

Within the 4 and 14 km ZOIs, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-5 for a total of 0.3% to 1.0% reduction in caribou habitat. The proportion of disturbed habitat within the total annual range for Bathurst caribou is much less than that in the post-calving and summer CEA boundary, thus the post-calving and summer CEA boundary was used as a conservative approach to assessing the overall effects of cumulative disturbance due to noise for Bathurst caribou.

The RSF model found a response curve (an increase in the probability of detection of caribou with distance from disturbance) of approximately 35 km from operating mines during the post-calving season, comparable to Johnson et al. (2005a), and 50 km during the summer, which are likely beyond the sensory limits of caribou. While the direction of selection coefficients suggest some avoidance, the size of the

selection coefficients and similar mean distances from disturbance between collar and random locations suggest that the response curves may be more a function of the number of collar locations combined with a low density of developments relative to the size of the study area. With a similar result, Johnson et al. (2005b) concluded the influence with industry warranted further investigation; however, the possibility cannot be discounted that industrial development may influence the distribution of caribou at broad spatial scales (e.g., seasonal range). Habitat productivity and climate change may ultimately be the most important components that drive caribou distribution and habitat use (Joly, Klein, Verbyla, Rupp and Chapin 2011). Under the current distribution of existing and proposed developments, impacts to habitat conditions on the post-calving and summer ranges are expected to be minimal provided that the integrity of the Contwoyto Lake and Nose Lake region is maintained, and that movements along the Burnside, Mara, and Hackett River corridors are not impeded.

The ZOIs were also mapped onto measures of vegetation quality within the combined post-calving and summer ranges of Bathurst caribou. Areas within the zones of disturbance with a high vegetation index, which indicates a higher quality of forage for caribou, were calculated as a portion of the amount available within each CEA boundary. The resulting analysis showed that in the 4 km scenario, the zone of disturbance would cover 0.8% of areas with high quality forage within the post-calving range (Table 5.6-5). For the 14 km scenario, these amounts increase to 2.9%.

This analysis provides an interesting result – the proportion of high quality habitat affected in the Bathurst CEA area is smaller than the total area affected. For example, using the 4 km ZOI, the proportion of high-quality habitat removed is 0.8%, but the total area removed is 2.8% of the CEA boundary. This indicates that industrial activities are, by and large, located outside of preferred habitat for this herd. Figures 5.1-13a and 5.1-13c illustrate this concept. The core area of high value habitat is located around Contwoyto Lake, while industrial activities are generally located distally to the lake.

A residual effect due to disturbance resulting from noise and anthropogenic activities associated with industrial sites in the Bathurst combined post-calving and summer CEA boundary is predicted to occur, albeit small.

Beverly Herd

Summer: The Beverly herd summer range, used for the cumulative effects assessment is approximately 33,999,052 ha. The area disturbed within the ZOI for each project and scenario is depicted on Figure 5.6-5 and reported in Table 5.6-6; the results of the 4 km and 14 km ZOI scenarios including adjustments for reduced occupancy are presented in Table 5.6-7.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects would cover 181,897 ha or 0.5% of the total summer range for Beverly herd caribou. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 722,201 ha, or 2.1 % of the summer CEA boundary. These numbers are decreased by 76% assuming that these areas would support a reduced occupancy and not total exclusion of animals, and are presented as adjusted areas in Table 5.6-7, equivalent to a 0.1% to 0.5% reduction in caribou range. The Back River Project contributes 27,352 ha of disturbed habitat (in the 4 km scenario), equivalent to 15.0% of all disturbed habitat in the Beverly summer CEA boundary and 182,617 ha or 25.3% of all habitat disturbed using the 14 km scenario in the Beverly summer CEA boundary.

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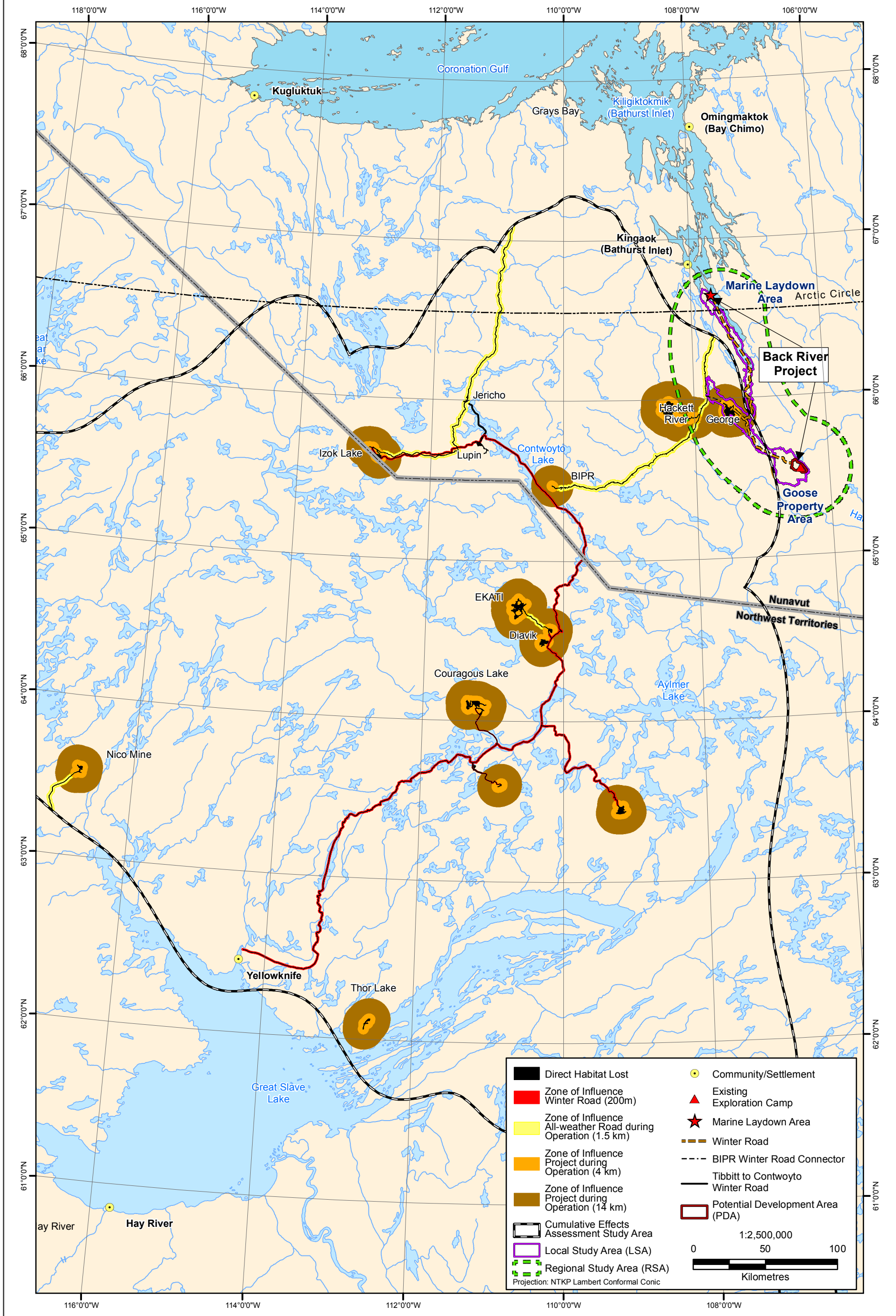

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Habitat Lost or Altered due to All Project Footprints and Disturbances in the Bathurst Caribou Annual Herd Range Cumulative Effects Assessment Boundary

Figure 5.6-4

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Table 5.6-6. Zone of Influence due to Disturbance in the Beverly Caribou Summer CEA Boundary

Range / Project	Areas of Habitat within ZOIs (ha)2				Total 4 km Mine ZOI		Total 14 km Mine ZOI	
	Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Mine (14 km)	Without Winter Roads	With Winter Roads	Without Winter Roads	With Winter Roads
Summer Range								
Back River Project[3]	n/a*	n/a	27,352	182,617	27,352	n/a	182,617	n/a
Existing Developments								
Doris North	n/a	0	17,156	97,455	17,156	n/a	97,455	n/a
Reasonably Foreseeable Future Developments								
BIPR[4]	n/a	55,745	8,026	75,170	63,771	n/a	130,915	n/a
George	n/a	n/a	20,348	104,118	20,348	n/a	104,118	n/a
Hackett River	n/a	0	36,096	148,683	36,096	n/a	148,683	n/a
Hope Bay (Phase 2)	n/a	10,407	12,378	84,972	22,786	n/a	95,380	n/a
Cumulative Areas								
Total Area	n/a	66,152	121,356	693,015	187,508	n/a	759,168	n/a
Total Area Accounting for Overlap[5]	n/a	65,287	116,610	656,914	181,897	n/a	722,201	n/a
% CEA Boundary	n/a	0.19	0.34	1.93	0.54	n/a	2.12	n/a
Winter Range								
Back River Project[3]	n/a*	n/a	27,272	182,276	27,272	n/a	182,276	n/a
Existing Developments								
Diavik Mine	n/a	n/a	11,725	64,087	11,725	11,725	64,087	64,087
Doris North	n/a	0	17,156	77,299	17,156	17,156	77,299	77,299
Ekati Mine	61	1,185	9,317	52,054	10,503	10,563	53,240	53,301
Snap Lake	1,329	n/a	7,654	70,743	7,654	8,983	70,743	72,072
TCWR[4]	17,963	n/a	n/a	n/a	n/a	17,963	n/a	17,963
Reasonably Foreseeable Future Developments								
BIPR[4]	n/a	56,440	12,167	91,165	68,607	68,607	147,605	147,605
Courageous Lake	1,404	n/a	17,954	81,841	17,954	19,358	81,841	83,245
Gahcho Kué	4,303	n/a	14,110	91,575	14,110	18,413	91,575	95,879

(continued)

Table 5.6-6. Zone of Influence due to Disturbance in the Beverly Caribou Summer CEA Boundary (continued)

Range	Project	Areas of Habitat within ZOIs (ha)2				Total 4 km Mine ZOI		Total 14 km Mine ZOI	
		Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Mine (14 km)	Without Winter Roads	With Winter Roads	Without Winter Roads	With Winter Roads
Winter Range *(cont'd)*									
	George	n/a	n/a	20,348	104,118	20,348	20,348	104,118	104,118
	Hackett River	n/a	0	36,096	148,683	36,096	36,096	148,683	148,683
	Hope Bay (Phase 2)	n/a	10,407	12,378	84,972	22,786	22,786	95,380	95,380
	Cumulative Areas								
	Total Area	25,060	68,032	186,178	1,048,814	254,210	279,271	1,116,846	1,141,906
	Total Area Accounting for Overlap[5]	25,060	67,930	181,119	1,004,529	249,049	274,109	1,072,459	1,097,520
	% CEA Boundary	0.06	0.17	0.44	2.45	0.61	0.67	2.62	2.68
Annual Range									
	Back River Project[3]	n/a*	n/a	27,272	182,276	27,272	n/a	182,276	n/a
	Existing Developments								
	Diavik Mine	n/a	n/a	11,725	67,232	11,725	11,725	67,232	67,232
	Doris North	n/a	n/a	17,156	97,455	17,156	17,156	97,455	97,455
	Ekati Mine	61	3,728	10,256	79,266	13,984	14,045	82,994	83,055
	Snap Lake	1,329	n/a	7,654	70,743	7,654	8,983	70,743	72,072
	TCWR[4]	19,146	n/a	n/a	n/a	n/a	19,146	n/a	19,146
	Reasonably Foreseeable Future Developments								
	BIPR[4]	n/a	57,207	13,714	126,278	70,921	70,921	183,485	183,485
	Courageous Lake	1,404	n/a	17,954	81,841	17,954	19,358	81,841	83,245
	Gahcho Kué	4,303	n/a	14,110	91,575	14,110	18,413	91,575	95,879
	George	n/a	n/a	20,348	104,118	20,348	20,348	104,118	104,118
	Hackett River	n/a	0	36,096	148,683	36,096	36,096	148,683	148,683
	Hope Bay (Phase 2)	n/a	10,407	12,378	84,972	22,786	22,786	95,380	95,380
	Cumulative Areas								
	Total Area	26,243	71,343	188,664	1,134,440	260,007	286,250	1,205,783	1,232,026

(continued)

Table 5.6-6. Zone of Influence due to Disturbance in the Beverly Caribou Summer CEA Boundary (completed)

Range	Project	Areas of Habitat within ZOIs (ha)2				Total 4 km Mine ZOI		Total 14 km Mine ZOI	
		Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Mine (14 km)	Without Winter Roads	With Winter Roads	Without Winter Roads	With Winter Roads
Annual Range *(cont'd)*									
	Total Area Accounting for Overlap[5]	26,243	70,477	182,058	1,068,242	252,535	278,778	1,138,719	1,164,963
	% CEA Boundary	0.04	0.12	0.30	1.76	0.42	0.46	1.88	1.92

[1] Beverly Summer, Winter, and Annual Cumulative Effects Assessment boundary approximates 33,999,052 ha, 40,985,127 ha, and 60,663,348 ha, respectively.
[2] Disturbance includes total area in ZOI and does not take into account habitat suitability within the area.
[3] Habitat within ZOIs of the Goose Property and MLA PDAs.
[4] TCWR = Tibbitt to Contwoyto Lake Winter Road, BIPR = Bathurst Inlet Port and Road Project
[5] Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.

Table 5.6-7. Results of the 4 km and 14 km Scenarios for Beverly Caribou Zone of Influence due to Disturbance

Range	Scenario[1]	ZOI (ha) and % of Range	Adjusted Area[2] (ha) and % of Range
Summer Range			
	Scenario 1 (4 km Mine)	181,897 (0.5)	43,655 (0.1)
	Scenario 2 (14 km Mine)	722,201 (2.2)	173,328 (0.5)
Winter Range			
	Scenario 1 (4 km Mine)	274,109 (0.7)	65,786 (0.2)
	Scenario 2 (14 km Mine)	1,097,520 (2.7)	263,405 (0.6)
Annual Beverly Herd Range			
	Scenario 1 (4 km Mine)	278,778 (0.5)	66,907 (0.1)
	Scenario 2 (14 km Mine)	1,164,963 (1.9)	279,591 (0.5)

[1]: Scenario 1 uses a 4 km buffer around mine infrastructure; Scenario 2 uses a 14 km buffer around mine infrastructure.
[2]: Adjusted area is calculated by assuming a 24% loss of habitat within the zone of influence.

A residual effect due to disturbance resulting from noise in the Beverly summer CEA boundary is predicted to occur, albeit small.

Winter: The Beverly herd winter range, used for the cumulative effects assessment approximates 40,985,127 ha. The ZOI for each project and scenario is depicted on Figure 5.6-5 and reported in Table 5.6-6; the results of the two scenarios including areas adjusted for reduced occupancy are presented in Table 5.6-7.

In the 4 km buffer scenario around mine infrastructure, the zone of influence around projects during the construction phase would cover 274,109 ha or 0.7% of the total winter range for Beverly herd caribou. In the 14 km buffer scenario around mine infrastructure, the zone of influence would cover 1,097,520 ha, or 2.7 % of the Beverly winter CEA boundary. These numbers are decreased by 76% assuming that these areas would support a reduced occupancy and not total exclusion of animals, and are presented as adjusted areas in Table 5.6-7, equivalent to a 0.2% to 0.6% reduction in caribou winter range.

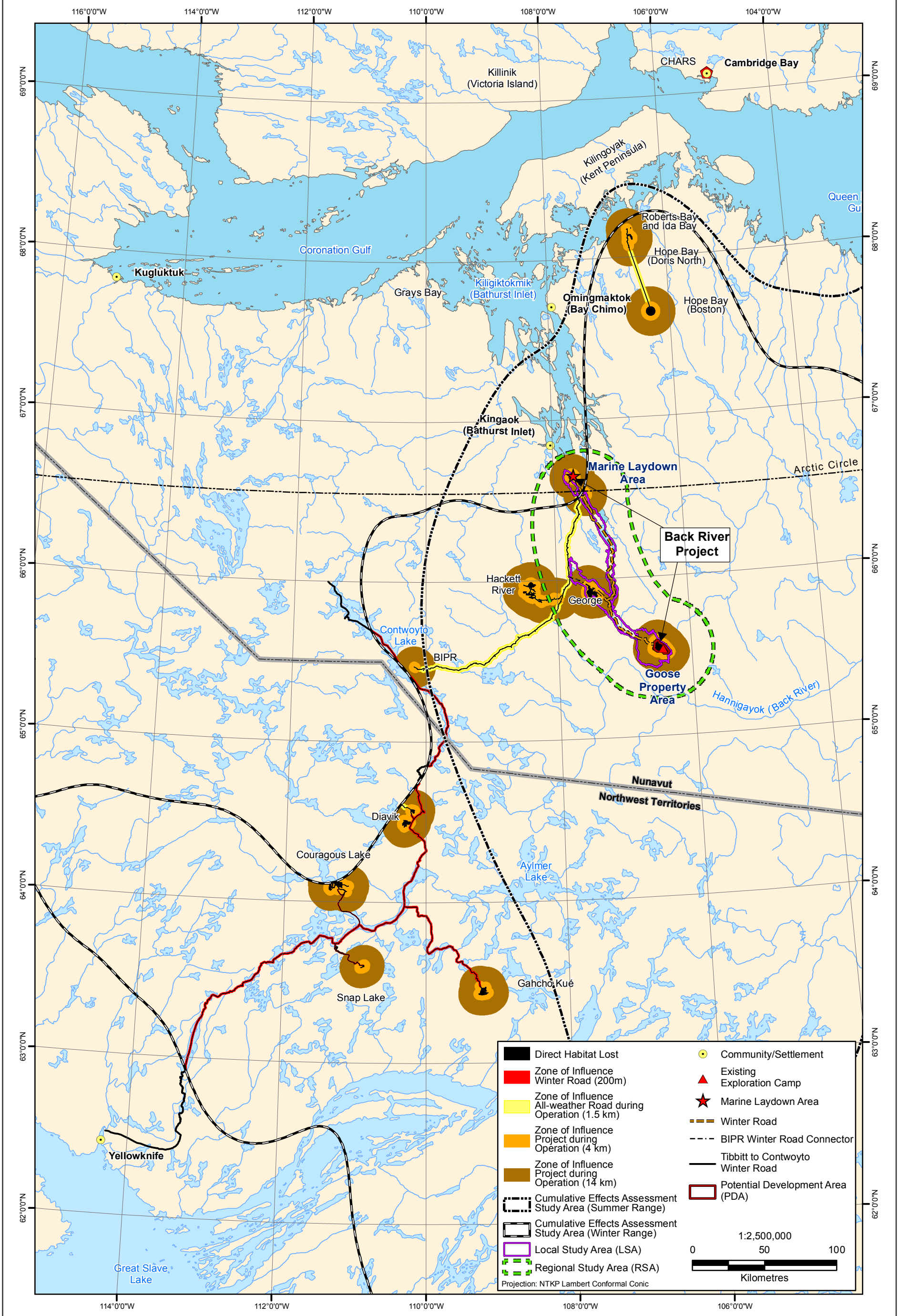
The Back River Project contributes 27,352 ha of disturbed habitat in the 4 km scenario, equivalent to 10.0% of all disturbed habitat in the winter CEA boundary (Figure 5.6-5), and 182,617 ha or 16.6% of all habitat disturbed using the 14 km scenario in the Beverly winter CEA boundary.

A residual effect due to disturbance resulting from noise in the Beverly winter CEA boundary is predicted to occur, albeit small.

Annual Herd Range: The proportion of area affected by disturbance due to industry was compared to the annual range of the Beverly herd, which is approximately 60,663,438 ha. The area contained within the ZOI for each project and scenario is depicted on Figure 5.6-6 and reported in Table 5.6-6; the results of the two scenarios including areas adjusted for reduced occupancy are presented in Table 5.6-7.

GIS # BAC-23-422e

November 13 2015



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Habitat Lost or Altered due to All Project Footprints and Disturbances in the Beverly Caribou Summer and Winter Range Cumulative Effects Assessment Boundary

Figure 5.6-5

Rescan an ERM company

GIS # BAC-23-422g

November 13 2015

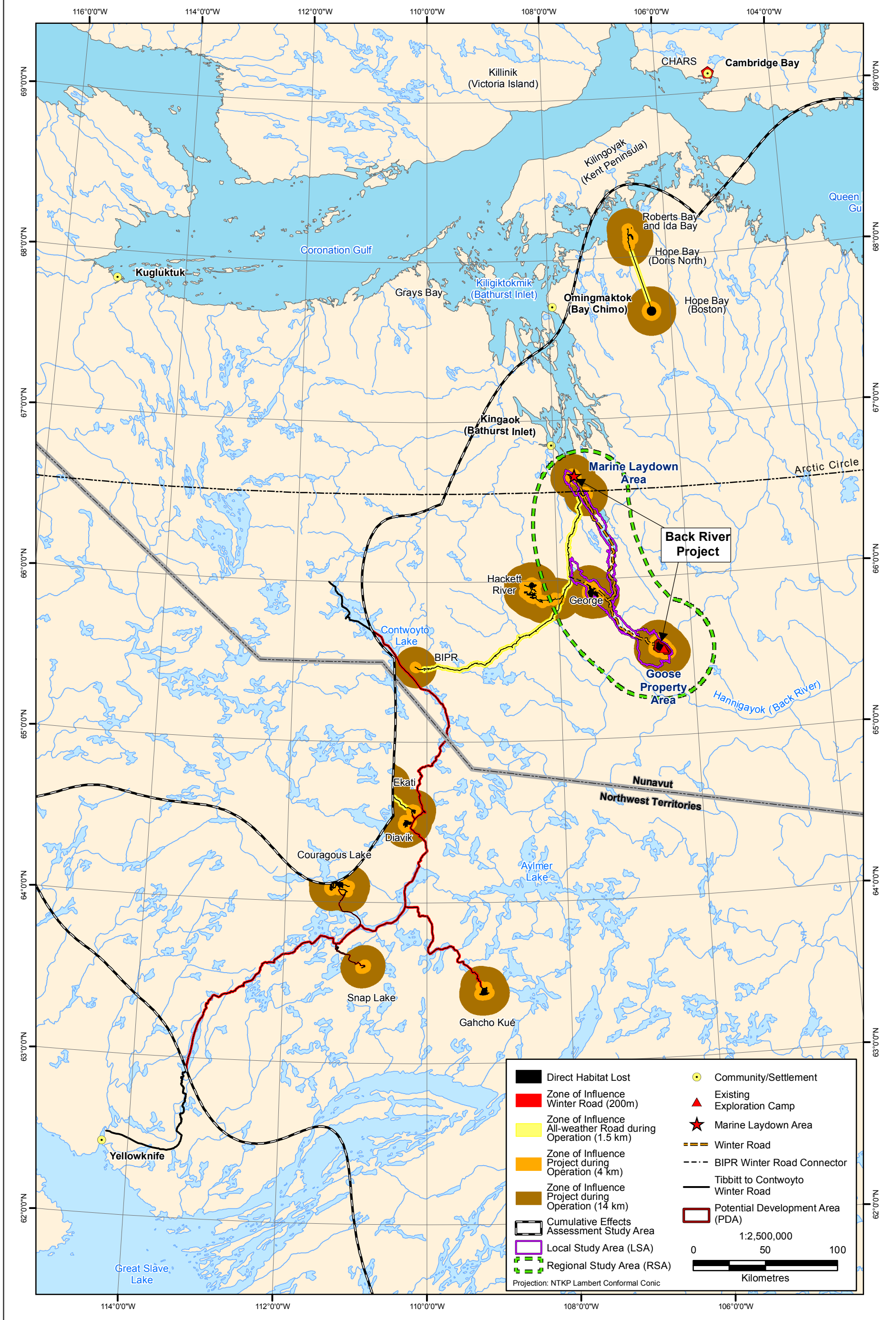

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Figure 5.6-6

Habitat Lost or Altered due to All Project Footprints and Disturbances in the Beverly Caribou Annual Herd Range Cumulative Effects Assessment Boundary

Rescan an ERM company

In the 4 km buffer scenario around mine infrastructure, the area within the zone of influence around projects would cover 278,778 ha or 0.5% of the annual range for Beverly herd caribou. In the 14 km buffer scenario around mine infrastructure, the area within the zone of influence around projects would cover 1,164,963 ha, or 1.9% of the annual range for Beverly caribou. Within these areas, caribou use is expected to drop by approximately 25% and are presented as adjusted areas in Table 5.6-7 for a total of 0.1% to 0.5% reduction in caribou habitat. The proportion of disturbed habitat within the total annual range for Beverly herd caribou is much less than that for the assessment of disturbance in the summer and winter CEA boundaries, thus the summer and winter seasonal CEA boundary were used as a conservative approach to assessing the overall effects of cumulative disturbance due to noise for Beverly herd caribou.

5.6.2.3 Reduction in Reproductive Productivity

Reproductive productivity of caribou can be affected by a number of factors on their seasonal and annual ranges. A review of these factors is provided in the effects assessment for caribou (Section 5.5.2.8).

Factors such as mortality from predators and hunters in addition to factors that may affect forage availability are thought to strongly influence reproductive productivity for caribou. The largest effect that industrial developments can have on reproductive productivity of barren-ground caribou herds is likely through the production of new roads that allow hunters to access new areas in the winter ranges. The Annual Allowable Harvest is regulated by the Government of the Northwest Territories and is outside of the scope of this assessment. The second-most important effect that industrial developments can have on barren-ground caribou is thought to be removal of habitat in the calving and winter range. The third-most important effect of industrial developments is thought to be the removal of and disturbance to foraging habitat.

It has been hypothesized that the primary way in which mines and other industrial developments on the tundra (outside of the winter range) affect caribou is through reduced body condition, resulting from displacement from preferred habitat with high quality forage, and behavioral responses resulting in a negative energy balance (A. Gunn et al. 2001; J. Adamczewski et al. 2012). Researchers have historically surmised that the greatest effect of industry would likely occur during lactation (the post-calving season) and late winter, when female caribou are energetically stressed (Gerhart et al. 1997). More recent results by Chen et al. (2013) indicate that forage availability on the post-calving and summer ranges may be driving recruitment of new animals. This work implies that energetic balances during the post-calving and summer periods are likely the driving factor for changes in herd levels.

Computer models have been developed that combine knowledge on caribou metabolism, forage availability, foraging rates and activity levels to predict the body condition of female caribou, and subsequently, pregnancy rates and calf survival (R. D. Boertje 1985; D. E. Russell, White, and Daniel 2005). These models were summarized and applied to predict the effects on caribou productivity of increased encounter rates with the Gahcho Kué project (De Beers Canada Inc. 2010).

To measure exposure to disturbances, GPS collar data were used to map the movement paths of females to calculate caribou encounter rates with active mine sites, mining exploration camps, and other developments (De Beers Canada Inc. 2010). Each day that a collared caribou spent within 15 km from active mines, and 5 km from other developments including roads, exploration camps, and ports was assumed to result in a disturbing encounter.

Encounter rates were used to estimate decreases in the energetic balance of caribou resulting from additional movements and excitation (R. D. Boertje 1985), from which changes in productivity were

predicted. It was assumed that females travelled about 2 km after being disturbed, and were energetically excited for 12 hours for which the total energetic cost was calculated as 1.69 MJ per disturbance. Results showed that collared Bathurst caribou experienced on average 14 encounters with developments during summer and autumn.

With encounters between caribou and mine sites, fecundity was predicted to decline by 8% in the absence of insect harassment, but to decline by 28% with insect harassment. In contrast, fecundity was predicted to change by less than 3% due to 19 predicted encounters per individual caribou with mine sites per year. Thus, insect harassment was predicted to have a much larger effect on reproductive productivity than did disturbance at mine sites.

In this section, the potential interaction between industrial developments on the seasonal and annual ranges of the Bathurst herd and Beverly herd caribou and factors that can affect reproductive productivity on these ranges is discussed. For past developments where activities are no longer conducted at these development sites, the influence of disturbance on habitat availability is not applicable, and direct habitat loss due to the removal of habitat for infrastructure would be the only factor influencing forage availability at in these areas.

The Cumulative Effects of Industrial Development on Bathurst Caribou

The Back River Project was predicted to have no interaction with any factors that may affect the reproductive productivity of the herd and was rated as negligible for the Bathurst herd. This is primarily due to the fact that all seasonal ranges of the Bathurst herd occur outside of the Project area, thus the Back River project is not anticipated to result in any residual effects to the reproductive productivity of the herd. Due to the status of the Bathurst herd and the concern for this herd from Aboriginal groups and government regulators, the potential effect of reduction in reproductive productivity was carried forward as a residual effect and is assessed in this cumulative effects assessment for Bathurst caribou.

Here the overlap between past, existing, and future foreseeable projects on the seasonal CEA ranges of the Bathurst herd (combined post-calving and summer range) and on the annual herd range for Bathurst caribou are discussed. The potential interaction of these projects with factors that may influence reproductive productivity within these ranges are assessed (Table 5.6-8). Since the Back River Project is closest to the post-calving and summer ranges, potential cumulative effects to the post-calving and summer ranges are addressed in this section first prior to effects on the annual range of the herd.

Table 5.6-8. Potential Project Effects on Factors Affecting Reproductive Productivity in Bathurst Caribou

Factor Affecting Reproductive Productivity	Potential Interaction	Evaluation of Potential Project Interactions
Forage availability	X	Interaction anticipated for projects that overlap with the post-calving and summer range including: past projects (Jericho, Lupin, Tundra, Salmita), existing projects (Ekati, Diavik) and future foreseeable projects (George, Hackett River, BIPR, Izok Corridor, Courageous Lake) which could result in habitat loss and disturbance to forage habitat
Annual variation in food quality	--	No interaction expected.
Disease and parasites	--	No interaction expected.

(continued)

Table 5.6-8. Potential Project Effects on Factors Affecting Reproductive Productivity in Bathurst Caribou (completed)

Factor Affecting Reproductive Productivity	Potential Interaction	Evaluation of Potential Project Interactions
Insect harassment	--	Projects on the summer grounds of Bathurst caribou that include roads could provide insect relief for caribou. However, the interaction with insect harassment is not anticipated to result in any additional energetic costs to caribou as these projects are not anticipated to result in an increase of insect abundance in these areas, thus are not anticipated to result in addition costs associated with less foraging.
Predation	--	Projects on or near the Calving grounds could influence reproductive productivity by creating avoidance zones whereby caribou may select less favorable grounds for calving which could lead to increased predation, and poor body condition of lactation females and calves as a result of lower quality forage. Alternatively, predators could avoid mines, yielding a benefit for caribou to approach mines.
Fire in the winter range	X	Projects on the winter grounds of Bathurst caribou could interact with naturally occurring factors, such as fire on the winter range by reducing access to high quality foraging areas on these grounds, forcing caribou to select less favourable wintering grounds. This could lead to a decrease in reproductive productivity due to increased predation, or by lost energy intake and greater energy expenditure.
Harvesting	X	Projects that may result in additional access to hunting grounds through the creation of roads could result in a decrease to the population. These particularly include projects on the winter grounds.
Climate change	--	No interaction expected.

Post-calving and Summer Range: Projects occurring on the post-calving and summer range of Bathurst caribou include four past projects: Jericho, Lupin, Tundra, and Salmita; two existing projects: Ekati, and Diavik; and four future foreseeable projects: George, Hackett River, BIPR, Izok Corridor projects. On their post-calving and summer ranges, caribou are dependent on high quality forage availability. Studies have indicated relationships between post-calving and summer forage quality on the overwinter survival of calves (W. Chen, Russellb, et al. 2013; Wenjun Chen et al. 2014). Development projects on the post-calving and summer ranges of barren-ground caribou could result in an effect of reduced reproductive productivity through habitat loss and disturbance associated with activities at these sites.

Habitat avoidance studies have been conducted at the two existing developments on the post-calving and summer range of Bathurst caribou (Boulanger et al. 2012). These studies have indicated that a ZOI of 14 km exists at the Ekati mine and an 11 km ZOI exists at the Diavik mine (Boulanger et al. 2012). These two projects are situated side by side on the southern portion of the summer range of Bathurst caribou, and together the cumulative footprint comprises an area of approximately 40 km^2. This area is much larger than most of the past and future foreseeable projects within the post-calving and summer range of the Bathurst herd and is approximately 10 times larger than the proposed size of the combined Goose and MLA PDAs proposed for the Back River Project.

The Back River Project currently falls outside of both the post-calving and summer foraging ranges for caribou. Thus, the effects on reduced reproduction, as a result of reduced foraging on the post-calving and summer grounds resulting in poor overwinter survival of calves, are expected to result mainly from

other larger projects found within these ranges, with minimal or no influence from the Back River Project. Projects that occur near the core areas of the post-calving and summer grounds will likely have the largest influence on this herd on these seasonal ranges. Thus, the Back River Project is not anticipated to contribute to the cumulative effects of reduced reproduction of the Bathurst herd caribou on the post-calving and summer range and only those projects that may directly influence these areas are anticipated to pose an effect.

Annual Range: In addition to effects of reduced forage availability on the post-calving and summer ranges on the productivity of caribou, several studies have indicated that winter may be a sensitive time for caribou and development activities on the winter grounds of caribou may have an influence on caribou reproductive productivity. Energetic stress is highest in female caribou during lactation and winter. Female caribou give birth at a time when they are protein deficient, because their primary winter food—lichen—is protein poor (Parker, Barboza, and Stephenson 2005). In winter, female caribou must maintain sufficiently high fat reserves to avoid using protein reserves that are necessary for foetal growth and survival (Post and Klein 1999; Barboza and Parker 2008).

Studies on the disturbance of woodland caribou by industrial development on the winter range indicate that development on the winter range of caribou may influence reproductive productivity of caribou. These studies indicate that reproductive productivity may be affected through the limitation of winter forage by avoidance of available winter forage, resulting in the selection of less favourable areas where snow conditions may limit forage availability. Caribou may also be vulnerable to increased predation in areas where snow conditions are not favourable as caribou may be in poor body condition and/or it may be more difficult to escape predators as a result of deep snow and ice. In addition, the winter grounds are closer to a number of communities including the larger community of Yellowknife, as well as several smaller communities including Behchokǫ̀, Gamètì, Wekweètì, and Whatì. Thus, caribou populations are susceptible to increased hunting pressures on their winter range.

While the calving range is typically not considered a foraging ground, it is included here as disturbance on this range could result in the most prominent effect to the survival of calves, and thus productivity of the herd. Several proposed projects may occur within or near the calving ranges of this herd (Figure 5.6-1). Barren-ground caribou select open flat areas far north of the treeline for their calving grounds. These areas are typically thought of as predator free during the calving period as wolves, the main predators of caribou are restricted to natal dens in areas around the treeline. Industrial developments on the calving ranges of caribou may attract predators of caribou to these areas due to odours associated with camps and cooking. Alternatively, habitat loss and disturbance on the calving grounds could result in caribou abandoning these grounds and selecting less favourable grounds for calving, making them more vulnerable to predation. Additional movements of females and their calves in addition to less time foraging as a result of disturbance activities on the calving grounds could result in a negative energy balance in both lactating females and calves, ultimately resulting in poor body condition or survival of calves.

The effects on reduced reproduction are expected to result mainly from other projects, with negligible influence of the Back River Project alone. Those projects that occur near the calving and rutting areas will likely have the largest influence on this herd. Thus, the Back River Project is not anticipated to contribute to the cumulative effects of reduced reproduction of the Bathurst herd caribou and only those projects that may directly influence these areas are anticipated to pose an effect.

Thus, the combined effects of lost habitat and disturbance due to all projects in the post-calving and summer range for Bathurst caribou are predicted to result in a residual effect on Bathurst caribou reproductive productivity.

The Cumulative Effects of Industrial Development on Beverly Caribou

The Back River Project was predicted to have some interaction with forage availability to Beverly caribou on their summer and winter ranges through habitat loss and disturbance from the Goose PDA. However, the magnitude of the effect was considered to be low. Additional projects located on these ranges could contribute additionally to habitat loss and disturbance resulting in reduced forage availability for the herd on these ranges, thus potentially resulting in a negative energetic balance in these caribou and a lowered reproductive productivity. The potential interaction of these projects with factors that may influence reproductive productivity within the seasonal and annual ranges are assessed for the Beverly herd caribou.

For the cumulative effects assessment, the potential effects of all projects on the summer and winter seasonal ranges for Beverly caribou are considered, as well as on the annual herd range for a comprehensive approach (Table 5.6-9). Since the Back River Project primarily overlaps with the summer ranges, and to a lesser extent the winter range, potential cumulative effects on the summer range are addressed first in this section followed by effects on the winter range and lastly, on the annual range of the herd.

Table 5.6-9. Potential Project Effects on Factors Affecting Reproductive Productivity in Bathurst Caribou

Factor Affecting Reproductive Productivity	Potential Interaction	Evaluation of Potential Project Interactions
Forage availability	X	Interaction anticipated for projects that overlap with the post-calving and summer range including: past projects (Jericho, Lupin, Tundra, Salmita), existing projects (Ekati, Diavik) and future foreseeable projects (George, Hackett River, BIPR, Izok Corridor, Courageous Lake) which could result in habitat loss and disturbance to forage habitat
Annual variation in food quality	--	No interaction expected.
Disease and parasites	--	No interaction expected.
Insect harassment	--	No interaction expected.
Predation	--	No interaction expected.
Fire in the winter range	--	No interaction expected.
Harvesting	X	Projects that may result in additional access to hunting grounds through the creation of roads.
Climate change	--	No interaction expected.

Summer CEA boundary: In addition to the Back River project, several projects will overlap with the summer range of the Beverly caribou, including the closed Robert's Bay project, the existing Doris North Project, and the future Hope Bay (Phase 2), George, Hackett River, and BIPR projects (Figure 5.6-2). On their post-calving and summer ranges, caribou are dependent on high quality forage availability. Studies have indicated relationships between post-calving and summer forage quality on the overwinter survival of calves (W. Chen, Russellb, et al. 2013; Wenjun Chen et al. 2014). Development projects on these ranges of could result in an effect of reduced reproductive productivity through habitat loss and disturbance associated with activities at these sites.

Similar to the Bathurst herd of caribou, some habitat avoidance due to the cumulative effects of all projects on the range is anticipated to occur on the summer range of Beverly caribou. However, relative to the Bathurst herd, the area of cumulative habitat avoidance on the summer range of the Beverly herd is anticipated to be smaller. This is primarily a result of the fewer number of existing and proposed projects on the summer range of Beverly caribou relative to the Bathurst herd. In addition, the size of

existing and proposed projects on the Beverly summer range are much smaller than existing projects. The Back River project is approximately 10% of the size of the Ekati and Diavik mine projects. Thus, the zone of influence due to disturbance from these projects is anticipated to me much smaller than that reported for the Ekati and Diavik projects (14 and 11 km respectively) and likely to be similar in size (4 km ZOI) to that reported for smaller mines. Thus, the energetic balance of the Beverly herd females and calves on the post-calving and summer range is not anticipated to result in a deficit that could affect the reproductive productivity of the herd to an extent where it could affect the health of the population.

Winter CEA boundary: In addition to the Back River project, several projects already overlap with the winter range of the Beverly caribou, including the Diavik, Doris North, Ekati, Snap Lake and TCWR. Several proposed projects will also overlap with the winter range of the Beverly caribou, including the George, Hackett River, Gahcho Kué, BIPR, and TCWR projects (Figure 5.6-2). While these projects can influence forage quality and quantity on the winter range of Beverly caribou, fewer industrial developments and communities are present on the wintering grounds of Beverly caribou relative to the Bathurst herd. Unlike the Bathurst herd, which overwinters below treeline, the Beverly herd caribou overwinter both above the treeline on the tundra and below the treeline. In addition, the winter range of the Beverly herd is located farther from communities relative to the Bathurst herd winter range and thus, Beverly caribou are less likely to be affected by hunting on their winter range relative to Bathurst caribou. While the TCWR is within the winter range of Beverly caribou, it occurs on the most western part of the range, and is not anticipated to result in an increase in hunting access to the herd. In addition, as Beverly caribou tend to have a mix of overwintering on the tundra and below treeline, they are less likely to be affected by predation on their winter range relative to Bathurst caribou.

Annual range CEA boundary: The projects found on the annual range are the same as those on the winter range. With the exception of Hope Bay Project, all of the projects within the annual range are located on the western edge of the range of this herd and may interact with a small proportion of Beverly caribou population. Since the calving and post-calving grounds for Beverly caribou are northeast of all past, current, future foreseeable projects most of these projects will interact with Beverly caribou after the sensitive calving and post-calving periods.

The effect of the Back River Project along is anticipated to contribute to a relatively small influence on reduced reproduction as avoidance due to the effects of habitat loss and disturbance are anticipated to be relatively small with the exception of the existing Ekati, and Diavik mines on the south-western edge of the annual range. The effect of reduced reproductive productivity due to the Back River Project is anticipated to be small relative to the summer and winter ranges of Beverly caribou. The Back River project on its own was anticipated to have a small residual effect with a low magnitude within the seasonal and annual range of the Beverly herd. The Project is not anticipated to result in an increase in mortality to the herd. The future foreseeable Hope Bay (Phase 2) project would likely have a greater effect on this herd as the proposed location of this project is closer to the post-calving grounds of the Beverly herd.

The combined effects of lost habitat, and disturbance due to all projects in the summer and the winter ranges for Beverly caribou are predicted to result in a reduction in reproductive productivity, albeit minimal.

5.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for caribou will be similar to those implemented for the Back River Project and will meet or exceed best management practices. For a list of mitigation and management measures applied for caribou at the Back River Project see Section 5.8 and Volume 10, Chapter 20 (Wildlife Mitigation and Monitoring Program [WMMP] Plan).

5.6.4 Characterization of Cumulative Effect

After the application of mitigation and management measures, there are three residual effects predicted in the caribou cumulative effects assessment areas: habitat loss, disturbance, and reduction in reproductive productivity.

5.6.4.1 Habitat Loss

The overall loss or degradation of area due to all projects in the Bathurst herd CEA boundary is 23,049 ha (approximately 0.3% of the Bathurst caribou post-calving/summer CEA boundary). The Back River Project is not expected to contribute to cumulative habitat loss for Bathurst caribou.

The overall loss or degradation of habitat in the Beverly herd summer CEA boundary is 20,181 ha (0.06% of boundary) and is 23,118 ha in the winter CEA boundary (0.06% of boundary). The proportion attributed to the Back River Project is approximately 30% of the area lost in the summer and winter CEA areas. However, the actual areas of loss due to the Back River Project will be much lower as approximately 10% or less of the PDAs will result in habitat loss due to the placement of project infrastructure. Hence, the Project will account for approximately 5% of the cumulative industrial development in the Beverly herd range. The amount of habitat loss is minimal relative to the amount of habitat in each of the CEA boundaries assessed for caribou, thus, the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as it will be contained close to project footprints. The frequency is sporadic, as habitat loss would occur during the construction periods for each Project and habitat degradation due to dusting would occur when blasting activities occur. The duration of the effect is long term (beyond the life of the projects) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline condition, although some area may be reclaimed. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss was converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible. Although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for both herds of caribou is concluded to be Not Significant.

5.6.4.2 Disturbance

Using the likely 4 km ZOI disturbance scenario, the overall disturbance of habitat due to all projects in the Bathurst herd post-calving/summer CEA boundary is 238,427 ha (approximately 2.9% of the Bathurst caribou post-calving/summer CEA boundary). The Back River Project will not contribute any disturbance to that in the Bathurst CEA post-calving/summer boundary.

The overall loss or degradation of habitat in the Beverly herd summer CEA boundary is 181,897 ha during (0.5% of the summer boundary) and is 274,109 ha in the winter CEA boundary (0.7% of the winter boundary) during the 4 km ZOI disturbance scenario. The Back River Project will contribute approximately 15% of the disturbance by all projects combined using this evaluation approach. The amount of habitat degraded is small relative to the amount of habitat in each of the CEA boundaries assessed for caribou, thus, the magnitude of the cumulative residual effect is considered low.

The effect is considered negative as disturbance to habitat could push herds out of utilizing ideal habitat. The extent of the effect of habitat loss is regional (i.e., it extends beyond the wildlife RSA but is contained within the CEA boundaries for Bathurst and Beverly caribou). The frequency is sporadic, as

habitat degradation would occur during the construction and operation periods for each Project during blasting events, vehicle use on roads and aircraft overflights. The duration of the effect is medium as the effect will discontinue when the projects are closed; and the effect is considered reversible, as areas will return to existing baseline condition and animals will likely return when the disturbance is ceased. The probability of the effect occurring is likely as habitat as noise will be created during Construction and Operation activities. The confidence of the effect occurring is considered high, as the effect of habitat disturbance was converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible. Although confidence in the area and proportion disturbed is considered medium as it is anticipated that a much smaller proportion of the area will be disturbed. The cumulative residual effect of disturbance for both herds of caribou is concluded to be Not Significant.

5.6.4.3 Reduction in Reproductive Productivity

The potential for a reduction in reproductive productivity in caribou depends on the magnitude of all other effects (disturbances) they experience. Disturbance leading to displacement of females with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young, would likely lead to the greatest effects on caribou populations in the region.

The residual effects of the Project on caribou include habitat loss and disturbance. These effects combined can result in a reduction in reproductive productivity in caribou if the magnitude of the effect is large enough. The highest magnitude of any of the residual effects on caribou after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on caribou is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of caribou in the regional area. The duration of the effect is expected to be medium term as decreases to population would be expected during poor years but anticipated to recover in good years. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as caribou have large home ranges and may come into contact with many of the Projects in the CEA boundary. The likelihood that a reduction in reproductive productivity on caribou will occur as a result of the cumulative effects of all projects is low as the overall percentage of high quality habitat lost as a result of industrial development is small. The confidence in the effect rating is low as it is unknown how the effects of the projects on reproduction of caribou may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

5.6.5 Significance of Cumulative Residual Effects

The cumulative effects assessment for caribou identified three residual effects as follows and in Table 5.6-10:

- habitat loss, rated Not Significant;
- disturbance, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of caribou is **Not Significant**.

Table 5.6-10. Summary of Cumulative Residual Effects to Caribou and their Significance

	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
Cumulative Residual Effects	**Direction** *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

5.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on caribou are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, the CEA boundary is designed to encompass the seasonal ranges of Bathurst and Beverly caribou when they interact with the Back River Project, and includes habitat within the Northwest Territories; thus, the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for caribou.

5.8 MITIGATION AND ADAPTIVE MANAGEMENT

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10 Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including caribou. Mitigation measures specific to caribou for potential Project effects are listed in Section 5.5.3 and summarized in Table 5.8-1 in Section 5.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including caribou. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4.
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18.
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11.
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock Management Plan: Chapter 9.
- Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosives Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.

- Borrow Pits and Quarry Management Plan: Chapter 16.
- Conceptual Fish Offsetting Plan: Chapter 21
- Tailings Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

5.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as identified caribou crossing locations along their migratory routes. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 5.8-1 in Section 5.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on caribou.

5.8.2 Best Management Practices

The WMMP Plan (Volume 10 Chapter 20) includes eleven separate mitigation and management plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects on caribou are listed in Section 5.5.3, and summarized in Table 5.8-1 in Section 5.8.5.

5.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these will need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the WMMP Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The WMMP Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

5.8.4 Monitoring

As part of the WMMP Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

5.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 5.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on caribou

Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou)

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	1. Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as caribou calving grounds and caribou high use areas. 2. Infrastructure designed to minimize the Project footprint to reduce habitat loss for caribou. 3. Consideration of the location of the stockpiles and windbreaks to minimize dustfall. 4. Open-water season shipping only (no ice-breaking) to avoid potential negative effects on wildlife dependent on ice (e.g., Dolphin Union Caribou migrations) 5. Winter only road access corridors (no all-weather roads for re-supply routes). 6. Winter roads designed to minimize the distance travelled. 7. Infrastructure located close to deposits to keep activities confined to specific areas, in order to confine noise-generating activities. 8. Underground mining used, where possible. 9. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination. 10. Buildings designed and maintained to exclude wildlife. 11. WAD Cyanide destruction inside the mill.
2. Best Management Practices	A comprehensive mitigation plan for caribou is described in the WMMP (Volume 10, Chapter 20, Section 6.10), which includes details on monitoring and mitigation triggered by caribou observations, including: 1. monitoring for caribou using satellite collars, incidental observations and dedicated environmental technicians; 2. Triggers for actions will be dependent on how sensitive caribou are in each season and the number of animals. During low sensitivity season, a trigger will require caribou to be closer to the Project and in larger groups to trigger mitigation. In sensitive seasons, the opposite will be true – smaller groups at greater distances will trigger the same mitigation actions; 3. should the calving ground of the Bathurst herd shift to overlap the Project site, planned reductions or cessation of Project activities will be conducted the following year; 4. should caribou be observed by helicopter pilots, pilots will avoid caribou and report to the sighting to the Environment Team; 5. should a drive observe a caribou, the drive will slow down if caribou are near the road, or stop and wait should caribou be on the road or attempting to cross the road; and

(continued)

Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou; continued)

Mitigation Category	Mitigation Measures
	6. should caribou be observed near the mine site during a sensitive season, then staged reductions in outdoor activities will occur, including vehicle stoppages, halting above ground blasting, and aircraft movement.
	Other best management activities will include:
	7. Pre-construction ground clearing will be conducted outside of sensitive periods for caribou (i.e., spring migration [Beverly herd], calving or post-calving migration [Bathurst herd]).
	8. Above ground blasting scheduled outside of the peak periods of Bathurst caribou presence in the wildlife RSA, where possible.
	9. Ground-based observations for caribou conducted prior to blasting during the calving and post-calving periods if incidental observations from helicopters indicate that caribou are in the area.
	10. Noise disturbance minimized by managing blasting activities to reduce disturbance (e.g., limiting above ground blasts) if large herds of female caribou with young (>100 animals) occur within 500 m (or line of site) of the site, until caribou pass through the area.
	11. All equipment maintained to reduce noise.
	12. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations and not permitted on winter road corridors outside of the frozen ground period (December to April).
	13. Aircraft to follow prescribed altitudes, when possible, as recommended in the draft caribou protection measure guidelines. Landing and take-off conducted only when herds of caribou are not present in the immediate area.
	14. Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats.
	15. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed.
	16. Berms or other markers built at high walls of quarries.
	17. Truck speed limited to 60 km/h, signage installed to alert drivers of speed limits, and enforcement of speed limits.
	18. Wildlife given the right-of-way on all roads at all times.
	19. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic, and road use restricted only to persons required for Project construction, operations and maintenance.
	20. Wildlife exclusion measures implemented to exclude wildlife from areas where water or waste could pose a risk to health of wildlife.
	21. A policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees during employee orientation and enforced.
	22. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continue throughout the life of the Project, and enforced.
	23. A policy prohibiting hunting from and within a buffered area along all Project infrastructure developed and enforced to prevent an increase in mortality to caribou.
	24. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers.
	25. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures, and participation by all contractors and employees working on the Project during orientation.

(continued)

Table 5.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife (Including Caribou; completed)

Mitigation Category	Mitigation Measures
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.
4. Monitoring	
	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. his program will include several monitoring plans relevant to caribou including: 1. footprint monitoring to monitor habitat loss; 2. human activity monitoring of Project site roads and winter roads; 3. noise monitoring to monitor disturbance to wildlife; 4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes; 5. infrastructure monitoring to record the status of wildlife exclusion measures, such as skirting and fencing; 6. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and 7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible. Focal-species monitoring program to monitor Project-related effects on specific terrestrial wildlife species including: 1. a collaboration with the Government of Nunavut to conduct herd-level monitoring for the Bathurst herd; 2. a monitoring program for caribou using remote cameras in the wildlife RSA to assess the zone of influence of the Project on caribou; 3. participation in governmental-based caribou monitoring program if one exists, such as a regional-habitat selection assessment program; and 4. incidental reporting of caribou observations during other wildlife and environmental monitoring programs.

5.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:

- Monitor wildlife interactions with Project Infrastructure;
- Monitor mitigation actions and their efficacy; and
- Identify opportunities for adaptive management.

2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to caribou are summarized in the following sections.

5.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10, Chapter 20):

- Footprint monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Birds;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Infrastructure Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA; Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds, and
- Pre-construction Surveys for Bear Dens.

5.9.2 Focal-species Monitoring

The proposed focal-species monitoring program will include monitoring caribou through collaborative programs with GN DOE, analyzing GPS collar data and monitoring caribou by remote motion-triggered cameras. All of the monitoring programs below are described in detail in the WMMP (Volume 10, Chapter 20).

Collaborations with GN DOE Caribou Programs

During February, 2013, meetings were held in Yellowknife at the invitation of GNWT ENR wildlife research, and including representatives from GN DOE and industry representatives, to decide the course of caribou research to investigate cumulative effects on the Bathurst caribou herd. The results of this meeting indicated that collaborative research projects between industry partners and government biologists was the path forward, in lieu of project-specific regional monitoring activities.

During the DEIS review phase, the Government of Nunavut requested that Sabina collaborate and contribute to herd-level monitoring programs for the Bathurst herd.

To that end, Sabina is proposing to work collaboratively with wildlife biologists from GN DOE to conduct collaborative regional research on cumulative effects. The format of this collaboration has yet to be formalized but could include contributing funds (e.g., purchasing collars or funding calving ground surveys), in-kind funds (fuel and accommodation) and/or consultant time to work with the GN and GNWT on government-lead research projects (e.g., continued resource selection function modelling, or vegetation monitoring on the summer range).

As part of the DEIS review, the KIA requested that Sabina propose an alternative monitoring program should the GN fail to produce a monitoring plan and Sabina be unable to collaborate with the GN. As a consequence, Sabina is proposing a backup plan to collaborate with the GNWT ENR on herd level research and conservation of the Bathurst Herd.

This proposed research collaboration, along with analysis of satellite collar data, is meant to satisfy the Government of Nunavut Department of the Environment requirements to monitor caribou on a regional scale. This work would also replace more traditional regional-scale monitoring such as aerial surveys.

Satellite Collar Program

As part of the section titled Mitigation and Monitoring for Caribou (Volume 10, Chapter 20, Section 6.10), Sabina is proposing to conduct an annual monitoring program using satellite collars for the Bathurst caribou herd. The analysis will examine the location of the Bathurst herd on a yearly basis, looking for any shifts in the location of the calving range. The Bathurst caribou herd used to calve to the east of Bathurst Inlet in the 1980s and may move again in response to climate, vegetation, or population triggers. The baseline satellite program will use 50% kernel UD and 95% kernel UD measures to evaluate the location of the core habitat and areas of active use, respectively.

Remote Motion-triggered Cameras

Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013e, Appendix V5-5C; 2014a). The use of remote cameras for annual monitoring of caribou is currently proposed for the focal-species monitoring of caribou as part of the WEMP (Volume 10, Chapter 20). Caribou use of the Project facilities will continue to be monitored every three years during Construction, and annually during all other phases using motion-triggered, all-weather cameras. A passive monitoring system was set up in 2012 and 2013 with the deployment of 60 motion-triggered cameras (Reconyx PC800 HyperFire™ Professional Semi-Covert

Infrared) in the wildlife RSA to document caribou (and other wildlife) activity around camp infrastructure, and on the tundra. Cameras were positioned at key proposed infrastructure locations, such as the proposed tailings impoundment area and at the various camp infrastructure locations of the Goose and George Properties and proposed Marine Laydown Area. Control areas will also be monitored to evaluate the use of the Project locations compared to undisturbed areas of the tundra near the camp. Finally, areas predicted to be important for caribou were also monitored – such as river crossings, lake shores, eskers, and locations with abundant caribou trails on the tundra. Cameras will be checked twice per year at minimum by on-site environment technicians. Cameras may be repositioned as deemed necessary pending results of the photo data.

The five objectives of this monitoring program are to:

1. Monitor the Project site to examine how caribou interact with Project facilities (e.g., on roads, pits);
2. Monitor the Project site at areas with and without mitigation structures or activities to evaluate the efficacy of mitigation activities (e.g., in areas with dust, vs. without);
3. Monitor areas identified as important for caribou from land user knowledge (e.g., eskers, river crossings) and at points with high number of caribou identified during baseline studies (e.g., the river crossing at the east end of Beechey Lake);
4. Monitor control areas distant from the mine and away from areas identified in 3); and
5. Record the times at which caribou use the wildlife RSA during the year.

The existing cameras in the wildlife RSA will be re-evaluated for how they address the five objectives above and re-deployed, if necessary. Methods for data management and analysis will follow those outlined in Volume 10, Chapter 20; Section 7.3.1 of the WMMP Plan.

5.10 IMPACT STATEMENT

Caribou, including Bathurst herd and Beverly herd were included as a valued ecosystem component for the FEIS. A review of the potential Project iterations with caribou identified eight potential effects that may occur. These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions among all potential effects.

The effects assessment included the identification of key indicators and quantitative thresholds for evaluation of potential effects. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on caribou and concluded that three of the potential effects would remain as residual effects after mitigation: habitat loss, disturbance, and reduction in reproductive productivity. Using the key indicators and thresholds, each of these residual effects were rated with a low magnitude and overall were rated as Not Significant, contingent on the implementation of mitigation measures outlined in the WMMP Plan (Volume 10, Chapter 20).

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. The residual effect anticipated to contribute the most to effects on the population is attributed to disturbance due to

noise. While the most current mitigation measures are proposed for the Project, effects of disturbance due to noise have been recorded at other existing projects with similar mitigation measures. Thus, it is anticipated that despite the best mitigation measures, disturbance due to the Project is likely to result in caribou avoiding these areas and potentially moving to habitats of lesser quality leading to range shifts and potential reduction in reproductive productivity.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for caribou that interact with the Project. Three potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, and reduction in reproductive productivity. Key indicators were calculated for those where data was available and residual cumulative effects were predicted for all three potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the caribou populations within the cumulative effects assessment boundaries.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of Not Significant was concluded for residual cumulative effects on caribou in the CEA boundaries. The overall effect of the Project on the VEC caribou is **Not Significant**.

6. Grizzly Bear

Sabina
GOLD & SILVER CORP.

6. Grizzly Bear

6.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

6.1.1 Introduction

Barren-ground grizzly bears (*Ursus arctos horribilis*), inhabit the northern edge of the grizzly bear range in North America. Habitats at these high latitudes are relatively low in forage productivity. As a result, barren-ground grizzly bears have large home ranges and exist at low densities compared to other grizzly bear populations in more productive ecosystems (McLoughlin 2000).

Inuit Traditional Knowledge indicates that barren-ground grizzly bears (hereafter, grizzly bears) are found throughout the Back River Project (the Project) wildlife Regional Study Area (RSA), especially in association with major river systems, watersheds and coastal areas (KIA 2012, 2014). Grizzly bears were hunted for meat and fat (food and oil) typically in spring or fall before denning. These mammals are also important and respected by Inuit as many legends and stories exist about them (KIA 2012).

6.1.2 Population Trends and Conservation

In the Canadian Arctic, the most recent surveys of population trends for the grizzly bears in 2003, indicated a stable or slightly increasing population (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Barren-ground populations of grizzly bears are listed as a species of "Special Concern", but are not yet listed under *The Species at Risk Act* (SARA; COSEWIC 2012). In the Northwest Territories and Nunavut, the Canadian Endangered Species Conservation Council lists grizzly bears as Sensitive (CESCC 2005; Working Group on General Status of NWT Species 2006; CESCC 2010).

There is no official estimate on grizzly bear population sizes for the West Kitikmeot region of Nunavut where the Project is located. However, a rough estimate of 800 grizzly bears was determined for a 200,000 km^2 portion of the northwestern mainland of Nunavut, which includes the wildlife RSA (Ross 2002). This estimate assumed a density of 4 bears per 1,000 km^2 based on grizzly bear densities in nearby areas (Ross 2002). Grizzly bear mark-recapture population studies conducted in the wildlife RSA in 2012 resulted in a rough estimate of 72 females (95% C.I. 68 – 81) and 52 males (95% C.I. 48 – 62); estimates in 2013 were 64 females (95% C.I. 62 – 71) and 54 males (95% C.I. 50 – 64) (Rescan 2013b, Appendix V5-6B; 2014b, Appendix V5-6A;) Across the two years of study, results indicate a detection frequency of approximately 6–8 grizzly bears/1,000 km^2 (Rescan 2014a, Appendix V5-6B). This does not represent a true density estimate because because the true spatial extent of the super-population, which lies outside the study grid, and individual residency times are both unknown parameters. The life history traits of grizzly bears generally limit the resilience of populations threatened by human disturbance (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Grizzly bears are long lived animals characterized by low reproductive rates due to a late age of maturity, small litter sizes, and long intervals between litters (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Barren-ground grizzly bears are expected to have relatively lower reproductive rates relative to their southern counterparts because they occupy areas of low productivity and high seasonality (Ferguson and McLoughlin 2000; McLoughlin, Ferguson, and Messier 2000). In addition, barren-ground grizzly bears have a later age of maturity, smaller litter sizes, and lower birth rates relative to southern populations of grizzly bears (McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003). This work implies that barren-ground grizzly bears may be more susceptible to population declines when disturbed by human-related activities as well as longer periods of population recovery after disturbance events are removed. The stability of grizzly bear populations in the Arctic may be dependent on several criteria

including mortality due to hunting and human-related activities, low reproductive productivity, and general health of individuals. Reproductive productivity and general health of grizzly bears may in turn be influenced by access to resources such as habitat and nutritional sources, exposure to contaminants, and climate change.

Grizzly bear populations in the central Canadian Arctic are structured into three spatially distinct groups; the Kugluktuk region, Bathurst Inlet region, and the North Slave region (McLoughlin et al. 2002). Traditional knowledge and baseline studies conducted in the wildlife RSA indicate that grizzly bears are found throughout the wildlife RSA (Gartner Lee Ltd. 2008; Rescan 2011a, Appendix V5-5E; KIA 2012; Rescan 2012a, Appendix V5-5D; 2013b, Appendix V5-6A; 2013e; KIA 2014; Rescan 2014b, Appendix V5-5E). Grizzly bears in the wildlife RSA are part of the Bathurst Inlet population (GN DOE 2005). There are few genetic differences between individuals among the three groups, thus it has been suggested that these populations be managed as one continuous population (McLoughlin et al. 2002).

It has been suggested that the barren-ground grizzly bear is at risk of decline if annual harvests and human activity are increased, which may have considerable negative effects on the population (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). McLoughlin and Messier (2001) indicate that a maximum removal of 15 bears per year should be the target for sustaiable harvest in the Kitikmeot region, based the densities and demographic parameters of barren-ground grizzly bears in the region. An average of 13.4 bears per year was reported as harvested between 1958 and 2000 in the central Canadian Arctic which included a portion of the Kitikmeot region (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). From the period of 2000 to 2008, the average harvest of grizzly bear in the Kitikmeot region, which encompasses the Back River Project, was 15.4 bears per year (Awan and Szor 2012). Recent estimates of grizzly bear harvest over the period from 1984 to 2013 indicated a farily consistent trend of 10 bears per year over the period, and that the harvest appears suistanable through local observations that grizzly bears remain at approximately historical densities throughout the region and that the neither the sex ratio nor the mean age of the harvest indicates any demographic change (GN DOE 2013). Thus, it appears that current harvest rates are below the suistainable target set by (McLoughlin and Messier 2001).

In 2007, the Total Annual Harvest (TAH) for grizzly bear, including problem kills, from the Bathurst Inlet population, which is contained within the GB02 wildlife management unit (MU), was six grizzly bear, at a ratio of two males to one female (GN DOE 2007). Current TAH are not available for grizzly bear populations in Nunavut (GN DOE 2013). At the time of the writing of the FEIS, the proposed Marine Laydown Area occurs within MU GB02, while the Goose PDA in an area without a formal Management Unit for grizzly bear.

The locations and causes of 265 grizzly bear kills were recorded in the West Kitikmeot region between 1981 and 2004, and indicate an annual known harvest of 11 bears per year (Dumond and Campbell in prep). The majority of bears killed in the Bathurst Region between 1981 and 2004 were killed by sport hunting (36%), or as problem kills (34%; (Dumond and Campbell in prep). Twenty-six percent were harvested for subsistence (no tag required) or for the sale of the hide with a tag. The remainder (4%) died of natural or unknown causes. Most problem kills occurred in June, July, or August, whereas most sport hunts occurred in May. The majority of bears killed (41%) were adult males. These data indicate that 29% of the reported kills, or 3.2 bears kills per year occurred in the Bathurst Inlet area of the West Kitikmeot Region (Dumond and Campbell in prep) which is close to where the Back River Project is located. The recorded kills in the Bathurst Inlet Region between 1981 and 2004 (3.2 bears/year) were below the recommended TAH for the Bathurst Inlet population. However, this estimate does not include unreported harvest.

Decreases in reproductive productivity may result from declines to general health of terrestrial wildlife. Health of wildlife can be influenced by a number of factors including exposure to contaminants. Baseline concentrations of contaminants in grizzly bear tissues is generally lacking in the Arctic. However, evidence from literature suggests that persistent organic pollutants are of most concern to Arctic carnivores, and the majority of literature relevant to Arctic carnivore species pertains to discussion of these types of contaminants. While some data for metals exists (e.g., Gamberg, Palmer, and Roach 2005), it suggests that metal concentrations are well below threshold values for adverse health effects in other carnivore species.

Climate change or climate warming may also affect populations of barren-ground grizzly bears. One of the most important changes in the Arctic as a result of recent warming trends, is an increase in the biomass of shrub species, such as birch, willow, and alder (Myers-Smith et al. 2011; Tremblay, Lévesque, and Boudreau 2012; Frost et al. 2013). The increase in these species will have important implications for the structure and function of Arctic ecosystems. The increase in plant cover may provide additional nutritional resources for ungulates and other species on which grizzly bears prey. However, the effects of climate warming on wildlife populations are not clear, and populations of important grizzly bear prey species may be controlled by additional factors such as extreme weather events (Parmesan, Root, and Willig 2000; Parmesan 2006).

Grizzly bears have recently been spotted in areas beyond their typical northern range including on Banks and Victoria islands (in the Canadian Arctic islands north of Bathurst Inlet) and on the sea ice northwest of Banks Island and as far north as Melville Island (Doupé et al. 2007). In 2006, a grizzly-polar hybrid was shot by a sport hunter near Sachs Harbour (Gormezano) on Banks Island and hybrids have been observed in other areas (Schliebe et al. 2006), potentially including Kugluktuk northwest of the wildlife RSA (Darwin). However, it is unclear how climate change may interact with other human-related activities such as industrial development, changes in contaminant exposures and reproductive viability of barren-ground populations of grizzly bears.

6.1.3 Distribution and Movement Patterns

The historic range of the grizzly bear extended along the western half of North American as far south as Mexico. The grizzly bear has been extirpated from much of their former southern range; however; the barren-ground grizzly bear population exists throughout northwestern Canada because it has not been subjected to the same intensity of exploitation and habitat changes (McLoughlin 2000).

Between 1995 and 1999, across the Southern Arctic Terrestrial Ecozone, which spans the northern coast of Mainland Northwest Territories, most of northern mainland Nunavut, and a portion of northwestern Quebec, a total of 81 grizzly bears were captured and fitted with satellite radio-collars and over 8,000 telemetry locations were recorded from collared animals (McLoughlin, Ferguson, and Messier 2000). The locations of these collared bears occurred mostly to the east and west of the wildlife RSA, however some collar locations were detected within the boundary of the wildlife RSA (Figure 6.1-1). These bears represent a small portion of the grizzly bears which may reside in the vicinity of the wildlife RSA. Average home range sizes derived from the satellite collaring study varied from 210,000 ha for females to 724,500 ha for males, and home ranges of individuals overlapped more than those reported in southern latitudes (McLoughlin, Ferguson, and Messier 2000; McLoughlin, Taylor, Cluff, Gau, Mulders, Case, Boutin, et al. 2003).

Grizzly bear movements were investigated using data collected during the 2012 and 2013 grizzly bear DNA studies. On average, males were recorded travelling the longest distances between sampling grid cells in both years (58 km in 2012, 49 km in 2013), and the average distances travelled by females were nearly half that of males in both years (25 km in 2012, 27 km in 2013). Potential family units travelled on

average 46 km in 2012 and 21 km in 2013 (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B). A notable trend in grizzly bear detections was recorded in 2012. Detections of grizzly bears in 2012 mainly occurred in the eastern portion of the wildlife RSA and along major river systems. During the summer and fall, bear detections were evenly distributed throughout the wildlife RSA. Traditional knowledge also indicates that major grizzly bear movements occur in the wildlife RSA, especially in association with major river systems, watersheds and coastal areas (Thorpe et al. 2001; KIA 2012, 2014).

6.1.4 Habitat Use and Diet

Habitat selection by grizzly bears mainly reflects spatial and temporal patterns in forage availability and abundance (McLoughlin et al. 2002). Habitat selection has been measured at two spatial scales; landscape and home range. At the landscape scale, grizzly bears select home ranges that have a higher proportion of eskers, tussock/hummock tundra, lichen veneer, birch seep, and riparian tall shrub habitat than surrounding areas. At the smaller home range scale, habitat selection varies by season, sex and reproductive status (McLoughlin et al. 2002). Habitat suitability modelling of the wildlife RSA (see Section 6.1.5) indicated that the habitat contained within the wildlife RSA contains a variety of suitable foraging habitat during the snow free season. However, modelling indicated that denning habitat within the wildlife RSA was in very low quantity, largely a result of the rarity of eskers and lacustrine deposits, habitat where bears may easily excavate den sites (Rescan 2013a, Appendix V5-5A).

Research on the dietary patterns of barren-ground grizzly bears indicates that five time periods correlate with seasonal changes in resource selection (Table 6.1-1; Gau et al. 2002): spring, summer, late summer, fall and denning.

Table 6.1-1. Seasonal Periods for Grizzly Bear

Season	Start Date	End Date
Spring	May 14	June 20
Summer	June 21	July 31
Late Summer	August 1	September 9
Autumn	September 10	October 15
Denning	October 16	May 15

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

Spring (May 14 to June 20)

Forage in spring is important for grizzly bears to recover from weight loss during winter hibernation. Upon emerging from dens, barren-ground grizzly bears feed on a variety of food, including caribou migrating north to their calving grounds (Gau et al. 2002). Overwintered berries and Arctic ground squirrels are also important food sources during this period (Gau et al. 2002).

Grizzly bears show the greatest preference for esker habitat during the spring, perhaps because ground squirrel burrows are abundant and more easily accessible there in spring than elsewhere (McLoughlin et al. 2002; Johnson et al. 2005). Male grizzly bears also show a preference for tussock/hummock tundra, while females without cubs show a preference for riparian tall shrub habitat (McLoughlin et al. 2002; Johnson et al. 2005). Habitat suitability modelling in the wildlife RSA indicated that approximately half of the wildlife RSA and a small portion of the wildlife Local Study Area (LSA) contained high or moderately suitable spring habitat for grizzly bears (Rescan 2013a, Appendix V5-5A). The largest concentrations of highly rated grizzly bear spring habitat was located northwest portion of the wildlife RSA (Rescan 2013a, Appendix V5-5A).

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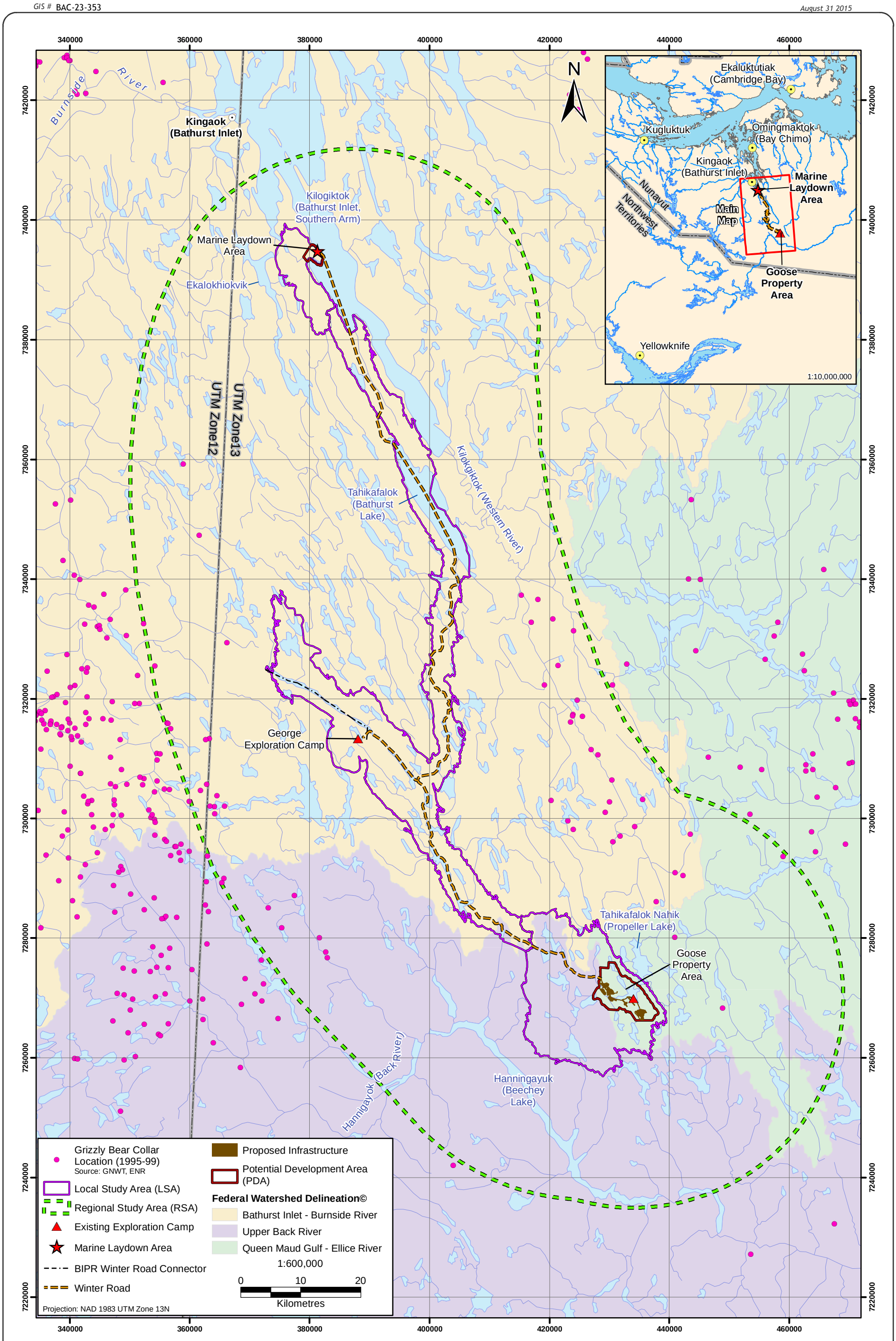

Figure 6.1-1

Grizzly Bear Satellite Collar Locations, 1995 to 1999

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Summer and Late Summer (June 21 to September 9)

The summer diet of barren-ground grizzly bears is highly variable. Early in the summer season when caribou are not as abundant in the wildlife RSA compared to other seasons, grizzly bears feed primarily on horsetails, Arctic cottongrasses, and sedges. Gau et al. (2002) studied food choice by grizzly bears in a study area to the south of the wildlife RSA, in an area used by the Bathurst caribou herd during summer. Gau et al. (2001) reported that by mid-summer, caribou become a more important component of the grizzly bear diet as post-calving herds of Bathurst caribou move southeast. Use of caribou in the wildlife RSA by grizzly bears would happen early in the season, since the Bathurst herd is present in the wildlife RSA only during post calving. This heard then moves further south to their summer range. Vegetation is still an important source of food during the summer. Grizzly bears resume consumption of Arctic ground squirrels in when the caribou leave the area (Gau et al. 2002).

During the summer, female grizzly bears (with and without cubs) show preference for eskers and riparian tall shrub habitat (McLoughlin et al. 2002). Females with young also prefer heath tundra. The majority of tall shrub habitat in the wildlife RSA occurs in the northern and western portion of the wildlife RSA near Bathurst Inlet and the Western River and along other major river systems. Males continue to show preference for tussock/hummock tundra in the summer (McLoughlin et al. 2002).

A habitat modelling study by Johnson et al. (2005) that overlaps the wildlife RSA shows that grizzly bears in the area select esker and low shrub habitats in the summer.

In late summer, barren-ground grizzly bears increase foraging in order to fatten up for the winter denning season (Gau 1998). During this time, berries are the primary component of the grizzly bear diet and are essential for fat deposition. Caribou continue to be an important source of food during the late summer, where they are available, and Arctic ground squirrels are consumed to some extent (Gau et al. 2002). The Ahiak caribou herd occurs in the wildlife RSA at low numbers during the fall, and grizzly bears likely prey on these animals.

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

Habitat suitability modelling conducted during baseline studies in the wildlife RSA (see Section 6.1.5) indicated that approximately 50% of the wildlife RSA and 75% of the wildlife LSA consisted of high-quality (habitat rated as high or moderate suitability) summer habitat (Rescan 2013a, Appendix V5-5A). High quality habitat was distributed fairly evenly throughout the wildlife RSA (see figures in Section 6.1.5).

Autumn (September 10 to October 15)

Autumn is a critical season for barren-ground grizzly bears because individuals must gain weight rapidly in order to survive winter hibernation (Zager and Jonkel 1983). The autumn diet of grizzly bears is similar to their spring diet. Depending on their location, grizzly bears feed primarily on caribou that are migrating south towards the treeline for winter. Arctic ground squirrels are also an important food source. However, fewer berries are consumed in autumn compared to the spring and summer seasons (Gau et al. 2002).

Important grizzly bear habitat in autumn includes riparian tall shrub habitat, lichen veneers and heath tundra. Habitat selection is strongly influenced by the occurrence of caribou during fall (Johnson et al.

2005). However, females with cubs significantly avoid riparian tall shrub habitat and select bedrock habitats, which are avoided by males. Females without young continue to prefer eskers in autumn (McLoughlin et al. 2002). A habitat modelling study by Johnson et al. (2005) shows that fall habitat selection by grizzly bears is strongly influenced by the presence esker, heath rock, low shrub, and peat bog vegetation types.

Habitat suitability modelling conducted during baseline studies in the wildlife RSA (see Section 6.1.5) indicated that approximately 50% of the wildlife RSA and the wildlife LSA consisted of high-quality (habitat rated as high or moderate suitability) summer habitat (Rescan 2013a, Appendix V5-5A). High quality habitat was concentrated in the northern portion of the wildlife RSA and along the major river systems in the wildlife RSA (Section 6.1.5).

Denning (October 16 to May 15)

In general, denning lasts from late October to early May for most bears; some bears, males in particular, may den for shorter periods of time (McLoughlin, Cluff, and Messier 2002). Dens have been found in a wide variety of habitat types.

A satellite-collaring study was conducted in the West Kitikmeot region (McLoughlin et al. 2002) to determine the denning ecology of grizzly bears in the area. This research indicated that most dens sites (60%) were located in heath tundra and heath-boulder habitats, with most of the remaining dens located in riparian tall shrub and birch seep habitats (McLoughlin et al. 2002). Although eskers accounted for only seven of 56 den sites studied, this habitat type was selected more than expected, given its low availability in the central Arctic.

Several characteristics such as aspect, and slope appear to influence selection of den sites. Grizzly bear den sites most commonly faced south (H. V. Reynolds, Curatalo, and Quimby 1976; Banci and Moore 1997; McLoughlin et al. 2002). The benefit of a southern exposure may be insulation (i.e., warmth) at emergence in the spring (and possibly at denning in the fall) or the accumulation of an insulating layer of snow that would result from the prevailing northerly winds. Grizzly bears also selected den sites on relatively steep slopes, averaging 25° (McLoughlin, Cluff, and Messier 2002). Steep slopes may permit the bears to construct horizontal or even upward-sloping tunnels, which would result in a warm air "trap" in the hibernation chamber (L. E. Harding 1976).

The substrates of den sites are typically well-drained and contain a large amount of sand and coarse material, including cobble and boulder sized stones. The structural integrity of den sites is maintained through root mats from dwarf birch and other shrubby vegetation located in the ceilings of dens. Often grizzly bear dens in the Arctic do not last long; by mid-summer, most partially or completely collapse (McLoughlin, Cluff, and Messier 2002). Thus, it appears that bears usually dig new dens each year. This is important for mitigation and management of Project activities, because identified dens are likely ephemeral.

During baseline studies conducted in the wildlife RSA, six grizzly bear dens have been observed. Two dens were detected in 2007, both of which were located in the central wildlife RSA near the George Exploration Camp (Gartner Lee Ltd. 2008). Both dens were shallowly dug into moderately sloped, heath tundra habitat and had root mats of heather and dwarf birch shrubs at the den entrances. Two additional grizzly bear dens were observed in 2012 and were dug into sandy soil in moderately sloped, glacial-fluvial habitat along the Western River and had south facing aspects (Rescan 2013e, Appendix V5-5C). One of these dens was determined to have been active in 2012 but was recently collapsed, so was unlikely to be used in subsequent years. In 2013, two grizzly bear dens were identified, one in the central wildlife RSA and the other roughly 15 km to the southwest of the Marine Laydown Area.

6.1.5 Baseline Data for Grizzly Bears

Three types of baseline surveys were conducted for grizzly bears in the wildlife RSA including: i) population-estimation using DNA mark-recapture; ii) den surveys; and iii) incidental observations. In addition, habitat suitability modelling was conducted in the wildlife RSA to evaluate the quality of habitat in the study area for grizzly bears foraging and denning.

Specific sources of baseline terrestrial wildlife information used in this section included the following reports:

- *Back River and Hackett River Projects: 2010*: *Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E).
- *Back River Project: 2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D);
- *Back River Project: 2012 Wildlife Baseline Report* (Rescan 2013e, Appendix V5-5C);
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014b, Appendix V5-5F);
- *Back River Project: 2012 Grizzly Bear and Wolverine DNA Baseline Report* (Rescan 2013b, Appendix V5-6A);
- *Back River Project Grizzly Bear and Wolverine DNA Baseline Report, 2013* (Rescan 2014a, Appendix V5-6B)*; and*
- *Back River Project: 2013 Wildlife Habitat Suitability Baseline* (Rescan 2013a, Appendix V5-5A)

Other sources of supplementary wildlife data used in this section include:

- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007a);
- *Bathurst Inlet Port and Road Project 2001-2002: Wildlife Baseline Studies* (Rescan 2007b).
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association* (KIA 2012)(Appendix V3-3A of FEIS); and
- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)*(KIA 2014) (Appendix V3-3B of FEIS).

6.1.5.1 Methods

DNA Mark-Recapture

The DNA based mark-recapture program was conducted over two years; 2012 and 2013, in an area of approximately 17,300 km^2 surrounding the Project location (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B). The program was conducted in a grid that included the wildlife RSA as well as an area of equal size adjacent to and west of the wildlife RSA. These areas, combined, were roughly triangular in shape, and stretched from Nose Lake in the south west, to Beechey Lake in the south east, and Bathurst Inlet in the north (Figures 6.1-2 and 6.1-3).

Grizzly bear DNA fingerprinting using hair has been used previously to mark and recapture bears (Woods et al. 1999; Mowat and Strobeck 2000; Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger et al. 2004; Proctor et al. 2005; Rescan 2011b). This method provides several benefits because live capture

of bears is unnecessary, individuals can be identified with a small risk of error, and hair removal sites are faster to set up and are checked less often than live-capture sites (Woods et al. 1999; Mowat and Strobeck 2000; Poole, Mowat, and Fear 2001; Apps et al. 2004; Boulanger et al. 2004; Rescan 2012a, Appendix V5-5D). Roots of mammalian hair contain sufficient DNA for analysis (Higuchi et al. 1988). For free-ranging bears, hair is an attractive DNA source because bears frequently leave hair on rub trees, in beds, and at foraging sites (Taberlet et al. 1993). Bears are readily attracted by scent lures, thus, permitting methods to obtain hair samples from free-ranging bears using systematic sampling regimes necessary for many ecological studies, such as animal censuses (Woods et al. 1999). In mark-recapture studies, an initial population sample is "marked", which corresponds to the bears detected in the first round of hair sampling. The population is then resampled during ≥ 1 additional sessions (Woods et al. 1999). The ratio of newly captured animals to recaptures is then used to compute a population estimate (White et al. 1982).

Bears traverse in and out of the study area during sampling, which violates the assumption of geographic closure in most studies that use mark-recapture or related methods (Miller et al. 1997). Abundance estimates derived from mark-recapture correspond to the "super-population" if movement is random across grid boundaries (Kendall 1999). In the context of mark-recapture DNA studies, the super-population is defined as the number of animals that inhabit the sampling grid and surrounding area (as opposed to the grid alone; Boulanger et al. 2004). While the super-population estimate represents the number of animals that traverse an area, the estimate is compromised by the undefined sampling area and therefore cannot be used to estimate density (Boulanger et al. 2004). Under a trend monitoring objective, however, an absolute abundance or density estimate is not necessary, and the assumptions of population closure can be relaxed (Apps 2010). In this case, the initial super-population estimate can be used as the basis for monitoring relative changes over the long term.

The grizzly bear DNA program in 2012 included a 130 cell grid of 12 × 12 km cells; which included 65 cells in the wildlife RSA and 65 cells in an area directly adjacent and west of the wildlife RSA. In 2013, two additional cells were added to the wildlife RSA, for a total of 132 cells (76 in the wildlife RSA and 65 cells adjacent and west of the wildlife RSA). In both years, each cell contained a baited post to attract bears which would investigate the post and leave hairs on barbed wire wrapped around the post; baited posts were not placed in any cells that contained existing camps to reduce the potential for human-bear intertions. The posts were checked six to eight times during the summer, every 9 to 12 days. Bears were identified from their hairs and a population estimate was calculated from the proportion of bears that return to the posts during the summer. Details of the methods are reported in the 2012 and 2013 Grizzly Bear and Wolverine DNA Baseline Reports (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B).

Grizzly bear capture information from 2013 was combined with data from 2012 to generate a population estimate for the DNA study grid. The super-population (N^) was modelled using a robust design with a Huggins estimator in program MARK. The super-population is the total number of bears that are expected to use the study area over the sampling period and is based on the relative probabilities of detecting and recapturing individuals. The robust design assumes that the active sampling period within a season or year (i.e., secondary sessions) is short enough to approximate closed population dynamics (no births, deaths, immigration, or emigration), but an open population dynamic is assumed during the interval between sampling years (i.e., primary sessions).

Candidate models were assessed for providing the best population estimate using Akaike's Information Criterion (AIC), a metric that provides the relative likelihood of any model given the available data (Burnham and Anderson, 2002). Survival was assumed to be equal for males and females. Individual heterogeneity in capture/recapture probabilities was assessed, but did not rank in the top candidate models. Additional individual covariates were not incorporated into the models.

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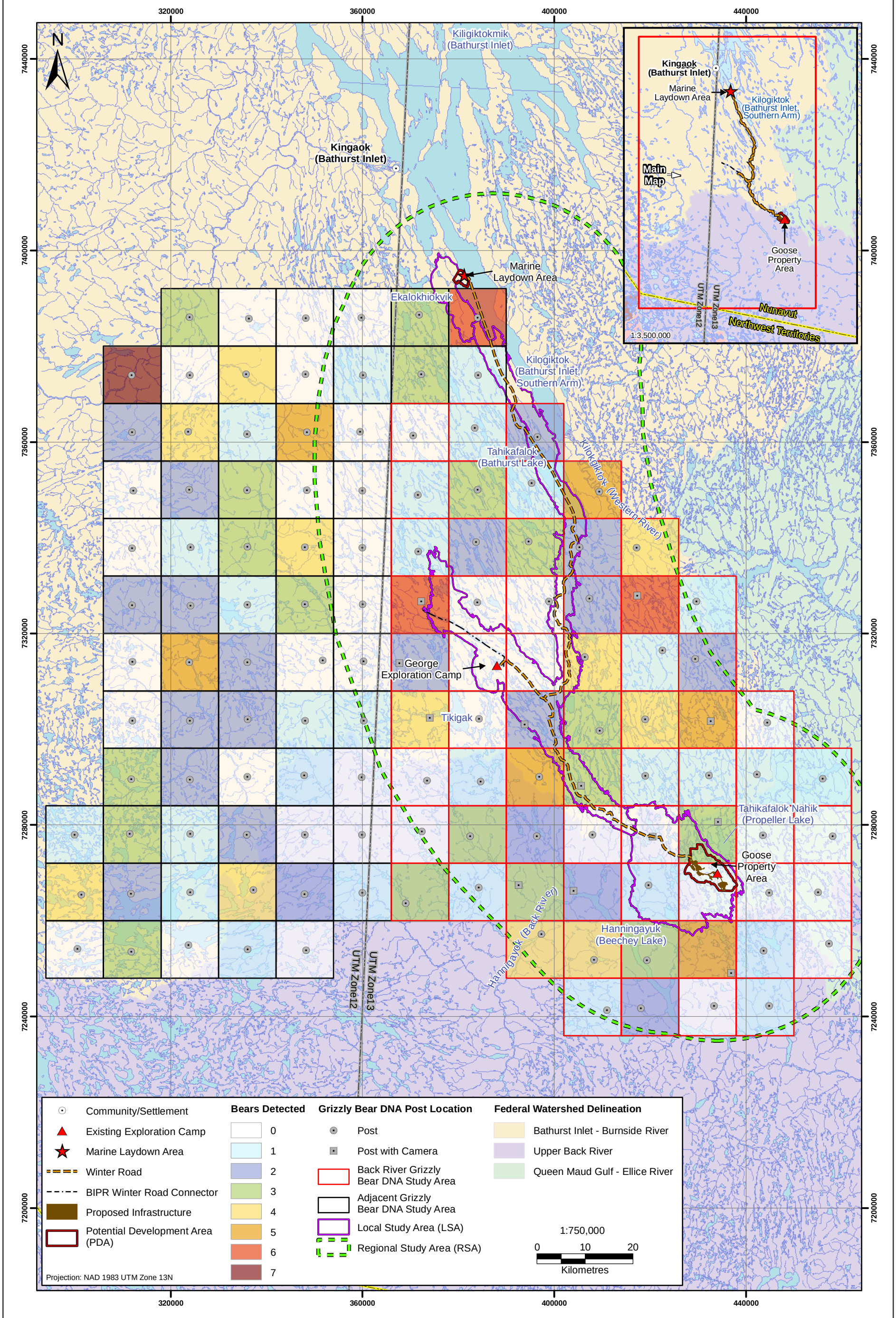

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Grizzly Bear DNA Grid, Post Locations and Capture Frequency, 2012

Figure 6.1-2

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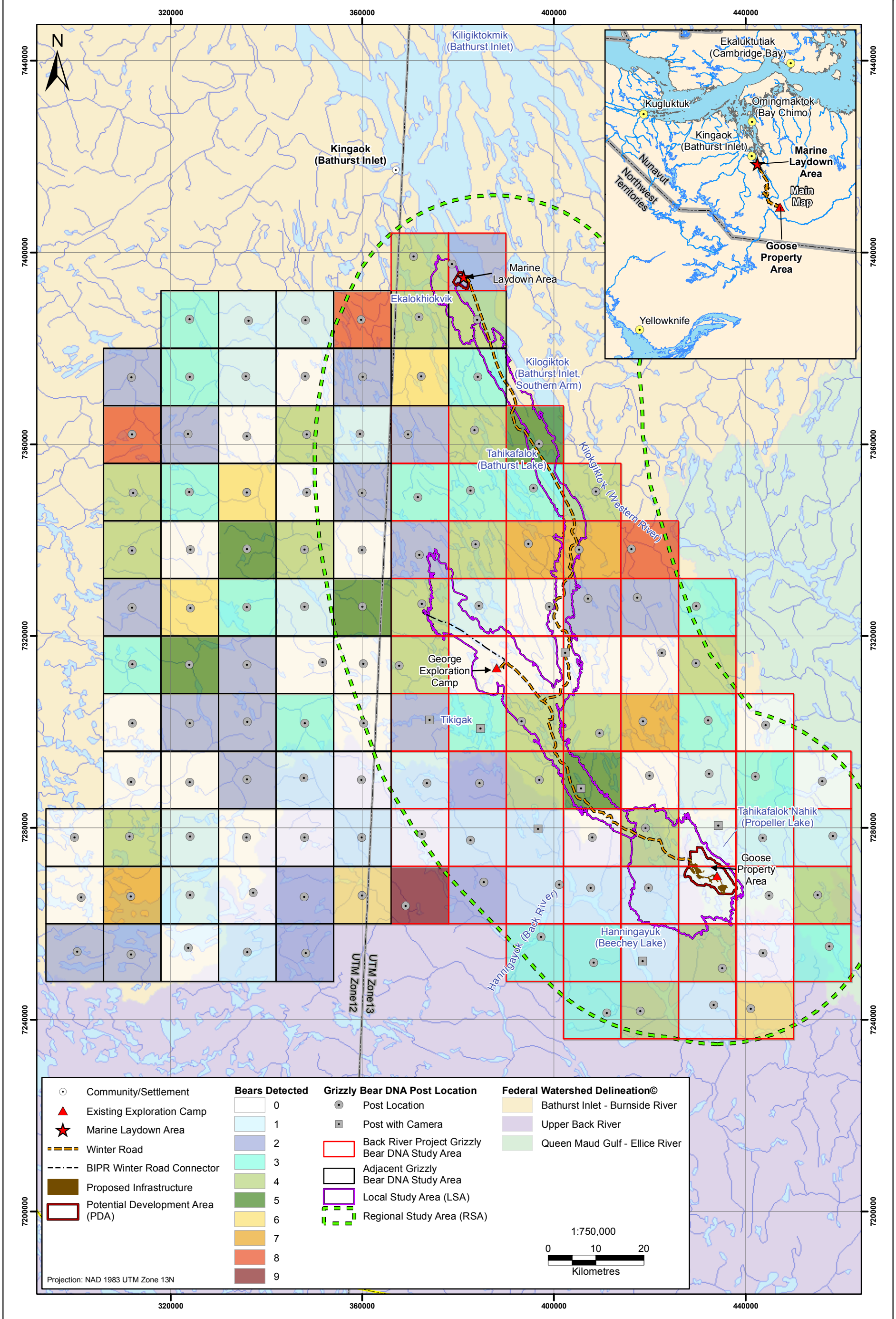

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Grizzly Bear DNA Grid, Post Locations, and Capture Frequency, 2013

Figure 6.1-3

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Precision in population estimates require that all individuals have an equal likelihood of being detected, and that detection probabilities are sufficiently high to ensure an adequate portion of the target population is being sampled. For grizzly bears, the target detection probability is 0.20.

Den Surveys

Den surveys for bears were carried out as part of surveys for wolf dens via low level aerial surveys in esker and glacial-fluvial habitat during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C). During these surveys, any grizzly bear dens observed were recorded. Surveys were flown at an altitude of 50 to 100 m above the terrain and at ground speeds between 30 to 80 km/h to minimize disturbance to other carnivores in the area but to maintain an effective height and speed for observers to effectively discern dens. Full details of the den survey methodology can be found in the 2007, 2011, and 2012 Wildlife Baseline Reports (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D; 2013e, Appendix V5-5C) (Rescan 2014b, Appendix V5-5F).

Incidental Observations

Incidental observations of grizzly bears were recorded in the wildlife RSA when observed on the tundra during other wildlife and environmental baseline surveys conducted between 2001 and 2013 and when captured by the remote cameras distributed throughout the wildlife RSA for caribou studies (Volume 5, Chapter 5) and those used to supplement grizzly bear DNA studies. Remote cameras for the caribou baseline studies recorded observations from late May 2012 to August 2013, and some of these cameras were placed near grizzly bear hair collection posts during the study periods of the 2012 and 2013 grizzly bear DNA studies to track grizzly bear activity. Images from these cameras were quality checked to remove duplicate images of the same individual and documented. Details of the methodology for remote cameras can be found in the 2012 and 2013 Wildlife Baseline Reports (Rescan 2013e, Appendix V5-5C) (Rescan 2014b, Appendix V5-5F).

Habitat Suitability Modelling

Wildlife habitat suitability studies were conducted within the wildlife Local Study Area (LSA) and the wildlife Regional Study Area (RSA) to inventory and rate the habitat types for grizzly bears and quantify suitable habitat available for this species within the local and regional study areas. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km^2 of the West Kitikmeot / Slave Study Area, which stretches from the Arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

Grizzly bears are omnivorous and opportunistic feeders that select habitat largely based on seasonal availability of forage (McLellan et al. 1999; Wellwood 2003). Table 6.1-2 presents the seasonal life requisites for grizzly bears used to develop habitat suitability ratings (HSRs). Habitat suitability ratings

focused on living requisites for spring, summer, fall, and denning seasons, based on an assessment of the ecosystem units' abilities to produce forage species and/or denning habitat. Vegetation phenology was used to rate ecosystem units for target forage species for a given season (e.g., blueberries are absent in the spring, ripen during the summer, and die off during the fall). Prey sources, mainly Arctic ground squirrel (*Spermophilus parryii*), that are strongly associated with specific ecosystem units were included in the ecosystem unit habitat suitability ratings (HSRs).

Table 6.1-2. Seasonal Life Requisites of Grizzly Bear

Season	Date	Life Requisite	Habitat Preference
Spring	May - June	Living	Esker, crowberry, blueberry, sedge, riparian shrub, caribou, ground squirrel
Summer	June - September	Living	Esker, blueberry, sedge, riparian shrub, ground squirrel
Fall	September - October	Living	Esker, blueberry, sedge, riparian shrub, caribou, ground squirrel
Denning	October to May	Reproduction	Lacustrine (lakeside) deposits, eskers

6.1.5.2 Results

Grizzly bears were detected in the wildlife RSA between 2001 and 2013. Of the three methods used to detect grizzly bears (DNA mark-recapture, den surveys, and incidental observations during other baseline studies including remote camera studies), DNA mark recapture detected the largest number of bears and gives the best approximation of the number of bears that occur in the wildlife RSA.

DNA Mark-Recapture

A total of 2,340 grizzly bear hair samples were collected during 2012 and submitted for DNA analysis from the 130 cell grizzly bear study grid. In 2013, a total of 3,624 hair samples were collected and submitted for analysis in the 132 cell grizzly bear study grid. Results from the 2012 grizzly bear DNA study indicated that 1,053 (45%) of the 2,340 samples were successfully extracted and assigned to 111 independent individuals, 46 males and 65 females (Rescan 2013b, Appendix V5-6A). Of the 3,624 samples collected in 2013, 922 (25%) were successfully extracted and assigned to 109 grizzly bear individuals, including 48 males and 61 females (Rescan 2014a, Appendix V5-6B). These totals represents the number of bears within the entire grizzly bear study grid that includes both those in the wildlife RSA and those detected in the cells adjacent to and west of the wildlife RSA (Figure 6.1-2 and 6.1-3). In 2012, twelve of the bears detected in the entire study area overlapped both the wildlife RSA and the cells to the west; in 2013, 18 bears were detected in cells within the wildlife RSA and those adjacent cells to the west.

For the combined DNA dataset (2012 and 2013), the mean capture probability in the DNA study grid was 0.25 (range 0.10 – 0.39) in 2012, and 0.33 (range 0.24 – 0.50) in 2013. The total number of grizzly bears estimated to be in the DNA study grid in 2012 was 72 females (95% C.I. 68 – 81) and 52 males (95% C.I. 48 – 62; Table 6.1-3). In 2013, the super-population over the combined study was estimated to be 64 females (95% C.I. 62 – 71) and 54 males (95% C.I. 50 – 64; Table 6.1-3).

These results suggest a detection frequency of approximately 6–8 grizzly bears/1,000 km^2. A density estimate is not possible because the true spatial extent of the super-population, which lies outside the study grid, and individual residency times are both unknown parameters.

Table 6.1-3. Number of Female and Male Grizzly Bears Estimated in the DNA Study Area Using Mark-Recapture Analysis

Sex	Year	$\hat{N}$	S.E.	Lower 95% CI	Upper 95% CI
Females	2012	72	3.2	68	81
Males	2012	52	3.1	48	62
Females	2013	64	2.0	62	71
Males	2013	54	3.3	50	64

$\hat{N}$ represents super-population estimate

In both years of study, family groups were identified through mapping bear movements. In 2012, eight family units totaling 20 grizzly bears were identified through the DNA analysis, while in 2013 four potential family groups totalling nine individual grizzly bear were identified. Two family units were confirmed by remote cameras in 2012 (i.e., the family unit identified through DNA analysis was confirmed as a mother with cub(s) on photos captured by remote camera), although none were confirmed by remote camera in 2013.

Grizzly bears identified in 2012 and 2013 have been detected in adjacent grizzly bear DNA studies. Four grizzly bears recorded in 2012 had also been detected in a DNA study area in the Lac de Gras region roughly 225 km to the south of the Project (Rescan 2013b, Appendix V5-6A). In 2013, one individual was detected that had also been recorded in a study approximately 200 km to the northwest of the Project (Rescan 2014a, Appendix V5-6B). This demonstrates the large movements of barren ground grizzly bears and the large territories they may utilize in a given year.

Grizzly bears exhibited a temporal distribution throughout the study grid in both years. In 2012, grizzly bears were detected mainly in the eastern half of the study grid between late-May and mid-June and in the western half between mid- to late-June. In July and August, 2012, detection of grizzly bears was fairly evenly distributed within the grid. In 2013, capture success was generally low in the western half of the study grid across the entire study period, and thus, most grizzly bear were recorded in the eastern half of the grid in 2013. Within the eastern half of the grid, grizzly bear detections increased in the northern portion of the grid (e.g., areas surrounding Bathurst Inlet) later in the season, possibly indicating that bears may have congregating near areas where they may have access to fish.

The results of the DNA studies in 2012 and 2013 indicated that grizzly bear travelled long distances during the survey period. The distances between the two furthest DNA tripods that an individual visited across the entire survey period were calculated to generate an estimate of the maxiumum distance that individuals travelled across the 75 to 80 day survey periods. Given the topography and presence of waterbodies between many of the cells, the actual distances travelled are likely to be much higher. On average, males travelled the longest distances in both years (58 km in 2012, 49 km in 2013), and the average distances travelled by females were nearly half that of males in both years (25 km in 2012, 27 km in 2013; Table 6.1-4). Potential family units travelled on average 46 km in 2012 and 21 km in 2013; the difference between years may be explained by sample size, as half the number of potential family groups were recorded in 2013 relative to 2012. Across years, the maximum distance travelled by a single individual was a male bear at 138 km in 2012. A full description of the position and distance movements of individuals can be found in the 2012 and 2013 Grizzly Bear and Wolverine DNA Baseline Report (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B).

Table 6.1-4. Distance Travelled and Area Used by Grizzly Bears, 2012 and 2013

Metric	Parameter	2012		2013	
		Average	Range	Average	Range
Distance travelled during entire survey period	Female	24.6 km	10.9 – 64.6 km	27.2 km	6.6 – 112.6 km
	Male	58.6 km	10.9 - 137.9 km	49.1 km	10.9 – 109.2 km
	Potential family unit	46.3 km	24.6 - 84.8 km	20.5 km	12.3 - 26.7 km
Area used during entire survey period	Female	250.8 km^2	30.7 - 496.0 km^2	245.0 km^2	50.0 – 1,169.5 km^2
	Male	431.3 km^2	2.6 - 1,278.6 km^2	726.3 km^2	3.3 – 2,572.0 km^2
	Potential family unit	305.6 km^2	0.5 – 462.2 km^2	94.3 km^2	69.7 – 142.3 km^2

For animals that were captured more than twice, a polygon of their capture locations was used to calculate an area of use for each bear (minimum convex polygon). In 2012, polygons were generated for a total of 29 bears that were detected at three or more tripods, including 11 males, 7 females, and 11 bears from six potential family groups. In 2013, polygons were delinated for 37 bears that were detected at three or more different tripods, including 16 males, 14 females, and 7 bears from three potential family groups. The areas used by females in both years were similar; on average, females used an area of 251 km^2 in 2012 and 245 km^2 in 2013 (Table 6.1-4). Conversely, males were recorded to have larger minimum convex polygon in 2013 (726.3 km^2) relative to 2012 (431.3 km^2; Table 6.1-4). The areas used by potential family groups were less in 2013 (94 km^2) than in 2012 (306 km^2). The differences between years may be attributable to sample size, as more males and females were detected at three or more tripods in 2013 relative to 2012, while fewer potential family groups were recorded in 2013 as compared to 2012.

Den Surveys

In 2007 and 2011, no grizzly bear dens were recorded during aerial surveys conducted in the wildlife RSA (Gartner Lee Limited 2007; Rescan 2012a, Appendix V5-5D). However, two dens were observed incidentally (Figure 6.1-4) during breeding bird surveys conducted in 2007, both of which were located in the central wildlife RSA near the George Exploration Camp (Gartner Lee Ltd. 2008). Both dens were shallowly dug into moderately sloped, heath tundra habitat and had root mats of heather and dwarf birch shrubs at the den entrances (Gartner Lee Limited 2007). In 2012, two additional grizzly bear dens were observed (Figure 6.1-4), one observed during the July Den survey, while the other den was recorded incidentally in June (Rescan 2013e, Appendix V5-5C). Both of the dens found in 2012 were situated along the Western River corridor in sandy glacial fluvial habitat with southerly aspects. In 2013, two grizzly bear dens were identified, one in the central wildlife RSA and the other roughly 15 km to the southwest of the Marine Laydown Area.

Incidental Observations

Incidental observations of grizzly bears were recorded between 2001 and 2013 during environmental baseline studies conducted in the wildlife RSA. Twelve incidental sightings of grizzly bears were observed in 2001 during aerial surveys conducted for caribou and muskox in the wildlife RSA (Rescan 2007b). No grizzly bears were observed during aerial surveys conducted in spring 2002 (Rescan 2007b). Eleven bears including two cubs were observed incidentally in 2007 (Gartner Lee Limited 2007). During the 2010 baseline field studies, four grizzly bears were recorded during the caribou and muskox aerial surveys (Rescan 2011a, Appendix V5-5E).

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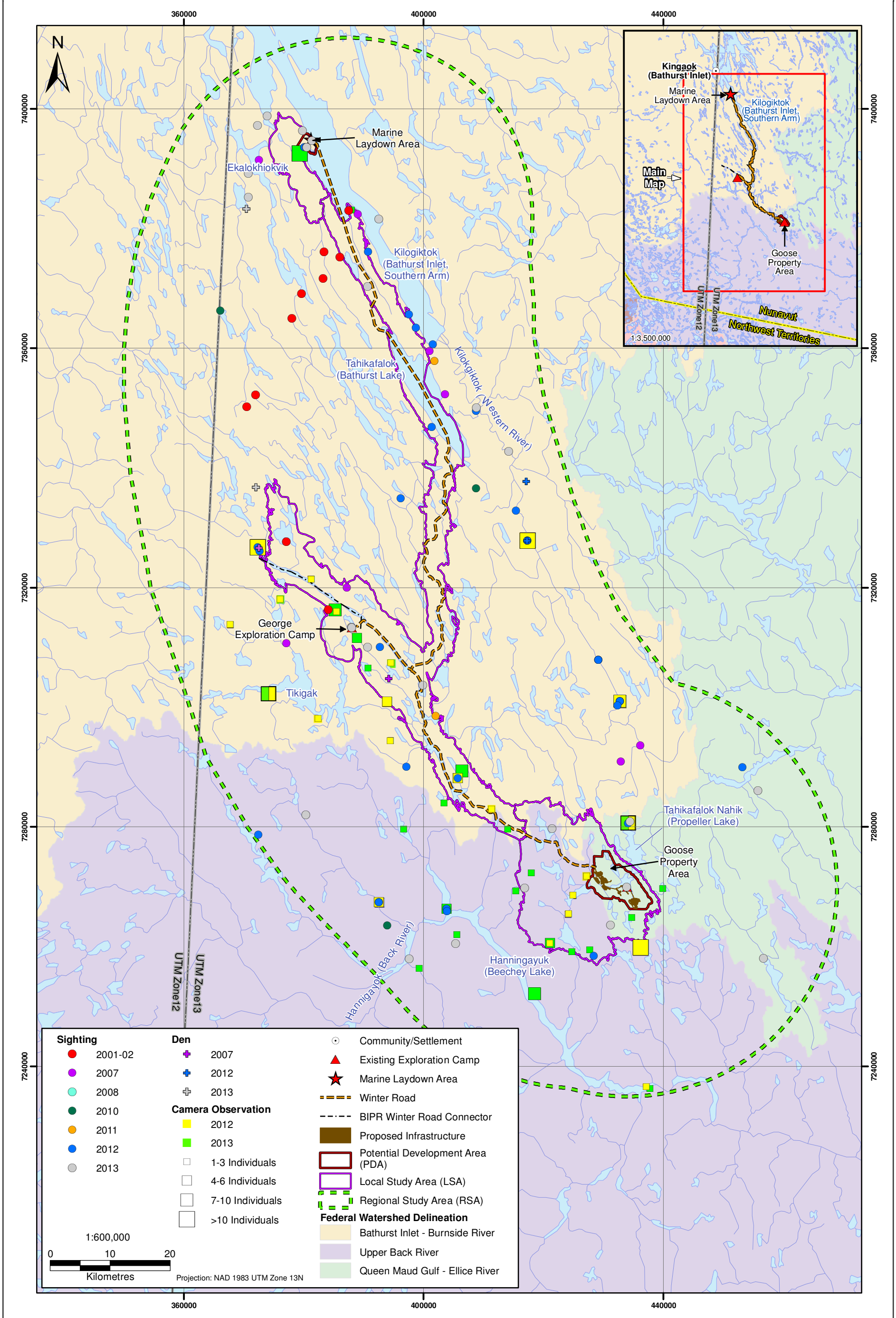

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Incidental Observations of Grizzly Bears in the Regional Study Area, 2001 to 2013

Figure 6.1-4

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In addition, a total of 19 adults and 16 cubs were observed incidentally during the baseline studies conducted in 2012. Many of these observations were along major river systems and in the northern portion of the wildlife RSA. In 2013, a total of 34 grizzly bears, including 20 Adults and 14 cubs/juveniles, were recorded (Figure 6.1-4). Similar to 2012, a large number of grizzly bear observations in 2013 were collected in the northern wildlife RSA near the Marine Laydown Area and along the Western River drainage. Across all years, very few bears have been recorded within the PDAs; one bear was recorded within the Goose PDA in 2013 and three bears were recorded in the proposed Marine Laydown Area PDA, one in 2012 and two in 2013 (Rescan 2013e, Appendix V5-5C; 2014b, Appendix V5-5F).

In addition to grizzly bear observed during other baseline studies conducted in the wildlife RSA, remote cameras distributed within the wildlife RSA recorded numerous observations of grizzly bear between May 2012 and August 2013 (Rescan 2013e, Appendix V5-5C; 2014b, Appendix V5-5F). Most detections of grizzly bear by cameras were recorded during the summer, with the highest number of detections recorded in July and August (65% detections in 2012, 71% detections in 2013). Several cameras located near the Goose Property had detections ranging from one to three individuals in 2012 and 2013; one camera located near the proposed Marine Laydown Area had detections of more than 10 individuals in 2013 (Figure 6.1-4). In all cases, it is likely that some of these observations are re-counted individuals.

Habitat Suitability Modelling

The results of the grizzly bear habitat suitability mapping are similar between the wildlife LSA and RSA for all seasons and suitability ranks (Table 6.1-5). High value spring habitat was limited in both the wildlife LSA and RSA (Figure 6.1-5), with moderate habitat comprising the majority of these study areas (Table 6.1-5). Summer habitat in the wildlife LSA and RSA was largely mapped as moderate and low value (Table 6.1-5; Figure 6.1-6). Fall habitat was also predominantly rated as moderate and low in both the wildlife LSA and the RSA (Figure 6.1-7). Table 6.1-5 contains the complete results for the wildlife LSA and RSA. The results of the denning potential indicated that in both the wildlife LSA and RSA high value denning was very limited, as was moderate value habitat (Table 6.1-5; Figure 6.1-8). This was an expected result due to the limited extent of eskers and lacustrine deposits, and the dominance of bouldery tundra and rocky areas.

Table 6.1-5. Area and Proportion of High, Moderate, Low, and Nil-rated Habitat within the LSA and RSA for Grizzly Bear

	Habitat in the LSA		Habitat in the RSA	
Suitability Rating	**Area (ha)[1]**	**% of LSA[2]**	**Area (ha)[1,3]**	**% of RSA[2]**
Spring				
High	3,182	2	5,457	< 1
Moderate	87,405	65	637,045	51
Low	19,075	14	412,168	33
Nil	24,707	18	202,483	16
Summer				
High	11,888	9	137,717	11
Moderate	90,219	67	540,367	43
Low	31,740	24	506,522	40
Nil	518	< 1	72,547	6

(continued)

Table 6.1-5. Area and Proportion of High, Moderate, Low, and Nil-rated Habitat within the LSA and RSA for Grizzly Bear (completed)

	Habitat in the LSA		Habitat in the RSA	
Suitability Rating	Area (ha)[1]	% of LSA[2]	Area (ha)[1,3]	% of RSA[2]
Fall				
High	7,348	5	5,457	< 1
Moderate	70,012	52	542,692	43
Low	56,449	42	636,456	51
Nil	557	< 1	72,547	6
Denning				
High	942	< 1	5,457	< 1
Moderate	532	< 1	0	0
Low	2,243	2	49,678	4
Nil	130,652	97	1,202,017	96

[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the RSA is 1,257,152.58 ha.
[2] For ease of presentation, hectares are presented as whole numbers and percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[3] Includes area of Local Study Area (LSA).

6.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Traditional Knowledge indicates that grizzly bears were important animals for Inuit and there were many legends about them (KIA 2012). Information regarding grizzly bear knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot study communities.

Inuit TK was adapted from the:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012)(Appendix V3-3A of DEIS/FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3C of FEIS);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

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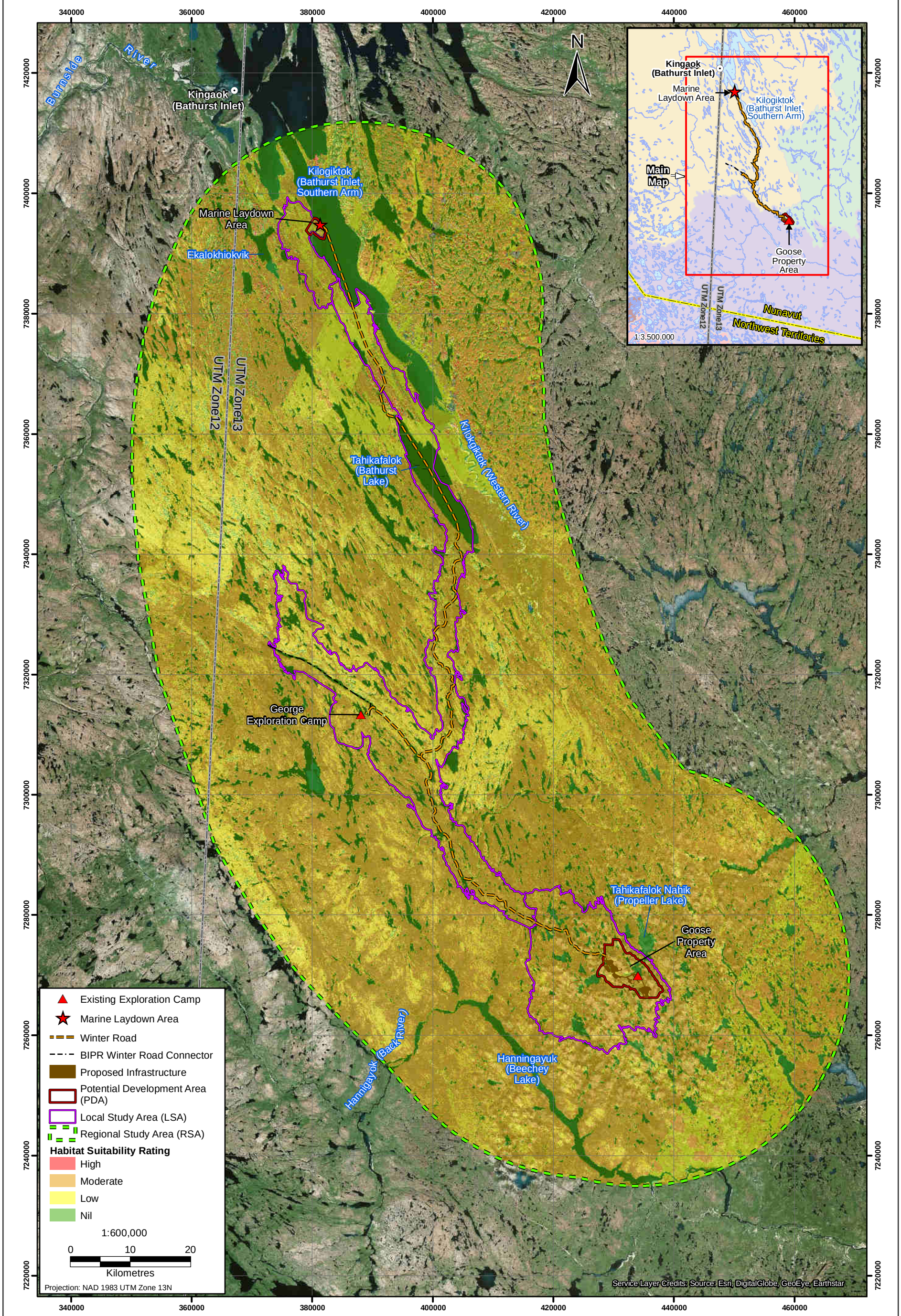

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Grizzly Bear: Spring Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-5

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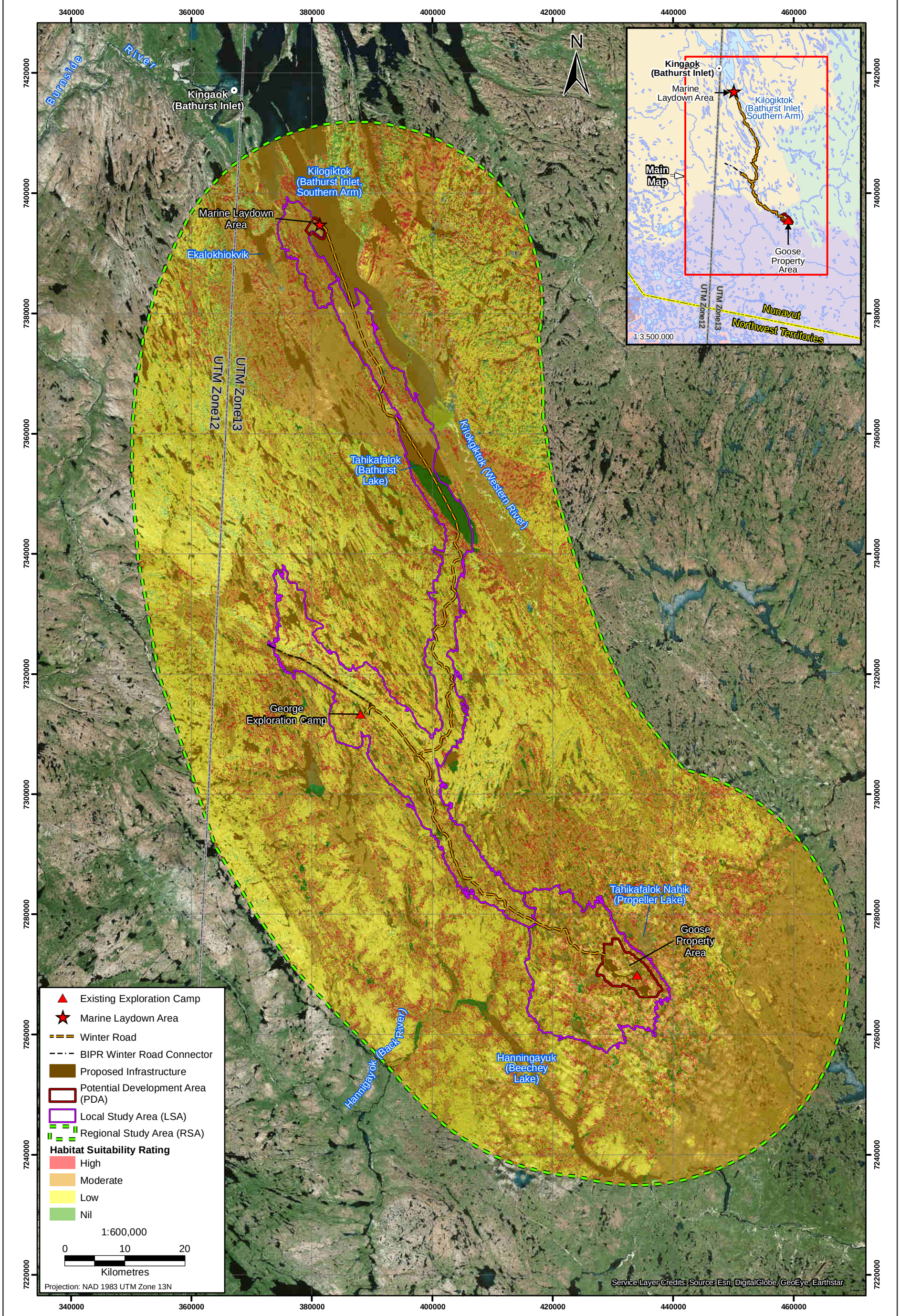
August 31 2015



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Grizzly Bear: Summer Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-6

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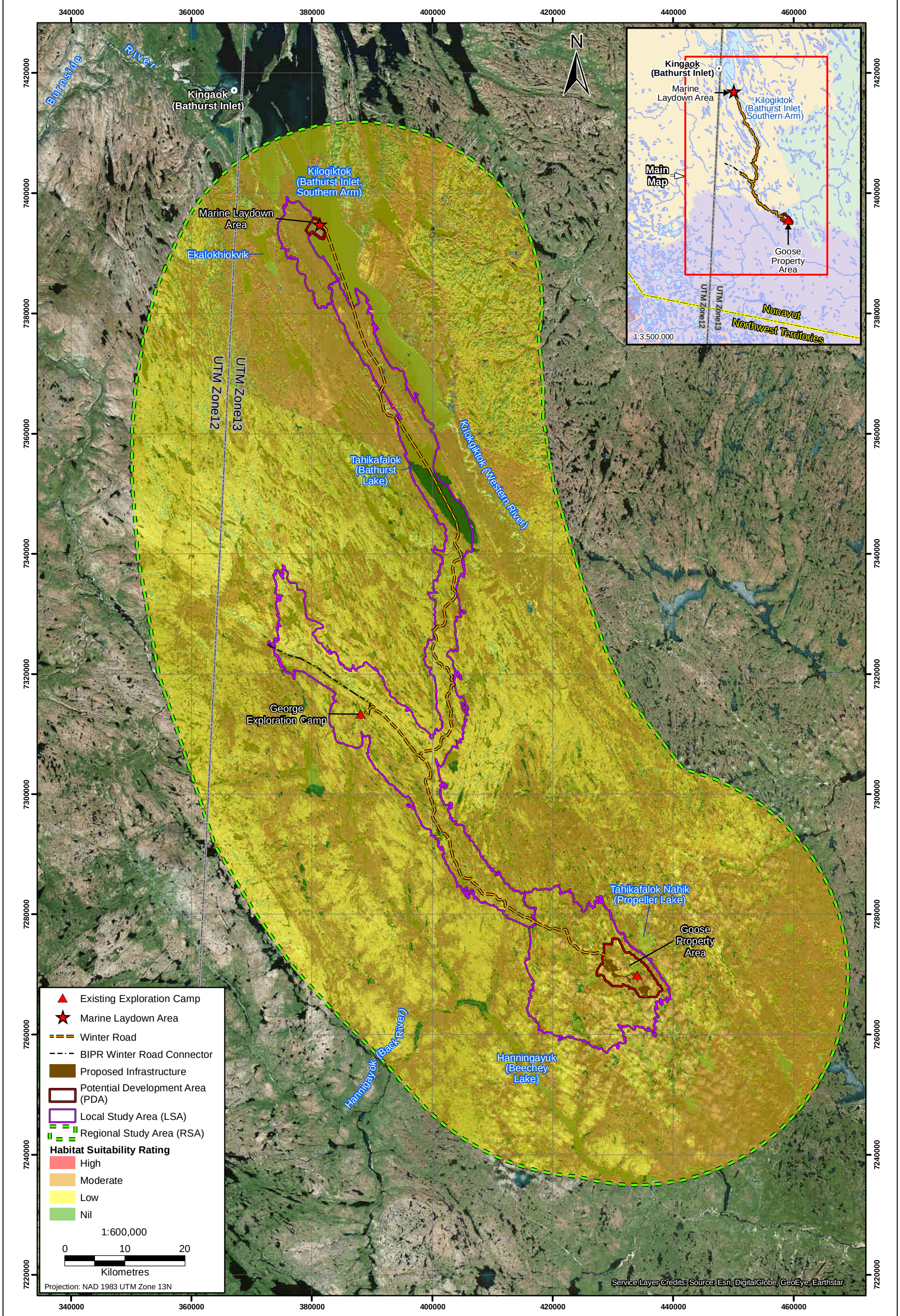

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Grizzly Bear: Fall Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-7

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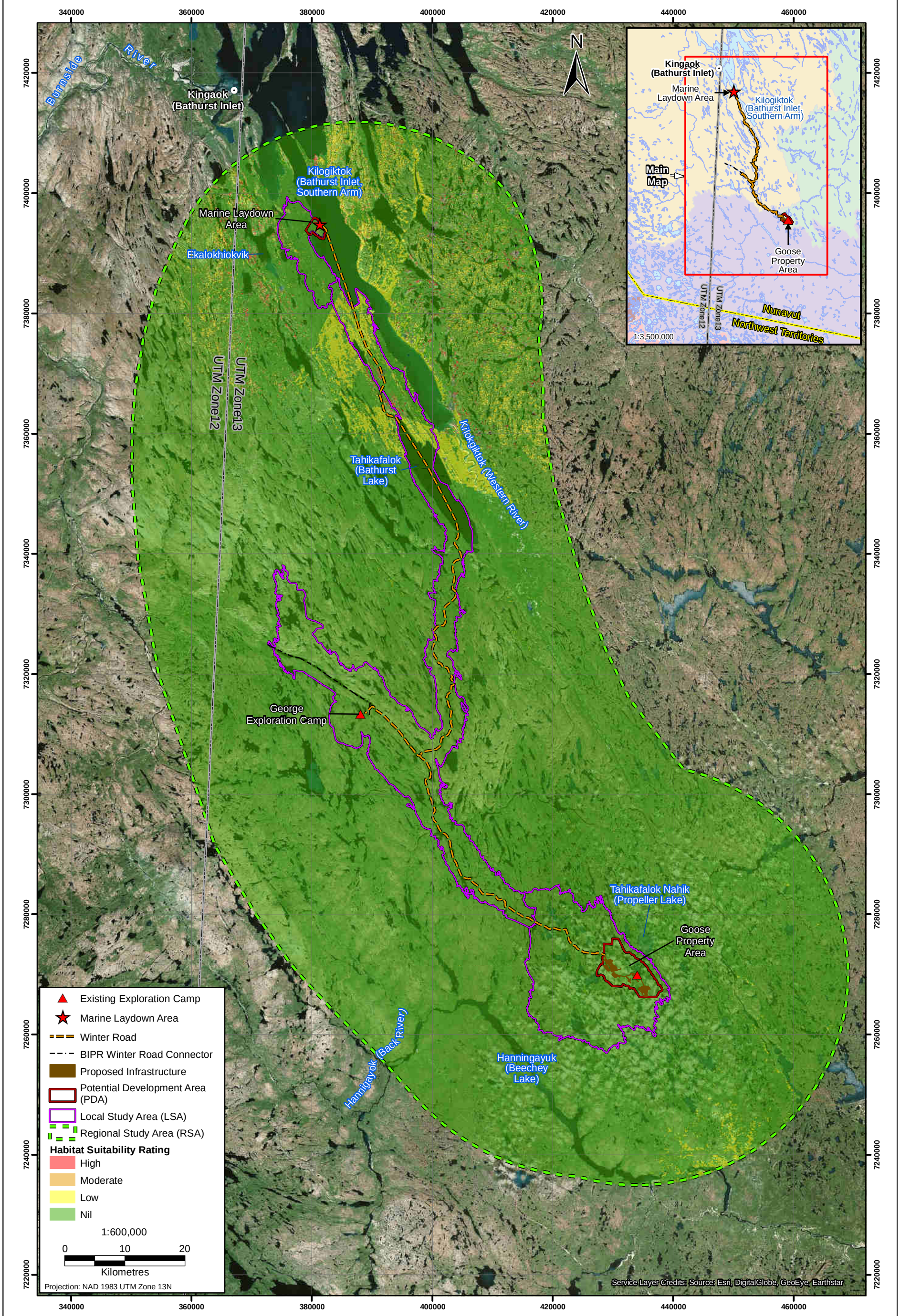

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Grizzly Bear: Denning Habitat in the Local Study Area and the Regional Study Area

Figure 6.1-8

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Traditional knowledge, land user knowledge and thoughts raised by the KIA and land users were incorporated into the effects assessment chapter in six primary ways:

1. Grizzly bear were included as a VEC for a number of reasons (Section 6.3.2), including that they are a culturally and socially important species in the Project area.
2. Land users were consulted and included on the positioning of the posts used for the DNA mark-recapture study. Land users provided insights on grizzly bear behaviour and habitat use and directed the installation of hair-capture posts in the best possible locations to attract grizzly bears (Section 6.1.5).
3. Traditional Knowledge and land user information were used to position the remote cameras to maximize capture of passing caribou and grizzly bears. Land users worked with Rescan biologists in the field to position and install cameras in high-quality foraging habitats and travel corridors (Section 6.1.5).
4. Habitat usage and foraging information from TK and land users was incorporated in the habitat suitability modelling report and therefore included in the environmental setting (Section 6.1.5) and effects assessment where habitat loss (Section 6.5.2.1) and disturbance (Section 6.5.2.2) is evaluated.
5. Concerns that were raised by the KIA and land users about whether bears would be affected by roads were addressed by the inclusion of the "Effects of Disruption of Movement" (Section 6.5.2.3) and "Effects of Direct Mortality" (Section 6.5.2.4) sections.
6. Traditional Knowledge and land user information was included in the preparation of management plans to reduce the attractiveness of the camps and other infrastructure (Volume 10, Chapter 20 - Incorporation of TK). As part of this process, grizzly bears were included as a VEC for the DEIS and FEIS.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

6.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of land users in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

6.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this process, grizzly bears were identified as a VEC for the EIS.

6.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modeling, were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods: Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

6.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap with the Project in these areas.

6.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation and Special Landfeatures: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

6.3 VALUED COMPONENTS

6.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or by the NWA);
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator and umbrella species; and
- species identified as being culturally, socially, and economically important to the Inuit and other community members through TK.

6.3.2 Valued Components Included in Assessment

Each potential VEC was screened for inclusion in the environmental assessment through an evaluation of the results of baseline studies, conservations status, biological importance, regulatory, cultural, social, and economic significance and the potential for each to be affected by the Project (Volume 9,

Chapter 1).The following bear species were included in the potential VEC list: brown bear, grizzly bear, and polar bear.

Polar bears were scoped out of the assessment. While polar bears do occur in other parts of Nunavut, they have no geographic interaction with the Project as they are not found on the mainland near or within the wildlife RSA.

The brown bear (*Ursus arctos*) is a holoarctic species that occurs in northern Asia, northern Europe and North America. Three sub-species of brown bear occur in North America, the mainland grizzly (*Ursus arctos horriblis*), the Kodiak (*Ursus arctos middendorffi*) and the peninsular grizzly (*Ursus arctos gyas*). Grizzly bears that live on the tundra are frequently referred to as "barren-ground grizzlies" because this sub-group has characteristic range use patterns and ecology and fall under the mainland grizzly sub-species. Barren-ground grizzly bears are the only subspecies of brown bears to occur in the Project area and are referred to as grizzly bears in this assessment.

Grizzly bears were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK reports (KIA 2012, 2014), consultation with regulatory agencies, and regulatory considerations, grizzly bears were selected as a VEC for the effects assessment.

Grizzly bears are listed as a species of "Special Concern"; but are not yet listed under *The Species at Risk Act* (COSEWIC 2012). In the Northwest Territories and Nunavut, the Canadian Endangered Species Conservation Council lists grizzly bears as Sensitive (CESCC 2005; Working Group on General Status of NWT Species 2006; CESCC 2010).

Grizzly bears also serve as umbrella species, because their large home range sizes and core habitat requirements typically captures a broad suite of ecosystem types and functions important to other fauna and flora (Simberloff 1998; Cluff and Paquet 2003). While decreases in populations of grizzly bears may not necessarily indicate decreases in other species, the protection of grizzly bears and their habitat ensures protection of habitat for a number of other species with smaller home ranges in various habitat types.

6.4 SPATIAL AND TEMPORAL BOUNDARIES

6.4.1 Spatial Boundaries

The grizzly bear effects assessment considered two study areas for wildlife inventory for the Project: a local study area (LSA) and a regional study area (RSA; Figure 6.4-1).

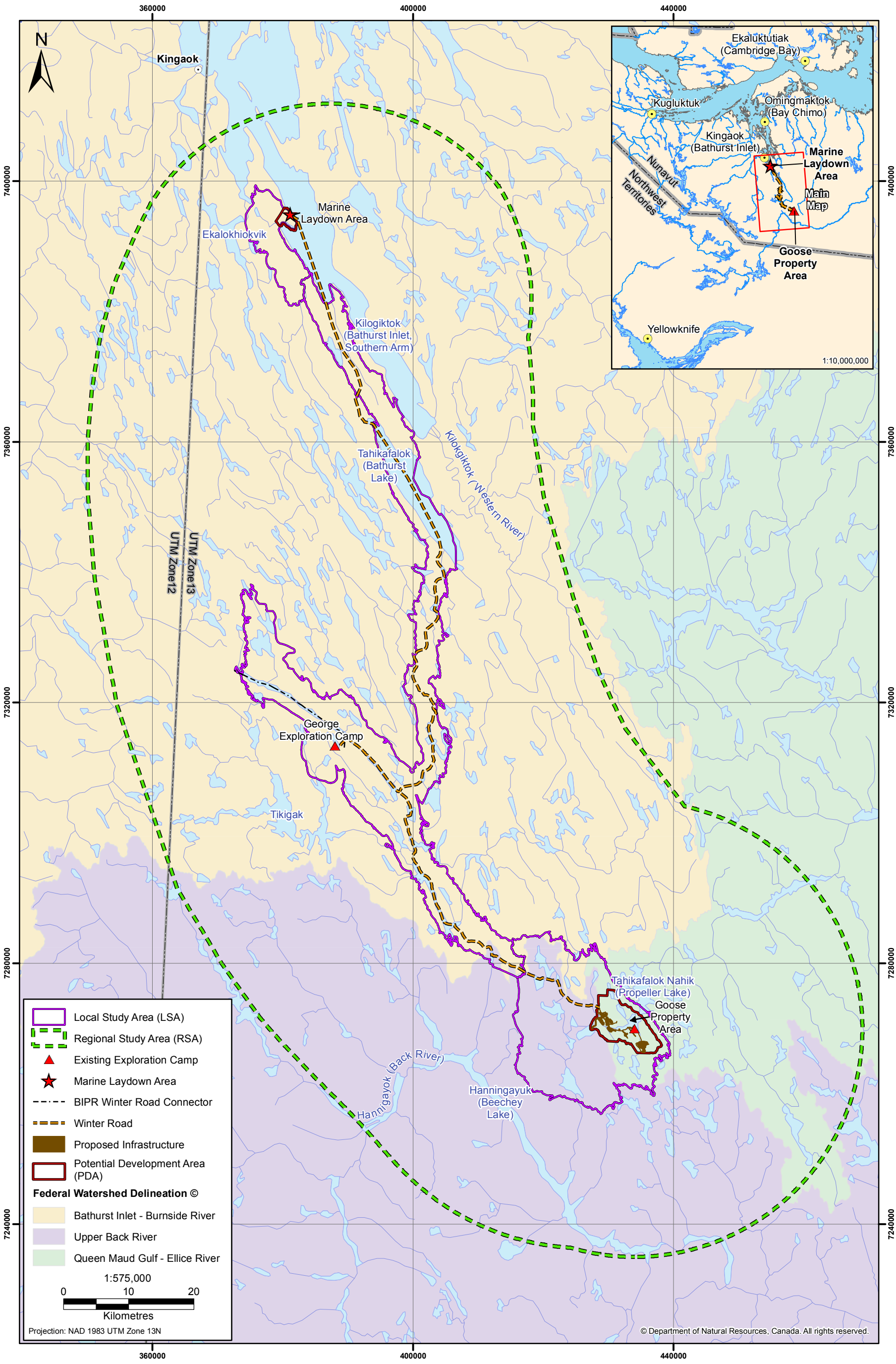
6.4.1.1 Local Study Area

The boundaries of the LSA for grizzly bear were set to encompass the following:

- the Goose Potential Development Area (PDA), which contains all proposed Project infrastructure for the Goose Property Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose and MLA PDAs.

GIS # BAC-23-392

October 20 2015



Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Grizzly Bear

Figure 6.4-1

Rescan an ERM company

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5; Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The LSA covers an area of approximately 134,369 ha (Figure 6.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

6.4.1.2 Regional Study Area

The RSA for grizzly bears encompasses the PDAs, the LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two Project areas (Goose Property Area and MLA). The RSA covers an area of approximately 1,262,005 ha (Figure 6.4-1). The RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side to encompass the Western River.

6.4.2 Temporal Boundaries

The temporal boundaries used for the grizzly bear effects assessment follow the time periods of the phases of the Project as presented in Table 6.4-1.

Table 6.4-1. Temporal Boundaries – Project Phase Durations

Phase	Duration
Construction (including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post-closure Monitoring	5 years
Other Potential phases:	
Temporary Closure	Less than 2 years
Care and Maintenance	2 to 10 years
Exploration	included in Construction and Operational phases

6.5 PROJECT EFFECTS ASSESSMENT

6.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on grizzly bears as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and grizzly bears.

2. Characterization of the potential effects that could result from these interactions.
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects.
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied.
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on grizzly bears including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on grizzly bear is evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

6.5.1.1 Indicators Used to Characterize Potential Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 6.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of potential residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of "yes" or "no" where triggering of residual effects assessment occurred if the indicator value was "yes" (e.g., attraction of grizzly bears to mining projects has occurred elsewhere at similar projects in Nunavut or the Northwest Territories).

Table 6.5-1. Criteria and Indicators Used to Characterize Potential Effects on Grizzly Bears

Potential Effect	Criteria	Indicator
Habitat Loss	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disturbance due to Noise	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disruption to Movement	Change in Population Health	Traffic timing, and traffic volume
Direct Mortality and Injury	Change in Population Health	Traffic timing, traffic volume, and vehicle speed
Indirect Mortality	Change in Population Health	Predicted increase in human access to wildlife RSA
Attraction	Change in Population Health	Attraction occurred at similar Projects in Nunavut and Northwest Territories
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on grizzly bears

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

6.5.1.1 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 6.5-2).

Table 6.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for grizzly bears, which provide benchmark measures, as well as estimates of the natural variability.

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

6.5.1.2 Overall Significance Ratings for Residual Effects

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 6.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as Positive, Not Significant, or Significant (Table 6.5-3). For example, a residual effect receives a rating of "Not Significant" typically if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Table 6.5-3. Definitions of Significance Ratings for Residual Effects on Grizzly Bears

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

6.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC grizzly bear and the Project is provided in Volume 9, Chapter 1. Potential effects on grizzly bear and grizzly bear habitat from the Project have been included in the assessment based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, Inuit Traditional Knowledge and land user knowledge, and a review of scientific literature of the effects of developments on grizzly bear. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin gold mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011c, 2013f).

Interactions of grizzly bears with Project components were evaluated to determine which of the following potential effects may occur (Table 6.5-4):

- habitat loss;
- disturbance due to noise (e.g. displacement from areas of habitat);

- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g. due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

Grizzly bears can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of suitable denning and foraging habitat. For this reason, habitat loss was included and evaluated in this assessment. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development.

Potential effects due to disturbance were evaluated for grizzly bears because research indicates that grizzly bears can be particularly sensitive to anthropogenic disturbance (McLellan 1990; Weaver, Paquet, and Ruggiero 1996; Ross 2002). It has been proposed that bears living in the central Canadian Arctic area a higher risk of effects due to disturbance because they naturally occur at low densities and the open tundra landscape (Ross 2002).

Grizzly bears are resident on the tundra, and maintain large home ranges that may contain separate seasonal habitats in which they move throughout the year. Juvenile bears may make long distance movements when dispersing from home ranges where they were born, to establish their own home range territories elsewhere. Disruption to movement was evaluated for its potential effect on bears because some researchers have reported that population-level consequences to grizzly bears may arise when movements on home ranges, and movements for dispersal, are disturbed or impeded (Proctor, McLellan, and Strobeck 2002; Proctor et al. 2012).

Direct mortality is typically a result of vehicle strikes with wildlife. Frequency of mortality is often related to specific locations, traffic volume, and speed (Jalkotzy et al. 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to grizzly bears also increases. Since the Project will have all-weather site roads, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed roads. In southeastern Alaska, where grizzly bears are legally hunted, there was a direct positive correlation between bear kills by hunters and cumulative kilometers of constructed roads (Titus and Beier 1991). Roads increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Camps and landfills may act as attractants to grizzly bears, which could subsequently lead to increased human-bear interactions and grizzly bear mortality. Both scientific studies (Herrero 1985) and the TK information (KIA 2012) indicate that grizzly bears can be attracted to human settlements in search of food. Benn and Herrero (2002) reported that over 70% of bear mortality were destruction of problem bears. Bears are particularly attracted to landfills, as well as aromatic waste material such as oils and aerosols. This attraction to project sites increases the potential for wildlife-human interaction and therefore an increased potential for grizzly bears to become nuisance animals, and resulting mortality. The barren ground population of grizzly bears is considered to be most susceptible to direct mortality as a result of human activity (McLoughlin, Taylor, Cluff, Gau, Mulders, Case and Messier 2003). Thus, the effect of attraction is included as a potential effect in the assessment.

Table 6.5-4. Potential Project-related Effects to Grizzly Bear in the Goose Property Area and the Marine Laydown Area

Potential Development Area	Project Component	Habitat Loss	Disturbance due to Noise	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity
Goose Property Area	Open Pits (Goose Main, Umwelt, Echo, and Llama)	X	X	X	X				X
	Haul and access roads	X	X	X	X	X			X
	Winter Roads					X			X
	Stockpiles	X	X						X
	Waste rock storage areas	X	X	X				X	X
	Explosives storage areas	X						X	X
	Tailings Impoundment Area	X	X					X	X
	Quarries	X	X						X
	Landfill	X	X				X	X	X
	Camp / Plant site	X	X	X	X	X	X	X	X
	Airstrip	X	X	X	X				X
	Other infrastructure (diversion channels, water intakes)	X							X
Marine Laydown Area	Camp	X	X				X	X	X
	Lightering Barge location	X	X						X
	Haul and access roads	X	X		X				X
	Winter Roads					X			X
	Other infrastructure (interception ditch)	X							X

Wildlife can be exposed to contaminants through ingestion of water or through the food chain. A formal risk assessment was undertaken as part of the effects assessment for wildlife including grizzly bear and detailed in the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of the risk assessment of contaminants in grizzly bears were summarized in the assessment of the VEC grizzly bear for determining the overall significance of Project-related residual effects to grizzly bears.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/activity in Table 6.5-4.

6.5.2.1 Habitat Loss

As part of the development of the Project, wildlife habitat will be lost wherever infrastructure is constructed or land is cleared and adjacent areas may be degraded. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 6.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operation phases of the Project. Wildlife habitat will be removed and degraded during Project development. Habitat degradation due to dust and compaction around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project. The assessment of habitat loss is based on the total area of lost and degraded habitat at the end of the Operation phase, which is the largest extent of the Project footprint.

To enable flexibility in siting of Project infrastructure, loss and degradation of grizzly bear habitat is assumed within the entire area of each of the two PDAs (Goose Property Area and the MLA). These areas greatly overestimate habitat loss as the entire area within each PDA will not be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The operation of winter roads could result in habitat compaction to vegetation due to compressed snow and ice and could result in minor habitat degradation during the foraging season. However, compaction is anticipated to be relatively minor and is not assessed further. In addition, the timing of construction and use of winter roads (January through April) corresponds to when grizzly bears are hibernating in winter dens, and would not result in a direct loss of habitat during the winter season. Thus, for the purposes of this assessment, winter roads are not considered for the assessment of habitat loss for grizzly bears.

<u>Calculation of Habitat Loss</u>

Habitat loss for grizzly bear was calculated by first identifying two key indicators:

1. Total area — a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs).
2. High-quality habitat — a calculation of the area of high-quality habitat for grizzly bears that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the RSA. The RSA provides the more representative comparison for the total habitat loss for grizzly bears, as the home range of a grizzly bear is, on average, larger than the LSA. To put the Project within the context of grizzly bear habitat use, these indicators were also compared to the average home range size of a grizzly bear.

Key indicators were also compared to the area of grizzly bear management units (MU) that overlap the Project area (GB02 or the Bathurst Inlet population) to provide context relative to grizzly bear population management in Nunavut following a request by the Government of Nunavut during the DEIS review.

Total Area of Loss

The total expected area lost in the PDAs was calculated by summing the areas of loss due to the entire Goose and MLA PDAs. The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary (the wildlife LSA and RSA). The actual area developed, and subject to loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to put the Project into the context of grizzly bear habitat, the total area of loss is compared to home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range sizes of these territories. Results of the assessment are presented as a proportion of an average bear's (male and female) home range that is lost due to Project-related activities.

The amount of habitat loss that occurs within Nunavut wildlife management units for grizzly bear were also calculated, to provide context for habitat loss within managed populations of grizzly bear.

Area of High-quality Habitat Loss

Habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A) for grizzly bears based on a four class rating system (High, Moderate, Low, and Nil habitat). The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA using remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

The availability of suitable habitat for grizzly bears varies between seasons and is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 6.1.5). Habitat loss and degradation for grizzly bear was assessed for spring, summer, fall, and winter denning habitat separately. Habitat ranked as High or Moderate was considered the most suitable habitat and is referred to as high-quality habitat for grizzly bears. The proportion of high-quality habitat lost due to mine development in the wildlife RSA was calculated to assess the extent of the effect of high-quality habitat loss for grizzly bears.

In order to calculate a conservative estimate of habitat loss, the total loss of high-quality habitat is compared to home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range sizes of these territories and that the proportion of high-quality habitat within the male and female grizzly bear home ranges is similar to that in the wildlife RSA (approximately 50% of the area during the foraging season). Results of the assessment are presented as a proportion of an average bear's (male and female) home range that is lost due to Project-related activities. In addition, the amount of high-quality habitat loss that occurs within Nunavut wildlife

management units for grizzly bear were also calculated, to provide context for habitat loss within managed populations of grizzly bear.

Evaluating Habitat Loss for Grizzly Bears

Total Area of Loss

The total area lost due to loss of the entire PDAs at the Goose Property and the MLA is projected to be 6,080 ha (Table 6.5-5). The PDAs are contained within the wildlife LSA and represents 4.5% of the wildlife LSA. This area accounts for 0.5% of the wildlife RSA. However, the actual loss will be much smaller as the design of the Project footprint is much smaller (approximately 10 % or less of the PDAs) relative to the PDAs assessed as lost. The wildlife RSA provides the more representative comparison for the total habitat loss for grizzly bears, as the home range of a grizzly bear is, on average, larger than the wildlife LSA.

Table 6.5-5. Habitat Loss due to the Potential Development Areas

Potential Development Area (PDA)	PDA Area Assumed to be Lost (ha)	Proportion of LSA (%)[1]	Proportion of RSA (%)[1]
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.5	0.1
Total	**6,080**	**4.5**	**0.5**

[1] *LSA = 134,369 ha; RSA = 1,262,005 ha*

The average size of a male and female grizzly bear home range is 724,500 ha and 210,000 ha, respectively. Habitat loss in the wildlife RSA is equivalent to 0.8% of a male grizzly bear's home range and 2.9% of a female grizzly bear's home range. These areas represent a small fraction of habitat loss for both male and female grizzly bears.

The total expected habitat loss in relation to MU GB02 that overlaps the RSA is relatively minimal. The overall area of MU GB02 is 6,048,024 ha. The entire area of MLA PDA (653 ha) is located within MU GB02; however, the Goose PDA falls outside of MU GB02 and will not contribute to habitat loss within this management unit. Considering the above, habitat loss due to the Project is anticipated to be 0.01% of MU GB02. Therefore, habitat loss within managed populations of grizzly bear will be very low.

Loss of High Quality Habitat

Some of the habitat removed in the Goose Property PDA and the MLA was rated as high-quality habitat (high or moderate habitat suitability rating) for grizzly bears. The proportion of high-quality habitat loss for grizzly bears changes by season and is summarized below and in Table 6.5-6:

- *Spring* — Baseline habitat suitability modeling in 2013 identified 67,728 ha of high-quality spring habitat in the wildlife LSA and 642,502 ha in the wildlife RSA. The proportion of high-quality spring habitat lost to development in the wildlife LSA is approximately 6.4% while that in the wildlife RSA was approximately 0.7%.
- *Summer* — A total of 73,903 ha of high-quality summer habitat was identified during baseline studies in the wildlife LSA. In the wildlife RSA, a total of 678,085 ha exists at baseline. The proportion of high-quality summer habitat loss in the wildlife LSA after development is approximately 6.0% while the proportion lost in the wildlife RSA is approximately 0.7%.
- *Fall* — Within the wildlife RSA, 548,149 ha of high-quality fall habitat was identified, 61,443 ha of which falls within the wildlife LSA. The proportion of high-quality fall habitat lost in the

wildlife LSA is approximately 6.6%, while the proportion lost in the wildlife RSA is approximately 0.7%.

- *Winter* — Denning habitat represents the limiting habitat for grizzly bears in the wildlife RSA. Within the wildlife RSA, 5,457 ha of high-quality winter denning habitat was identified, 386 ha of which is within the wildlife LSA. The proportion of high-quality denning habitat lost after development of the PDAs is approximately 5.6% of the wildlife LSA and 0.4% of the wildlife RSA. These areas represent a relatively small proportion of the available suitable habitat within the wildlife RSA and LSA.

Table 6.5-6. High-quality Grizzly Bear Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project

		High-quality Habitat (HQH)		High-quality Habitat Lost[1] due to Potential Development Areas	
Area	**Season**	**Amount (ha)**	**% Area**	**Area (ha)**	**% HQH**
Local Study Area	Spring	67,728	50.4	4,323	6.4
	Summer	73,903	55.0	4,447	6.0
	Fall	61,443	45.7	4,030	6.6
	Denning	386	0.2	22	5.6
	All Seasons	90,588	67.4	4,996	5.5
Regional Study Area	Spring	642,502	50.9	4,324	0.7
	Summer	678,085	53.7	4,545	0.7
	Fall	548,149	43.4	4,032	0.7
	Denning	5,457	4.3	23	0.4
	All Seasons	866,050	68.6	5,094	0.6

[1] Includes area of habitat loss due to entire PDA areas and not facility specific habitat loss thus overestimating actual habitat loss.

Loss of high-quality habitat during the active foraging periods (spring, summer, and fall) in the wildlife RSA is equivalent to 0.6% of a male grizzly bear's home range across all seasons, and 1.9 to 2.2% of a female grizzly bear's home range with summer habitat representing the higher percentage of lost high-quality habitat for females.

For denning, the loss of high-quality habitat is minimal and equivalent to less than a percent of both a male and female grizzly bear home range (<0.1%). Similarly, the amount of denning habitat that may be removed from MU GB02 is expected to be minimal. A total of 260,065 ha of denning habitat may be available within MU GB02 (assuming similar proportions available within the MU as identified in the wildlife RSA, 4.3%), of which 23 ha (<0.01%) will be lost as a result of the development of the MLA PDA that falls within GB02.

Summary of Habitat Loss

Conservative estimates of habitat loss for grizzly bear indicate that the total loss of habitat is approximately 0.5% of the wildlife RSA and 0.01% of MU G02 that overlaps the wildlife RSA. Alteration and loss of habitat (both total and high-quality habitat) within the typical home ranges of male and female grizzly bear total less than 0.6% and 2% of a home range, respectively. Despite mitigation to design the mine footprint to be as small as possible, a small, but measurable amount of habitat is expected to be lost, resulting in a residual effect, which is evaluated in Section 6.5.4.1.

6.5.2.2 Disturbance due to Noise

This section evaluates the effects of Project-related disturbance on grizzly bears, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise.

Noise affects wildlife species in three primary ways: acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). The source, duration, and intensity of noise all influence the nature and magnitude of wildlife response. First, an acute effect of noise — brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997; AMEC Americas Limited 2005), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment. Attraction of bears to camp infrastructure is described in Section 6.5.2.6.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level."

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to disturbances than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat.

Potential sources of sensory disturbance for grizzly bears associated with Project activities include:

- blasting noise and ground vibrations from mining and construction;
- general Project noise (e.g. camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the open pits while continuous Project noise includes rock crushing and stockpiling of materials for the TSF bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during all Project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required during Post Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to

four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15).

Sensitive periods for grizzly bears include denning periods in the winter. Disturbance during denning periods may result in bears abandoning their dens (H. V. Reynolds, Curatalo, and Quimby 1976) and potentially their young (Schoen et al. 1987), as well as potential displacement from high-quality denning habitats (Craighead Jr. and Craighead 1972; Linnell et al. 2000). Females in particular are vulnerable to the effects of disturbance at their den sites (Linnell et al. 2000). Reduced reproductive success of pregnant females has been documented as a result of den disturbance and den abandonment and has been linked to a greater probability of death for dependent offspring (Linnell et al. 2000; Ross 2002). Other research has shown that hibernating bears are unlikely to be disturbed by anything but extreme noise events (Amstrup 1993; Linnell et al. 2000). Even the noise resulting from blasting may have a limited effect on hibernating grizzly bears, as the dens are usually acoustically isolated when covered with snow (Linnell et al. 2000). As the wildlife LSA and RSA do not contain much high-quality denning habitat for grizzly bears, and the majority of high-quality grizzly bear denning habitat occurs in the northern portion of the wildlife RSA near Bathurst Inlet, but south of the MLA and in along the Western River, disturbance due to Project-related activities conducted during the denning period (November to May) is not anticipated to result in a residual effect to grizzly bears and is not discussed further.

Calculation of Disturbance to Grizzly Bears

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose Property rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat 'loss' will occur indirectly for grizzly bears that avoid the zone of influence because they are disturbed within it.

The potential effect of disturbance on grizzly bear was evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the year when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case; this coincides with Year Three of Operations at the Goose Property. The Operational phase is also the longest Project phase, and thus would have the greatest impact to wildlife. All other phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance. The area of affected habitat was calculated by using specific noise level contours from the literature where bears are shown to have behavioural effects from the noise.

Threshold noise values were determined from the literature, above which grizzly bears are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for grizzly bears. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 6.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated

as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling; Section 6.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Blasting noise models were conducted during peak noise levels as identified in Volume 4, Chapter 2 (worst case scenario), which is Year Three of Operations at the Goose PDA.

General Project-related noise levels, or continuous noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). For the Goose Property, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013d).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) grizzly bear seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 6.5.2.1), but within the noise level contours for blasting noise (≥120 dB representing functionally lost habitat; or ≥108 dB representing disturbed habitat), general Project noise (≥45 dBA) or noise generated from aircraft (≥80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each season within the wildlife RSA and LSA after accounting for habitat loss (Section 6.5.2.1).

The amount of habitat that may be functionally lost or altered due to noise within grizzly bear MU GB02, both in the context of total area and area of high-quality habitat, was also evaluated.

Evaluation of Disturbance to Grizzly Bears

Once mitigated, disturbances during construction activities are expected to be short-term in duration and localized in extent. Continuous disturbance of wildlife VECs will occur due to Project-activities throughout the life of the Project, beginning at Construction. Other sources of disturbance include human presence and aircraft noise. The potential effects of these disturbances to behaviour and habitat use were assessed within the relevant spatial scale for grizzly bear.

Blasting Noise

A total of 9 ha that falls outside the Goose PDA is predicted to be functionally lost from noise modelng of blasting above an L_{peak} of 120 dB, and 316 ha is modeled outside of the Goose PDA due to noise from blasting with an L_{peak} above 108 dB. All blasting noise above 120 dB L_{peak} is completely contained within the 108 db L_{peak} contour; therefore, only 307 ha outside of the area modeled as functionally lost (≥120 dB L_{peak}) will be disturbed by blasting noise above 108 db L_{peak}. Blasting noise, considered independently (i.e., habitat functionally lost due to blasting above 120 dB L_{peak} and additional area outside of 120 dB L_{peak} disturbed by blasting noise above 108 dB L_{peak}) and cumulatively (i.e., all habitat disturbed by blasting noise above 108 db Lpeak which includes 120 dB Lpeak), accounts for less than 1% of the wildlife LSA and less than 0.1% of the wildlife RSA (Table 6.5-7).

The amount of high-quality foraging habitat that is within the area that is modeled as functionally lost from noise (≥ 120 dB L_{peak}) outside of the Goose PDA ranges from 7.3 ha in the summer and fall to 8 ha in the spring, while that which will be disturbed (≥ 108 dB L_{peak}) outside of the Goose PDA ranges from 186 ha in the fall to 231 ha in the spring (Table 6.5-8). In all cases, the amount of high-quality foraging habitat that is modeled as functionally lost or disturbed due to blasting outside of the Goose PDA represents less than 1% of the high-quality habitat available within wildlife LSA and less than 0.1% of that within the wildlife RSA (Table 6.5-8), both when considering blasting noise independently and cumulatively. The total amount of high quality habitat that is functionally lost or disturbed due to blasting is mapped in Figure 6.5-1 for all seasons combined.

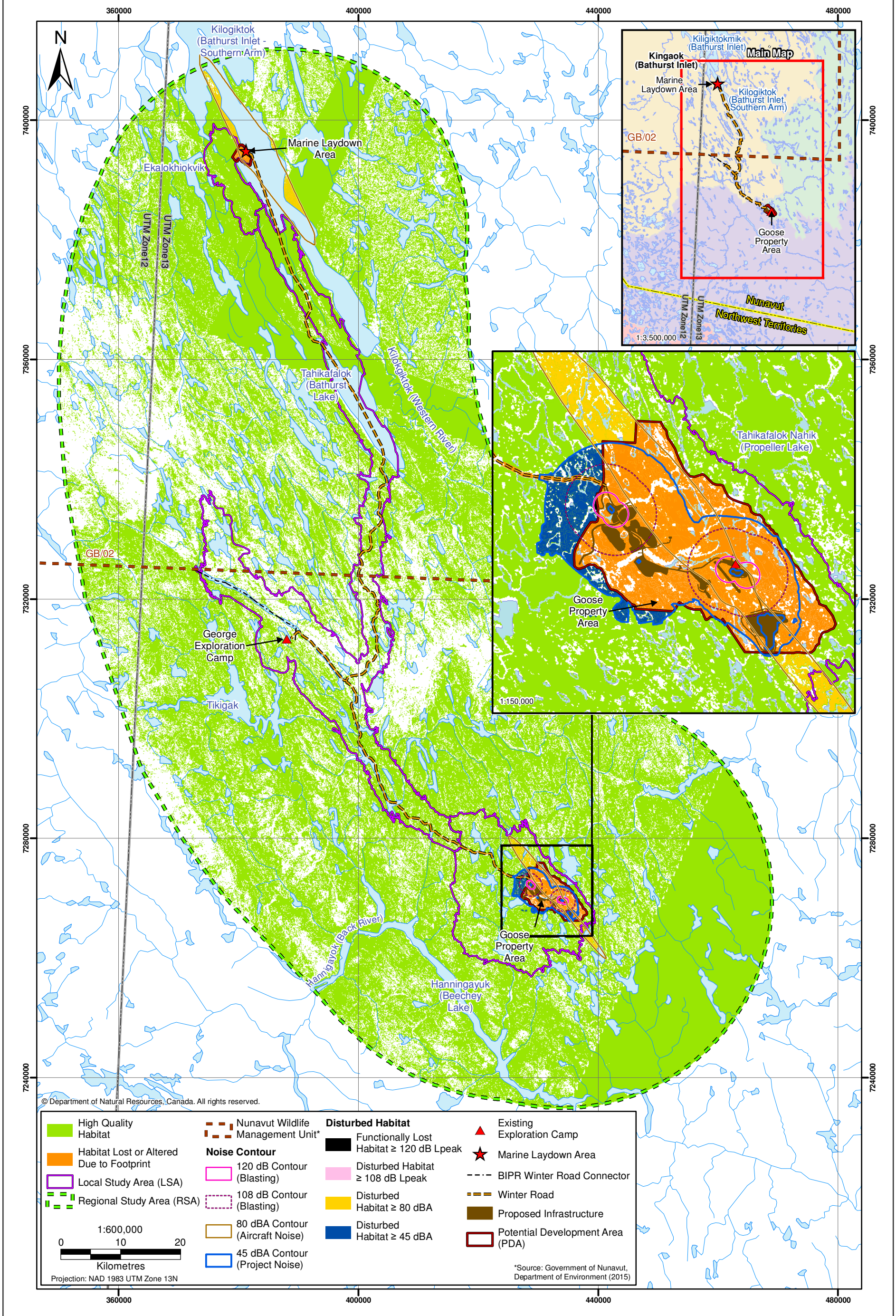
General Project Noise

The total amount of area modeled as affected by elevated noise levels due to general Project noise (outside of the Goose and the MLA that are already considered to be lost (Section 6.5.2.1) is 1,212 ha. All noise attributable to blasting above 108 dB Lpeak, which is an intermittent noise source, will occur entirely within the area disturbed by continuous general project noise above 45 dBA. Therefore, grizzly bear will experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap.

A breakdown of the percentage of high quality habitat modeled as lost due to noise disturbance in each season outside of the PDAs can be found in Table 6.5-8. In all seasons, the percentage of high-quality habitat disturbed by general project noise outside of the PDAs is small (1% of the wildlife LSA; 0.1% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife LSA and RSA (Table 6.5-8; Figure 6.5-1). As noted above, general project noise completely encompasses areas disturbed by blasting; the amount of high-quality habitat were grizzly bear may encounter multiple sources of noise accounts for less than 1% of high-qualaity habitat in the wildlife LSA and less than 0.1% of the wildlife RSA. The majority of sensory disturbance will be associated with the development and operation of the TSF, processing plant, roads and camps.

GIS # BAC-23-382f

October 06 2015



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Grizzly Bear High-quality Habitat Lost, Altered, or Disturbed due to the Project

Figure 6.5-1

Rescan an ERM company

Table 6.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise

Project Area	Area Already Considered Lost due to PDAs (Section 6.5.3.1)			Areas Lost or Disturbed due to Noise outside of the PDA Areas											
				Additional Area Functionally Lost due to Blasting (120 dBA)			Additional Area Disturbed due to Blasting (108 dBA)			Additional Area Disturbed due to General Project Noise (45 dBA)			Additional Area Disturbed due to Aircraft Noise (80 dBA)		
	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA[1]	% RSA
Goose Property Area	5,427	4	0.4	9	< 0.1	< 0.1	316	0.2	< 0.1	1,212	0.9	< 0.1	1,824	1.3	0.1
MLA	653	0.4	0.1	-	-	-	-	-	-	-	-	-	12,367	9.2	1
Total	**6,080**	**4.5**	**0.5**	**9**	**< 0.1**	**< 0.1**	**316**	**0.2**	**< 0.1**	**1,212**	**0.9**	**< 0.1**	**14,191**	**10.5**	**1.1**

[1]*Some of the area of disturbance due to noise falls outside of the wildlife LSA but within the wildlife RSA (see Figure 6.5-1).*

Table 6.5-8. Expected Grizzly Bear High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas

Area	Season	High-quality Habitat (HQH) Available Area (ha)	HQH Lost or Altered due to the Project Footprint		Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
			Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH
Local Study Area	Spring	67,728	4,323	6.4	8.0	< 0.1	231	0.4	855	1.3	900	1.4
	Summer	73,903	4,447	6.0	7.3	< 0.1	208	0.3	735	1.1	744	1.1
	Fall	61,443	4,030	6.6	7.3	< 0.1	186	0.3	628	1.1	675	1.2
	All Seasons	90,588	4,996	5.5	8.0	< 0.1	253	0.3	964	1.1	1,015	1.2
Regional Study Area	Spring	642,502	4,324	0.7	8.0	< 0.1	231	< 0.1	855	0.1	2,149	0.3
	Summer	678,085	4,545	0.7	7.3	< 0.1	208	< 0.1	735	0.1	2,740	0.4
	Fall	548,149	4,032	0.7	7.3	< 0.1	186	< 0.1	628	0.1	2,429	0.4
	All Seasons	866,050	5,094	0.6	8.0	< 0.1	253	< 0.1	964	0.1	3,352	0.4

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 6.5.2.1).*

Aircraft Noise

The total amount of area modeled as affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 6.5.2.1) is 14,191 ha (1.1% of the wildlife RSA). Sensory disturbance modeled due to aircraft noise is greater near the MLA (12,367 ha, 1% of the wildlife RSA) relative to the Goose PDA (1,824 ha, 0.1% of the wildlife RSA; Table 6.5-7), as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. However, much of the habitat modeled as disturbed by aircraft noise at the MLA is over marine habitat in Bathurst Inlet, with only 2,273 ha of terrestrial habitat along the shorlines modeled as receiving elevat4ed noise levels, which is equivalent to 0.2% of the wildlife RSA. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area modeled as disturbed by continuous general project noise above 45 dBA, thus representing the area where grizzly bear may encounter multiple types of Project noise.

A breakdown of the percentage of high quality habitat modeled as disturbed due to aircraft noise in the wildlife RSA can be found in Table 6.5-8. In all seasons, the percentage of additional high-quality habitat in the wildlife RSA modeled as disturbed by aircraft noise after accounting for habitat lost within the PDAs is small relative to the amount of available high-quality habitat in the wildlife LSA (<2%) and wildlife RSA (<1%; Table 6.5-8). A very small amount of high-quality foraging habitat (between 9 and 10 ha) occurs near the Goose PDA where intermittent aircraft noise and general Project noise are expected to overlap, representing the area where grizzly bear may encounter multiple types of Project noise.

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose Property, a maximum of two flights per day are planned in the “worst case” years used for noise modelling (during Operations), while at the MLA, when it is active, a maximum of six flights per week are planned during the “worst case” scenario. In addition, areas of disturbance due to noise are expected to be localized near the landing strips at the Goose Property and within Bathurst Inlet at the MLA.. Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

Wildlife Management Units

The total amount of habitat that is modeled as functionally lost or disturbed due to Project-related noise outside of the MLA PDA (which is already considered as lost habitat) and within the grizzly bear MU GB02 is 12,591 ha, which accounts for 0.2% of MU GB02. The majority of this area is over the ocean, because aircraft will be using either an ice runway or landing on floats. The calculation only considers Project noise related to aircraft, because all other sources of Project noise (e.g., general project noise, blasting noise) occurs at the Goose Property, which is outside of GB02. The total modeled disturbance due to aircraft within MU GB02 is slightly larger than that within the wildlife RSA because the 80 dBA aircraft noise contour extended outside of the wildlife RSA at the northern tip; the area outside of the wildlife RSA and within the 80 dBA contour totals 224 ha. However, all of this habitat outside of the wildlife RSA and within the 80 dBA contour is located within marine habitat in Bathurst Inlet. The amount of terrestirial habitat within MU GB02 that may be disturbed by noise as a result of aircraft landing at the MLA is the same as reported for the wildlife RSA, which totals 2,273 ha and represents less than 0.1% of of the area of MU GB02.

The amount of high-quality habitat modeled as disturbed by aircraft noise at the MLA within MU GB02 is 969 ha, 1,660 ha, and 1,529 ha for spring, summer, and fall habitats, respectively. Assuming that MU GB02 has the approximate proportion and distribution of high-quality habitat as the wildlife RSA for spring (51%), summer (54%) and fall seasons (43%), the total amount of high-quality spring, summer, and fall habitat in GB02 is anticipated to 3,084,492 ha, 3,265,933 ha, and 2,600,650 ha, respectively.

The proportion of high-quality seasonal habitat functionally lost or disturbed within MU GB02, due to Project-related noise, accounts for <0.1% of of the MU for all seasons.

Summary Of Disturbance due to Noise

Overall, the effect of sensory disturbance is anticipated to result in a residual effect on grizzly bear. There will be a small (1.1%), but measurable area of the RSA outside of the PDA that is modeled as having elevated noise levels that bears may avoid, and hence loose habitat. Note that this is an extremely conservative estimate of the area where grizzly bears may be affected by noise because the thresholds used to model the area affected are just above background noise levels, and grizzly bears are known to occupy areas of elevated noise and to approach camps and active mines in the Canadian Arctic.

The total area of habitat modeled as affected by all noise sources combined represents roughly 0.2% of the terrestrial wildlife RSA. The largest amount of habitat that may be affected from a single noise source is not the mine itself, but is modeled as intermittent aircraft noise. The total amount of terrestrial habitat modeled as disturbed by all noise sources is 0.7% of a male home range and 3% of a female home range. Because it is larger than the RSA, a smaller proportion of habitat was modeled as disturbed in the grizzly bear MU GB02 that overlaps the MLA (<0.1%), and thus Project disturbance should not affect the grizzly bear population residing within this MU.

6.5.2.3 Disruption to Movement

Disruption to movement by grizzly bears can result from 1) linear corridors such as roads which may isolate seasonal habitats and from 2) point sources of disturbance where grizzly bears will avoid areas, and thus displace movement due to human activities. The haul roads for the Project are designed as winter roads only. These roads will be constructed and used while grizzly bears are hibernating. Thus, the effect of disruption to movement due to linear corridors was not assessed further.

Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which bears use and cause noise and sensory disturbance to a level with which bears will avoid these areas, movement of bears may be altered. In these cases, bears may need to expend additional energy to travel around Project developments during their large distance movements. Disruption to movement may begin during the construction phase of the Project when infrastructure are built and continue during the operation and reclamation/closure phases of the Project. Potential Project infrastructure and activities that were evaluated for the potential disruption to movement of grizzly bears include the PDAs for the Goose Property Area and the MLA. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Evaluation of Disruption to Movement on Grizzly Bears

The Goose Property and MLA PDAs are unlikely to act as barriers to seasonal movements or dispersal of grizzly bear because they represent small point sources of disturbance rather than a linear feature acting as barrier. Evidence collected during the 2012 and 2013 DNA studies indicate that grizzly bears in the area of the Project regularly make long distance movements which are far greater than the areas that each PDA occupies. In both years of study, grizzly bear movements ranged from 7 to 138 km, while four bears detected in the study had been recorded in other studies over 200 km away from the Project (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B). The Goose Property and MLA PDAs total 5,427 ha and 653 ha, respectively. Therefore, it is unlikely that either of the PDAs will impede the movements of grizzly bear using the area, and no residual effect is expected.

6.5.2.4 Direct Mortality and Injury

Mortality and injury to grizzly bears may result from development activities and is thus evaluated in this assessment. Potential Project activities that may contribute to direct mortality and injury are generally anticipated to be a result of vehicle strikes. Mortality to grizzly bears may also result when wildlife attracted to Project infrastructure become human habituated and aggressive, and thus pose a threat to human safety. The resulting effects of attraction to the Project are evaluated in Section 6.5.2.6.

Calculation of Direct Mortality and Injury on Grizzly bears

To assess the likelihood and population-level significance of grizzly bear mortality and injury resulting from interaction between grizzly bear and the Project, literature from other projects in Nunavut or Northwest Territories (Ekati, Diavik, and Hope Bay) and/or from GN-DOE was reviewed, and estimates of wildlife mortality rates due to Project activities were summarized.

Evaluation of Direct Mortality and Injury on Grizzly bears

Grizzly bear mortality and injury due to development activities is most often a result of vehicle collisions (Benn, Jevons, and Herrero 2005). Frequency of road mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to grizzly bears also increases. However, all of the Project roads, except for local site roads are winter roads, and will be constructed and used between January and April when grizzly bears are hibernating in their dens. Grizzly bear typically enter their dens in late October to early-November (before construction of the winter road has begun) and emerge in late-April to early-May (McLoughlin 2000), after the winter road has closed. Thus, winter roads are not further assessed.

The all-weather local site roads within the PDAs will be restricted to 60 km/h. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/h. All wildlife, including bears, will have the right of way on all project roads. In addition, there have been no reports of mortality to grizzly bear on site roads at other larger developments in the Arctic including Ekati (Rescan 2013g), Diavik (RioTinto 2012) and Hope Bay (Rescan 2013f). Thus, mortality due to vehicle strikes is not anticipated to result in a residual effect on grizzly bears.

6.5.2.5 Indirect Mortality

Indirect mortality to grizzly bears may result if public access is facilitated by the proposed roads. Indirect mortality from increased hunting pressure resulting from Project-related activities is assessed based on the results the socio-economic assessment (Volume 8, Chapter 3) which reports that an increase in human immigration and hunting is unlikely in the Back River area.

Mitigation measures are in place to prevent public access to Project roads (Section 6.5.3 and Volume 10, Chapter 20). A policy prohibiting hunting within a buffered area along all infrastructure may be developed and enforced (Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in grizzly bear mortality due to facilitation of hunter access (i.e., indirect mortality) and is therefore not anticipated to result in a residual effect on grizzly bear.

6.5.2.6 Attraction

Wildlife attractants refer to Project-related human activities, infrastructure, or environmental changes that are of interest or provide resources to wildlife. Changes in spatial distribution and habitat

selection have been observed for species attracted to anthropogenic activity, but mortality is perhaps of greater concern.

Grizzly bears may be attracted and become habituated to the Project due to the camps and other facilities that could create odours. Habituated bears can pose a threat to the safety of both humans which often necessitates relocation or destruction of these animals (Gibeau and Herrero 1998). While relocation of habituated or food-conditioned bears reduces the chances of an immediate negative attraction, bears are moved into territories that are either occupied by other bears or have relatively less suitable habitat which may lead to decreased survival (Blanchard and Knight 1995). In some cases, bears that are attracted to human activity centres and are perceived as a threat to life or property are destroyed.

The effect of attraction is anticipated to commence upon construction when the camps are in use and continue throughout operation and reclamation/closure phases of the Project while odourous materials are present on site.

Evaluation of Attraction for Grizzly Bears

The Project will have in place a number of mitigation measures to limit the attractiveness of the site to grizzly bear. These will include standard mitigation techniques such as: incinerating food wastes, managing garbage and scents, etc. Project activities will adhere to a Waste Management Plan (Volume 10, Chapter 10), Incineration Management Plan (Volume 10, Chapter 11), and waste management protocol in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) which may include mitigation measures to store and remove all food wastes and wildlife attractants, erect bear fences in appropriate areas, remove carrion from roads, and monitor the waste management facilities. In addition, the Fuel Management Plan (Volume 10, Chapter 4), and the Hazardous Materials Management Plan (Volume 10, Chapter 12) ensures that all chemicals will be contained and properly stored so that grizzly bears will not have access to these substances. Mitigation measures such as employee education in wildlife awareness and protocols in dealing with nuisance bears may also be implemented in the WMMP Plan (Volume 10, Chapter 20).

A review of existing developments indicates that strict compliance with waste management and site cleanliness policies will result in low incidences of grizzly bears being attracted to project sites. For example, in the one and half decades of construction and operations at the Diavik Mine (2000 to present), incidental observations by staff and environment personnel recorded variable numbers of grizzly bear on or near the project site, ranging from 5 individuals up to 97 (Golder 2014). In the same time frame, there was one instance of a attraction-related mortality (2004) and four instances where bears were presumed to be attracted to the site and relocated for safety reasons (2001, 2003, 2012, and 2013). Review of incident of mortality indicated that grizzly bear was trying to access the cafeteria area and was subsequently destroyed for safety reasons (EMAB 2005), which may indicate that the bear was attracted to food smells emanating from food preparation areas. No further instances of attraction-related mortality has occurred at Diavik since 2004, though on two recent occasions (2012 and 2013) grizzly bears were relocated for safety reasons (Golder 2014). At the Ekati Mine, there was one occasion in 2000 where a sow and a cub were reported to be attracted to the Misery landfill site, and the cub was subsequently destroyed for safety reasons. Review of the incident suggested that the cub was in very poor condition and that food wastes were improperly managed at Misery landfill, which likely caused the hungry bears to seek out the food contained within the landfill (Golder 2001). Since then, Ekati has continually improved waste management protocols, and no further incidences of attraction that required relocation or destruction have been recorded (Rescan 2013h; ERM Rescan 2014b; ERM 2015b). Prior to 2008, a number of bears were recorded at the Doris North project, where bears appeared to be attracted to a pre-existing camp at the project site that had not been properly closed (Rescan 2010). Following a cleanup at the closed camp, and strict compliance with waste

management protocols, the number of bears reported atthe Doris North project camps and waste facilities has been zero in recent years (ERM Rescan 2014a; ERM 2015a). These results underscore the importance, and effectiveness, of waste management protocols in limiting the attractiveness of developments to grizzly bear.

A review of mitigation measures and bear issues at other Arctic mines indicates that problem (or habituated) bears are a rare occurrence when the project adheres to proper waste management and camp cleanliness protocols. Mitigation measures for the Project include a program to exclude grizzly bears from camps using skirting and fencing (where needed), a program of Waste Management for Wildlife, and a camp and waste monitoring program to continuously monitor the site and trigger additional waste and site cleanup activities. In addition, a program for managing problem bears is proposed, which triggers a review of the waste and camp management programs if a bear is observed several times at the Project site. Therefore, it is expected that with mitigation proposed, there will be a low number of bears attracted to the Back River Project, and that no problem bears will be encountered that will require destruction for safety reasons. Considering the above, mitigation cannot wholy elimitate the potential for attraction and thus, the effect of attractants is predicted to result in a residual effect on grizzly bears, albeit small.

6.5.2.7 Exposure to Contaminants

Exposure to contaminants in grizzly bears due to the Project was evaluated in the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in soils and surface waters, and evaluation of predicted future vegetation concentrations relative to baseline, all of which are items that would be consumed by the prey of grizzly bear (e.g., fish, caribou, etc) or grizzly bears themselves (e.g., water), were either less than one (which means future concentrations are predicted to be less than soil or water quality guidelines), or are predicted to be within the range of baseline. Therefore, risks to grizzly bear are considered to be negligible. Thus, a residual effect due to exposure to contaminants in grizzly bear is not anticipated and is not considered further in the assessment.

During the DEIS review, Sabina committed to discussing why mercury could potentially effect the health of humans, but will not threaten the health of grizzly bears. Mercury exposure in humans was found to be slightly elevated for ingestion of caribou organ meats (inorganic mercury) and ingestion of freshwater fish and ringed seal muscle (methyl mercury) (Table 5.1-6; Volume 8, Chapter 5). While dietary modelling was completed for humans as part of the Country Foods Assessment (Volume 8, Chapter 5), dietary modelling was not required for the grizzly bear, based on the Screening Level Ecological Risk Assessment (SLERA) conducted (see Volume 8, Chapter 6). In this Screening Level ERA, mercury concentrations in baseline soils, surface waters and sediments did not exceed regulatory guidelines, and hence, baseline dietary modelling was not required.

This assessment discusses the potential future exposure of grizzly bears to mercury as a result of Project activities. Grizzly bears could incur exposures to mercury via both terrestrial exposure pathways (e.g., ingestion of berries), as well as fish consumption. For berries, dust deposition onto soils and vegetation, as well as uptake of dusts via roots of berry plants were accounted for in the SLERA (see Volume 8, Chapter 6). Predicted future berry concentrations of mercury were less than analytical detection limits (baseline concentration: <0.001 mg/kg Hg; predicted project increment based on average dust deposition at Country Food VEC locations inside of the PDA: 0.00000079 mg/kg; see Table 6.4-16 of Chapter 6, Volume 8). This indicates there will be no measurable change in mercury concentrations in berries within the PDA. Concentrations outside the PDA but within the LSA will experience even lower rates of dust deposition and are likewise predicted to have no measurable increase in mercury.

With respect to fish consumption, the potential for area lakes to be influenced by dust deposition was evaluated in the Environmental Risk Assessment (see Volume 8, Chapter 6). Dust deposition onto sediments was predicted for several area lakes. Sediment mercury concentrations in area lakes as a result of dust deposition were not predicted to change measurably. For example, baseline sediment mercury concentrations of 0.060 mg/kg (95th Upper Confidence Limit of the Mean for area lakes) were predicted to increase by an additional 0.0000076 mg/kg in Rascal lake as a result of 10 years of dust deposition (see Table 6.4-11 of Chapter 6, Volume 8). Similarly, baseline water mercury concentrations (0.000005 mg/L) were predicted to increase in Rascal Lake by an additional 0.000000017 mg/L (see Table 6.4-8 of Chapter 6, Volume 8). These increments are within the range of baseline concentrations, and hence, are not likely measurable. For Goose Lake, which will receive inputs from various Water Management Features, mercury concentrations in surface waters are also predicted to change slightly. Median baseline mercury concentrations within Goose Lake are < 0.00001 mg/L, whereas the predicted lake-wide Project increment is estimated at 0.000004 mg/L (Maximum at Post Closure scenario; Table 6.4-14 of Chapter 6, Volume 8), which is unlikely to be measurable, and still within Canadian Council of Ministers of the Environment (CCME) water quality guidelines. Therefore, based on the future predicted increments of mercury related to Project activities, in conjunction with existing baseline mercury concentrations, future Baseline + Project concentrations are likely to be within existing baseline concentration ranges, and hence, no significant increase in mercury exposures for grizzly bears are anticipated. Hence, dietary modelling was not considered necessary for mammals such as the grizzly bear.

To further explore this issue, the CCME tissue residue guideline for mercury for fish-eating wildlife (which is based on the body weight and ar body weight and food intake rafood intake rate of a mink; see CCME, 2000) was re-calculated for the grizzly bear using a grizzly bete provided by the BC MOE (2001). The revised tissue residue mercury guideline for grizzly bear consumption of fish is 951 µg/kg, or 0.951 mg/kg (using the equation Residue Concentration (RC) = Total Daily Intake (TDI) / (Food intake/Body weight), where TDI equals 22 µg/kg body weight/day (CCME 2000), and grizzly food intake rate was estimated at 10.4 kg/d, and average weight of 450 kg (BC MOE, 2001). A comparison of the measured baseline fish tissue concentrations in the LSA (mean of 0.251 mg/kg; maximum of 0.549 mg/kg; see Appendix C of Appendix V8-5b) to this tissue residue guideline established for grizzly bear (0.951 mg/kg) further supports the conclusion that grizzly bear are not anticipated to be affected by baseline mercury concentrations in fish tissues.

6.5.2.8 Reduction in Reproductive Productivity

A reduction in reproductive productivity was evaluated for grizzly bears due to project developments; and evaluates whether individual-level effects can result in population-level effects. Potential Project effects could result in reduced reproductive productivity of bears if habitat loss and degradation, disturbance, and disruption to movements resulted in physiological stress, lower feeding and increased movement rates, or displacement from preferred habitat. Reductions in body condition could, in turn, reduce reproductive productivity.

Barren-ground grizzly bears are foraging for 3.5 to 5.5 months per year and are under pressure to store energy reserves in order to make it through to the following winter. There are energy costs associated with reproduction, foraging movements, and exposure to weather. Grizzly bears maintain large home ranges in the Arctic, thus require larger energy costs associated with these movements. However, it is hypothesized that their home ranges are large in the tundra to meet their nutritional and energetic requirements in an environment that is relatively less productive compared to coastal and alpine areas. Therefore, the benefits of maintaining these large home ranges must outweigh the costs of energy expenditure in order to reproduce.

Evaluation of Reduction in Reproductive Productivity in Grizzly Bears

Reduction in reproductive productivity was evaluated for the various potential effects of the Project act in a synergistic fashion. Following mitigation, residual effects are expected for direct habitat loss, disturbance due to noise, and attraction. Therefore, these three effects were evaluated for their potential to affect the reproductive productivity of grizzly bear.

The results of these assessments indicate that the amount of habitat directly lost due to the Project, or and indirectly lost due to disturbance, is unlikely to significantly reduce the amount of foraging habitat available for grizzly bear in the area. A small area habitat will be removed by the Project PDA, and relatively small amounts of habitat outside of the Project footprint (i.e., the PDAs) will disturbed due to noise. Together, the amount of habitat affected totals roughly 1.6% (0.5% lost and 1.1% disturbed) of the available habitat within the wildlife RSA and less than 2% of a typical home range of a female grizzly bear and less than 1.1% of a male home range. Note that since approximately 10% of the PDA will be occupied by the actual Project footprint, the area lost will realistically be 0.05% lost in the RSA and 0.11-0.2% of a male and female home range.

Of the three residual effects, both disturbance due to noise and attraction could potentially contribute to a potential reduction in productivity, given the evidence that grizzly bear are sensitive to noise and are known to become attracted to industrial sites (e.g., Section 6.5.2.6). However, as noted in Section 6.5.2.2, the amount of habitat within modeled noise contours (blasting, continuous general Project noise, and aircraft noise) totals roughly 1.1% of the available habitat within the wildlife RSA, with aircraft noise being the largest contributor to Project noise, followed by continuous general Project noise, and finally minimal amounts of habitat modeled as disturbed by blasting. Given the low amount of habitat that is modeled as disturbed by Project noise and the availability of high-quality habitat outside of the influence of the Project, it is not expected that grizzly bear, and females in particular, that come into contact with the Project will have substantially altered behaviour patterns or increased energy budgets as a result of disturbances.

Predictions of indirect habitat loss due to disturbance were consistent with published reports of bears avoiding disturbed areas. In areas of frequent disturbances, grizzly bears are known to avoid areas or to alter their behaviour, e.g., increase nocturnal activity, in response to the presence of roads, seismic blasting and other industrial activities (L. Harding and Nagy 1980; Archibald, Ellis, and Hamilton 1987; McLellan and Shackleton 1988; Mace and Waller 1996; Mueller 2001; Gibeau et al. 2002; Wielgus, Vernier, and Schivatcheva 2002). Grizzly bears frequently alter their behaviour and avoid areas with human activity (such as high-use roads) and periods when human-related activities are most active (Mueller 2001). Grizzly bears may avoid habitat up to 900 m of high-use areas (Mattson, Knight, and Blanchard 1987; McLellan and Shackleton 1988; Kasworm and Manley 1990), particularly where there are new disturbances and areas where crews are working. Several studies indicate that grizzly bears are highly responsive to aircraft overflights (Kucera 1974; Mccourt K. H. et al. 1974; L. Harding and Nagy 1980; P. E. Reynolds, Reynolds, and Follmann 1986) and have indicated that repeated flyovers of aircraft at 300 m may alter their home range, foraging patterns and breeding behaviour. Other studies suggest that bears do not generally respond to aircraft if flights remain above 200 m above ground level (B.N. McLellan and D.M. Shackleton 1989; B.N. McLellan and D.M. Shackleton 1989).

Despite a conservative approach to evaluating disturbance to bears, the area lost to them will be approximately <1.6% (0.5 lost and 1.1% disturbed) of the RSA when combined effects of habitat loss and disturbance are evaluated. As noted above, there are large amounts of undisturbed high-quality seasonal habtiat surrounding the Project and the level of Project activity is not expected to approach those described above that result in altered behavior patterns of grizzly bear. For instance, the majority of traffic associated with the Project will be travelling along winter roads, which will be

active while grizzly bear are hibernating during the winter. There will be a minimum amount of site and haul roads, and these will be contained within the Goose and MLA PDAs. Therefore, it is not expected that Project roads will cause the same level of avoidance as reported by (Mueller 2001) and others. In addition, aircraft disturbance at the Project is expected to be relatively infrequent (Section 6.5.2.2), and all aircraft servicing the Project will maintain an minimum altitude of 300 m wherever possible (Volume 10, Chapter 20). Therefore, it is unlikely that aircraft disturbance resulting from the Project will cause grizzly bear to alter their habitat use and breeding behavior to the degree noted by (Kucera 1974; Mccourt K. H. et al. 1974; L. Harding and Nagy 1980; P. E. Reynolds, Reynolds, and Follmann 1986). There have been few long term studies to determine disturbance effects on the grizzly bear population. One such study is the long term population monitoring in the area surrounding the Ekati and Diavik Mines which has seen a stable grizzly bear population over time, suggesting that these mines have not had an effect on the local population of bears.

It is expected that a very low number of grizzly bear individuals may become attracted to the Project site, but that following waste management protocols outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20), none of these bears will require destruction for safety reasons. Therefore, the Project is not expected to result in removal of grizzly bear from the local population, which then should not alter the population dynamics and reproductive capacity of that population.

A residual effect for reduction in reproductive productivity is therefore not expected for grizzly bear due to the expected low amounts of habitat directly and indirectly lost due to the Project and that no bears are expected to require destruction as a result of attraction-related mortality. Grizzly bear are a wide-ranging species that have known sensitivies to industrial development, both in terms of avoidance and attraction. However, given the concern expressed by regulators for grizzly bear and the effects of industrial developments on this species, potential effect of reduction in reproductive productivity is rated as a residual effect following the precautionary principle.

This assessment evaluated disturbance and reduction in reproductive productivity by examining the area where bears may choose to avoid the Project due to disturbance. However, should bears choose to occupy this relatively small area immediately surrounding the mine, it is not expected that grizzly bears will suffer effects of reduced energetic intake, stress or population health. The area is relatively small compared to the habitat available, meaning that potential stress effects would make up a small proportion of a grizzly bear's time budget and grizzly bears are known to be robust to some levels of disturbance.

6.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring (WMMP) Plan (Volume 10, Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including grizzly bears. In addition, a number of other mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on grizzly bears was predicted to result from habitat loss, disturbance due to noise, attraction, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to grizzly bears. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

6.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to grizzly bears may include the following:

- Project infrastructure designed to avoid, where possible, identified grizzly bear sensitive habitat such as identified denning habitat (Volume 10, Chapter 20); and
- infrastructure designed to minimize the Project footprint to reduce habitat loss for grizzly bears (Project Description; Volume 2, Chapter 2).

6.5.3.2 Mitigation for Disturbance due to Noise

The primary mitigation and management strategies to minimize the effects of disturbance due to noise to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement for Wildlife program (Volume 10, Chapter 20). Additional wildlife specific measures to minimize the effect of disturbance due to noise to grizzly bears may include:

- winter roads designed to avoid known grizzly bear dens along the proposed alignment to ensure that works and activities do not disturb grizzly bears during hibernation (Volume 10, Chapter 20);
- pre-construction ground clearing conducted outside of denning periods for grizzly bears, where possible, to reduce disturbance to grizzly bears (Volume 10, Chapter 20);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to grizzly bears (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to grizzly bear habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed distance from observed beards whenever possible (Volume 10, Chapter 20).

6.5.3.3 Mitigation for Disruption to Movement

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to grizzly bears:

- winter access roads only, when grizzly bears are hibernating, so access roads will not cause disruption of movement for bears (Volume 10, Chapter 20) Mitigation for Direct Mortality and Injury.

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the WMMP Plan (Volume 10, Chapter 20) and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to grizzly bears may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);

- setting speed limits for trucks, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to grizzly bears (Volume 10, Chapter 14);
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

6.5.3.4 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to grizzly bear may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by employees while on site (Volume 10, Chapter 23).

6.5.3.5 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of attraction to the Project to grizzly bears and other wildlife are described in the Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11) and employee education plan, described in the WMMP Plan (Volume 10 Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to grizzly bears:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- bear-proof receptacles used for all waste and wildlife attractants, where possible, to ensure bears do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- relevant employees and contractors trained in bear safety procedures to minimize risk to humans and wildlife (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20);
- a protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers (Volume 10, Chapter 20), and;

- a problem bear management program that focuses on monitoring both the Project site for attractants and incidental observations of bears, and triggers further mitigation to avoid attraction of bears and on non-lethal responses should any bear become attracted to site.

6.5.3.6 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to grizzly bears.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including grizzly bears from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);
- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

6.5.4 Characterization of Residual Effects

In Section 6.5.3, eight potential effects were evaluated whether they would result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Four of these effects were rated as having the potential for residual effects: 1) habitat loss, 2) disturbance from noise, 3) attraction, and 4) reduction in reproductive productivity. The significance of residual effects is evaluated here for these four effects. Each residual effect is described in this section in terms of eight descriptors (see Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and

confidence. The magnitude of the residual effect was evaluated by using the information in Table 6.5-2. Table 6.5-3 provides a description of the significance ratings used for residual effects.

6.5.4.1 Habitat Loss

The total area of habitat calculated as lost in the Goose and MLA PDAs is 5,094 ha of high quality habitat (high and moderate habitat combined), or 0.5% of the wildlife RSA. The habitat calculated as lost and altered is roughly equivalent to 0.6% of a male grizzly bear's home range and approximately 1.8% of a female grizzly bear's home range. Note that since approximately 10% of the PDA will be occupied by the actual Project footprint, the area lost will realistically be 0.05% lost in the RSA and 0.06-0.2% of a male and female home range.

Loss and alteration of habitat within the grizzly bear management unit GB02 is expected to be minimal (<0.1%), both in terms of total habitat and potential high-quality habitat removed. The actual Project footprints which are designed to be as small as possible are anticipated to be much smaller than the Project PDAs which have been assumed lost in this assessment. When the proportion of habitat loss, in terms of loss within the wildlife RSA, within grizzly bear home ranges, and within the grizzly bear MU GB02, is compared to the quantitative thresholds for magnitude of effect (Table 6.5-1), the magnitude of the effect is considered low.

The extent of the effect of habitat loss is confined to the Project footprint (within the PDAs), the frequency is sporadic, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas within the PDAs will not be affected and may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during construction and operation. The confidence of the effect occurring is considered high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose and MLA PDAs will not be developed. The residual effect of habitat loss for grizzly bears is concluded to be Not Significant.

6.5.4.2 Disturbance due to Noise

After considering the effects of habitat loss, the amount of habitat calculated as receiving an elevated noise level where a grizzly bear may be disturbed by noise was ~1% of the high-quality habitat for bears in the RSA. The largest source of noise is predicted to be aircraft, not the mine site itself. Blasting noise and continuous noise (generators, etc) are predicted to be largely contained in the PDAs and occupy approximately <0.01% of habitat in the RSA. The area of increased noise was calculated as <1% of a male grizzly bear's home range and approximately 1.8% of a female grizzly bear's home range. Minimal amounts of habitat (<0.1%) are expected to be disturbed by noise within MU GB02. Thus, when noise disturbance, in terms of disturbance within the wildlife RSA, within grizzly bear home ranges, and within the grizzly bear MU GB02, is compared to quantitative thresholds for magnitude listed in Table 6.5-1, the magnitude of the effect is considered low.

The extent of the effect of noise disturbance is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for dB 108 and 120 Lpeak during blasting activities and for aircraft noise, thus sporadic overall; the duration is considered medium as the effect of disturbance due to noise is expected to subside at Reclamation and Closure. The effect is considered to be reversible as grizzly bears are anticipated to relocate to areas of disturbance once the effect subsides. The probability of the effect occurring is moderate, and confidence is high, as bears are known to be sensitive to blasting activities related to mining. The residual effect of sensory disturbance on grizzly bears is assessed as Not Significant.

6.5.4.3 Attraction

The effect of attraction of the Project on grizzly bears can be direct and adverse if bears attracted to the site become habitutated to the site. Monitoring reports from existing developments suggest that with proper waste management protocols, such as contained within the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20), minimal numbers of individuals may become attracted to the Project and no problem bears that require destruction should be anticipated. For this reason, the the magnitude of the effect of attractants on grizzly bear is rated as low.

The geographic extent is contained to the Project footprint. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used, but not after Reclamation and Closure. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is moderate contingent on rigourous application of mitigation and managmenent mearures in relation to waste and attractant managment. The confidence in the assessment is high, as it is well documented that bears have been attracted to mining camps that have implemented standard waste management protocols. The residual effect of attractants on grizzly bears is concluded to be Not Significant.

6.5.4.4 Reduction in Reproductive Productivity

The residual effect of reduction is reproductive productivity is expected to have a negative direction, as the combination of residual effects of the Project (habitat loss, disturbance due to noise, and attraction) will cause a minor amount of direct and indirect habitat loss and potentially a very low number of individuals to be attracted to the Project but not requiring destruction of safety reasons. Therefore, the combination of residual effects is not predicted to significantly increase the energy demands or alter the demography of the local grizzly bear population to a degree that could substantially affect the reproductive potential of that population.

Reduction in reproduction for grizzly bear is expected to be of low magnitude, as generally small amounts (~2%) of habitat may be affected by habitat loss and disturbance due to noise combined, and very low numbers of individuals are expected to be attracted to site. The combined effects of habitat loss and disturbance due to noise may affect up to 10% of a typical female home range should the entire Project be contained within one home range; however, it is expected that multiple home ranges of females overlap the Project given that over 60 females have been recorded during DNA studies in 2012 and 2013. Thus, predicted direct and indirect habitat loss is expected to affect much smaller proportions of the home ranges of females that overlap the Project.

With the evaluation predicting a small to negligible effect on reproductive productivity, it is not expected that the local or regional population of bears will be adversely affected by the Project. Likewise, the grizzly bear population in the area surrounding the Ekati and Diavik Mines has seen a growth in the grizzly bear population over time, suggesting that these mines have had no effect on the local population of bears.

During the DEIS review phase, the GNWT requested that any predicted decrease in reproductive productivity be compared with the natural variability of grizzly bear productivity. The Project is not expected to affect the reproductive productivity of grizzly bears, and not in a measurable way. As a consequence, it is not expected that any Project effects would be greater than the natural variability in productivity and a low magnitude was used.

The duration of the effect is expected to be medium. The frequency of the effect is anticipated to be sporadic as the primary residual effects that could affect productivity, i.e., disturbances to grizzly bear

that are using habitat near the Project and attraction of grizzly bear to the Project, are expected to occur infrequently.The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the mine is closed. The geographic extent of this residual effect is anticipated to be regional.

The likelihood that a reduction in reproductive productivity on grizzly bears will occur is unlikely as the Kitikmeot region supports a moderate grizzly bear population and habitat is fairly evenly dispersed throughout the region, thus bears are expected for the most part to avoid contact with the mine and choose alternative habitat in areas that are not disturbed, which are widely available within the wildlife RSA. The confidence in the effect rating is medium as it is unknown how the residual effects of the Project on reproduction of grizzly bears may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the residual effect of reduction of reproductive productivity is concluded to be Not Significant.

6.5.5 Significance of Residual Effects

The effects assessment for grizzly bear identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. The residual effect anticipated to contribute the most to effects on the population is those attributed to attraction. Habitat loss and disturbance due to the Project leading to avoidance of habitat is anticipated to result in less of an effect on the population of grizzly bears as the total amount of habitat lost or altered due to disturbance is small relative to the size of a grizzly bear home range. Thus, these effects will not result in a decline in the grizzly bear population in the region.A summary of residual effects on grizzly bear and overall significance ratings are presented in Table 6.5-9. Contingent on the implementation of mitigation measures outlined in the WMMP Plan (Volume 10, Chapter 20), the combined significance of residual effects for grizzly bear is predicted to be **Not Significant**.

With the predicted effect on the local population of grizzly bears being not-significant, it is not expected that there will be any effect on regional harvest opportunities or hunting allocations.

Table 6.5-9. Summary of Residual Effects on Grizzly Bear and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	High	N
Disturbance due to Noise	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Attraction	Negative	Low	Medium	Sporadic	Footprint	Reversible	Moderate	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

6.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

6.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The Cumulative Effect Assessment (CEA) follows the methodology as described in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 6.5.1.1). Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 6.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for grizzly bears.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 6.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for grizzly bear and not the wildlife RSA.

6.6.1.1 Spatial Boundary

Grizzly bear female and male adults can range over 210,000 to 724,500 ha, and sub-adult male grizzly bears can range over 4,000,000 ha (McLoughlin et al. 2002). The spatial boundaries for grizzly bears include the area within which a sub-adult male may travel and interact with existing and proposed developments. This area was defined using the diameter of a 4,000,000 ha home range (approximately 226 km) as well as the longest straight line distance travelled by an individual male. The maximum grizzly bear movement recorded during the Project baseline was approximately 140 km straight line distance by a male grizzly bear moving between hair snag stations. The CEA spatial boundary is a

relative average of these values resulting in a CEA area extending 200 km from the Back River Project Infrastructure and consists of 18,726,990 hectares (Figure 6.6-1). Note that the CEA boundary is different for each VEC species for which a CEA assessment was conducted – in each case based on the movement patterns and/or home range size for that species.

The relative scale of the CEA boundary for grizzly bears was then checked against data from grizzly studies in Nunavut and Northwest Territories. Five exploration or operating mines were conducting grizzly bear work in the early 2010's: Back River Project, Hackett River project, Izok Corridor project, Ekati/Diavik Operating Diamond Mines, and the Doris North (Hope Bay) project. Grizzly bears detected at the Back River Project were also detected at Hackett River, and Ekati/Diavik, and Hope Bay, while Izok bears were also detected at Ekati/Diavik. This suggests that the CEA spatial boundary is appropriately sized for the Project and includes the appropriate neighbouring projects.

6.6.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

6.6.2 Potential Interactions of Residual Effects with Other Projects

Four residual Project-related effects were identified during the grizzly bear effects assessment: habitat loss; disturbance due to noise; attractants; and reduction in reproductive productivity. Several additional Projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of grizzly bears that interact with the Back River Project.

Figure 6.6-1 displays the past, present, and foreseeable future developments that could interact with grizzly bears in the CEA boundary. Eleven projects have been identified within the CEA spatial boundary for grizzly bears including three past projects which are closed (Roberts Bay/Ida Bay, Jericho, and Lupin), thee existing developments (Doris North, Ekati, and Diavik), and five foreseeable future projects (George, Hope Bay (Phase 2), BIPR, Hackett River, and Izok Corridor projects) in addition to the Back River Project.

The George project was included in the original Back River DEIS submission as part of the Back River Project, but in the FEIS submission, it has been moved to a future foreseeable project. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the Exploration Camp. Should the George project proceed, it will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned for George project.

A description of the type of potential cumulative effect due to all projects combined is listed in Table 6.6-1.

Potential cumulative effects are assessed for April to November when grizzly bears are active; effects relating to winter dens will be addressed where applicable. Denning bears are still susceptible to effects that occur in close proximity to den sites, such as disturbance due to noise during construction.

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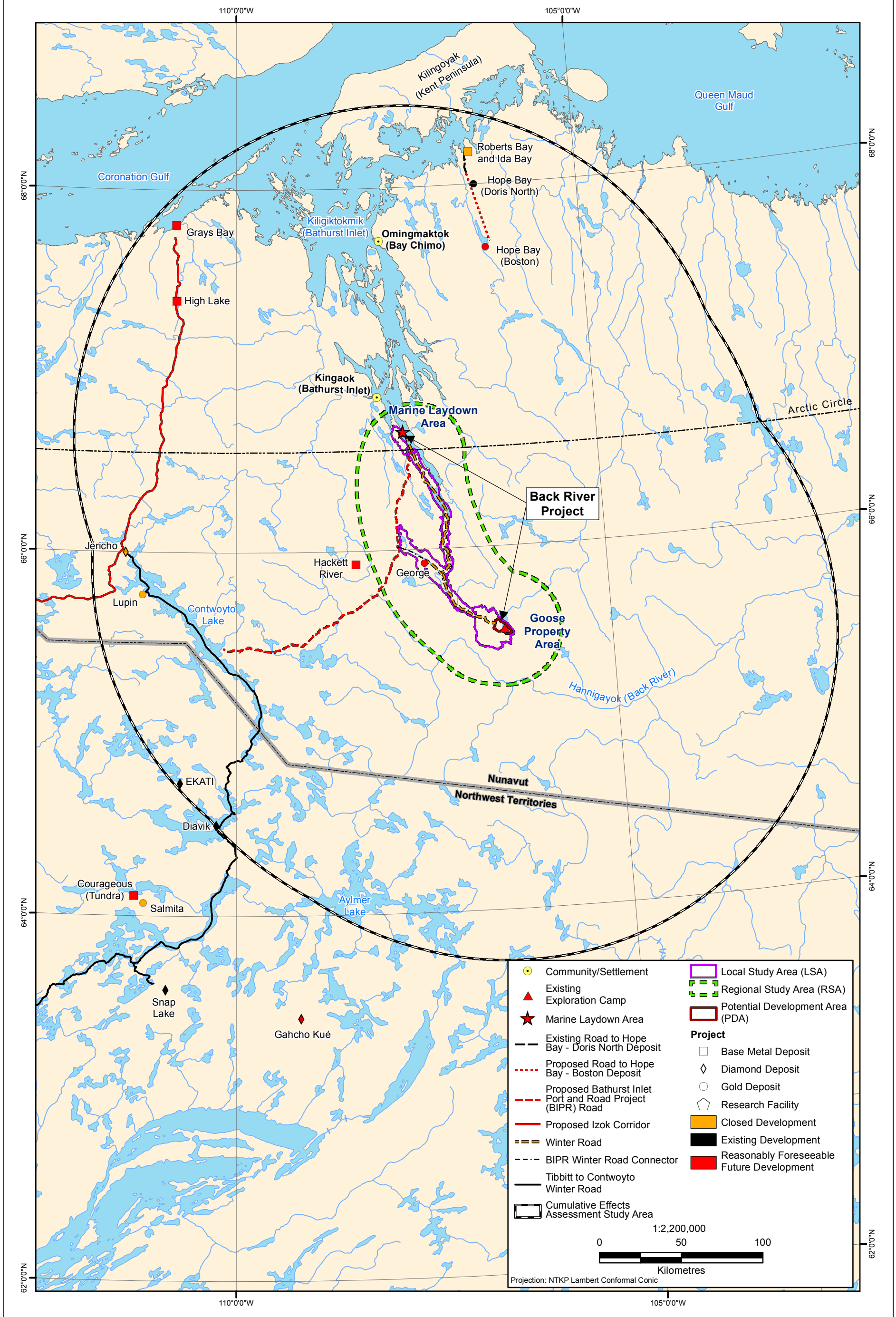

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Figure 6.6-1

Spatial Boundary for Grizzly Bear Cumulative Effects Assessment

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Table 6.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Grizzly Bears in the Area

Residual Effect from Back River Project	Magnitude of Residual Effect Rating from Back River Project	Other Project or Activity			Type of Potential Cumulative Effect
		Past	Existing	Reasonably Foreseeable Future	
Habitat Loss	Low	Roberts Bay and Ida Bay, Lupin, Jericho	Doris North, Ekati, Diavik	George, Hope Bay (Phase 2), BIPR*, Hackett, Izok Corridor	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
Disturbance due to Noise	Low	N/A	Doris North, Ekati, Diavik	George, Hope Bay (Phase 2), BIPR*, Hackett, Izok Corridor	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance
Attractants	Low	Roberts Bay and Ida Bay, Lupin, Jericho	Doris North, Ekati, Diavik	George, Hope Bay (Phase 2), BIPR*, Hackett, Izok Corridor	Additive attraction to foods and wastes resulting in attraction and negative human-wildlife interactions and destruction of nuisance bears
Reduction in Reproductive Productivity	Low	Roberts Bay and Ida Bay, Lupin, Jericho	Doris North, Ekati, Diavik	George, Hope Bay (Phase 2), BIPR*, Hackett, Izok Corridor	Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects

** BIPR = Bathurst Inlet Port and Road Project*

6.6.2.1 Habitat Loss

The Project effects assessment rated the residual effect of habitat loss from the Back River Project as Not Significant, with a low magnitude. Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible. While habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 6.5.4.1), additional habitat loss within the range of a grizzly bear may contribute to a nibbling effect, whereby the total amount of habitat lost to all potential and current projects is additive, resulting in larger habitat loss for grizzly bears.

A number of closed projects including Roberts Bay and Ida Bay, Lupin, and Jericho have already removed some habitat within the CEA boundary for grizzly bear. Other existing developments including Doris North, Ekati, and Diavik, overlap with the CEA boundary for grizzly bear and may further decrease the available habitat or habitat quality (e.g., due to dust fall-out, etc.) for grizzly bears using this area. The proposed Hope Bay (Phase 2), BIPR, Hackett River, and Izok Corridor projects have the potential to overlap with the CEA boundary for grizzly bear and may contribute to additional habitat loss if these projects are developed. The Tibbett to Contwoyto Winter Road was not considered in the assessment for grizzly bears as it is constructed and used only when grizzly bears are anticipated to be hibernating.

Calculation of Cumulative Habitat Loss

The amount of habitat removed ("area removed") was estimated from the generalized footprints of all projects and road corridors in the CEA boundary for grizzly bears and used as a key indicator to determine potential cumulative effects. For all existing and future foreseeable projects, habitat within 100 m of footprints were considered degraded due to dust (Walker and Everett 1987; Rescan 2012b). Habitat loss for the Back River Project was calculated within the PDAs which already includes a dust-disturbance area.

Detailed habitat mapping does not exist for the entire CEA boundary for bears. Hence, it was assumed that the CEA boundary contains approximately the same proportion of high quality habitat as the wildlife RSA (approximately 50%). The total area of lost habitat from these calculations was compared to the area of the CEA boundary and to the home range sizes for male and female grizzly bears with the assumption that the area lost falls entirely within the home range size of a male or female territory.

Evaluation of Cumulative Habitat Loss

Within the CEA boundary for grizzly bear, the cumulative effects assessment identified 16,197 ha of removed habitat, and 17,516 ha of degraded habitat (each 0.1% of the total area in the CEA boundary). These areas account for a total of 26,591 ha after accounting for overlap between projects. The Back River Project alone will contribute 6,080 ha (22.9%) of the total area of habitat loss within the CEA boundary for grizzly bears which is equivalent to less than 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10% or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

Assuming that approximately 50% of the cumulative effects area consists of high-quality habitat for grizzly bears, a total of 13,296 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the CEA boundary for grizzly bears are developed.

The average size of a grizzly bear home range is 724,500 ha and 210,000 ha, for male and female grizzly bears, respectively. Thus, total habitat loss from all projects in the CEA boundary is 3.7% of a male grizzly bear's home range and 12.7% of a female grizzly bear's home range, assuming that all of the habitat lost or degraded would fall within one home range of a bear. If it is assumed that the density of grizzly bears in the CEA boundary is similar to that in a study which encompasses the CEA boundary of four bears per 100,000 ha (Ross 2002), approximately 750 grizzly bears would be expected to frequent the CEA boundary. Based on this estimate, and assuming an even distribution of habitat loss in the CEA boundary, an average of approximately 35 ha of habitat per bear (26,591 ha total) may be altered, which is equivalent to < 0.1% of a home range of a male or female grizzly bear home range per bear.

The amount of grizzly bear habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 6.6-2) and that of the home range of male and female grizzly bears. The carrying capacity of the habitat for grizzly bear at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to grizzly bears.

6.6.2.2 Disturbance

The residual effect of disturbance due to noise to grizzly bears due to Project auditory stimuli from the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment. Habitat lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the CEA boundary is discussed in this section.

Table 6.6-2. Cumulative Habitat Loss in the Grizzly Bear CEA Boundary[1]

Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)
Back River Project[3]	6,080	n/a	6,080
Past Developments			
Jericho Mine	242	**n/a**	242
Lupin Mine	796	**n/a**	796
Roberts Bay and Ida Bay	3	**n/a**	3
Existing Developments			
Diavik Mine	80	32	112
Doris North	279	532	811
Ekati Mine	2,630	1,860	4,490
Reasonably Foreseeable Future Developments			
BIPR[4]	656	4,920	5,576
George	172	239	411
Hackett River	1,454	2,056	3,510
Hope Bay (Phase 2)	2,987	1,067	4,053
Izok Corridor Project[5]	818	6,810	7,627
Cumulative Areas			
Total Area	16,197	17,516	26,591
Total Area Accounting for Overlap[6]	16,197	17,516	26,591
% CEA Boundary	0.09	0.09	0.14

[1] Grizzly Bear Cumulative Effects Assessment boundary approximates 18,726,990 hectares.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] Bathurst Inlet Port and Road Project
[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.
[6] Represents the total area of habitat loss and degredation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degredation, these are were dissolved to provide a total accounting for overlap.

Potential cumulative effects from existing and proposed projects was assessed; including Doris North, Ekati, and Diavik, and the proposed Hope Bay (Phase 2), BIPR, Hackett River, and Izok Corridor Projects (Figure 6.6-1). Closed projects were excluded from the analysis. A background on the potential effects of disturbance due to noise to grizzly bears is presented in Section 6.5.2.2.

Calculation of Cumulative Disturbance on Grizzly Bears

To evaluate the effects of disturbance on grizzly bear, the area in which grizzly bear may be affected by disturbance was calculated and used as a key indicator of this potential effect.

A zone of influence (ZOI) approach was taken to evaluate the cumulative effect of disturbance on the VEC. A ZOI represents the area where grizzly bear may avoid industrial developments or features due to noise, human presence, or altered habitat within a particular distance of that development or feature. The results of noise modeling produced in Volume 2, Chapter 4 and literature values were used to develop ZOIs for all project features occurring with the CEA boundaries for grizzly bear.

The ZOI of 4 km was applied to all existing and reasonably foreseeable future developments and associated infrastructure areas (e.g., port facilities). This value was chosen based on a wide range of theoretical zones of influence for large arctic mammals, which have ranged from 500 m up to 5 km (Czech 1991; Nellemann and Cameron 1998; Vistnes and Nellemann 2001; Mahoney and Schaefer 2002; Frid 2003; Johnson et al. 2005) Thus, a conservative value of 4 km was used, and is a commonly reported ZOI for large mammals such as caribou (see Sections 5.5.2.2 and 5.6.2.2).

All-weather roads associated all existing and reasonably foreseeable future developments with were assigned a ZOI of 1.5 km. This value was selected based on the results of noise modelling in research studies, and the distance from the feature where noise is anticipated to attenuate to below the threshold value of 45 dBA, as per the conservative guideline for minimizing disturbance outlined in Environment Canada (2010) (Section 6.5.2.2). Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km.

ZOIs for project features overlap one another. For example, ZOIs associated with all-weather roads exiting a development area will overlap 4 km ZOIs for that certain development. Thus, a priority was assigned to each ZOI to account for overlaps in features. The 4 km ZOI for developments took precedence over all other ZOIs, as it was assumed that the physical presence of the development, noise (in some cases continuous noises such as generators), and other associated activities, would cause more potential disturbance than roads which will have more infrequent disturbance during hauling periods.

In some cases, ZOIs for certain projects overlap one another. In these cases, the amount of overlap was calculated and removed from the total disturbance within ZOIs to avoid double-counting areas where ZOIs overlap.

The total area of indirect habitat loss due to all projects was compared to the total area of the CEA boundary for grizzly bears and to the average home range size of a male and female grizzly bear.

Evaluation of Cumulative Disturbance on Grizzly Bears

The CEA boundary for grizzly bear is approximately 18,726,990 ha. The area of habitat loss for the cumulative effects of disturbance due to all existing and proposed projects (including the Back River Project) in the CEA boundary for grizzly bear, assuming a worst case scenario whereby all projects are operational at the same time, would result in 316,001 ha of disturbed habitat (1.7% of the CEA boundary). The area of habitat altered due to disturbance from the Back River Project alone would cover 27,352 ha, or 0.1% of the CEA boundary for grizzly bears (Figure 6.6-2). Estimated areas of disturbance for each project are reported in Table 6.6-3.

The cumulative effect of disturbance due to all projects results in the equivalent of 44% of a male grizzly bear home range size or approximately 1.5 female grizzly bear home ranges, respectively. Assuming a similar density of bears in the CEA boundary as reported in the literature which includes the CEA boundary area of four bears per 100,000 ha (Ross 2002), approximately 750 grizzly bears would be expected to frequent the CEA boundary. Based on this estimate, an average of approximately 421 ha of habitat per bear (316,001 ha total) may be altered which is equivalent to < 0.1% of a home range of a male grizzly bear and 0.2% of a female grizzly bear home range per bear. Thus, only a small proportion of each of the 750 grizzly bear's home range, assuming an even distribution of disturbance, is anticipated to be altered. Despite mitigation measures, a residual effect is anticipated for disturbance to grizzly bears.

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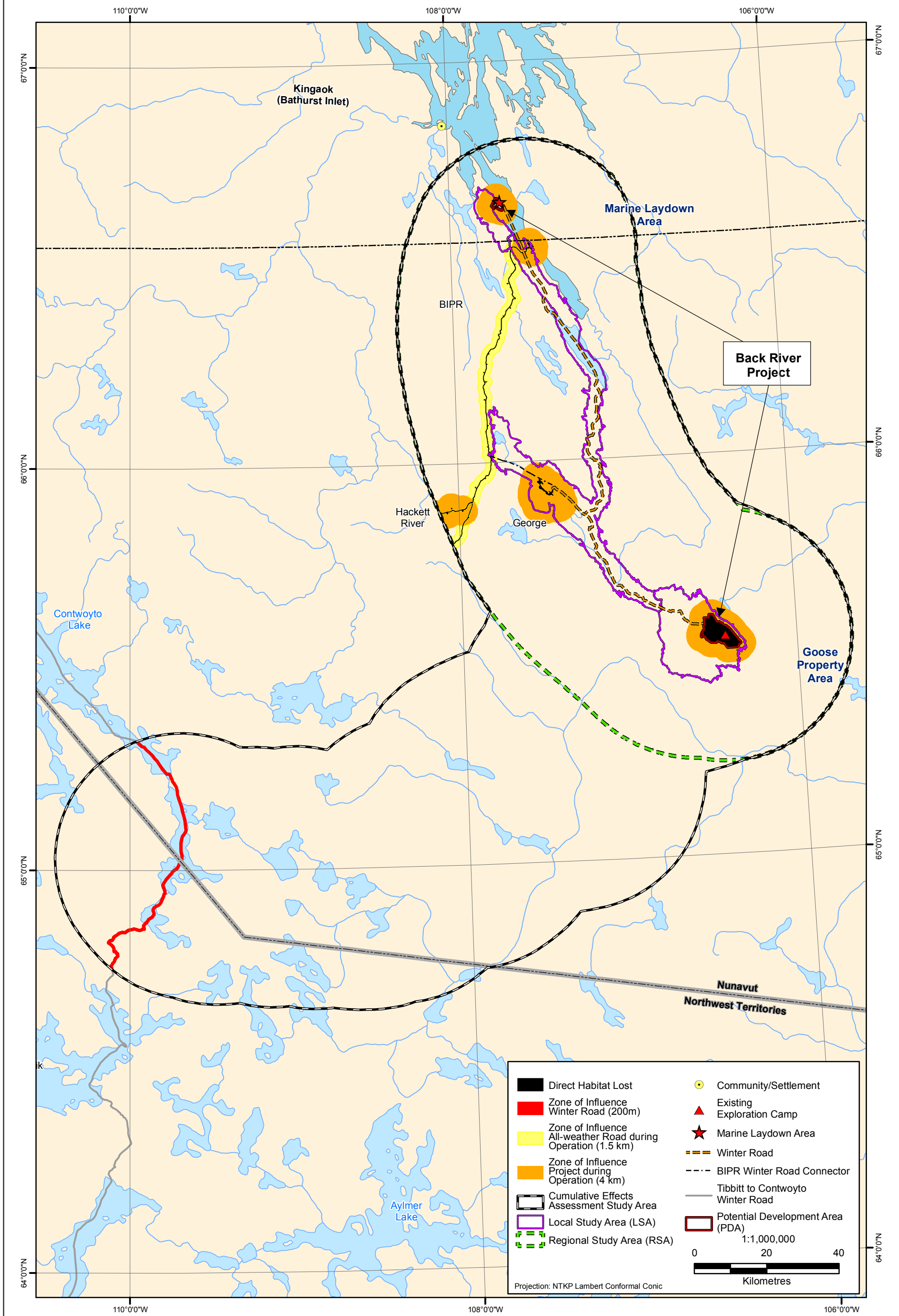

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Figure 6.6-2

Habitat Lost or Altered due to All Project Footprints and Disturbances in the Grizzly Bear Cumulative Effects Assessment Boundary

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Table 6.6-3. Zone of Influence due to Disturbance in the Grizzly Bear CEA Boundary[1]

Project	Area of Habitat within ZOIs (ha)[2]		Total
	All-weather Roads (1.5 km)	Mine (4 km)	
Back River Project[3]	n/a	27,352	27,352
Existing Developments			
Diavik Mine	n/a	4,073	4,073
Doris North	0	17,156	17,156
Ekati Mine	4,030	25,273	29,303
Reasonably Foreseeable Future Developments			
BIPR[4]	57,207	13,714	70,921
George	n/a	20,348	20,348
Hackett River	0	36,096	36,096
Hope Bay (Phase 2)	10,409	12,378	22,787
Izok Corridor Project[5]	74,783	15,042	89,825
Cumulative Areas			
Total Area	146,429	171,432	317,861
Total Area Accounting for Overlap[6]	146,429	169,572	316,001
% CEA Boundary	0.78	0.91	1.69

[1] Grizzly Bear Cumulative Effects Assessment boundary approximates 18,726,990 hectares.
[2] Disturbance includes total area in ZOI and does not take into account habitat suitability within the area.
[3] Habitat within ZOIs of the Goose Property and MLA PDAs.
[4] Bathurst Inlet Port and Road Project
[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.
[6] Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.

6.6.2.3 Attractants

Grizzly bears are often attracted from long distances to a human settlement in search of food. Additional present developments and future foreseeable projects in the CEA boundary for grizzly bears will increase the probability of attraction of bears (same projects as in Table 6.6-2).

Once a bear becomes habituated to either humans or food, the probability of a human-bear interaction increases (Herrero 1985; Peine 2001). Conflicts often negatively affect the survival of bears. In Yellowstone National Park, bears that came into conflict with humans had a higher probability of dying within a year of the conflict (Haroldson, Schwartz, and White 2005). If problem grizzly bears avoid conflict with humans for more than two years, their survival rate returns to that of bears with no known history of conflict with humans (Haroldson, Schwartz, and White 2005).

Evaluation of Attraction for Grizzly Bears

Best management practices for reducing the attractiveness of camps and infrastructure are anticipated to be implemented at all project sites. However, existing mines and camps in Nunavut and Northwest Territories still report problem bears in low number despite implementing these best management practices. Therefore a residual effect is predicted for the cumulative assessment of attractants for bears.

6.6.2.4 Reduction of Reproductive Productivity

The residual effect for a reduction in reproductive productivity in grizzly bears was rated as Not Significant with a low magnitude in the Project effects assessment.

The contribution of the Back River Project to cumulative effects of reduction of reproductive productivity on grizzly bear is anticipated to be small relative to other projects in the CEA boundary. While the effect of attraction is anticipated to be similar to other developments where human development wastes and attractants will be present, the Back River Project does not include linear corridors that will be present when grizzly bears are using the tundra to hunt and forage, thus does not have a residual effect of disruption to movement on grizzly bears. Other projects in the CEA boundary will have linear developments including all-weather roads, which may contribute to the effect of disruption to movement on grizzly bears. This effect may have higher consequences on the reduction of reproductive productivity on grizzly bears relative to the residual effects of habitat loss, disturbance, and attraction anticipated from the Back River Project. Reduction in reproductive productivity is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

6.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for grizzly bears will be similar to those implemented for the Back River Project and will meet or exceed best management practices. For a list of mitigation and management measures applied for grizzly bears at the Back River Project see Section 6.5.3, and Volume 10.

6.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures, there are four residual effects predicted in the grizzly bear cumulative effects assessment area: habitat loss, disturbance, attraction, and reduction in reproductive productivity.

6.6.4.1 Habitat Loss

The overall loss or degradation of area due to all projects in the grizzly bear CEA boundary is 26,591 ha (approximately 0.1% of the CEA boundary) which is roughly equivalent to the loss or alteration of 3.7% of the home range of a male grizzly bear or 12.7% of a home range of a female grizzly bear assuming all habitat lost falls within one bear's home range. Assuming a grizzly bear density estimate similar to that within an area encompassing the CEA boundary of four bears per 100,000 ha, and an even distribution of habitat loss or alteration within the CEA boundary, an average of approximately 35 ha of habitat per bear may be altered which is equivalent to < 0.1% of home range of a male or female grizzly bear per bear. As this amount of habitat loss is small relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local , the frequency is sporadic, as habitat loss would occur during construction periods for each Project, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of

habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for grizzly bears is concluded to be Not Significant.

6.6.4.2 Disturbance

The total additional area of habitat disturbed due to all projects within the CEA boundary is 316,001 ha. These areas are equivalent to 0.1% of the CEA boundary for grizzly bears. The maximum area of disturbance is equivalent to 44% of one male grizzly bear home range size or approximately 1.5 female grizzly bear home ranges. However, the area of disturbance is somewhat spread out over the CEA boundary and assuming a similar density of bears in the CEA boundary to that reported in the literature in an area which contains the CEA boundary (four bears per 100,000 ha; Ross 2002) a total of 421 ha per bear is disturbed. This area is equivalent to < 0.1 to 0.2% of a home range for male and female bears, respectively. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for grizzly bears, thus, the magnitude of the effect is considered low.

The extent of the effect of disturbance is local, the frequency is expected to be continuous. The duration is considered medium as the effect of disturbance is expected to subside at closure of the projects. The effect is considered to be reversible as grizzly bears are anticipated to relocate to areas of disturbance once the effect subsides. The probability of the effect occurring is moderate. The confidence in the effect of disturbance is high, as the effect of disturbance was converted to area calculations and these calculations are conservative as to not dilute the effect in the large CEA boundary and as literature suggests that grizzly bears are known to be sensitive to blasting activities related to mining. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed. The cumulative residual effect of disturbance on grizzly bears is concluded to be Not Significant.

6.6.4.3 Attractants

With mitigation measures applied and assumed similar among projects, the magnitude of the effect of attractants on grizzly bear is determined from the definitions of qualitative effects (Table 6.5-1) is rated as low. The geographic extent is local as the effect will occur close to camps and other infrastructure. The effect of attraction is anticipated to result in a negative effect as bears that become habituated to Project-related attractants may have to be destroyed if they become nuisance bears. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used. The frequency of bears being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is moderate, and confidence is high, as bears are known to be attracted to mining camps, but with effective mitigation the potential to attract bears and cause problem bears is medium. The cumulative residual effect of attractants on grizzly bears is concluded to be Not Significant.

6.6.4.4 Reduction in Reproductive Productivity

The potential for a reduction in reproductive productivity in grizzly bears depends on the magnitude of all other effects (disturbances) they experience. Disturbance leading to displacement of female grizzly bears with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young due to bears becoming nuisance animals as a results of being attracted to projects, would likely lead to the greatest effects on grizzly bear populations in the region.

Reduction in reproduction for grizzly bear is expected to be of low magnitude, as generally small amounts (~2%) of habitat may be affected by cumulative habitat loss and disturbance combined, and

very low numbers of individuals are expected to be attracted to development sites, as it is anticipated that all developments will have in place a number of mitigation measures to limit the attractiveness of the site to grizzly bear, similar to those proposed for the Back River Project.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of grizzly bears in the regional area. The duration of the effect is expected to be medium term as the effects of reduction in reproductive productivity are anticipated to occur in bad foraging years and recover in good years. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as grizzly bears have large home ranges and may come into contact with many of the Projects in the CEA boundary. The likelihood that a reduction in reproductive productivity on grizzly bears will occur is unlikely as the Kitikmeot region supports a moderate grizzly bear population and habitat is fairly evenly dispersed throughout the region, thus bears are expected for the most part to avoid contact with the mine and choose alternative habitat in areas that are not disturbed. The confidence in the effect rating is medium as it is unknown how the effects of the Project on reproduction of grizzly bears may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

6.6.5 Significance of Cumulative Residual Effects

The cumulative effects assessment for grizzly bear identified four effects as residual after mitigation as follows and in Table 6.6-4:

- habitat loss, rated Not Significant;
- disturbance, rated Not Significant;
- attraction, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of grizzly bears is **Not Significant**.

6.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on grizzly bears are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, the CEA boundary is designed to encompass the range of a male grizzly bear and includes habitat within Northwest Territories; thus, the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for grizzly bear. The overall residual cumulative effect on grizzly bears predicted in the cumulative effects assessment was Not Significant, thus transboundary effects are predicted to be **Not Significant**.

6.8 MITIGATION AND ADAPTIVE MANAGEMENT

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the wildlife mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including grizzly bears. Mitigation measures specific to grizzly bears are listed in Section 6.5.3 and summarized in Section 6.8.5, Table 6.8-1.

Table 6.6-4. Summary of Cumulative Residual Effects to Grizzly Bear and their Significance

	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
Cumulative Residual Effects	**Direction** *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Attraction	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including grizzly bears. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incinerator Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;
- Ore Storage Management Plan: Chapter 8;
- Mine Waste Rock Management Plan: Chapter 9;
- Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosives Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Fish Offseting Plan: Chapter 21;
- Tailings Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

6.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of grizzly bear dens. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 6.8-1 in Section 6.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on grizzly bears.

6.8.2 Best Management Practices

The WMMP Plan (Volume 10, Chapter 20) includes eleven separate mitigation and management sections designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to grizzly bears are listed in Section 6.5.3, and listed in Table 6.8-1 in Section 6.8.5.

6.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the WMMP may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The WMMP Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

6.8.4 Monitoring

As part of the WMMP Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal-species monitoring.

6.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 6.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on grizzly bears.

Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	1. Project infrastructure designed to avoid, where possible, identified grizzly bear sensitive habitat such as identified denning habitat.
	2. Project infrastructure designed to minimize the footprint of infrastructure.
	3. Consideration of the location of the stockpiles and windbreaks to minimize dustfall.
	4. Winter road access corridors only (no all-weather roads for re-supply routes).
	5. Winter roads designed to avoid area which are more likely to support grizzly bear dens.
	6. Infrastructure located close to deposits to keep activities confined to specific areas, and minimize noise-generating activities.
	7. Berms or other markers built at high walls of quarries to deflect grizzly bear movement.
	8. Buildings designed and maintained to exclude wildlife to minimize exposure to chemicals that may be stored inside.
	9. Cyanide destruction conducted in the mill.
2. Best Management Practices	
	1. Pre-construction ground clearing conducted outside of denning periods for grizzly bears, where possible.
	2. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations outside of the frozen ground period (December to April).
	3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude when possible wherever grizzly bears are observed.
	4. Speed limits for trucks used, signage installed to alert drivers of speed limits, and speed limits enforced.
	5. Wildlife will be given the right-of-way on all roads at all times (including within camp and marine laydown area).
	6. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance.
	7. Bear-proof receptacles used for all waste and wildlife attractants, where possible.
	8. A waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants.
	9. All employees and contractors trained in bear safety procedures.
	10. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation, and enforced.
	11. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.

(continued)

Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears (continued)

Mitigation Category	Mitigation Measures
2. Best Management Practices *(cont'd)*	
	12. A policy prohibiting hunting from and within a buffered area along all infrastructure developed and enforced. 13. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers. 14. Wildlife exclusion measures implemented if grizzly bears are frequently accessing or attempting to access waste storage areas. 15. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to grizzly bears. 16. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures.
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.
4. Monitoring	
	A facility-specific monitoring program will assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. his program will include several monitoring plans relevant to grizzly bear including: 1. footprint monitoring to monitor habitat loss; 2. human activity monitoring of Project site roads and winter roads; 3. noise monitoring to monitor disturbance to wildlife; 4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes; 5. infrastructure monitoring to record the status of wildlife exclusion measures, such as skirting and fencing; 6. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; 7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible; and 8. monitoring for grizzly bear dens along the winter road alignment to reduce the chances of direct mortality during construction of the winter road.

(continued)

Table 6.8-1. Summary of Mitigation and Management Measures Applicable to Grizzly Bears (completed)

Mitigation Category	Mitigation Measures
4. Monitoring *(cont'd)*	
	Focal-species monitoring program to evaluate predictions in the effects assessment on grizzly bears. This plan may include: 1. a monitoring program using remote cameras in the wildlife RSA to record grizzly bear activity and interactions with the Project; and 2. incidental reporting of grizzly bear observations during other wildlife and environmental monitoring programs

6.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to grizzly bears are summarized in the following sections.

6.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10, Chapter 20):

- Footprint Monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Nests;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- InfrastructureMonitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA;
- Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds; and
- Pre-construction Surveys for Bear Dens.

The objective of the waste management monitoring is to reduce the effects of attraction to grizzly bear and other wildlife. Waste disposal facilities will be monitored frequently to ensure that wastes are being properly disposed of. Waste facilities will be inspected for signs of wildlife activity (e.g., chew marks on waste, wildlife mediated waste dispersion, wildlife scat or tracks). Any incidents where wildlife have been observed to interact directly with wastes, or observations of habituated wildlife (particularly bears) will be reported to Project Environment Team and the Department of Environment, Nunavut. Problem wildlife will be evaluated by Environment Team and corrective measures implemented in consultation with the Nunavut Department of Environment.

6.9.2 Focal-species Monitoring

The proposed focal-species monitoring program will include partnering with the Government of Nunavut to conduct regional monitoring of grizzly bear populations. If a program is not produced by the the Government of Nunavut, then the Project will partner with the Government of Northwest Territories to expand the industry-government collaboration conducted there. See section 7.3 of the WMMP (Volume 10, Chapter 20) for more information on the proposed partnerships to monitor large mammals for the Project.

If neither monitoring program is available for the Project to partner with, then regional monitoring will be conducted using remote motion-triggered cameras. Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013c, 2014b). Grizzly bears along with other wildlife are often recorded by these cameras. The use of remote cameras for annual monitoring of grizzly bear is currently proposed for the WEMP (Volume 10, Chapter 20). Incidental observations of grizzly bears detected during other wildlife monitoring surveys will continue to be recorded.

The two objectives of this monitoring program are to:

1. monitor the Project site to examine how grizzly bear interact with Project facilities (e.g., camps and waste-management facilities); and
2. record the times at which grizzly bear use the wildlife RSA during the year.

Methods for data management and analysis will follow those for caribou detailed (Section 7.3.1 of the WMMP Plan, Volume 10, Chapter 20).

6.10 IMPACT STATEMENT

A review of the potential Project interactions with grizzly bears identified eight potential effects that may occur. These seven potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other proposed effects.

The effects assessment included the identification of key indicators and quantitative thresholds for evaluation of potential effects. The assessment described the mitigation and management activities planned to reduce or eliminate potential effects on bears and concluded that four of the potential effects would remain as residual effects after mitigation: habitat loss, disturbance due to noise, attraction and reproductive productivity. Using the key indicators and thresholds, each of these effects were rated with a low magnitude and overall were rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10; Chapter 20).

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. The residual effects anticipated to contribute the most to a negative effect on the grizzly bear population are those attributed to attraction. While the most current mitigation measures are proposed for the Project, effects of attraction on grizzly bears have been recorded at other existing projects with similar mitigation measures. However, with proper follow-up through adaptive mitigation and management, the effect of attraction on grizzly bears is anticipated to be small.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for bears that interact with the Project. Four potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, attraction and reproductive productivity. Key indicators were calculated for those where data was available and residual cumulative effects were predicted for all four potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the grizzly bear population within the cumulative effects assessment area.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on grizzly bears in the CEA boundary. The overall effect of the Project on the VEC grizzly bear is **Not Significant**.

7. Muskox

Sabina
GOLD & SILVER CORP.

7. Muskox

7.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

7.1.1 Introduction

Muskox (*Ovibos moschatus*) and caribou are the only abundant ungulate species that live on the tundra year round (Larter and Nagy 2004). Muskox were close to extinction in the late nineteenth and early twentieth centuries due to overhunting (Fournier and Gunn 1998; Campbell and Setterington 2001). A hunting moratorium was enacted by the Canadian Government in 1917, and then lifted in 1969 (Giroux et al. 2012). The Inuit have remarked on the expansion in distribution and numbers of muskox since the 1960s. In the last three decades, muskox numbers have increased and most populations have recovered throughout the historic range (Fournier and Gunn 1998; Campbell and Setterington 2001).

Muskox are large herbivores and a key species in the tundra trophic food chain. Muskox feed on riparian shrubs, in wet meadows, and in winter dig craters to find willows and grasses. Muskox comprise an important food source for wolves and to a lesser degree, grizzly bears (Gunn and Miller 1982; Reynolds, Wilson, and Klein 2002; Wiebe et al. 2009; Mech 2010). Muskox are highly valued by the Inuit as a source of food, hides, horns, and wool, as well as for the commercial export of meat. These ungulates also attract tourists to Nunavut for guided sport hunting and wildlife viewing.

Inuit Traditional Knowledge indicates that muskox are sparely distributed within the Back River Project (the Project) wildlife Regional Study Area (wildlife RSA). Muskox were hunted by the Inuit when caribou and seals were not available. Inuit did not hunt muskox during the summer months as the meat is not as good to eat during this season and the pelts were poor quality. Besides meat, muskox provided bedding, dog mats, and the horns are made into a wide assortment of tools and crafts (KIA 2012, 2014).

7.1.2 Population Trends and Conservation

The population size in 1997 of muskox in Nunavut and the Northwest Territories was estimated as 140,000 animals, about 85% (119,000) of which occurred on the Canadian Arctic islands (Fournier and Gunn 1998). In 2001, muskox numbers in Canada were estimated as having increased to 166,000 animals (Gunn and Adamczewski 2003).

Though population size has been estimated, there has been no large scale assessment of muskox population trends in Nunavut. However, similar to caribou, the population size of muskox likely naturally fluctuates in response to snow depth (i.e., food availability) and predator numbers (Reynolds, Wilson, and Klein 2002). Like caribou, muskox populations periodically have large-scale die-offs, which may be due to starvation following rain-on-snow events that form ice crusts too thick to dig through (Nagy, Gunn, and Wright 2009a). On Banks Island, thousands of muskox died, resulting in a population decline of 50% between 2001 and 2005 (Nagy, Gunn, and Wright 2009b). This has been attributed to starvation following icing (Nagy, Gunn, and Wright 2009a, 2009b); however, the cause of Arctic ungulate die-offs has yet to be unequivocally related to icing (Tyler 2010). An alternative explanation is disease (Larter and Nagy 1999; Kutz et al. 2004).

The Government of Nunavut estimates that there are 13 populations of muskox within Nunavut; these populations have been split into 13 units for managing populations and harvest levels (GN DOE 2015). Muskox that occur within the Project area are referred to as the central Kitikmeot population, which occur

within the MX-11 management unit (GN DOE 2015). Management Unit MX-11 completely encompasses the Project area, as well as area to the west to Kugluktuk and east to the central Queen Maude Gulf.

Surveys were conducted for muskox in the MX-11 management unit in 1986 and 2005 (Dumond 2007). In 1986, the number of muskox between northeast Contwoyto Lake and southwestern Bathurst Inlet was estimated at 3,400 ± 460 animals from counts made during a systematic strip transect survey (Gunn 1990) This 1986 survey area overlapped the northern wildlife RSA along the western shores of Bathurst Inlet south to Bathurst Lake, and in the southern wildlife RSA around the Back River and Beechey Lake. In August 2005, the Government of Nunavut extended the surveyed area to include the region between Coppermine River and Bathurst Inlet (Dumond 2007), which also covered areas in the wildlife RSA between Bathurst Lake and Beechey Lake not surveyed in 1986. During the 2005 survey, 732 adult muskox were observed along transects, which resulted in a population estimate of 2,560 ± 460 animals (Dumond 2007). On both population surveys, muskox were observed at densities much less than 1 animal per kilometre surveyed. Results indicate that between 1986 and 2005, muskox increased in the western extent of the survey area, but decreased significantly in the eastern extent. Thus, although the abundance of muskox in the Kitikmeot region has been increasing over the past three decades (Fournier and Gunn 1998), these survey data and observations from hunters suggest that mainland populations, including that within the area of the wildlife RSA, have been declining (Dumond 2007).

The Department of Environment in Nunavut recommends a total annual harvest (TAH) of 225 individuals from the muskox population in the MX-11 Management Unit (GN DOE 2015). On the West Kitikmeot mainland, Bathurst Inlet harvests of muskox for subsistence or sport hunts are between 20 and 30 animals annually (M. Dumond, GN DOE, personal comm.). Kugluktuk harvests of muskox are between 35 and 50 animals annually. Harvest statistics from Bathurst Inlet and Kugluktuk include muskox hunts near Contwoyto Lake and Pellat Lake, areas which are located approximately 150 to 175 km to the west of the Goose Property Area.

Muskox are presently designated as “Secure” in Nunavut (CESCC 2010). Muskox are sensitive to disturbance during the calving season (late March through May), disturbance to herds that culminates in stampeding behaviour can cause calves to be trampled or abandoned (Gunn 1984). Muskox is managed and protected as a big game species within the *Nunavut Wildlife Act*.

Impacts of climate change will have uncertain effects on muskox. Climatic shifts in winter weather have been known to affect muskox populations in Greenland (e.g., Forchhammer et al. 2002). Climate change in the last four decades appears to have accelerated the development of parasitic lungworms (*Umingmakstrongylus pallikuukensispallikuukensis*) in Arctic muskox populations (Kutz et al. 2005). Additional impacts of climate change are shifting vegetation communities. Some shifts in vegetation communities may be beneficial to muskox, particularly increases in shrubby vegetation which constitutes much of the muskox’s seasonal diet (Section 7.1.3).

7.1.3 Distribution and Migration Patterns

The global range of muskox extend across most Arctic islands, northern Greenland, and most of the Canadian tundra, including the Kitikmeot region of Nunavut (Gunn and Adamczewski 2003). Muskox are found throughout the Kitikmeot region at relatively low densities (Gunn 1990; Dumond 2007). Population surveys conducted in 2005 by Dumond (2007) suggest that muskox occur at low very densities near the Project. Extrapolation from the number of individuals counted (103 individuals, including 101 adults and 2 calves) and the total survey area (13,645 km^2) indicates that muskox occurred at a density of roughly 7 muskox per 1,000 km^2. Inuit Traditional knowledge indicates that muskox are distributed around Contwoyto Lake, Nose Lake, northeast of Nose Lake, and at the south end of Bathurst Lake (KIA 2012, 2014).

These animals have relatively small seasonal home ranges, but sometimes can move relatively long distances, up to 140 km, between summer and winter ranges (Reynolds 1998; Gunn and Fournier 2000). In the winter, muskox home range size varies from 27 to 70 km^2 and in the summer the average home range size is 223 km^2 (Reynolds 1998). Reflecting their small home ranges, muskox are relatively sedentary in winter, moving on average 1 to 1.5 km/day. Muskox move about twice that distance in summer (average of 2.6 km/day), and movement rates are highest when plant biomass is greatest (Reynolds 1998). A high degree of fidelity to geographic areas observed in Nunavut populations may explain the observation that range contraction does not appear to be correlated with large scale population declines. Muskox continue to occupy preferred sites even after population declines (Dumond 2007; Nagy, Gunn, and Wright 2009a). Muskox herds are larger in winter (average of 28 individuals) as compared to the summer (average of 12 individuals; Gunn and Fournier 2000), likely because suitable forage sites are limited by snow depth and as a defensive strategy against wolf predation (Heard 1992).

7.1.4 Habitat Use and Diet

Muskox primarily forage on sedges (*Carex* and *Eriophorum* spp.) and willows (*Salix* spp.) year round. Willows are most nutritious and valuable for muskox in spring when willow leaves are emerging and the plants are easily digested (Gunn and Sutherland 1997a; Larter and Nagy 2004; Kristensen et al. 2011). Thus, muskoxen are usually found in moist areas where sedges and willow are abundant including riparian corridors (Reynolds, Wilson, and Klein 2002). Muskox generally birth calves very early in the year, between late March and late May, before vegetation has greened. Similar to caribou, muskox also show a high degree of selectivity for moist sedge meadow during the calving and post-calving periods; upland shrubs are also selected during this time, when emergent willow leaves are more nutritious than later in the season (Reynolds, Wilson, and Klein 2002). The summer and early fall seasons are critical for muskox, as they must accumulate sufficient fat reserves to survive the winter (Reynolds, Wilson, and Klein 2002). Furthermore, there is evidence that the likelihood of pregnancy and successful parturition are positively related to the fat reserves a female accumulates during the summer and early fall (Adamczewski et al. 1998). In the early spring, muskox need to ingest at least 2.58 kg/day of graminoid and forage material and 2.84 kg/day in the summer in order to maintain body weight (Adamczewski et al. 1998). Lactating cows need to eat approximately 48% more food in the summer months than non-breeding muskox due to the energetic costs of lactation (Adamczewski et al. 1998).

Survival and calf productivity of muskox is highly dependent on forage availability in winter (Reynolds, Wilson, and Klein 2002; Barboza and Reynolds 2004). To conserve energy, muskox are sedentary in winter, and thus, sites chosen for over-wintering must contain adequate forage to support the nutritional requirements of the herd. Forage availability depends on snow depth and hardness (Gunn and Adamczewski 2003; Barboza and Reynolds 2004). Key characteristics of over-wintering sites that improve nutritional status of muskox are sites where sedges and grasses are abundant but where snow depth is low (Heard 1992; Reynolds, Wilson, and Klein 2002; Gustine et al. 2011). Typically these sites are lower elevation riparian corridors with windblown vegetated bluffs (Reynolds, Wilson, and Klein 2002).

The major mortality source for muskox is predation by the grey wolf (Mech 2005). As with all Arctic mammals, disease and extreme weather events (icing) can cause local or regional die-offs (Nagy, Gunn, and Wright 2009a). To a lesser degree, grizzly bears will also prey on muskox in the summer (Heard 1992).

7.1.5 Baseline Data for Muskox

Two types of baseline data are available for muskox. Firstly, aerial surveys were conducted during baseline studies for the Project, and at nearby developments; these studies provide numbers and distribution of muskox in the area surrounding the Project during various times of the year. Secondly, habitat suitability mapping was conducted to evaluate the quality of habitat within and surrounding the Project for muskox throughout the year.

Baseline information for muskox used in this section included the following reports:

- *Back River and Hackett River Projects*: *2010 Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E).
- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012, Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013e, Appendix V5-5C);
- *Back River Project: 2013 Wildlife Habitat Suitability Baseline* (Rescan 2013b, Appendix V5-5A); and
- *Back River Project: 2013 Wildlife Baseline Report* (Rescan 2014, Appendix V5-5F).

Other sources of supplementary wildlife data used for muskox in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association* (KIA 2012)(Appendix V3-3A of DEIS/FEIS);
- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)*(KIA 2014) (Appendix V3-3C of FEIS);
- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007b);
- *2008 Wildlife Baseline Report Hackett River Project* (Rescan 2008);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008); and
- *Bathurst Inlet Port and Road Project: Wildlife Baseline studies, 2001-2002* (Rescan 2007c).

7.1.5.1 Aerial Surveys

Aerial surveys were flown 2001, 2002, 2007, 2008, and 2010 during the spring and/or summer. The surveys in 2001 and 2002 were conducted along the Proposed Bathurst Inlet and Road (BIPR) project corridor and included much of the northern portion of the wildlife RSA for terrestrial wildlife (Figure 7.1-1). Surveys in 2007, 2008 and 2010 followed pre-determined parallel transect lines that were spaced 8 km apart within the wildlife RSA. Total survey length was approximately 1,400 transect km representing about 12.5% of the wildlife RSA. Duration of the surveys was between 14 to 15 hours over two days and there were three observers per survey flight. In 2007, five aerial surveys were conducted in May, June, early July, late July, and September. In 2008, two surveys were conducted in May and June and in 2010, aerial surveys were conducted on May, June, and July. These surveys were done in conjunction with the caribou surveys (Volume 5, Chapter 5). No aerial surveys were carried out after 2010. Incidental observations of muskox were recorded during all baseline studies. Full details on survey methodology can be found in the 2001-2002, 2007, 2008, and 2010 Wildlife Baseline Reports (Rescan 2007b, 2007c; Gartner Lee Ltd. 2008; Rescan 2008; 2011a, Appendix V5-5E).

Observations of muskox were made during nearly all of the aerial surveys. Wildlife biologists conducting the surveys noted that a large group of muskox (> 30 animals) were routinely observed on the low, shelving hills, to the west of Bathurst Inlet. The Inuit have also noted that muskox populations have been increasing since the 1960s and that they are present on western side of Bathurst Inlet, but that they are more common on the east side of Bathurst Inlet in comparison to the west side (KIA 2012, 2014). Most surveys also recorded one to two additional groups of muskox in the survey area, although their location was not consistent between surveys. Most muskox were observed in groups, with few animals observed in associations of less than 4 individuals.

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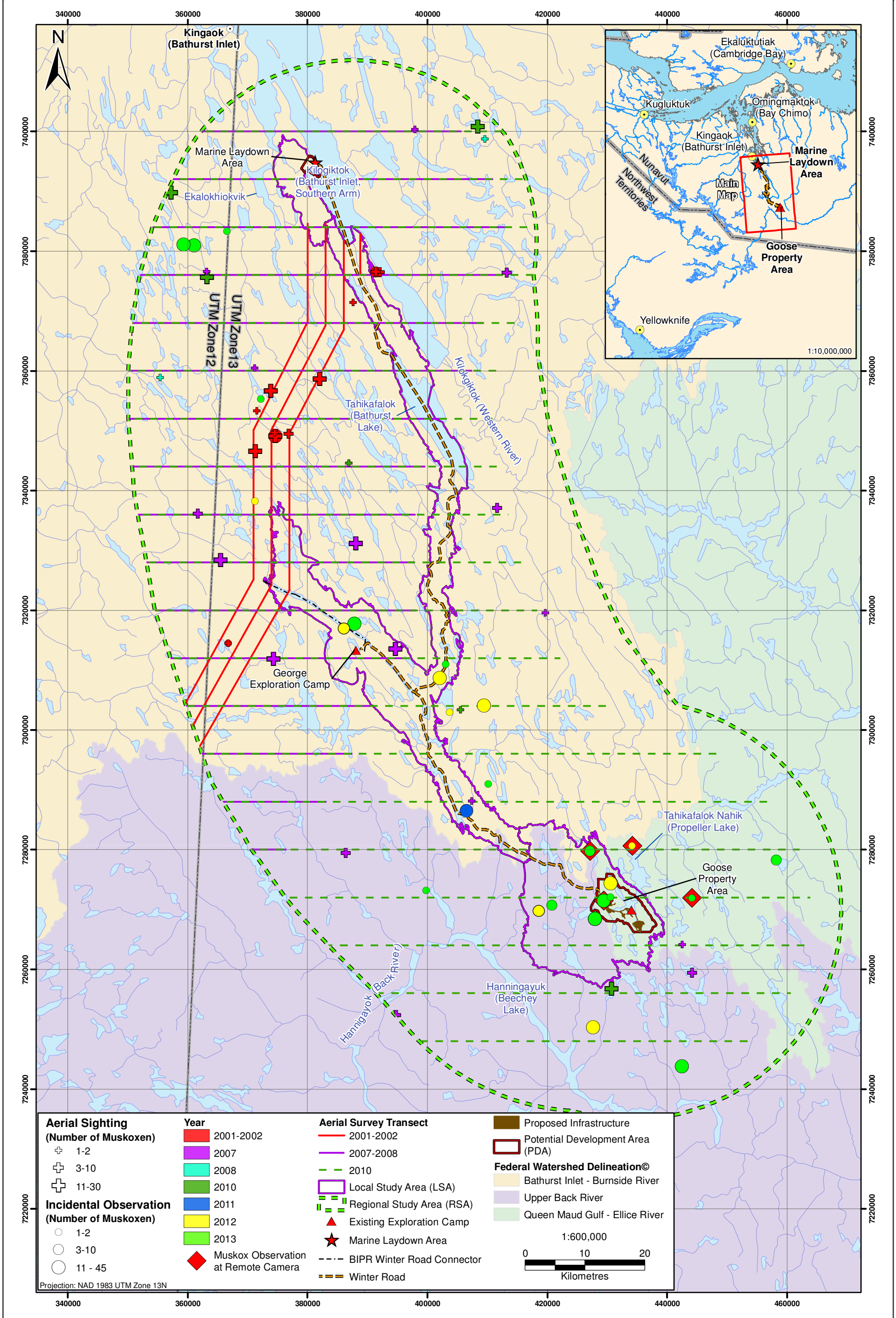

Figure 7.1-1

Muskox Observations in the Regional Study Area, 2001 to 2013

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During the aerial surveys, muskox were recorded throughout the wildlife RSA at relatively low densities during all years surveyed. In relation to Project areas, muskox have been observed near Project infrastructure sites at the Goose Property in 2012. Muskox have also frequently observed along the western shores of Bathurst Inlet within several kilometres of the Marine Laydown Area (MLA; Figure 7.1-1).

Baseline data collection consisted of both aerial surveys and incidental observations. Across surveys in 2001 and 2002, a total of 219 muskox were observed on transect along the BIPR road, with another 56 individuals recorded off transect. Muskox were also recorded during ground surveys; 106 individuals were recorded during the summer of 2001. While average densities within survey areas were low (less than one animal per square kilometre across surveys and years), the highest numbers of animals were detected near the Bathurst Inlet and Contwoyto Lake (Rescan 2007c). A total of 54 muskox were recorded in 2007 with an additional 147 observed off transect (> 500 m; Rescan 2007b; Gartner Lee Ltd. 2008). Of the 98 muskox observed in 2007, 84 were adults and 14 were calves; group size ranged from 1 to 18 individuals. In 2008, two groups of muskox consisting of two adults each, were recorded, one during each scheduled survey (Rescan 2008). In 2010, 87 were observed on transect during the aerial surveys with an additional 34 observed off transect mostly in the Bathurst Inlet area. Of the 87 muskox observed on transect, 82 adults and 5 calves were recorded; group size ranged from 1 to 34 individuals (Rescan 2011a, Appendix V5-5E).

Incidental observations in 2011 to 2013 recorded 3, 114, and 261 muskox, respectively, in the wildlife RSA (Rescan 2012, Appendix V5-5D; 2013e, Appendix V5-5C; 2014, Appendix V5-5F). In 2011, all three muskox were observed in a single group. Ten separate incidental observations of muskox were observed in the wildlife RSA in 2012. Of these, five observations were made of herds with greater than 10 individuals. In 2013, there were 18 separate incidental observations recorded during other wildlife surveys with group sizes ranging from one individual up to forty. Muskox were also incidentally recorded at remote cameras in 2013; groups of 9 to 14 individuals were recorded at two remote cameras located near the Goose Property in the southern wildlife LSA. Calves, although low in number, were recorded in two of the herds observed in 2012 and three of those observed in 2013. The larger number of muskox in 2012 and 2013 potentially represents repeated counts of the same herds as observations were made in relatively the same area within a few days. Across the RSA, there appear to be three areas where larger muskox groups have been observed regularly, which include the southern RSA south of the Goose Property, the central RSA adjacent to the winter road alignments, and the northern RSA on the hills to the west of Bathurst Inlet. In each of these areas groups of 20 to 30 individuals have been recorded in 2012 or 2013.

7.1.5.2 Habitat Suitability Ratings

Overview

Wildlife habitat suitability studies were conducted within the wildlife Local Study Area (wildlife LSA) and wildlife RSA to inventory and rate the habitat types for muskox and quantify suitable habitat available for this species. These data can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Sciety (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA, with Geobase Land Cover data used to infill data gaps from the WKSS data set (Rescan 2013b, Appendix V5-5A). Ecosystems identified in this vegetation map were then rated for

their value for wildlife within a specified season or for a specific use. Muskox habitat suitability was assessed for the summer and fall combined (June 1 to September 30) and the winter and early spring combined (October 1 to May 31).

The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km^2 of the West Kitikmeot / Slave Study Area, which stretches from the Arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001). The GeoBase Land Cover data, circa 2000, was derived from multiple sources including Landsat 5 and 7 imagery from a partnership of provincial, territorial, and federal agencies (GeoBase 2009).

For continuity of habitat suitability results across the Project study areas, the regional ecosystem mapping was used to identify habitat quality for wildlife within both the wildlife LSA and RSA. Additional ecosystem mapping techniques were employed within the wildlife LSA (for more details, see the 2012 Ecosystems and Vegetation Baseline Report; Rescan 2013a, Appendix V5-4A). Full details of the wildlife habitat suitability mapping can be found in Rescan (2013b).

Results

The results of the habitat suitability modelling indicate that high value summer and fall habitat in both the wildlife LSA (18%) and wildlife RSA (13%) is less common than low value habitat, which comprises the majority of the wildlife LSA (55%) and wildlife RSA (56%; Figure 7.1-2; Table 7.1-1). During the winter and early spring months, 4% of the wildlife LSA and 6% of the wildlife RSA was mapped high value habitat (Figure 7.1-3). Low to Moderate habitat make up the majority of both the wildlife LSA and the wildlife RSA during the winter and early spring (Table 7.1-1). Nil rated habitat is considerably higher for both the wildlife LSA and wildlife RSA during the winter and spring season relative to the summer and fall, a result that may be expected given that much of the area in winter and early spring is covered in variable amounts of snow that limits foraging opportunities.

Table 7.1-1. Muskox Seasonal Habitat within the Local Study Area and Regional Study Area

	Amount of Habitat in the LSA		Amount of Habitat in the RSA	
Suitability Rating	**Area (ha)[1]**	**% of LSA[1]**	**Area (ha)[2]**	**% of RSA[1]**
Summer and Fall				
High	23,880	18	168,222	13
Moderate	25,921	19	314,381	25
Low	73,816	55	702,003	56
Nil	10,314	8	72,547	6
Winter and Early Spring				
High	5,120	4	69,629	6
Moderate	34,840	26	340,442	27
Low	37,032	28	330,149	26
Nil	56,939	43	516,932	41

Notes:
For ease of presentation, hectares are presented as whole numbers and percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100%.
[1] wildlife LSA = 134,369.3 ha, wildlife RSA = 1,262,004.6 ha. Approximately 439 ha of the wildlife LSA and 4,852 ha of the wildlife RSA fell in the Unclassified or No Data classes and was not included in modelling, thus the total amount of habitat modelled in the wildlife LSA is 133,930.3 ha and the total amount of habitat modelled in the wildlife RSA is 1,257,152.6 ha.
[2] The wildlife LSA is nested within the wildlife RSA; thus these values include the wildlife LSA.

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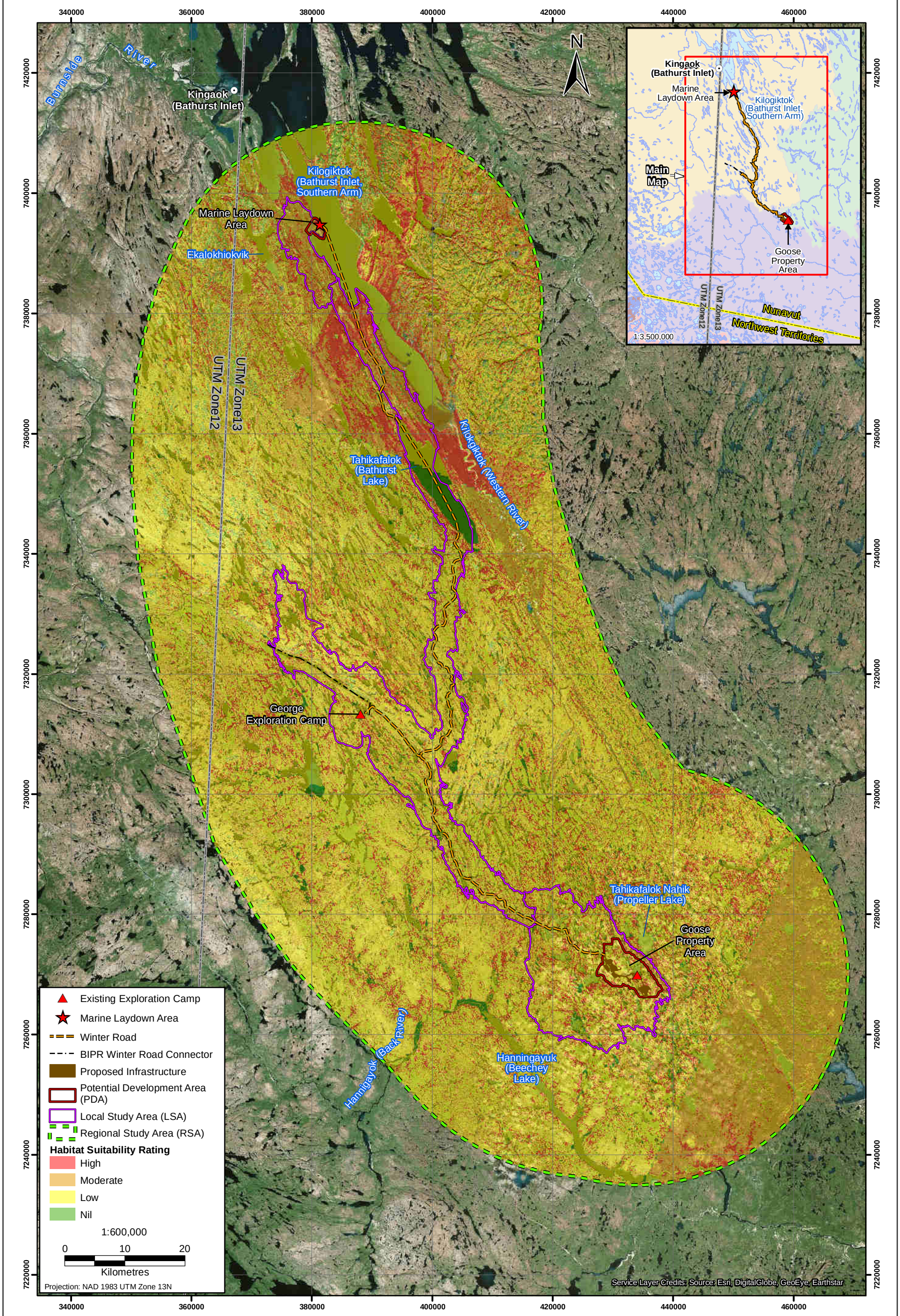

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Muskox: Summer and Fall Habitat in the Local Study Area and Regional Study Area

Figure 7.1-2

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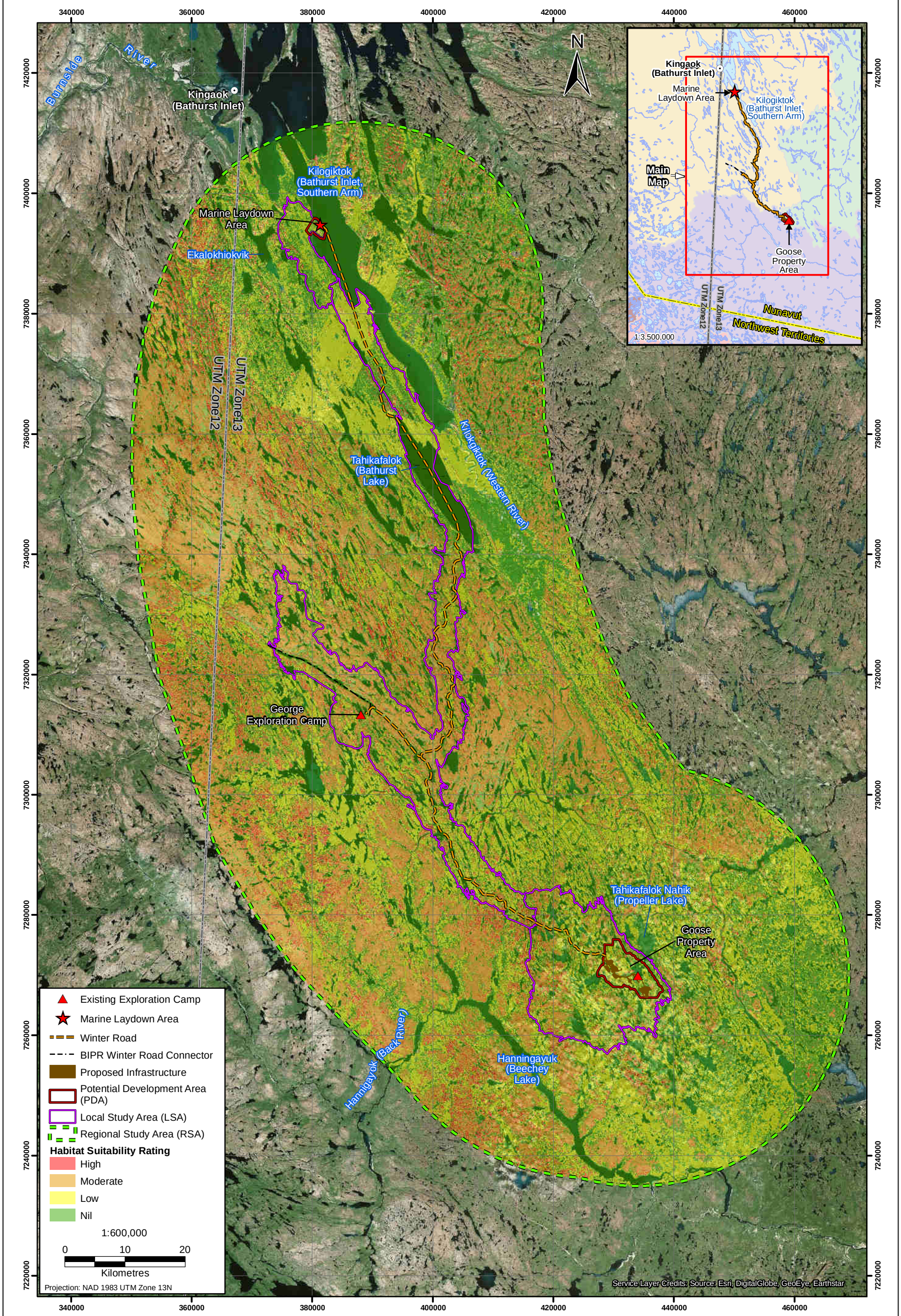

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Muskox: Winter and Early Spring Habitat in the Local Study Area and Regional Study Area

Figure 7.1-3

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During the DEIS review, the Government of Nunavut requested that Sabina confirm the accuracy of the habitat suitability modelling for muskox. The habitat model for muskox was developed using a bottom-up approach by identifying which types of vegetation are preferred by muskox. The modeling used the WKSS ecosystem mapping, which was infilled with Geobase Land Cover data which uses a 30 m cell size. Habitat ratings were based on the forage quality of the vegetation present. Each vegetation type was assigned a habitat value using literature on muskox habitat selection (See the habitat suitability mapping baseline, Rescan 2013b, Appendix V5-5A), with vegetation types providing better forage receiving higher habitat values. During winter, these habitats were identified at higher elevations where dry lichens are available where the wind removes snow. During summer, lowland areas were identified due to their wetland vegetation and willow browse, as described below:

During winter and spring, the following classification of habitat was made:

- High ratings were given to vegetation associations where limited snowpack is likely (e.g., windswept ridges) and areas with a significant amount of early vegetation.
- Moderate ratings assumed that forage opportunities were available, but were not as accessible or available as early in the season as high value vegetation associations.
- Low ratings were given to vegetation associations with limited seasonal forage, or areas where the snowpack likely persists thereby reducing foraging opportunities.
- Nil ratings were given to vegetation associations with sparse vegetation, high disturbance, and those that typically occur in landscape positions where snow packs are deep and persistent.

During summer and fall, the following classification of habitat was made:

- High ratings were given to vegetation associations that contain preferred forage species, mainly willow and sedges – which typically grow in valleys, draws and lowland areas.
- Moderate ratings were assigned to vegetation associations that contain some preferred forage species, but typically have a lower cover of sedges and willow species.
- Low ratings were given to vegetation associations that contained limited forage opportunities.
- Nil ratings were given to vegetation associations that contained sparse vegetation, or where travel was difficult.

The higher rated habitats identified above are consistent with muskox habitat use studies conducted in Arctic (e.g., Schaefer, Stevens, and Messier 1996; Gunn and Sutherland 1997b, 1997a; Nellemann and Reynolds 1997; Reynolds, Wilson, and Klein 2002; Gunn and Adamczewski 2003; Larter and Nagy 2004; Kristensen et al. 2011). Therefore, the assumptions used to develop seasonal habitat models for muskox are deemed valid.

In some cases, aerial observations can be used to validate habitat mapping if the accuracy of the location is appropriate. Position information from aerial surveys was taken from the survey aircraft whereas the actual position of the muskox can be 100-500 m away from the aircraft. The scale of the WKSS vegetation mapping is a 30 X 30 m cell. Hence, the two types of data are not compatible; i.e., the GPS location of the observation is not within the same vegetation cell as the muskox. Therefore, aerial observations could not be used to validate the habitat suitability modeling for muskox.

7.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Traditional Knowledge indicates that muskox were important animals for Inuit; muskox are hunted when preferred food sources (e.g., caribou, seal) are absent, such as in the winter when caribou are below the treeline (KIA 2012). TK also provided information on the distribution and abundance of muskox in the area of the Project. Muskox are distributed around Contwoyto Lake, Nose Lake, northeast of Nose Lake, and at the south end of Bathurst Lake. The Inuit have also noted that the local population has been rebounding from the population crash in the 1800's and that muskox are now common in areas that had been vacant for years (KIA 2012). Information regarding muskox knowledge and the current and traditional use of this species, was provided during a series of Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot study communities. Landusers noted that muskox populations on the mainland and on Victoria island declined in 2012 (due to increased predation) and that hunters travelled farther to hunt muskox (Rescan 2013c). The *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)*(KIA 2014) observes the rebound in their population. The following reports were reviewed for TK specific information related to muskox:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) (Appendix V3-3A of DEIS/FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3C of FEIS);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, effects assessment, and recommendations for mitigation and adaptive management.

7.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed. Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high-quality habitat, wherever applicable.

7.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this process, muskox was identified as a VEC for the DEIS and FEIS.

7.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modeling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

7.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

7.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components VSECs that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes, which thereby reduces potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall, and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds and seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

7.3 VALUED COMPONENTS

7.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

- species at risk or of conservation concern (i.e., species listed by COSEWIC or under SARA, or by CESCC or under the NWA);
- species or focal groups requiring enhanced consideration under the mandates of regulatory agencies, such as caribou and carnivores (Nunavut Department of the Environment [NU DOE]), and migratory birds (Canadian Wildlife Service [CWS]);
- species identified as having a strong biological importance in the ecosystem in the Project study area, including importance as keystone, indicator, and umbrella species; and
- species identified as being culturally, socially and economically important to the Inuit and other community members through TK.

7.3.2 Valued Components included in Assessment

Muskox were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012),

consultation with regulatory agencies, and regulatory considerations, muskox were selected as a VEC for the effects assessment.

Muskox are an important food source for the Inuit when caribou or seals are scarce, particularly during the summer and fall (KIA 2012). Muskox are also an important prey species for grizzly bears and wolves. Muskox are particularly sensitive to disturbance during the late winter/calving season (April 1 to June 15; Gunn 1984).

7.4 SPATIAL AND TEMPORAL BOUNDARIES

7.4.1 Spatial Boundaries

The muskox effects assessment considered two study areas for wildlife inventory for the Project: a local study area (LSA) and a regional study area (RSA; Figure 7.4-1).

7.4.1.1 Local Study Area

The boundaries of the LSA for muskox were set to encompass the following:

- the Goose Property Potential Development Areas (PDAs), which contains all proposed Project infrastructure for the Goose Property Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose Property and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The wildlife LSA covers an area of approximately 134,369 ha (1,344 km^2; Figure 7.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

7.4.1.2 Regional Study Area

The wildlife RSA for muskox encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two Project areas (Goose Property Area and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (12,620 km^2; Figure 7.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

7.4.2 Temporal Boundaries

The temporal boundaries used for the muskox effects assessment follow the time periods of the phases of the Project as presented in Table 7.4-1.

Table 7.4-1. Temporal Boundaries — Project Phase Durations

Phase	Duration
Construction (Including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post-closure Monitoring	5 years
Other Potential Phases	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years
Exploration	included in Construction and Operational phases

7.5 PROJECT-RELATED EFFECTS ASSESSMENT

7.5.1 Methodology Overview

The effect assessment process comprises a stepwise method to assess the potential effects of the Project on muskox as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and muskox.
2. Characterization of the potential effects that could result from these interactions.
3. Identification and description of mitigation or management measures that could be taken to eliminate or reduce the potential effects.
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied.
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on muskox including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on muskox are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

7.5.1.1 Indicators Used to Characterize Potential Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 7.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of potential residual effects. For other potential effects, indicator values were qualitative in nature in the form of ‘yes’ or ‘no’ where triggering of residual effects assessment occurred if the indicator value was ‘yes’.

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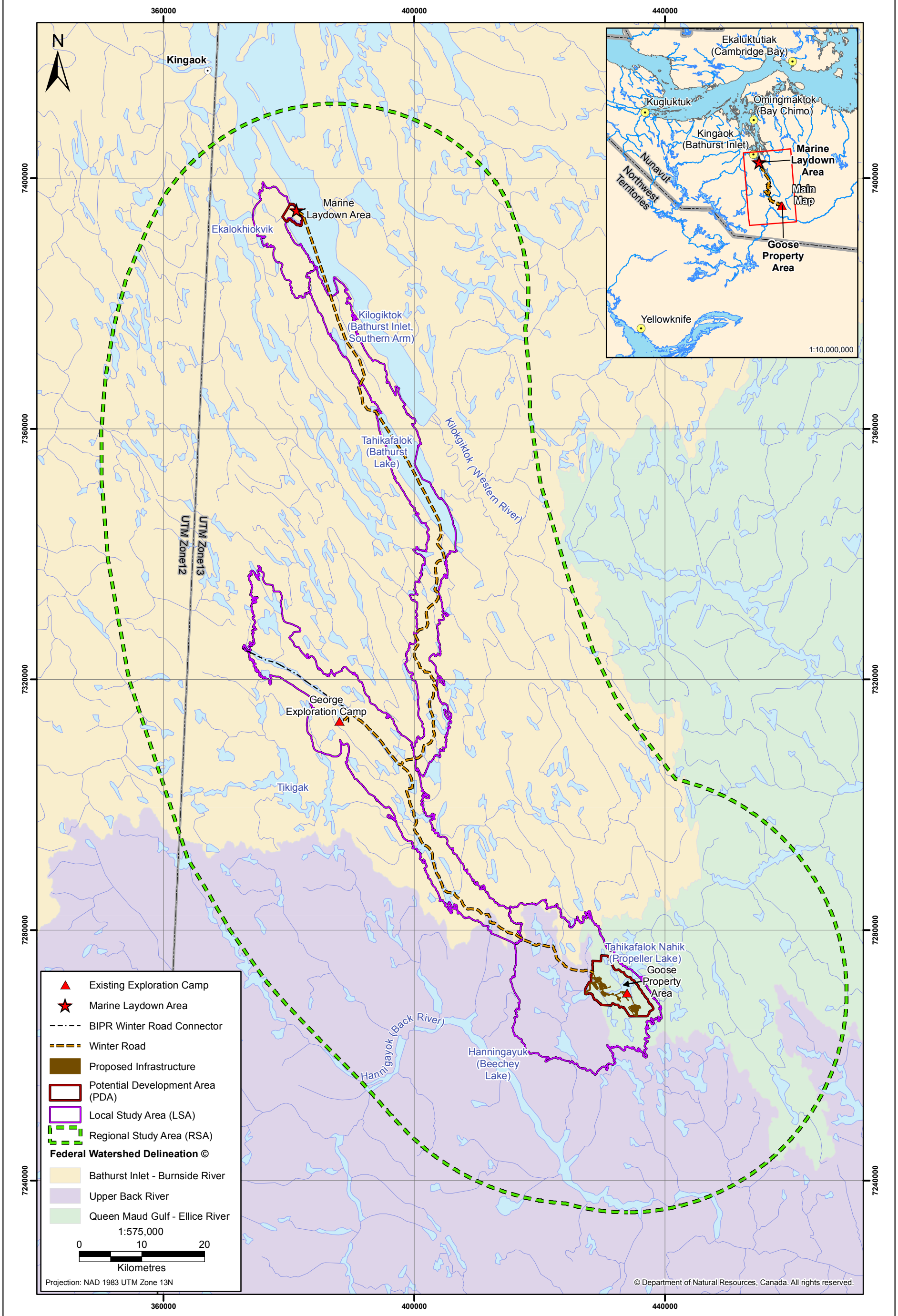

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Local Study Area and Regional Study Area for Muskox

Figure 7.4-1

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Table 7.5-1. Criteria and Indicators Used to Characterize Potential Effects on Muskox

Potential Effect	Criteria	Indicator
Habitat Loss	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disturbance due to Noise	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disruption to Movement	Change in Population Health	Traffic timing, and traffic volume
Direct Mortality and Injury	Change in Population Health	Traffic timing, and traffic volume, and vehicle speed
Indirect Mortality	Change in Population Health	Predicted increase in human access to wildlife RSA
Attraction	Change in Population Health	Evidence collected at similar Projects in Nunavut and Northwest Territories
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on muskox

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

7.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 7.5-2).

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

Table 7.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was >20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgment and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

7.5.1.3 Overall Significance Ratings for Residual Effects

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 7.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria. Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 7.5-3). For example, a residual effect receives a rating of 'not significant' typically if it is expected to be one of the following: negligible or low magnitude, confined to wildlife LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

7.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VEC muskox and the Project is provided in Volume 9, Chapter 1. Potential effects on muskox and muskox habitat from the Project have been included based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories, and a review of scientific literature of the effects of developments on muskox. The effects of mining developments in the Arctic have been documented through monitoring programs at the Lupin gold Mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011b, 2013f).

Table 7.5-3. Definitions of Significance Ratings for Residual Effects on Muskox

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Potential effects on muskox from the Project have been scoped based on NIRB guidelines. Interactions of muskox with Project components were evaluated to determine which of the following potential effects may occur (Table 7.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction to infrastructure;
- exposure to contaminants; and
- reduction in reproductive productivity due to combined effects of the Project.

Muskox can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of high-quality foraging habitat. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development. For these reasons, habitat loss was included and evaluated in this assessment.

Disturbances, including visual and auditory stimuli, can cause muskox to alter their regular behaviour patterns, resulting in lost feeding time, stress, reduced reproductive potential, or avoidance of disturbed areas (McLaren and Green 1985). For example, muskox herds often run from people on foot, snowmobiles or other vehicles (Gray 1973; Russell 1975). Very young calves can be left behind when muskox herds run from a disturbance (Gunn and Adamczewski 2003). For these reasons, potential effects of disturbance on muskox were included in this assessment.

Muskox are resident on the tundra and occupy small seasonal home ranges in comparison to other ungulates (e.g., caribou). Muskox can undergo movements up to 140 km between seasonal ranges used for calving and wintering, and areas used during the summer and fall rut (Reynolds 1998; Gunn and Fournier 2000). When dispersing, males may move short distances from the herd it was associated with (~38 km), or they may make a longer distance movement (~101 km; Smith 1989). The Goose Property, the MLA, and the winter roads may disrupt movement of muskox by bisecting home ranges or impeding dispersal. Linear developments such as roads have been shown to fragment wildlife habitat across many taxa (Jalkotzy, Ross, and Nasserden 1997). For this reason, potential effects of disruption of movement on muskox were included in this assessment.

Table 7.5-4. Potential Project-related Effects in Muskox in the Goose Property Area and the Marine Laydown Area

Potential Development Area Project Component	Habitat Loss	Disturbance due to Noise	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity
Goose Property Area								
Open Pits (Main (Goose, Umwelt, Echo, and Llama)	X	X						X
Haul and access roads	X	X	X	X	X			X
Winter Roads	X	X	X	X	X	X		X
Stockpiles	X	X						X
Waste rock storage areas	X	X					X	X
Explosives storage areas	X						X	X
Tailings Impoundment Area	X	X					X	X
Quarries	X	X						X
Landfill	X	X						X
Camp / Plant site	X	X					X	X
Airstrip	X	X	X	X				X
Other infrastructure (diversion channels, water intakes)	X							X
Marine Laydown Area								
Camp	X	X					X	X
Lightering Barge location	X	X					X	X
Haul and access roads	X	X	X	X	X			X
Winter Roads	X	X	X	X	X	X		X
Other infrastructure (interception ditch)	X							X

Direct mortality and injury can result from vehicle strikes with wildlife. Frequency of mortality and injury is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to muskox also increases. As muskox are year-round residents on the tundra and the Project will have all-weather site roads as well as winter road connecting the PDAs, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed Project roads. Roads increase access and can create opportunities for illegal hunting (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Project infrastructure such as winter road alignments may act as attractants to muskox for ease of travel during the winter, which could subsequently lead to increased vehicle-muskox interactions and muskox mortality. Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants due to the Project through ingestion of water or through the food chain. For this reason, exposure to contaminants was included as a potential effect in the assessment, and was evaluated through a formal risk assessment conducted as part of the Human Health and Environmental Risk Assessment (Volume 8, Chapter 6).

Some of the environmental effects discussed above have the potential to affect the reproductive potential of muskox, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for muskox (i.e., calving in April and May, and rutting in the fall). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/ activity in Table 7.5-4.

7.5.2.1 Habitat Loss

As part of the development of the Project, wildlife habitat will be lost wherever infrastructure is built or land cleared for mining operations and potentially degraded in adjacent areas. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 7.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operational phases of the Project. Habitat degradation due to dust around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987a). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project.

The assessment of habitat loss focuses on the total amounts of lost habitat at the end of the Operational phase, which is the largest extent of the Project footprint. To facilitate the analysis of habitat loss for muskox, the entire area of each PDA (Goose Property Area and MLA) is assumed to be lost. This analysis overestimates the true amount of habitat loss due to Project development, because only approximately 10% of the PDAs will be developed. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The winter roads were also considered for habitat loss for muskox during the winter, as this species is present in the wildlife RSA year round. The PDA for winter roads includes a 200 m corridor along each alignment (Volume 2). The operation of winter roads could also result in compaction of vegetation due to compressed snow and ice and could result in habitat degradation during the foraging season. However, compaction is anticipated to be relatively minor and is not assessed further.

Calculation of Habitat Loss for Muskox

Habitat loss for muskox was calculated by first identifying two key indicators:

1. Total area: a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs); and
2. High-quality habitat: a calculation of the area of high-quality habitat for muskox that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the wildlife RSA. To put the Project within the context of muskox habitat use, these indicators were also compared to the average home range size of a muskox. Key indicators were also compared to the area of muskox management units (MU MX-11) that encompasses the Project area to provide context relative to muskox population management in Nunavut following a request by the Government of Nunavut during the DEIS review.

Total Area of Loss

The total expected area lost by the PDAs was calculated by summing the areas of loss within each of the PDAs (Goose Property, MLA, and Winter Road).

The total area of loss is assessed as the net change, in hectares, and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to place the estimate of total habitat loss into a spatial context for the local muskox population, the area lost is presented as a proportion of an average muskox individual/herd's summer and winter home range that is lost due to Project-related activities. In addition, the area lost is presented in relation to the proportion of individuals that may be affected, assuming a density of 7 animals/1,000 km^2 (Dumond 2007).

The amount of habitat loss that occurs within MU MX-11 was also calculated, to provide context for habitat loss within managed populations of muskox.

Area of High-quality Habitat Loss

Habitat loss was further evaluated in the context of the alteration of the high-quality habitat within the PDAs compared to the availability of high-quality habitat in the wildlife LSA and RSA. High-quality habitat is defined as habitat receiving a moderate or high habitat suitability rating (Rescan 2013b,

Appendix V5-5A); the availability of high-quality habitat is summarized by season (summer and fall; winter and early spring) and by all seasons combined.

Similar to the total amount of habitat altered, the amount of high-quality habitat altered is presented as 1) the proportion of an average seasonal home range that is lost due to Project-related activities, and, 2) the number of individuals that may be affected by the loss, assuming a density of 7 animals/1,000 km^2 (Dumond 2007), and 3) assumed high-quality habitat loss within MU MX-11.

Evaluation of Habitat Loss for Muskox

Total Area of Loss

The total area considered as habitat loss within the Goose Property and MLA PDAs is 6,080 ha; this area represents the largest anticipated area of habitat loss for muskox during the snow free periods. During the winter, additional habitat loss will take place within the Winter Road PDA, which is approximately 3,397 ha. Thus, the total habitat loss during the winter for muskox is evaluated at 9,477 ha.

The PDAs account for 7.0% of the wildlife LSA and 0.8% of the wildlife RSA (Table 7.5-5). However, the actual loss of habitat in the wildlife LSA and RSA will be much smaller as the design of the Project footprint is much smaller (10% or less of the PDAs) than the PDAs assessed as lost or 600 to 950 ha.

Table 7.5-5. Habitat Loss within the Project Potential Development Areas (PDAs)

Potential Development Area (PDA)	Area Lost (ha)	Proportion of Wildlife LSA (%)[1]	Proportion of Wildlife RSA (%)[1]
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.4	0.1
Winter Roads[2]	3,397	2.5	0.3
Total	**9,477**	**7.0**	**0.8**
Total without Winter Roads	**6,080**	**4.5**	**0.5**

[1] Wildlife LSA = 134,369 ha, wildlife RSA = 1,262,005 ha

[2] Represents area of habitat loss during the winter only period only; habitat degradation due to compaction during the snow free period is expected to be minor is not assessed further.

The average size of the core winter and summer home ranges for female muskox in Alaska are 7,000 and 22,300 ha, respectively (Reynolds 1998). The size of muskox ranges in Nunavut is not well known but are likely larger based on the research on several collared females in the areas west of Kugluktuk from 1988 to 1991 (Gunn and Fournier 2000). Multiple females were located across an area of over 3,000 km^2 during the winter; in the summer, the same individuals dispersed to coastal areas in the summer and were found across a total area of over 15,000 km^2 (Gunn and Fournier 2000). For the most part, winter and summer home ranges overlap (Gunn and Fournier 2000).

The total expected habitat loss is equivalent to a quarter (27%) of the home range of a female/herd during the summer (based on 6,080 ha of habitat lost) and roughly one and a half winter home ranges of a muskox female/herd (based on 9,477 ha of habitat lost). Given the spatial distribution of the PDAs and connecting winter roads, in that each is relatively segregated from one another, it is unlikely that the total habitat altered will take place within one home range of a muskox female/herd. There are likely several herds that are resident in areas surrounding the Project, such as the ones that have consistently been observed around Bathurst Inlet and south of the Goose Property during baseline studies (Section 7.1.5.1). Therefore, habitat alteration due to the Project will likely take place within portions of multiple home ranges, and the total habitat alteration within one muskox female/herd's

home range will be much less than calculated above. Given that approximately 10% of the PDAs will be developed, this area would represent 2.7% to 15% of a muskox home range.

The most recent population surveys (2005) conducted by Dumond (2007) suggest that muskox occur at low very densities near the Project (7 muskox/1,000 km^2; Section 7.1.4). Assuming the density of animals is similar within the wildlife RSA (12,620 km^2), approximately 95 muskox may be present in the wildlife RSA and the total habitat loss (9,477 ha; 94.8 km^2) will likely affect less than one muskox that inhabits the wildlife RSA. Alternatively, based on the population estimate of 95 muskox within the wildlife RSA, approximately 100 ha of habitat per muskox may be altered; this alteration represents 1.4% of a winter home range and 0.4% of a summer home range of a muskox female/herd.

The total expected habitat loss in relation to MU MX-11 that encompasses the RSA is relatively minimal. The area of MX-11 is 21,151,867 ha. The total area of habitat loss due to the Project PDAs that falls within MU MX-11 is the same as described above, which totals 6,080 ha without the Winter Road PDA, and 9,477 ha including Winter Road PDA. Overall, the total area of habitat loss is anticipated to be 0.03% during both the snow free period and 0.05% during the winter when winter roads will be operational (0.003-0.005% assuming the footprint of the Project to be 10% of the PDA areas). It should be noted that all habitat within the Winter Road PDA will only be temporarily removed from MU MX-11 while the winter roads are operational (January to April) and no permanent habitat loss due to winter roads is expected. Therefore, habitat loss for managed populations of muskox will be negligible.

Loss of High-quality Habitat

Summer and Fall: A total of 49,801 ha of high-quality summer and fall habitat for muskox was identified within the wildlife LSA (37% of LSA; Tables 7.1-1 and 7.5-5). Roughly 482,602 ha of high-quality summer and fall habitat was mapped within the wildlife RSA (38% of wildlife RSA). Project development within the Goose Property and MLA PDAs will result in the direct loss of 2,291 ha of high-quality summer and fall habitat for muskox within the wildlife LSA; an additional 11 ha of habitat loss due to the Goose Property and MLA PDAs occurs outside the wildlife LSA, but within the wildlife RSA. Cumulatively, this habitat loss equates to 4.6% of the habitat available within the wildlife LSA and 0.5% of that available in the wildlife RSA (Table 7.5-6). Comparatively, the total of amount of high-quality habitat altered relative to the wildlife RSA is roughly equivalent than the total amount of habitat altered relative to the wildlife RSA (0.5%, see above).

Winter and Early Spring: Habitat suitability ratings for muskox identified 39,959 ha of high-quality winter and early spring habitat in the wildlife LSA (30% of wildlife LSA) and 410,072 ha within the wildlife RSA (33% of wildlife RSA; Tables 7.1-1 and 7.5-6). Project development (Goose Property, MLA, and Winter Road PDAs) will result in the direct loss of 1,342 ha of high-quality habitat within the wildlife LSA; an additional 9 ha of high-quality habitat loss will take place outside the wildlife LSA, but within the wildlife RSA. Cumulatively, this habitat loss is roughly 3% of habitat of equivalent value available in the wildlife LSA, and roughly 0.3% of that available in the wildlife RSA. Comparatively, the total of amount of high-quality winter and early spring habitat altered relative to the wildlife RSA is just slightly less than the total amount of habitat altered relative to the wildlife RSA (0.5%, see above).

The overall alteration of 2,302 ha of high-quality summer and fall habitat is equivalent to 10% of the summer home range of a muskox female/herd. However, the loss will likely affect less than one individual, assuming the density of animals within the wildlife RSA is roughly 7 muskox per 1,000 km^2. Based on the population estimate of 95 muskox within the wildlife RSA, approximately 24 ha of high-quality summer and fall habitat per muskox may be altered; this alteration represents 0.1% of a summer home range of a muskox female/herd.

Table 7.5-6. High-quality Muskox Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project

Area/Season	High-quality Habitat (HQH)		High-quality Habitat Lost or Altered due to Project Footprint[1]		
	Area (ha)	% Total Area	Potential Development Area without Winter Roads (ha)	Potential Development Area including Winter Roads (ha)[2]	% HQH[3]
Local Study Area[4]					
Summer and Fall	49,801	37.1	2,291	-	4.6
Winter and Early Spring	39,959	29.7	880	1,342	2.2 - 3.4
All Seasons	**84,641**	**63.0**	**3,103**	**4,381**	**3.7 - 5.2**
Regional Study Area[4]					
Summer and Fall	482,602	38.2	2,302	-	0.5
Winter and Early Spring	410,072	32.5	882	1,351	0.2 - 0.3
All Seasons	**823,045**	**65.2**	**3,115**	**4,433**	**0.4 - 0.5**

[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.
[2] The inclusion of habitat loss due to winter roads accounts for winter roads that occur within the wildlife LSA or RSA, and is calculated for the Winter and Early Spring season when habitat loss will occur, and across all seasonal habitat (All Seasons) as a conservative estimate of habitat alteration
[3] Range in percent is due to the exclusion and inclusion of the Winter Road PDA.
[4] A small amount of the MLA PDA extends outside of the wildlife LSA, as well as portions of the Winter Road PDA. Therefore, the amount of high-quality habitat altered within a season will be slightly different within the wildlife LSA as compared to the wildlife RSA.

The overall alteration of 1,351 ha of high-quality winter and early spring habitat is equivalent to 19% of the winter home range of a muskox female/herd. However, the loss will likely affect less than one individual, assuming the density of animals within the wildlife RSA is roughly 7 muskox per 1,000 km^2. Based on the population estimate of 95 muskox within the wildlife RSA, approximately 14 ha of high-quality winter and early spring habitat per muskox may be altered; this alteration represents 0.2% of a winter home range of a muskox female/herd.

To evaluate the loss of high-quality habitat in relation to MU MX-11, the proportion of high-quality habitat in the MU was assumed to be the same as that within the wildlife RSA for the summer and fall season (38%) and winter and early spring season (33%), as defined by habitat suitability modelling (Section 7.1.5.2). The Winter Road PDA was only included in the loss of high-quality habitat during the winter and early spring season, as winter roads will only be operational during the winter.

Summer and Fall: The amount of high-quality summer and fall habitat lost as a result of the development of the PDAs that fall within MU MX11 is the same as that within the RSA (2,302 ha). The total amount of high-quality summer and fall habitat in the MU MX-11 is assumed to be 8,080,013 ha, of which 0.03% will be lost.

Winter and Early Spring: The amount of high-quality winter and early spring habitat lost as a result of the development of the PDAs that fall within MU MX11 is the same as that within the RSA (1,351 ha). The total amount of high-quality winter and early spring habitat in MU MX-11 is assumed to be 6,874,356 ha, respectively. Overall, 0.02% of high-quality habitat will be lost within MU MX-11.

Summary of Habitat Loss

Habitat loss due to the Project was measured for total area and area of high-quality habitat; the assessment indicated that varying amounts of habitat may be affected. Conservative estimates of habitat loss are predicted to be 0.8% of the total habitat and 0.3% of the high-quality habitat present in the wildlife RSA will be lost due to the PDAs. The overall alteration of 9,477 ha due to Project development and activities represents larger proportions of the seasonal home ranges for a muskox female/herd, which include roughly one-quarter of a summer home range and over one winter home range. The loss and alteration of high-quality habitat within seasonal home ranges of a muskox female/herd represents less than a quarter of these home ranges (both summer and winter home ranges). As mentioned above, habitat alteration due to the Project will likely take place within portions of multiple home ranges of muskox herds that are resident in areas surrounding the Project, and the total habitat alteration within one muskox female/herd's home range will be much less than calculated above for total area and area of high-quality habitat. Given the low numbers of animals observed in the wildlife RSA (Section 7.1.5.1) and the low density observed on recent, regional surveys near the Project, the loss is likely to affect low numbers of individuals (~1 individual). Furthermore, the overall alteration in the context of the proportion of habitat altered per muskox within the wildlife RSA represents very small portions of the total summer and winter home ranges of a muskox. Alteration of habitat within muskox MU MX-11, both in terms of total habitat and high-quality habitat altered, is minimal (< 0.1%), indicating that the amount of habitat lost as a result of Project development should not affect the muskox population residing within this MU.

The loss of habitat for muskox within the wildlife RSA is unavoidable and some of it will be permanent. Despite mitigation to design the mine footprint to be as small as possible, a minimal (<1%), but measurable amount of habitat is expected to be lost, resulting in a residual effect, which is evaluated in Section 7.5.4.1.

7.5.2.2 Disturbance due to Noise

This section evaluates the effects of Project-related disturbance on muskox, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise. Noise affects wildlife species in three primary ways: acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). The source, duration, and intensity of noise all influence the nature and magnitude of wildlife response. First, an acute effect of noise — brief, intense, localized noise (such as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997; AMEC Americas Limited 2005), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid the source of disturbance sources resulting in the functional loss of that habitat (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). Mild habitat loss due to noise disturbance can reduce the amount of energy that an animal can intake and result in low level effects. Alternatively, larger scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level".

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to noise disturbances than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat. Potential sources of sensory disturbance for muskox associated with Project activities include:

- blasting noise and ground vibrations from mining and construction;
- general Project noise (e.g., camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the open pits while continuous Project noise includes rock crushing and stockpiling of materials for the TSF bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during all project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required during Post Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15).

Sensitive periods for muskox occur during late winter/calving (April 1 to June 15) and rutting/autumn (August 15 to September 15) when animals are calving and developing fat reserves necessary for reproduction and survival. Late winter/calving is potentially one of the most sensitive period for muskox because animals are in their poorest condition at the end of winter and females have high energetic demands during calving.

Calculation of Area of Disturbance due to Noise for Muskox

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose Property rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise, and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence.

The potential effects of disturbance on muskox were evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum

of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case; this coincides with Year Three of Operations phase at the Goose Property. The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature where muskox or other wildlife are shown to have behavioural effects from noise.

Threshold noise values were determined from the literature, above which ungulates are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for muskox. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 7.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling: Section 7.1.5).

Three types of noise were considered during the Construction and Operational phases: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in L_{peak}, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

L_{peak} noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB L_{peak}), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB L_{peak}). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (L_{peak}) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (L_{peak}) or higher for instantaneous noise effects on muskox during Construction and Operational phases. Blasting noise models were conducted during peak noise levels for Goose Property, which is Year 3 of Operations.

General Project-related, or equivalent noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The threshold for general Project noise was 45 dBA. This noise level value was selected based upon the criteria outlined in the Environment Code of Practice for Metal Mines (Environment Canada 2010), which recommends that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas. Specifically, the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night (Environment Canada 2010). Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in muskox habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter

2001). For the Goose Property, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013d).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) muskox seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 7.5.2.1), but within the noise level contours for blasting noise (≥ 120 dB representing functionally lost habitat; or ≥ 108 dB representing disturbed habitat), general Project noise (≥ 45 dBA) or noise generated from aircraft (≥ 80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each season within the wildlife RSA and LSA after accounting for habitat loss (Section 7.5.2.1).

The amount of habitat that may be functionally lost or altered due to noise within muskox MU MX-11, both in the context of total area and area of high-quality habitat, was also evaluated.

Evaluation of Disturbance due to Noise for Muskox

After mitigation, the potential effects of disturbance due to noise from blasing activites, general Project noise and aircraft noise is described below for muskox.

Blasting Noise

A total of 9 ha that falls outside the Goose Property PDA is predicted to be functionally lost from the noise modeling above an L_{peak} of 120 dB, and 316 ha is modeled with an L_{peak} above 108 dB outside of the Goose Property PDA. No blasting noise above 120 dB L_{peak} overlaps with the Winter Road PDA, but a small portion of habitat (23 ha) occurs where the modeled contour for 108dB L_{peak} overlaps the Winter Road PDA. Thus, during the winter, a total of 293 ha outside of the Goose and Winter Road PDA is modeled above an L_{peak} of 108 dB. All blasting noise above 120 dB L_{peak} is completely contained within the 108 db L_{peak} contour; therefore, only 307 ha outside of the area modeled as functionally lost (≥120 dB L_{peak}) will be disturbed by blasting noise above 108 db L_{peak} during the snow free period, which will be reduced to 284 ha when winter roads are operational. Blasting noise, considered independently (i.e., habitat functionally lost due to blasting above 120 dB L_{peak} and additional area outside of 120 dB L_{peak} disturbed by blasting noise above 108 dB L_{peak}) and cumulatively (i.e., all habitat disturbed by blasting noise above 108 db L_{peak} which includes 120 dB L_{peak}), accounts for less than 1% of the wildlife LSA and less than 0.1% of the wildlife RSA in both the snow-free period and when winter roads are operational (Table 7.5-7).

The amount of high-quality seasonal habitat that is within the area that is modeled as functionally lost from noise (≥ 120 dB L_{peak}) outside of the Goose PDA ranges from 2 ha in the summer and fall season to less than a hectare during the winter and early spring, while that which will be disturbed (≥ 108 dB L_{peak}) outside of the Goose PDA ranges from 97 ha in the summer and fall season to 55 ha in the winter and early spring (Table 7.5-8). Approximately 1 ha of high-quality winter and early spring habitat within the modeled area of 108 db L_{peak} overlaps the Winter Road PDA, and thus 54 ha of high-quality habitat may be disturbed by blasting above 108 db L_{peak} when winter roads are operational. In all cases, the amount of high-quality seasonal habitat that is modeled as functionally lost or disturbed due to blasting outside of the Goose PDA, and outside of the Goose PDA and Winter Road PDA when winter roads are operational, represents less than 1% of the high-quality habitat available within wildlife LSA and less than 0.1% of that within the wildlife RSA (Table 7.5-8), both when considering blasting noise independently and cumulatively. The total amount of high-quality habitat that is functionally lost or disturbed due to blasting is mapped in Figure 7.5-1 for all seasons combined.

Table 7.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise

	Area Considered Lost to PDAs			Additional Area Functionally Lost due to Blasting (120 dBA)			Additional Area Disturbed due to Blasting (108 dBA)			Additional Area Disturbed due to General Project Noise (45 dBA)			Additional Area Disturbed due to Aircraft Noise (80 dBA)		
Project Area	**Area (ha)**	**% LSA**	**% RSA**	**Area (ha)**	**% LSA**	**% RSA**	**Area (ha)**	**% LSA**	**% RSA**	**Area (ha)**	**% LSA**	**% RSA**	**Area (ha)**	**% LSA[1]**	**% RSA**
Goose Property Area	5,427	4.0	0.4	9	<0.1	<0.1	316[a]	0.2	<0.1	1,212[b]	0.9	<0.1	1,824	1.3	0.1
Marine Laydown Area	653	0.5	0.1	-	-	-	-	-	-	-	-	-	12,367[c]	9.2	1
Total	**6,080**	**4.5**	**0.5**	**9**	**<0.1**	**<0.1**	**316[a]**	**0.2**	**<0.1**	1,212[b]	**0.9**	**<0.1**	**14,191[d]**	**10.5**	**1.1**

[1] Some of the area of disturbance due to noise falls outside of the wildlife LSA but within the wildlife RSA (see Figure 7.5-1).

[a] A total of 23 ha of habitat modeled as disturbed by blasting noise at 108 dB overlaps the Winter Road PDA exiting the Goose Property Area; therefore, only 293 ha of habitat (0.2% of LSA, < 0.1% of RSA) is modeled as disturbed by blasting noise at 108 dB during the winter when winter roads are operational.

[b] A total of 134 ha of habitat modeled as disturbed by general project noise at 45 dBA overlaps the Winter Road PDA exiting the Goose Property Area; therefore, only 1,078 ha of habitat (0.8% of LSA, < 0.1% of RSA) is modeled as disturbed by general project noise during the winter while winter roads are operational.

[c] A total of 107 ha of habitat modeled as disturbed by aircraft noise at the MLA overlaps the Winter Road PDA in Bathurst Inlet; therefore, only 12,260 ha of habitat (9.1% of LSA, 1% of RSA) is modeled as disturbed by aircraft noise during the winter while winter roads are operational.

[d] Accounting for the overlap between aircraft noise and the Winter Road PDA, roughly 14,084 ha (10.5% of LSA, 1.1% of RSA) will be disturbed by aircraft noise during the winter when winter roads are operational

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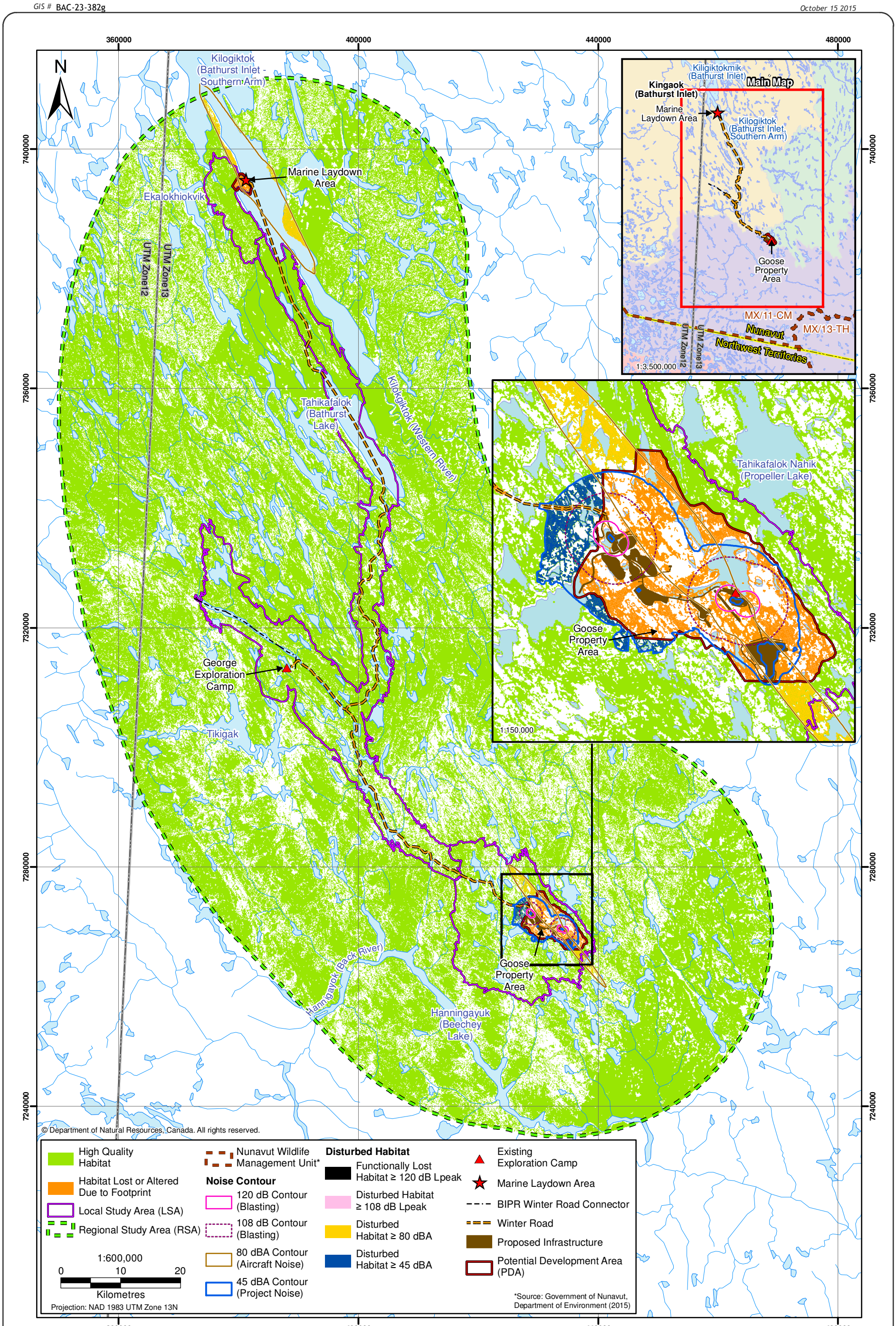
October 15 2015



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Muskox High Quality Habitat Lost, Altered or Disturbed due to the Project

Figure 7.5-1

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Table 7.5-8. Expected High-quality Habitat Functionally Lost or Disturbed due to Noise outside of the Project Potential Development Areas

Area/Season	High-Quality Habitat (HQH) Available Area (ha)	HQH Lost or Altered due to the Project Footprint			Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project Noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
		PDA without Winter Roads (ha)	PDA including Winter Roads (ha)[2]	% HQH[3]	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH
Local Study Area												
Summer and Fall	49,801	2,291	-	4.6	2.4	< 0.1	97	0.2	373	0.8	445	0.9
Winter and Early Spring	39,959	880	1,342	2.2 - 3.4	0.7	< 0.1	55 – 54[a]	0.1	278 - 265[a]	0.7 – 0.6[a]	426	1.1
All Seasons	84,641	**3,103**	**4,381**	**3.7 - 5.2**	3.1	< 0.1	151 - 143[a]	0.2	644 - 588[a]	0.8 – 0.7[a]	861	1.1
Regional Study Area												
Summer and Fall	482,602	2,302	-	0.5	2.4	< 0.1	97	< 0.1	373	< 0.1	2,278	0.5
Winter and Early Spring	410,072	882	1,351	0.2 - 0.3	0.7	< 0.1	55 - 54[a]	< 0.1	278 - 265[a]	< 0.1	857	0.2
All Seasons	823,045	**3,115**	**4,433**	**0.4 - 0.5**	3.1	< 0.1	151 - 143[a]	< 0.1	644 - 588[a]	< 0.1	3,024	0.4

[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 7.5.2.1).

[a] Ranges are presented for areas where noise contours overlap with the Winter Road PDA for the Winter and Early Spring season when habitat loss will occur, and across all seasonal habitat (All Seasons) as a conservative estimate of habitat alteration. The first number represents the area without the Winter Road PDA and the second considers the loss of the Winter Road PDA.

General Project Noise

The majority of sensory disturbance due to general Project noise modeled as above 45 dBA will be associated with the development and operation of the TSF, processing plant, roads and camps. Traffic noise was modeled along the winter road alignments; the results indicated that traffic noise will dissipate to 45 dBA at less than 50 from the road alignment (Volume 4, Chapter 2). The Winter Road PDA is assumed to be a 200 m wide corridor (Volume 2). Therefore, all traffic noise above 45 dBA along winter roads will be contained within the Winter Road PDA already assessed as lost (Section 7.5.2.1) and no additional disturbance outside of the Winter Road PDA is expected.

The total amount of area modeled as affected by elevated noise levels due to general Project noise (outside of the PDAs already considered to be lost; Section 7.5.2.1) is 1,212 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 1,708 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs; Table 7.5-7). All noise attributable to blasting above 108 dB L_{peak}, which is an intermittent noise source, will occur entirely within the area modeled as disturbed by continuous general Project noise above 45 dBA. Therefore, muskox will experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap when winter roads are not operational, and in 293 ha of habitat when winter roads are operational.

A breakdown of the percentage of high-quality habitat within modeled noise contours for each season outside of the PDAs can be found in Table 7.5-8. The percentage of high-quality habitat modeled as disturbed due to general Project noise outside of the PDAs is minimal (<1% of the wildlife LSA; <0.1% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife LSA and RSA, both for the summer and fall period and for the winter and early spring period when winter roads are operational (Table 7.5-8; Figure 7.5-1). As noted above, general Project noise completely encompasses areas disturbed by blasting; the amount of high-quality habitat were muskox may encounter multiple sources of noise accounts for less than 1% of high-quality habitat in the wildlife LSA and less than 0.1% of the wildlife RSA during the snow-free period and when winter roads are operational.

Aircraft Noise

The total amount of area modeled as affected by aircraft noise (80 dBA) outside of the areas already considered lost to Project footprint (Section 7.5.2.1) is 14,191 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 14,084 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs); in both cases (with and without winter roads), the percentage of habitat modeled as affected by aircraft noise within the wildlife LSA and wildlife RSA is the same, at 10.5% of the wildlife LSA and 1.1% of the wildlife RSA (Table 7.5-7). Sensory disturbance modeled due to aircraft noise is greater near the MLA (12,367 ha during the snow-free period and 12,260 ha during the winter when winter roads are operational; 1% of the wildlife RSA) relative to the Goose PDA (1,824 ha during both the snow-free period and during the winter while winter roads are operational, 0.1% of the wildlife RSA), as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. However, it should be noted that much of the habitat modeled as disturbed by aircraft noise at the MLA is over marine habitat in Bathurst Inlet. Thus, during the snow-free periods, only 2,273 ha of terrestrial habitat along the shorelines is modeled as receiving elevated noise levels, which is equivalent to 0.2% of the wildlife RSA. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area modeled as disturbed by continuous general Project noise above 45 dBA, thus representing the area where muskox may encounter multiple types of Project noise.

A breakdown of the percentage of high-quality habitat modeled as disturbed due to aircraft noise in the wildlife RSA can be found in Table 7.5-7. Across seasons, the percentage of additional high-quality

habitat in the wildlife LSA and RSA modelled as disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (1% of wildlife LSA, 0.2% of the wildlife RSA) relative to the amount of available high-quality habitat in these areas (Table 7.5-7). A very small amount of high-quality seasonal habitat (9 ha of high-quality summer and fall habitat and 1 ha of winter and early spring habitat) occurs near the Goose PDA where intermittent aircraft noise and general Project noise are expected to overlap, representing the area where muskox may encounter multiple types of Project noise.

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose Property, a maximum of two flights per day are planned in the "worst case" years used for noise modelling (during the Operational phase), while at the MLA, when it is active, a maximum of six flights per week are planned during the "worst case" scenario. In addition, areas of disturbance due to noise are expected to be localized near the landing strips at the Goose Property and within Bathurst Inlet at the MLA. Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

Wildlife Management Units

The total amount of habitat that is modeled to be functionally lost or disturbed due to Project-related noise outside the PDAs and within the muskox MU MX-11 is 15,388 ha during the snow-free period, and 15,147 ha during the winter while winter roads are operational. This calculations considers all noise sources from the Goose and MLA PDAs combined and accounting for overlap between noise type (i.e., overlap in blasting, general Project, and aircraft noise). In both cases (with or without winter roads), the combined amount of habitat modeled as disturbed due to noise accounts for less than 0.1% of MU MX-114.

The amount of high-quality habitat that is modeled as functionally lost or disturbed due to Project-related noise (across all noise sources combined) within MU MX-11 is 2,643 ha for summer and fall habitat, and 1,134 ha for winter and early spring habitat. Assuming that MU MX-11 has the approximate proportion and distribution of high-quality habitat as the wildlife RSA for the summer and fall season (38%) and winter and early spring season (33%), the total amount of high-quality habitat in MX14 is anticipated to be 8,080,013 ha for summer and fall habitat, and 6,874,356 ha for winter and early spring habitat. The proportion of high-quality summer and fall season and winter and early spring season habitat modeled as functionally lost or disturbed, due to all Project-related noise sources combined, accounts for < 0.1% of MU MX-11.

Summary of Disturbance due to Noise

Overall, the effect of sensory disturbance is anticipated to result in a residual effect on muskox. There will be a minimal (~1%), but measurable area outside of the PDA that is modeled as having elevated noise levels. Note that this is a conservative estimate of the area where muskox may be affected by noise; muskox within these areas are expected to react with short-term responses (e.g., flight) and long-term responses (avoidance or habituation).

In all cases, this area that is modeled as functionally lost or disturbed by noise outside of PDAs represents less 1.1% or less of the total habitat and high-quality habitat available in the wildlife RSA (Tables 7.5-7 and 7.5-8). The largest amount of habitat that may be affected from a single noise source is not the mine itself, but is modeled as intermittent aircraft noise. As muskox are assumed to occur at low densities within wildlife RSA, few muskox may thus be exposed to Project noise. Because MU MX-11 completely encompasses all the Project PDAs and it is much larger than the RSA, a smaller proportion of habitat (<0.1%) was modelled as disturbed due to the Project noise within the MU thus Project disturbance should not affect the muskox population residing within MU MX-11.

7.5.2.3 Disruption of Movement

Disruption to movement for muskox can result from linear corridors such as roads which may isolate seasonal habitats. Linear developments, including roads, railways, and pipelines, have been shown to create temporary or permanent barriers to movement in many wildlife species (Jalkotzy, Ross, and Nasserden 1997). Muskox will be present and active on the tundra all year and thus may interact with both winter roads connecting the PDAs (used from January to April) and permanent site roads within the PDAs. Therefore, the effect of disruption to movement due to linear corridors is included in the assessment. However, muskox live in an environment where there are few temporary or permanent roads, and the effect of roads as barriers to movement in this species has not been studied. Therefore, the assessment for muskox relied on evaluations of disruption of movement for similar species. Developments may also cause disruption to movements by avoidance of areas due to Project-related activities. If Project sites are large enough relative to the habitat in which muskox use and cause noise and sensory disturbance to a level that results in muskox avoiding these areas, movement of muskox may be altered. In these cases, muskox may need to expend additional energy to travel around Project developments during their daily or seasonal movements.

Disruption to movement may begin during the Construction phase of the Project when roads and infrastructure are built and continuing during the Operational and Reclamation and Closure phases of the Project. Wherever possible, reclamation activities will be undertaken and designed to remove barriers and accommodate movement following mine closure.

Evaluation of Disruption of Movement on Muskox

Data collected from a variety of locations suggests that road traffic on the order of 4,000 to 10,000 vehicles per day begin to impose a barrier to movement to most large wildlife species, whereas roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). In Alaska and Arctic Canada, winter roads with high traffic volumes and a snow bank height of > 0.5 m have been found to deflect ungulate movements (Rescan 2007a).

The winter roads will be used for hauling equipment, fuel and cargo from January to April across an operating window of 100 days (Volume 2, Project Description). The projected traffic volumes to transport materials along winter roads are presented in Table 7.5-9. It was assumed that this level of traffic would be present within a day along all portions of the winter roads connecting the property areas.

Table 7.5-9. Traffic Volumes along Winter Road Corridors

	Average No. of One-way Trips*	
	Construction	Operations
per Year**	1,908	4,045
per Day**	19	40
per Hour**	1.2	2.5

**Average number of vehicles required during all of Construction and Operations.*
***Calculations based on 100 day operating window between January and April and a 16 hour operating period per day.*

Traffic volumes will be on average 19 one way truck trips per day from January to April during Construction. Assuming transits are evenly spaced across the 16 hour operating period for trucks within a day, the traffic volume translates to roughly 1 vehicle passing along any one point of the winter road per hour Table 7.5-9). During Operations, the traffic volume will increase to an average of 40 one way truck trips per day, with between two to three trucks passing any one point of winter road per hour. These traffic volumes are well below the threshold value for roads that are permeable (1,000 vehicles

per day; Müller and Berthoud 1997). Therefore, the traffic alone on winter roads are not expected to create a permanent barrier to muskox movement.

To mitigate effects of road traffic on muskox, truck speed limits will be developed and drivers may also reduce speeds or stop completely when muskox herds are observed near or on the road to allow safe passage. See Section 7.5.2.4 for a discussion on the potential for direct mortality due to vehicle strikes with muskox.

Snowbanks may disrupt movements should they increase to a height beyond which muskox cannot travel over, with 0.5 m being the threshold based on evidence from other studies (Rescan 2007). Winter roads in Nunavut typically have low height of snowbanks due to low snowfall during the winter, typically less than 0.5 m. Project winter roads are designed such that they will have minimal height above the tundra.

The Project design, as well as mitigation and adaptive management measures (Section 7.5.3) are all expected to lessen the effect of the Project roads acting as a barrier to movement in muskox and no residual effect is expected.

7.5.2.4 Direct Mortality and Injury

The potential for muskox to incur injury or mortality resulting from Project activities was evaluated for the Project due to vehicle accidents and altered predator-prey relationships.

Vehicle-muskox collisions are expected to be rare or non-existent. Muskox are expected to avoid roads during periods of hauling to some degree (Disturbance due to Noise; Section 7.5.2.2) and traffic volumes on winter roads will be low (one to three trucks passing per hour), and thus there will be a low potential for interactions between vehicles and muskox. In addition, truck speed limits will be set at 50 km/h. Studies have found that vehicle-ungulate collision rates fall sharply at or below 70 km/h (Seiler 2005; Ng, Nielson, and St Clair 2008). Wildlife, including muskox, on or near the road corridor may also be given the right-of-way to safely cross and exit the road corridor to lessen the probability of vehicle strikes. Therefore, residual effects following mitigation are not expected.

Effective and sustained mitigation and monitoring of waste management and camp infrastructure and compliance with the Sabina policies of wildlife management are predicted to result limited attraction or avoidance of the Project site by predators such as wolves, wolverine or grizzly bears. These activities will also reduce/prevent the potential for the creation of problem animals that must be destroyed (See Chapters 6 and 8). With no local or regional population-level effect predicted for predators, no altered predator-prey interactions are predicted for muskox due to the project.

7.5.2.5 Indirect Mortality

The potential for the Project roads to increase public access, and thereby increase hunting (indirect mortality) was assessed for the Project. The socioeconomic assessment (Volume 8, Chapter 3) reports that an increase in human immigration and hunting is unlikely in the Back River area (Volume 8, Chapter 3).

Mitigation measures are in place to prevent public access to Project roads (Section 7.5.3 and Volume 10, Chapter 20). A policy prohibiting hunting within a buffered area along all infrastructure may be developed and enforced (Volume 10, Chapter 20). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees while at the Project site. Thus, construction and operation of the road is not expected to cause an

increase in muskox mortality due to facilitation of hunter access (i.e., indirect mortality). Increased hunting is unlikely and is therefore is not anticipated to result in a residual effect on muskox.

7.5.2.6 Attraction

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Potential Project infrastructure that may attract muskox include the winter roads. Plowed winter roads may be attractive for muskox as travel routes due the lower snow depths, thereby facilitating ease of travel.

For the most part, muskox are expected to avoid the Project as a result of the physical presence and noise associated with the Project infrastructure (Section 7.5.2.2). Therefore, use of winter roads for travel is more likely during periods of inactivity along the road routes. During the hauling period, roads will be inactive for longer period during Construction, where roughly one truck may pass a fixed point along the winter road per hour, than during Operations, where up to three trucks pass per hour. Overall, the traffic volumes per hour are very low for both Construction and Operations. Mitigation measures for wildlife encounters on all Project roads, such as speed limits and giving wildlife the right of way on the road, will ensure that, should muskox be attracted to winter roads for ease of travel, this should not result in an increase in vehicle-muskox interactions. Therefore, no residual effects of attraction are expected for muskox following mitigation.

7.5.2.7 Exposure to Contaminants

Exposure to contaminants in muskox due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in soils and surface waters, and evaluation of predicted future vegetation concentrations (upon which muskox forage), relative to baseline, were either less than one (which means future concentrations are predicted to be less than soil or water quality guidelines), or are predicted to be within the range of baseline. Therefore, risks to muskox are considered to be negligible. Thus, a residual effect due to exposure to contaminants in muskox is not anticipated and is not considered further in the assessment.

7.5.2.8 Reduction in Reproductive Productivity

This section evaluates whether the potential effects of the Project may act in a synergistic fashion to reduce muskox productivity. Should animals have reduced habitat areas, physiological stress, lower feeding and increased movement rates, their body condition may be reduced. Individuals in poor body condition can have lower productivity (fewer young). The condition of muskox females during the summer through the early winter, particularly the body fat content, appears to be directly related to successful pregnancy; muskox females that have low fat mass during the summer and fall have a lower chance of having a successful pregnancy and calving the following spring (White, Rowell, and Hauer 1997; Adamczewski et al. 1998). The key to this analysis is determining if the magnitude of predicted residual effects are sufficient to reduce female body condition in muskox.

Evaluation of Reduction of Reproductive Productivity in Muskox

Following mitigation, residual effects are expected for direct habitat loss and disturbance due to noise (Sections 7.5.2.1 and 7.5.2.2). Therefore, these two effects were evaluated for their potential to affect the reproductive productivity of muskox.

The results of these assessments indicate that the amount of habitat directly lost due to the Project, or and indirectly lost due to disturbance, is unlikely to significantly reduce the amount of foraging habitat available for muskox herds in the area. A small quantity of high-quality seasonal habitat will be removed by the Project footprint, and relatively small amounts of habitat outside of the Project

footprint (i.e., the PDAs) will disturbed due to noise. Together, the amount of habitat affected totals roughly 2% of the available habitat within the wildlife RSA and 0.1% in the muskox management unit MX-11. Thus, the direct and indirect loss of seasonal habitat is offset by the large quantities of high-quality habitat outside of the influence of the Project.

Between the two residual effects, disturbance due to noise was modeled as having the greater potential to affect muskox, given their known sensitivity to noise disturbance. However, as noted in Section 7.5.2.2, the amount of habitat within modeled noise contours (blasting, continuous general Project noise, and aircraft noise) totals roughly 1% of the available habitat within the wildlife RSA. Given that muskox are expected to occur at low densities in the wildlife RSA, noise disturbance is expected to affect a very small number of individuals. The individuals that may utilize habitat near the Project and be exposed to noise disturbance are expected to react with short term responses that may proceed to habituation based on the frequency of exposure. For example, distinct changes in sound, such as those that may be caused by Project blasting or aircraft noise, have been shown to cause alert and avoidance behaviours in muskox. Muskox reacted to the start-up and acceleration of snowmobiles at distance of over a kilometre; responses varied from becoming alert to moving away from the source of disturbance (McLaren and Green 1985). Muskox generally become more alert during disturbance events caused by aircraft (e.g., aerial surveys), and several studies have documented a number of adverse responses to aircraft noise (Miller and Gunn 1979; Olesen 1986 cited in Aastrup and Mosbech 2000). However, there are several examples of where muskox have become tolerant of noise and related industrial activity. In 1996 and 1997, several muskox spent time in the summer months in close proximity of Lupin mine (Gunn et al. 1997). In 2014, a herd of muskox with young were seen foraging within a kilometre of the Doris North mine and helipad in June; the herd spent several days at the site before they were diverted away from the mine site for safety reasons (ERM 2015). This suggests that muskox that utilize habitat near sources of disturbance can acclimatize and continue normal activities (e.g., foraging).

The potential magnitude of the effects of habitat loss and disturbance is expected to be low, since such a small area of muskox habitat will be affected. However, concern has been raised by government biologists about the status of the muskox population in Nunavut. The muskox population in the wildlife RSA is reported to be declining and reproductive rates are low (Dumond 2007); therefore, muskox have a limited capacity to buffer additional stresses. Hence, a residual effect for reduction in reproductive productivity is predicted for muskox, following the precautionary principle.

This assessment evaluated disturbance and reduction in reproductive productivity by examining the area where muskox may choose to avoid the Project due to disturbance. However, should muskox choose to occupy this relatively small area immediately surrounding the mine, it is not expected that muskox will suffer effects of reduced energetic intake, stress or population health. The area is relatively small compared to the habitat available, meaning that potential stress effects would make up a small proportion of a muskox's time budget and muskox are known to be robust to some levels of disturbance.

7.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including muskox. In addition, there are a number of other mitigation and management measures will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on muskox is predicted resulting from habitat loss, disturbance due to noise, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects

to muskox. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

7.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to muskox may include the following:

- Project infrastructure designed to minimize the Project footprint to reduce habitat loss for muskox (Project Description; Volume 2, Chapter 2);
- winter only road access corridors proposed (no all-weather roads for re-supply), to minimize direct habitat loss, and habitat degradation due to dust deposition for muskox (Project Description; Volume 2, Chapter 2).

7.5.3.2 Mitigation for Disturbance due to Noise

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife due to noise are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement for Wildlife program (Volume 10, Chapter 20). Additional wildlife specific measures to minimize the effect of disturbance due to noise to muskox may include:

- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to muskox (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during the Construction and Operational phases to avoid unnecessary disturbance to muskox habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

7.5.3.3 Mitigation for Disruption of Movement

The following mitigation measures and best management practices may be applied to minimize the effects of disruption to movement to muskox:

- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce the disruption of movement to muskox (Volume 2, Chapter 2).

7.5.3.4 Mitigation for Direct Mortality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the WMMP Plan (Volume 10, Chapter 20), and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to muskox may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- truck speed limits set at 50 km/h, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to muskox (Volume 10, Chapter 20);
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

7.5.3.5 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of indirect mortality specific to muskox may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project employees and contractors while on site (Volume 10, Chapter 23).

7.5.3.6 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of attraction to the Project to muskox and other wildlife are described in the Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), the Borrow Pits and Quarry Management Plan (Volume 10, Chapter 16), and the Employee Wildlife Education program, described in the WMMP Plan (Volume 10, Chapter 20). There is no specific mitigation for the effect of attraction to roads in muskox. However, mitigation in place or other effects (e.g., Direct Mortality and Injury) will minimize effects of attraction to the Project in muskox.

7.5.3.7 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality

of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to muskox.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including muskox, from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures could include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

7.5.4 Characterization of Residual Effects

In Section 7.5.3, eight potential effects were evaluated for whether they may result in residual effects after mitigation. Residual effects are those effects predicted to remain after the application of mitigation and management. Two of these effects were rated as having the potential for residual effects: 1) habitat loss, and 2) disturbance due to noise, with a third, 3) reduction in reproductive productivity added following the precautionary principle. Each residual effect is described in this section in terms of eight descriptors (Volume 9, Chapter 1), including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability, and confidence. The magnitude of the residual effect was evaluated by using the information in Table 7.5-1. Table 7.5-2 provides a description of the significance ratings used for residual effects.

7.5.4.1 Habitat Loss

The direction of the residual effect is negative, as small but measureable amount of habitat will be lost. The alteration of habitat due to Project development represents a small percentage of the available high-quality seasonal habitats for muskox in the wildlife RSA and also within muskox management units (MUs) that overlap the Project area.

The total area of habitat in the Goose Property and MLA PDAs during the snow free period is 2,302 ha of high-quality habitat (high and moderate rated habitat combined), or 0.5% of that available in the wildlife RSA. During the winter while winter roads are operational, additional areas of habitat will be temporarily removed from December to April, which combined with the loss of habitat within the Goose and MLA PDAs is 1,351 ha or 0.8% of the wildlife RSA. The portion of high-quality seasonal habitat lost within MU MX-11 < 0.1% of the assumed available high-quality habitat within these MUs.

The actual Project footprints are designed to be as small as possible and are anticipated to occupy approximately 10% of the PDAs, yielding a habitat loss value of 0.05% to 0.08% of the RSA or 0.01% of the management unit. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 7.5-2.

The extent of the effect is confined to the Project footprint, as habitat loss is generally limited to PDAs. The effect of habitat loss on muskox will have a long term duration (beyond the life of the Project). However, the frequency of effect is sporadic, as the majority of habitat loss or degradation will occur during Construction. The effect is irreversible for muskox, as some area will not be reclaimed during Reclamation and Closure and thus will be permanently lost to the local muskox population. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose Property, MLA, and Winter Road PDAs will not be developed.

Overall, the effect of habitat loss for muskox is assessed as Not Significant.

7.5.4.2 Disturbance due to Noise

Disturbance due to Noise is considered to be a residual effect with a negative direction as the development will affect a small, but measureable amounts of high-quality habitat for muskox outside of those areas assessed as lost.

After considering the effects of habitat loss, the amount of habitat calculated as receiving an elevated noise level where a muskox may be disturbed by noise was 1.1% or less of the total habitat and high-quality habitat available in the wildlife RSA (Tables 7.5-7 and 7.5-8). The largest source of noise is predicted to be aircraft, not the mine site itself. Blasting noise and continuous Project noise (generators, etc.) are predicted to be largely contained within the PDAs and occupy <0.1% of habitat within the wildlife RSA. Minimal amounts of the predicated high-quality habitat (<0.1%) are expected to be disturbed by noise within MU MX-11. Following the quantitative thresholds for magnitude listed in Table 7.5-2, the magnitude of the effect is considered low.

Disturbance effects due to noise is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA). The frequency is expected to be continuous for general Project noise and sporadic for blasting activities and aircraft noise throughout the life of the Project, but overall sporadic in nature. The duration of noise disturbance causing indirect habitat loss is medium as disturbance due to noise will cease following closure. Muskox are expected to resume normal behaviours following the cessation of noise disturbances, and may even begin to acclimatize to the presence of Project infrastructure and associated noise; therefore, the effect will be reversible for muskox. The probability that the effect will occur is moderate, as muskox aren't expected to occur near areas of noise disturbance most of the time and the confidence in the significance rating is medium as the confidence in the effect occurring to muskox when they are present in disturbed areas is high, but it is uncertain how frequently they will occur near areas of disturbance due to noise.

Overall, the effect of disturbance due to noise for muskox is assessed as Not Significant.

7.5.4.3 Reduction in Reproductive Productivity

The potential for a reduction in reproductive productivity was given a residual rating due to the precautionary principle. Reduced productivity could result from other, direct, effects on muskox from habitat loss and disturbance. However, the areas likely affected by habitat loss and disturbance are small at the scale of the RSA and negligible at the scale of the muskox management unit. In addition,

the predicted effects of disturbance were very conservative (estimated to be larger than they may actually be). Therefore, the combination of residual effects is not predicted to significantly increase the energy demands of the local muskox population to a degree that could substantially affect the reproductive potential of that population.

Reduction in reproduction for muskox is expected to be of low magnitude, as the combination of habitat loss and disturbance due to noise is predicted to affect less than 2% of the available high-quality seasonal habitat for muskox within the wildlife RSA. Furthermore, muskox are expected to occur at low densities within the wildlife RSA, and very few individuals are expected to experience the effects of habitat loss and disturbance, which will thereby lessen the potential for these effects to manifest in a reduction in reproductive productivity within the local muskox population. While the effect may only be experienced by a small proportion of local muskox population, the extent of the effect is regional, as the home ranges of muskox extend beyond the boundaries of the Project footprint and wildlife LSA.

The effect will be of medium term duration, as the reproduction of individual muskox may be affected anytime during the life time of the Project. However, this effect will likely manifest on a sporadic basis, as females are not expected to consistently occupy habitat near the Project throughout the entire year. Muskox generally move between winter and summer ranges, which will limit the time when they may be present in the vicinity of the Project. Reduction in reproductive productivity is expected to be a reversible effect for muskox, as disturbances and other negative effects are reduced when the mine is closed.

The residual effect of reduction in productivity is unlikely to occur. Muskox are expected to avoid the PDAs for the most part during the Construction and Operational phases, thereby lessening the chances that individuals are disturbed on a regular basis. In addition, the amount of high-quality habitat that will be altered during Project development represents a very small portion of what is available in areas surrounding the Project. Therefore, some muskox may be displaced from habitats near the Project, but this displacement is not expected to lead to a reduction in productivity. The confidence in the significance rating is medium as it is unknown how the effects of the Project on reproduction of muskox may interplay with the effects of climate change and disease vectors that may be introduced or spread (e.g., muskox lungworm) within the Arctic environment and change habitat and habitat use within the area.

Overall, the effect of reduction of reproductive productivity for muskox is assessed as Not Significant.

7.5.5 Significance of Residual Effects

Three residual effects for muskox were assessed and resulted in the following significance ratings:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant; and
- reduced reproductive productivity due to a combination of the previous effects, rated Not Significant.

The overall residual effect of the Project on muskox is considered to be **Not Significant**.

The criteria used in the determination of the significance of each residual effect is detailed in Section 7.5.4 and summarized in Table 7.5-10.

Table 7.5-10. Summary of Residual Effects on Muskox and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	High	N
Disturbance due to Noise	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	Medium	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

7.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

7.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. Following the methodology outlined in Volume 9, Chapter 1, a cumulative effects assessment is conducted because there are predicted residual effects for the VEC muskox. The following residual effects are included in the potential cumulative effects assessment: direct habitat loss, disturbance due to noise, reduction in reproductive productivity.

The cumulative effect assessment (CEA) methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 7.5.1.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 7.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary for muskox.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 7.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for muskox and not the wildlife RSA.

7.6.1.1 Spatial Boundaries for the Cumulative Effects Assessment

The spatial boundary for the cumulative effects assessment for muskox (referred to as the CEA boundary) was a 140 km buffer surrounding the Project (Figure 7.6-1). This distance represents the longest (straight line) distance travelled by a radio-collared muskox in the Rae Richardson river valley west of Kugluktuk. Radio-collared females travelled on average from 75 to 85 km from winter and summer ranges, but the longest distance travelled was 140 km (Gunn and Fournier 2000). Therefore, this distance is used to represent the longest distance that muskox that inhabit areas in the vicinity of the Project may travel and thus may interact with other developmental projects. The total area of the CEA boundary for muskox is 10,508,200 ha.

7.6.1.2 Temporal Boundaries for Cumulative Effects Assessment

The temporal boundaries used for the cumulative effects assessment are the timescale of past, existing, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

7.6.2 Potential Interactions of Residual Effects with Other Projects

Three residual Project-related effects were identified during the muskox effects assessment: habitat loss, disturbance due to noise, and reduction in reproductive productivity. Several additional projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of muskox that interact with the Back River Project.

A total of 12 projects have been identified within the CEA boundary for muskox, including four that are closed (past developments), three that are existing developments, and five that are reasonably foreseeable future projects (Figure 7.6-1; Table 7.6-1).

Table 7.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Muskox in the Cumulative Effects Assessment Boundary

Residual Effects from Back River Project	Rating from Back River Project	Other Project or Activity			Type of Potential Cumulative Effect
		Past	Existing	Reasonably Foreseeable Future	
Habitat Loss	Not Significant	n/a	Tibbitt to Contwoyto Lake Winter Road*	George, BIPR**, Hackett, Hope Bay (Phase 2)	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
Disturbance due to Noise	Not Significant	n/a	Tibbitt to Contwoyto Lake Winter Road*	George, BIPR**, Hackett, Hope Bay (Phase 2)	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance
Reduction in Reproductive Productivity	Not Significant	n/a	Tibbitt to Contwoyto Lake Winter Road*	George, BIPR**, Hackett, Hope Bay (Phase 2)	Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects

** The Tibbitt to Contwoyto Lake Road was included as a source of habitat loss and disturbance for muskox during the winter.*
*** BIPR = Bathurst Inlet Port and Road Project*

The George project was included in the Back River DEIS as a part of the Back River Project, but is considered in the FEIS as a reasonably foreseeable project. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the Exploration Camp. Should the George project proceed, it will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip,

maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned for George project.

7.6.2.1 Habitat Loss

The effects assessment rated habitat loss from the Back River Project as a Not Significant residual effect with a low magnitude. Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible. While high-quality habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 7.5.2.1), habitat alteration from past, existing, and potential projects within the range of a muskox that may interact with the Back River Project is expected to be an additive effect, and therefore a larger loss of high-quality habitat for muskox can occur at the cumulative scale.

No past projects occur within the CEA boundary for muskox (Table 7.6-1). One existing project overlaps with the muskox CEA boundary, the Tibbitt to Contwoyto Lake Winter Road, which will only be operational during the winter period. The proposed George, Bathurst Inlet Port and Road (BIPR), Hackett River, and Hope Bay (Phase 2) projects have the potential to overlap with the CEA boundary for muskox and may contribute to additional habitat loss if these projects are developed.

Calculation of Cumulative Habitat Loss for Muskox

The amount of habitat removed ("area removed") was estimated from the generalized footprints of all projects and road corridors (including the Back River Project) in the CEA boundary for muskox and used as a key indicator to determine potential effects. For all existing and reasonably foreseeable future projects, habitat within 100 m of removed habitat (due to Project infrastructure) was considered to be degraded habitat because 100 m is the distance within which most effects of large dust particles extend from roads and other developments (Walker and Everett 1987b). Habitat loss for the Back River Project was calculated within the PDAs, which already includes a dust-disturbance area. The calculation of total habitat loss is presented with and without winter roads because winter roads will remove available habitat for muskox during the winter but not during the snow-free periods (summer and fall). In order to calculate a conservative estimate of habitat loss due to all projects (including the Back River Project) in the CEA boundary for muskox, the total loss of habitat calculated in this boundary are compared to summer and winter home range sizes for female muskox, with the area used by a female representing the estimation of the area used by a herd (Section 7.5.2.1). This is an overestimate of the amount of habitat loss within a home range of a muskox female/herd, but will enable a calculation of the maximum number of home ranges that could be potentially lost due to the cumulative effect of habitat loss within the CEA boundary. In addition, the area lost is presented in relation to the proportion of individuals that may be affected, assuming a density of 7 animals/1,000 km^2 within the CEA boundary (Dumond 2007).

Evaluation of Cumulative Habitat Loss for Muskox

Within the CEA boundary for muskox, the cumulative effects assessment identifies 11,291 ha (0.1% of total habitat in the CEA boundary) of removed habitat and 7,705 ha of degraded habitat (0.1% of total habitat in the CEA boundary; Table 7.6-2). These areas account for a total of 22,464 ha with the inclusion of winter roads, and 18,996 ha without the inclusion of winter roads. The Back River Project alone will contribute 32 to 42% of the total habitat loss within the CEA boundary for muskox (<0.1% of the total CEA boundary). Note that the actual footprint of the Project is anticipated to be much smaller (10% or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

GIS # BAC-23-380c

October 26 2015

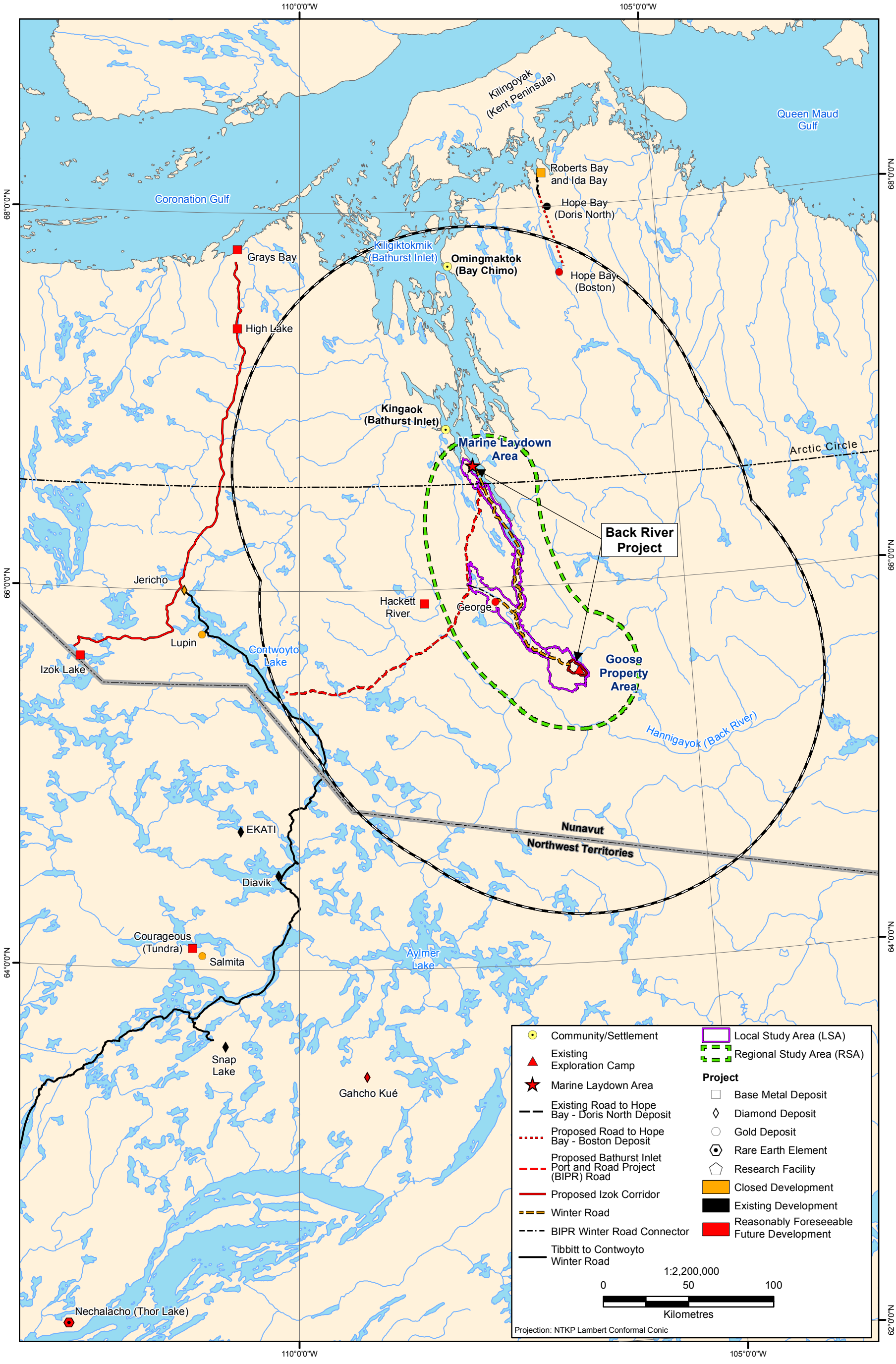

Figure 7.6-1

Spatial Boundary for Muskox Cumulative Effects Assessment

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Table 7.6-2. Cumulative Habitat Loss in the Muskox CEA Boundary[1]

Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Back River Project[3]	6,080	n/a	6,080	9,477
Past Developments				
n/a				
Existing Developments				
TCWR[4]	n/a[4]	n/a[4]	n/a[4]	74
Reasonably Foreseeable Future Developments				
BIPR[5]	656	4,919	5,576	5,576
George	172	239	411	411
Hackett River	1,454	2,056	3,510	3,510
Hope Bay (Phase 2)	2,928	491	3,419	3,419
Cumulative Areas				
Total Area	11,291	7,705	18,996	22,467
Total Area Accounting for Overlap[6]	11,291	7,705	18,996	22,464
% CEA Boundary	0.1	0.1	0.2	0.2

[1] Muskox Cumulative Effects Assessment boundary approximates 10,508,200 hectares.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] Tibbitt to Contwoyto Lake Winter Road. Habitat loss for the Tibbitt to Contwoyto Lake Winter Road is only considered under Total Lost or Degraded including winter roads as the habitat loss will be temporarily lost each winter, while other project footprints are assumed to be permanent. In addition, there will be no habitat degradation due to dust associated with winter roads.
[5] Bathurst Inlet Port and Road Project
[6] Represents the total area of habitat loss and degradation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degradation, these were dissolved to provide a total accounting for overlap.

The average size of the core winter and summer home ranges for female muskox/herd used in the effects assessment (Section 7.5.2.1) are 7,000 and 22,300 ha, respectively. Thus, total habitat loss from all projects in the CEA boundary is roughly equivalent to 85% of a summer home range for muskox female (based on 18,996 ha lost or degraded during the summer period) and approximately 3 winter home ranges for muskox female (based on 22,464 ha lost or degraded during the winter period when winter roads are operational). Given the spatial distribution of projects across the landscape, it is more likely that individual projects remove small portions of habitat within seasonal home ranges of muskox herds in the vicinity of these projects. However, this may also mean that more individuals/herds may be affected by minor losses of seasonal habitat within their ranges due to project development than is calculated above.

If it is assumed that the density of muskox in the CEA boundary is similar to that recorded by Dumond (2007) in areas surrounding the Project (7 muskox/1,000 km^2), approximately 735 muskox would be expected to frequent the CEA boundary. Based on this estimate, and assuming an even distribution of habitat loss in the CEA boundary, an average of approximately 26 to 31 ha of habitat per muskox (based on cumulative habitat loss and degradation without and including winter roads, respectively) may be altered, which is equivalent to 0.1% of a summer home range of a muskox and 0.4% of a winter home range of a muskox.

The amount of muskox habitat that may be lost or degraded if all projects, including the Back River Project, are developed represents a small portion (0.1%) of the total amount of habitat available in the CEA boundary. The amount of habitat lost at the cumulative level does represent nearly one summer home range and more than one winter home range of a muskox female/herd, but very low proportions of these seasonal home ranges if each individual within the CEA boundary takes on a portion of the loss (0.1 to 0.4%). Evaluation by the total number of home ranges that may be affected by habitat loss is a very conservative estimate of the cumulative habitat loss, while the proportion of a home range altered per individual underestimates the loss as muskox are not uniformly distributed across the landscape and occur in herds throughout most of the year. However, neither estimate suggests that the carrying capacity of the muskox habitat at the landscape level will be affected due to the cumulative habitat loss of all projects (including the Back River Project) in the CEA boundary. As mitigation and reclamation activities cannot wholly eliminate habitat loss, a residual effect of habitat loss on muskox is predicted.

7.6.2.2 Disturbance

The disturbance to muskox due to auditory stimuli from the Back River Project was rated as Not Significant with a low magnitude in the effects assessment. Habitat functionally lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the CEA boundary is discussed in this section.

Potential disturbance effects from existing and reasonably foreseeable future projects was assessed; including the Tibbitt to Contwoyto Lake Winter Road, and the proposed BIPR, George, Hope Bay (Phase 2), Hackett River projects (Figure 7.6-1). Past projects were excluded from the analysis. A background on the potential effects of disturbance due to noise to muskox is presented in Section 7.5.2.2.

Calculation of Cumulative Disturbance

To evaluate the effects of disturbance on muskox, the area in which muskox may be affected by disturbance was calculated and used as a key indicator of this potential effect.

A zone of influence (ZOI) approach was taken to evaluate the cumulative effect of disturbance on the VEC. A ZOI represents the area where muskox may avoid industrial developments or features due to noise, human presence, or altered habitat within a particular distance of that development or feature. The results of noise modeling produced in Volume 2, Chapter 4 and literature values were used to develop ZOIs for all project features occurring with the CEA boundaries for muskox.

The ZOI of 4 km was applied to all existing and reasonably foreseeable future developments and associated infrastructure areas (e.g., port facilities). This value was chosen based on a wide range of theoretical zones of influence for large arctic mammals, which have ranged from 500 m up to 5 km (e.g., Czech 1991; Nellemann and Cameron 1998; Vistnes and Nellemann 2001; Mahoney and Schaefer 2002; Frid 2003; Johnson et al. 2005). Thus, a conservative value of 4 km was used, and is a commonly reported ZOI for large mammals such as caribou (see Sections 5.5.2.2 and 5.6.2.2).

Linear features, including all weather roads and winter roads, were assigned ZOIs primarily on the results of noise modelling. For both types of roads, the distance from the feature where noise is anticipated to attenuate to below the threshold value of 45 dBA was calculated, as per the conservative guideline for minimizing disturbance outlined in Environment Canada (2010)(Section 7.5.2.2).

All-weather roads associated all existing and reasonably foreseeable future developments with were assigned a ZOI of 1.5 km. Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m

at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km.

Winter roads for all existing and reasonably foreseeable future developments were assigned a ZOI of 200 m. The results of noise modelling produced in Rescan (2013d) indicated that traffic along winter roads would attenuate to 45 dBA at roughly 200 m from vehicle traffic and activities on these roads. No ZOI was applied to winter roads associated with the Back River Project as the results of noise modeling produced in Volume 2, Chapter 4 indicated that traffic noise above 45 dBA will be completely contained within the footprint of the Winter Road PDA, and no additional disturbance outside of the PDA was expected (Section 7.5.2.2).

ZOIs for project features overlap one another. For example, ZOIs associated with all-weather roads exiting a development area will overlap 4 km ZOIs for that certain development, and ZOIs for all-weather roads connecting to existing winter road networks will overlap the ZOIs for those winter roads. Thus, a priority was assigned to each ZOI to account for overlaps in features. The 4 km ZOI for developments took precedence over all other ZOIs, as it was assumed that the physical presence of the development, noise (in some cases continuous noises such as generators), and other associated activities, would cause more potential disturbance than roads which will have more infrequent disturbance during hauling periods. All-weather roads ZOIs took precedence over ZOIs for winter roads on account of the smaller predicted area of habitat above noise thresholds around winter roads relative to all-weather roads.

In some cases, ZOIs for certain projects overlap one another. In these cases, the amount of overlap was calculated and removed from the total disturbance within ZOIs to avoid double-counting areas where ZOIs overlap.

Evaluation of Cumulative Disturbance

The area of disturbance within ZOIs associated with the Back River Project would cover 27,352 ha, or 0.3% of the CEA boundary for muskox (Figure 7.6-2). The area of cumulative disturbance within ZOIs for all existing and reasonably foreseeable future projects in the CEA boundary for muskox (including the Back River Project), assuming a worst case scenario whereby all projects are operational at the same time, would result in 170,177 ha of disturbed habitat during the snow-free period and 172,140 ha during the winter when winter roads are operational. Overall, these cumulative areas (both excluding and including winter roads) represent 1.6% of the CEA boundary. Estimated areas of disturbance within ZOIs for each project including the Back River Project are reported in Table 7.6-3.

The cumulative effect of disturbance due to all projects, including the Back River Project, is anticipated to result in a residual effect on muskox. Muskox inhabiting areas near existing and reasonably foreseeable future projects may to react to these disturbances with short-term responses (e.g., flight) and long-term responses (avoidance or habituation). In all cases, this area that is modeled within ZOIs for each Project within the CEA boundary represents 1.6% of the habitat available to muskox. As muskox are assumed to occur at low densities within CEA boundary, few muskox may thus be exposed to noise from construction and operation activities.

7.6.2.3 Reduction in Reproductive Productivity

The muskox population in the wildlife RSA is currently declining and reproductive rates are low (Dumond 2006, 2007); therefore, an increase in projects in this area may affect this population. The combined influence of the existing and reasonably foreseeable future projects has the potential to reduce muskox reproductive productivity. This effect is theoretical in nature is being qualitatively assessed based on best judgement.

Table 7.6-3. Zone of Influence due to Disturbance in the Muskox CEA Boundary[1]

Project	Areas of Habitat Within ZOIs[2] (ha)			Total without Winter Roads	Total including Winter Roads
	Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)		
Back River Project	n/a*	n/a	27,352	27,352	27,352
Existing Developments					
TCWR[4]	1,963	n/a	n/a	0	1,963
Reasonably Foreseeable Future Developments					
BIPR[4]	n/a	57,207	13,714	70,921	70,921
George	n/a	n/a	20,348	20,348	20,348
Hackett River	n/a	0	36,096	36,096	36,096
Hope Bay (Phase 2)	n/a	3,081	12,378	15,459	15,459
Cumulative Areas					
Total Area	1,963	60,288	109,889	170,177	172,140
Total Area Accounting for Overlap[5]	1,963	60,288	109,889	170,177	172,140
% CEA Boundary	0.02	0.57	1.05	1.62	1.64

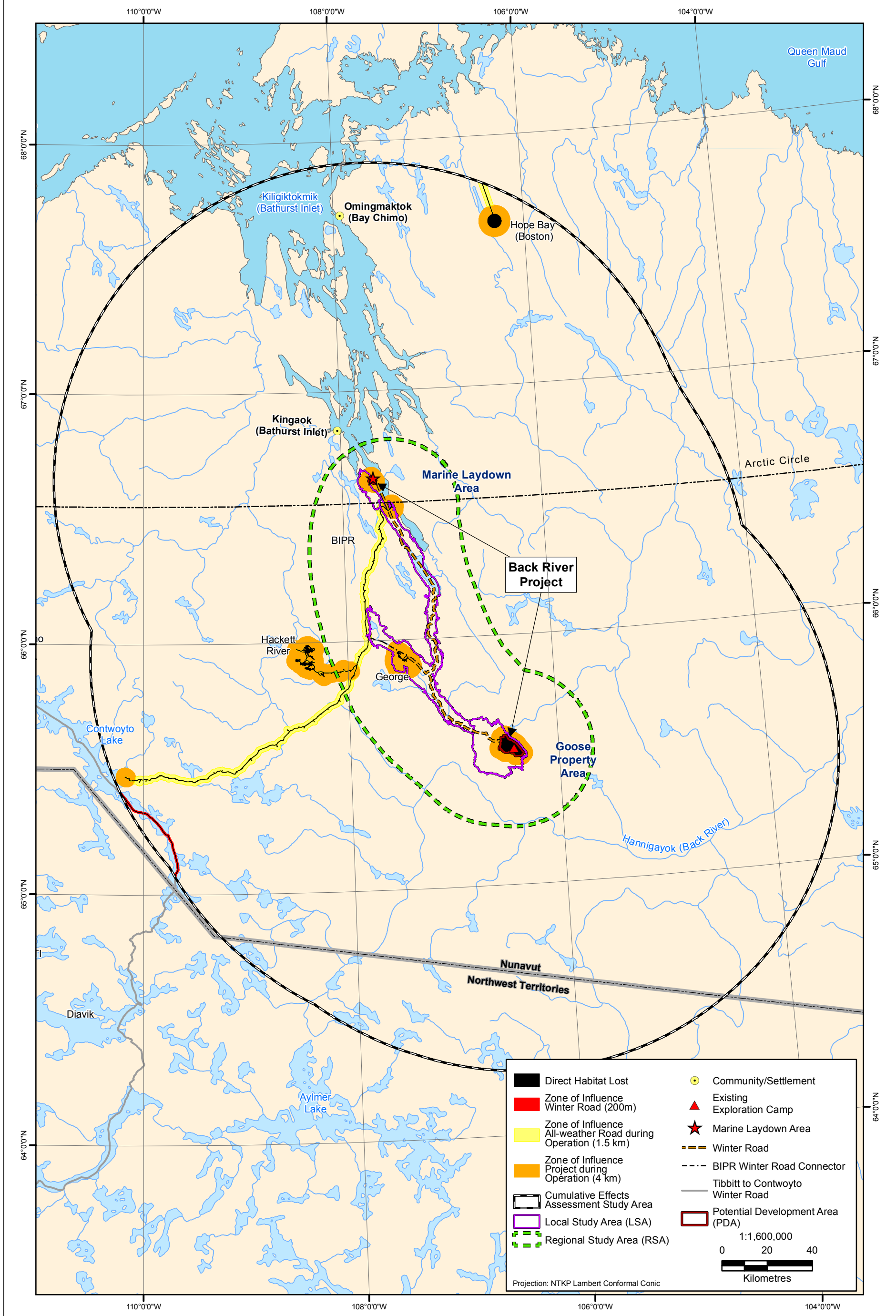
[1] Muskox Cumulative Effects Assessment boundary approximates 10,508,200 hectares.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] TCWR = Tibbitt to Contwoyto Lake Winter Road, BIPR = Bathurst Inlet Port and Road Project
[5] Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.
** No ZOI was applied to winter roads for the Back River Project as all of the area above noise thresholds is predicted to be contained within the Winter Road PDA and no disturbance outside of the Winter Road PDA was expected (Section 7.5.2.2)*

Potential reduction in reproductive productivity is related to habitat loss and disturbance. The effects and how they may act in a synergistic fashion may be of the greatest concern during sensitive periods for muskox (i.e., calving in April and May, and rutting in the fall). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals.

The contribution of the Back River Project to cumulative effects of reduction of reproductive productivity on muskox is anticipated to be small relative to other projects in the CEA boundary. While the Project does remove proportionally more habitat than other existing or future developments and will disturb similar amount of habitats (Tables 7.6-2 and 7.6-3), the habitat loss due to the Project is overestimated as only a small proportion (10 % or less) of the PDAs assumed to be lost will be developed. An important consideration in cumulative effects is that the Back River Project does not include linear corridors, and thus does not have a residual effect of disruption to movement on muskox. Other projects in the CEA boundary will have linear developments including all-weather roads, which may contribute to the effect of disruption to movement on muskox. If all-weather roads become a barrier to movement for muskox, then this effect will likely add to the effects of habitat loss and disturbance experienced from these projects. Thus, this synergy of project-related effects elsewhere may have higher consequences on the reduction of reproductive productivity on muskox relative to the residual effects of habitat loss and disturbance anticipated to result from the Back River Project.

GIS # BAC-23-422c

November 13 2015



Sabina GOLD & SILVER CORP.

Habitat Lost or Altered due to All Project Footprints and Disturbances in the Muskox Cumulative Effects Assessment Boundary

Figure 7.6-2

Rescan an ERM company

Reduction in reproductive productivity is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

7.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for muskox will be similar to those applied for the Back River Project and will meet or exceed best management practices. For a list of these mitigation and management measures applied for muskox at the Back River Project, see Section 7.5.3 and Volume 10.

7.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures there are three predicted residual effects in the VEC cumulative effects assessment, including habitat loss, disturbance, and reduction in reproductive reproductively.

7.6.4.1 Habitat Loss

The alteration of habitat due to all existing and reasonably foreseeable future development represents a small percentage of the available habitat for muskox in the CEA boundary. The overall loss or degradation of area due to all projects in the muskox CEA boundary is between 18,996 to 22,464 ha (approximately 0.2% of the CEA boundary), which is roughly equivalent to the loss or alteration of 85% of a single summer home range for a muskox female and approximately 3 winter home ranges for muskox.

However, given the spatial distribution of the Back River Project and other existing or reasonably foreseeable future developments across the landscape, in that each is relatively segregated from one another, habitat loss is more likely to affect smaller portions of muskox home ranges. Assuming a muskox density within the CEA boundary of seven muskox per 1,000 km^2, and an even distribution of habitat loss or alteration within the CEA boundary, between 26 to 31 ha of habitat per muskox may be altered (based on whether winter roads are included in habitat loss or not), which is equivalent to 0.1% of a summer home range of a muskox and 0.4% of a winter home range. Comparing these values to the thresholds listed for quantitative key indicators in Table 7.5-2, the magnitude of the effect is considered low.

The extent of the effect is local, as habitat loss (both existing and future) will be contained near project infrastructure for all projects in the CEA boundary. The effect of cumulative habitat loss on muskox will have a long-term duration (beyond the life of the Back River Project) or may be permanent. However, the frequency of effect is sporadic and is mainly concerned with habitat loss for reasonably foreseeable future projects, which will occur mainly during the construction phases. By in large, habitat loss is minimal for existing projects given that the habitat loss or degradation took place during construction. The effect is irreversible for muskox, as some areas associated with existing and reasonably foreseeable future projects cannot not be reclaimed fully post-closure (e.g., pits, waste-rock storage) and thus will be permanently lost to the local muskox population. The probability of the effect occurring is likely, and the confidence in the significance rating is high.

Overall, the cumulative residual effect of habitat loss for muskox is assessed as Not Significant.

7.6.4.2 Disturbance

The total cumulative area of habitat disturbance within ZOIs for all projects (including the Back River Project) within the CEA boundary is between 172,140ha during the winter months and between 170,177 ha when winter roads are not active. These areas account for 1.6% of the CEA boundary for

muskox. Comparing these values to the thresholds listed for quantitative key indicators in Table 7.5-2, the magnitude of the effect is considered low.

The extent of the effect of disturbance is local and the frequency is expected to be continuous. The duration is considered medium as the effect of disturbance is expected to subside at closure of the projects. Muskox are expected to resume normal behaviours following the cessation of noise disturbances, and may even begin to acclimatize to the presence of infrastructure and associated noise; therefore, the effect will be reversible for muskox. The probability that the effect will occur is moderate, and the confidence in the significance rating is medium, as it is not certain to what extent muskox may avoid areas of noise disturbance.

Overall, the cumulative residual effect of disturbance for muskox is assessed as Not Significant.

7.6.4.3 Reduction in Reproductive Productivity

The potential for other effects to interact and produce a reduction in reproductive productivity for muskox was rated as a residual effect following the precautionary principle. Reduction in reproduction for muskox is expected to be of low magnitude. It is assumed that other existing and reasonably foreseeable future developments will mitigate for effects on muskox to a similar degree as the Back River Project. Therefore, only a few individuals within the muskox population inhabiting areas within the CEA boundary may experience lowered productivity in relation to construction and operations of projects. While the effect may only be experienced by a small proportion of local muskox population, the extent of the effect is regional, as effects are considered within the CEA boundary.

The effect will be of medium term duration. This effect will likely manifest on a sporadic basis, as females are not expected to consistently occupy habitat near developments throughout the entire year. Reduction in productivity is expected to be a reversible effect for muskox, though it may take a few years following the closure of developments for muskox to return to their baseline reproductive potential.

The residual effect of reduction in productivity is unlikely to occur. Muskox are anticipated to avoid areas near developments for the most part during the construction and operations of these developments, thereby lessening the chances that individuals are disturbed on a regular basis. In addition, the amount of habitat that has been altered already within the CEA boundary and the amount that will be altered during development of reasonably foreseeable future projects represents a very small portion of what is available within the CEA boundary. Therefore, some muskox may be displaced from habitats near projects, but this displacement is not expected to lead to a reduction in productivity. The confidence in the significance rating is medium as it is unknown how the effects of the Project on reproduction of muskox may interplay with the effects of climate change and disease vectors that may be introduced or spread (e.g., lungworm) within the Arctic environment and change habitat and habitat use within the area.

Overall, the cumulative residual effect of reduction in reproductive productivity for muskox is assessed as Not Significant.

7.6.5 Significance of Cumulative Residual Effects

Following methodology in Volume 9, Chapter 1 for determining significance, as well as the wildlife definitions for magnitude (Table 7.5-2) and significance (Table 7.5-3), the three residual cumulative effects on muskox are expected to have the following significance:

- direct habitat loss, rated Not Significant;

- disturbance, rated Not Significant;
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

The overall residual cumulative effect of the Back River Project and all past, existing, and reasonably foreseeable future projects within the CEA boundary for muskox is considered to be **Not Significant**.

The criteria used in the determination of the significance of each cumulative residual effect is detailed in Section 7.5.4 and summarized in Table 7.6-4.

7.7 TRANSBOUNDARY EFFECTS

No transboundary effects on muskox are expected; very rarely would muskox that inhabit areas surrounding the Project travel into the Northwest Territories. In addition, the cumulative effects assessment considered a large area that encompassed the maximum straight line distance recorded for a muskox female (140 km). This 140 km buffer was applied to all Back River Project infrastructure and extended into the Northwest Territories. Thus, the transboundary effects that cross jurisdictional boundaries are predicted to be accounted for in the cumulative effects assessment for muskox — all of which are rated as **Not Significant**.

7.8 MITIGATION AND ADAPTIVE MANAGEMENT

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10 Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including muskox. Mitigation measures specific to muskox for potential Project effects are listed in Section 7.5.3 and summarized in Table 7.8-1 in Section 7.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including muskox. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17, and the Incineration Management Plan can be found in Volume 10, Chapter 11;
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effects Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.

Table 7.6-4. Summary of Cumulative Residual Effects to Muskox and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	Medium	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock Management Plan: Chapter 9.
- Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosives Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21
- Tailings Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

7.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 7.8-1 in Section 7.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on muskox.

7.8.2 Best Management Practices

The WMMP Plan (Volume 10, Chapter 20) includes eleven separate mitigation and management sections designed to eliminate or minimize effects of the Project on wildlife. The plan is focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to muskox are listed in Section 7.5.3 and summarized in Table 7.8-1 in Section 7.8.5.

7.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these will need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the WMMP Plan may be amended pending further literature reviews, scientific findings and management

needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The WMMP Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

7.8.4 Monitoring

As part of the WMMP Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

7.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 7.8-1 includes all planned mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on muskox.

Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Muskox

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	1. Project infrastructure designed to minimize the footprint of infrastructure.
	2. Consideration of the location of the stockpiles and windbreaks to minimize dustfall.
	3. Infrastructure, waste rock storage areas, and the TSF at the Goose Property confined to the local watersheds where the deposits are located.
	4. Winter road access corridors only (no all-weather roads for re-supply routes).
	5. Infrastructure located close to deposits to keep activities confined to specific areas, and minimize noise-generating activities.
	6. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination.
	7. Berms or other markers built at high walls of quarries to deflect muskox movement.
	8. Buildings designed and maintained to exclude wildlife.
	9. WAD cyanide destruction conducted in the mill.
2. Best Management Practices	
	1. Vehicles restricted to road, winter road and quarry footprints during Construction and Operational phases.
	2. Pre-determined flight paths developed to provide horizontal and vertical buffer distances between flight paths and sensitive habitats, where possible.
	3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever muskox are observed.

(continued)

Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Muskox (continued)

Mitigation Category	Mitigation Measures
2. Best Management Practices *(cont'd)*	
	4. Truck speed limits set at 50 km/h, signage installed to alert drivers of speed limits, and speed limits enforced. 5. Wildlife given the right-of-way on all roads at all times. 6. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance. 7. Waste management measures developed. 8. A policy of no feeding and no intentional attraction of wildlife developed, disseminated to all Project and contractor employees during employee orientation, and enforced. 9. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced. 10. A policy prohibiting hunting by Project employees and contractors while on site. 11. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers. 12. Appropriate measures taken to exclude muskox from areas where water or waste could pose a risk to the health of muskox. 13. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures.
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.
4. Monitoring	A facility-specific monitoring program will assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This program will include several monitoring actions relevant to muskox including:: 1. footprint monitoring to monitor habitat loss; 2. noise monitoring to monitor disturbance to wildlife; 3. human activity monitoring of Project site roads and winter roads; 4. infrastructure monitoring to record the status of wildlife exclusion measures, such as skirting and fencing; 5. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and 6. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to muskox and adaptively manage conflicts where possible.

(continued)

Table 7.8-1. Summary of Mitigation and Management Measures Applicable to Muskox (completed)

Mitigation Category	Mitigation Measures
4. Monitoring (*cont'd*)	A focal-species monitoring program will evaluate predictions in the effects assessment on muskox. This plan may include: 1. collaborating with the Government of Nunavut to conduct herd-level monitoring; 2. a monitoring program using remote cameras in the wildlife RSA to record muskox activity and interactions with the Project; and 3. incidental observations of muskox during other wildlife and environmental monitoring programs.

7.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to muskox are summarized in the following sections.

7.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife interactions include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10; Chapter 20):

- Footprint Monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Nests;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Infrastructure Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA;
- Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds; and
- Pre-construction Surveys for Bear Dens.

7.9.2 Focal-species Monitoring

Following a request by the Government of Nunavut during the DEIS review phase, the Project has committed to working with the GN to conduct regional-scale monitoring of muskox, should the GN develop a regional monitoring plan. Should the GN not produce such a plan, the Project will conduct a proposed motion-triggered camera program.

Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013e, Appendix V5-5C). Muskox are rarely detected by remote camera. The use of remote cameras for annual monitoring of muskox is currently proposed for the WEMP (Volume 10, Chapter 20). Incidental observations of muskox detected during other wildlife monitoring surveys will continue to be recorded.

The three objectives of the camera monitoring program are to:

1. Monitor the Project site to examine how muskox interact with Project facilities (e.g., on roads, pits);
2. Monitor areas identified as important for muskox from landuser knowledge (e.g., eskers, windswept benches) and at points with high number of muskox identified during baseline studies (e.g., the hilly area west of the MLA); and
3. Record the times at which muskox use the area near the Project during the year in order to guide mitigation activities.

Methods for data management and analysis will follow those for caribou (Section 7.3.1 of WMMP Plan, Volume 10, Chapter 20).

7.10 IMPACT STATEMENT

Eight potential effects on the VEC muskox due to the Project were identified. These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and

injury, indirect mortality, attraction to infrastructure, exposure to contaminants, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of muskox was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on muskox resulted in the evaluation of three potential effects as likely having residual effects after mitigation: habitat loss, disturbance due to noise, and reduced productivity. These effects are rated with a low magnitude and are and the effects of the Project overall is considered to be **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20).

The residual effect on muskox due to the Project that is anticipated to contribute the most to effects on the population is attributed to reduction in reproduction, which may occur due to a number of other potential or residual effects interacting with one another. However, the overall likelihood of a reduction in reproductively in muskox is low because of the high availability of habitat of varying quality outside of the influence of the Project. It is not expected that muskox will be displaced into lower quality habitats as a result of the Project. Displacement could lead to lower productivity due to stress or reduced foraging success, particularly during sensitive periods such as calving.

The combined significance of residual effects due to the cumulative effects of the Back River Project and all past, existing and reasonably foreseeable future projects in the CEA boundary for muskox is anticipated to be **Not Significant**. There were several developments that were considered in the CEA boundary for muskox that could contribute to residual cumulative effects for muskox. Like the Project effects assessment, the cumulative effect on the reproductive output of muskox is the greatest concern, as this has the greatest potential to affect the muskox population on a whole. Mainland populations appear to be declining (Dumond 2006; Rescan 2013c), and thus, muskox population have a lower capacity to buffer additional stresses. However, all cumulative residual effects were rated as low magnitude and were reversible. Therefore, the cumulative effect of all past, existing, and reasonably foreseeable future projects (including the Back River Project) is not expected to affect muskox on a population level.

8. Wolverine and Furbearers

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8. Wolverine and Furbearers

8.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

8.1.1 Introduction

Arctic furbearers include wolverine, wolves, red and Arctic foxes, Arctic hare, and Arctic ground squirrels, and to a lesser degree lynx and marten which are found closer to the treeline. Hare and ground squirrels are considered to be small mammals, which are discussed separately in the Environmental Risk Assessment (Section Volume 8, Chapter 6). This chapter evaluates the potential effects of the Project on furbearers, using wolverines and grey wolves as representative furbearer species.

Wolverine

Wolverines (*Gulo gulo*) are members of the mustelid family, which includes weasels, badgers, and marten. Like other mustelids, wolverines are carnivorous, and are both scavengers and predators on a wide range of prey (COSEWIC 2003). Very large home ranges and low population densities are characteristic of this solitary species, which makes research on this species challenging (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). However, recent advances in camera trapping and DNA analysis have resulted in new information on population dynamics, including more rigorous and potentially higher estimates of population densities (Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011). Inuit have generally regarded wolverines as pests as they cause damage to caches, destroy property, and steal food (KIA 2012). Wolverine pelts were used as fur mats when hunting seals otherwise wolverines were seldom hunted. Their status as pests changed because of the fur trade as their pelts were highly valued and sought after (KIA 2012). This resource dramatically increased trapping and hunting of wolverines by Inuit. The use of wolverine fur as trim on parkas is a relatively recent custom, however, this local use by Inuit became very important (KIA 2012).

Grey Wolf

The grey wolf (Canis lupis) is the largest member of the Canis genus and was once abundant over much of North America and Eurasia. However, the range of the grey wolf has contracted due to habitat destruction and hunting. The wolf is still widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. Populations are stable or increasing within their Canadian range, except in northern Alberta and some parts of the Northwest Territories (Frame, Cluff, and Hik 2008). Wolf reproductive success and population trends are largely regulated by the availability of caribou (Frame, Cluff, and Hik 2008). Wolf pelts were highly valued and sought after by Inuit and the fur was used for trim on clothing, pups for sled dogs, and meat was either thrown away or used to feed dogs (KIA 2012).

8.1.2 Population Trends and Conservation

Wolverine

The wolverine is ranked as “Secure” in Nunavut (CESCC 2010), but the western Canadian population (which includes wolverine in Nunavut) was listed as a species of “Special Concern” by COSEWIC (2003). The population size for the western population, estimated as 15,000 to 19,000 individuals, is above the threshold of 10,000 individuals or less for designation as “Threatened” under COSEWIC’s ranking system (Slough 2007). The western population has not yet been listed under SARA. The geographically disjunct eastern population, extending across northern Quebec and Labrador, is listed as “Endangered” under Schedule 1 of SARA.

Wolverine populations in the central Arctic appear to be stable, the most recent estimate was in 1990 (COSEWIC 2003). Population density is thought to be relatively high in the western Arctic (e.g., Yukon and Northwest Territories), moderate in western Nunavut (including the Kitikmeot region), and low in eastern Nunavut and on Arctic islands (Slough 2007). The total population size of wolverines in Nunavut is estimated as 2,000 to 2,500 individuals (COSEWIC 2003; Slough 2007).

Due primarily to low reproductive rates and low population densities, wolverines are susceptible to population declines (Slough 2007; Inman et al. 2012). For example, the eastern Canadian population may be near extinction, and wolverines have likely been extirpated from Vancouver Island (Slough 2007). Despite high pregnancy rates, fewer than half of all pregnant females produce cubs — most females do not reproduce in consecutive years (Persson 2005; Inman et al. 2012). Reproductive failure occurs early, during gestation or just after birthing, and is thought to result primarily from poor nutritional status of females (Inman et al. 2012). Thus, food availability, especially during winter, is thought to be the main factor limiting reproduction and structuring the population dynamics of wolverines (Persson 2005). In some populations, mortality due to starving is also an important factor (Inman et al. 2012). Population modelling suggests that viable wolverine populations require at least 45 sexually mature females (> 3 years of age; Persson 2005).

The wolverine population in the wildlife RSA occurs within the W/01-KT management area, and is considered to be an abundant breeding population (GN DOE 2005). The Nunavut Department of Environment recommends a TAH of 160 wolverines for the W/01-KT management area. Between 1989 and 2004, 292 wolverines were reported as harvested in Nunavut; but reported harvest rates underestimate actual harvest rates by as much as 80% (Figure 8.1-1; COSEWIC 2003; Slough 2007). For example, the locations of 1,714 wolverine kills were recorded in the West Kitikmeot between 1986 and 2005, and indicate an annual known harvest of 85.7 wolverines per year (Mathieu Dumond, GN DOE, unpublished data). These data indicate that 4% of the kills occurred in the Bathurst Inlet region. Within the wildlife RSA, wolverine harvests were recorded near Bathurst Inlet (Figure 8.1-1).

The Nunavut Department of Environment has recommended that wolverines not be trapped after April 15 or shot after April 30 until October 31 to minimize the harvest of young wolverines (GN DOE 2005). Wolverines give birth in natal dens from late February to early April, young are weaned at 7 to 10 weeks of age, and begin to accompany the mother on foraging trips after late June (Mulders, Boulanger, and Paetkau 2007; Inman et al. 2012). Cubs are nearly full grown and independent by seven months of age (September to November) but stay on the mother's home range until about one year of age (Inman et al. 2012).

Grey Wolf

The *Canis lupis occidentalis* (northern timber wolf) and *nubilus* (plains wolf) subspecies are listed as "Not at Risk" by COSEWIC, while the *arctos* subspecies (Arctic wolf) is listed as "Data Deficient" (COSEWIC 2012). The wolf is listed as secure in Nunavut (CESCC 2010).

Wolves are still found in 90% of their original range in Canada, which is home to an estimated 60,000 individuals (Walton et al. 2001). In Nunavut and parts of the Northwest Territories, wolf populations were thought to be stable or increasing within their range to 1995 (Hayes and Gunson 1995). There are no recent estimates of population trends of wolves for Nunavut. However, wolf den surveys between treeline and Contwoyto Lake from 1996-2009 show declines since 2006 in the number of active dens in late August; Adamczewski et al. (2009) reports this is due to high levels of pup mortality. For this wolf population, reproductive success decreased with increasing distance from dens to migration routes of the Bathurst caribou (Frame, Cluff, and Hik 2008). Because of this relationship between wolves and caribou, in the spring when wolves are raising young, they must travel back and forth to the den site each day until early fall (Cluff, Walton, and Paquet 2002). Wolf productivity and population trends are largely regulated by the availability of ungulate prey. Thus, population decline in tundra wolves in recent years is plausible given high rates of population decline in caribou herds across the Arctic.

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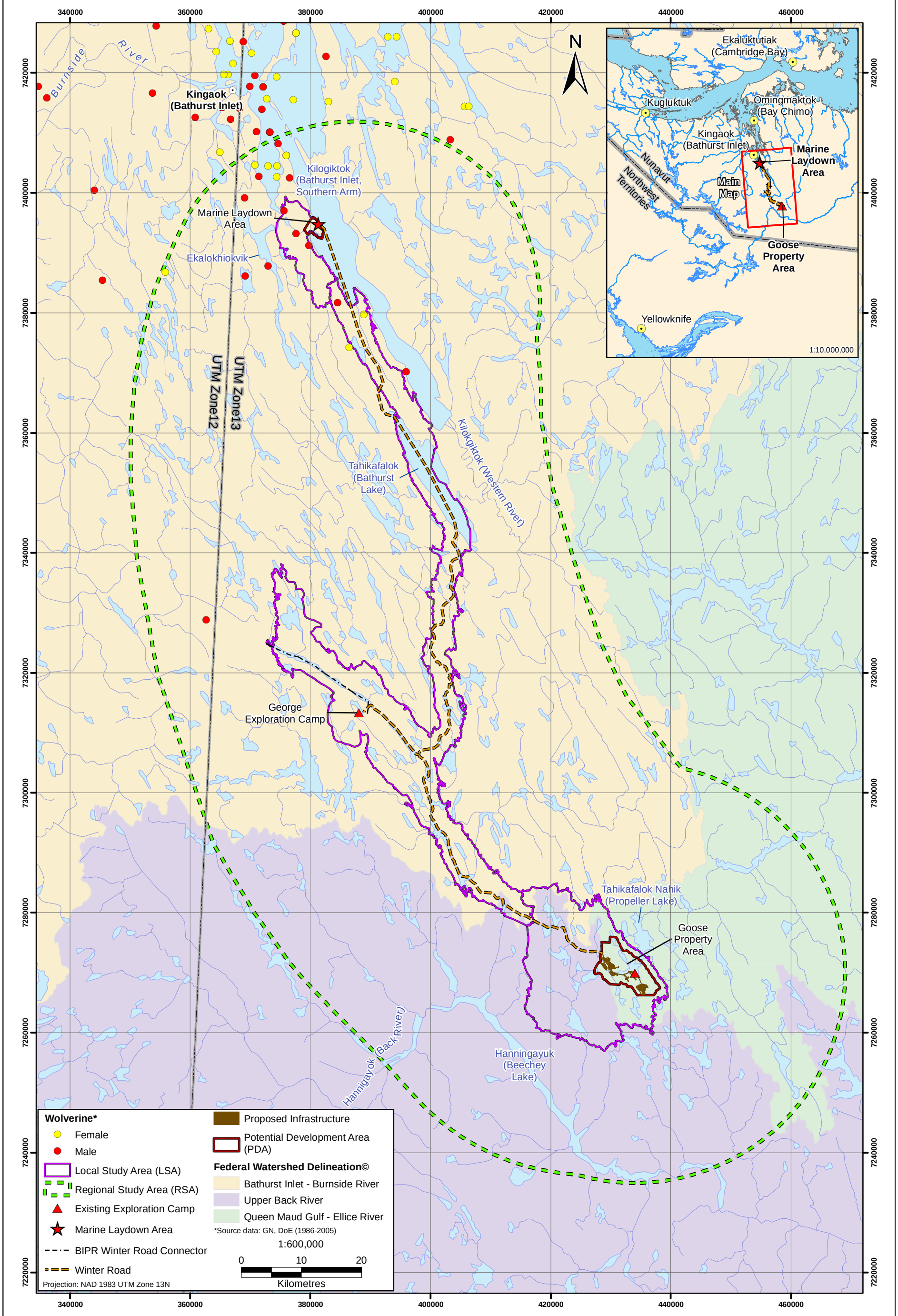

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Figure 8.1-1

Wolverine Harvest Data (1986 to 2005)

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Climate Change

Potential direct effects of climate change on wolverine and furbearers include effects such as increasing temperatures and competition from new species. Increased temperatures and the onset of earlier spring melt will affect overall snow cover and persistence. This combination could have a negative effect on denning sites for wolverines as field observations indicate that all reproductive dens are located in areas that retain snow in the spring (Magoun and Copeland 1998; McKelvey et al. 2011). A low snow pack or early melt can may negatively impact the breeding success and restrict suitable habitat for wolverine. Other furbearers such as Arctic fox populations are declining due to the northward expansion of the competitively dominant range red fox. Another reason Arctic foxes could be declining is the possibly of lower winter survival of small mammals due to less stable winters leading to frequent thawing and icing (Killengreen et al. 2007 ; Post et al. 2009).

Potential indirect effects include changes to caribou populations. Both wolverine and in particular the Arctic grey wolf depend on caribou for sustenance, thus any effect on the caribou herds will have negative implications for both species. The timing of caribou migrations, size of the herd, and routes followed could be affected by earlier and/or warmer spring/summer seasons (see Volume 5, Chapter 5 on potential effects of climate change on caribou). Post and Stenseth (1999) observed that several ungulate populations were declining following warmer winters and Hinzman et al. (2005) suggest a warming climate will likely have a negative population effect on the health of caribou due to overheating and increased mosquito harassment. Any negative population effects on caribou will also have negative impacts on wolverines and furbearers.

8.1.3 Distribution and Migration Patterns

Wolverine

Wolverines are found throughout the Arctic and boreal forests of North America and Eurasia (Copeland and Whitman 2003). In North America, the geographic range of the wolverine extends from Alaska throughout most of northern and western Canada, including the West Kitikmeot region of Nunavut (COSEWIC 2003; Slough 2007).

There are two separate populations of wolverine: the endangered Eastern population is limited to Labrador and Quebec and the Western population (COSEWIC - Special Concern) ranges from Hudson Bay to Alaska with some small extensions into the western United States and into the Great Lakes area (van Zyll de Jong 1975). In the north, wolverines have very large territories ranging from 100 km^2 for an adult female to over 600 km^2 for an adult male (Copeland and Whitman 2003).

Population densities of wolverine are low, approximately one individual per 40 km^2 to one per 800 km^2, depending on habitat and the availability of prey (Persson, Wedholm, and Segerstrom 2010; Inman et al. 2012). Robust estimates of population density using remote cameras and DNA analysis have confirmed previous estimates of low densities derived from winter track counts in Northwest Territories and Nunavut (10 -15 wolverines per 1,000 km2; Mulders, Boulanger, and Paetkau 2007; Royle et al. 2011). Home ranges of male wolverine are on average at least four times larger than female home ranges (Mulders, Boulanger, and Paetkau 2007; Persson, Wedholm, and Segerstrom 2010). For example, estimates of average home range size on the tundra are 73 to 126 km^2 for breeding females and 404 to 666 km^2 for males (Magoun 1985; Mulders 2000). Male home ranges overlap those of several females, in accordance with a polygynous (multiple females per male) mating system, but adult male-male and female-female home ranges rarely overlap due to territorial behaviour (Persson, Wedholm, and Segerstrom 2010). Intra-sexual competitors avoid each other, and when in contact, aggressively defend resources, sometimes to the point of death (Persson, Wedholm, and Segerstrom

2010). These life history strategies indicate that resources — food for males and females, and sexually mature females for males — are very limiting for the wolverine.

Inuit traditional knowledge indicates that wolverines use the Project area (KIA 2012). Specifically, the area surrounding Bathurst Inlet was noted as important for wolverine, potentially due to its importance to caribou, an important food source of wolverine (KIA 2014). Data from wolverine harvests indicate that Bathurst Inlet is a main site for wolverine hunting in the West Kitikmeot (Mulders 2000).

Grey Wolf

The wolf is still widespread throughout much of northern Canada, including the West Kitikmeot region of Nunavut. There are three subspecies of the grey wolf in Canada — all three subspecies may be found within the wildlife RSA (Chambers et al. 2012): *occidentalis* (northern timber wolf), *nubilus* (plains wolf), and *arctos* subspecies (Arctic wolf). The Arctic grey wolf, because their main prey are the migratory caribou, the annual home ranges of Arctic wolves are much larger than those of wolves in more southern latitudes (Walton et al. 2001; Cluff, Walton, and Paquet 2002). Annual home-range sizes averages 63,000 ± 13,000 km^2 for males and 45,000 ± 7,500 km^2 for females (Walton et al. 2001).

During the spring, wolves follow the caribou herds north of the treeline and do not den near calving grounds selecting sites near the treeline south of the calving grounds (Heard and Williams 1992). Although the movement of wolves is localized, this strategy likely optimizes the availability of caribou and alternative food resources for rearing pups (Walton et al. 2001). Local or regional disturbances may affect reproductive success of wolves due to their localized movements during denning. According to Traditional Knowledge, wolves were found wherever there were caribou. Inuit generally hunted the two species together (KIA 2012). Hunting areas for wolves within the wildlife RSA included areas in Bathurst Inlet as well as areas south of Goose near Beechey Lake (KIA 2012, 2014). In addition, TK indicated that wolves make their dens where it is easier to dig, such as eskers and glacial deposits such as sandy areas along riverbanks (KIA 2012). Several areas were identified as denning areas through Inuit TK. Including lower Bathurst Inlet and around Beechey Lake (KIA 2014).

8.1.4 Habitat Use and Diet

Wolverine

Wolverines are unique among northern non-hibernating carnivores because they birth very early in the year (February to early April; Inman et al. 2012). Mating occurs during summer, but implantation of the embryo into the uterine wall, and thus gestation, is delayed until at least December. Gestation occurs over 45 days, and thus females may give birth as early as February, but most give birth from late March to early April (reviewed in Inman et al. 2012). Females usually move cubs from natal dens (where cubs were born) to one or more maternal dens (where cubs are nursed) until they are weaned at 7 to 10 weeks of age. Thus, den use may extend from February to early May. After weaning, females forage for cubs and leave them at rendezvous sites, until after late June when cubs are able to forage with females.

Wolverines usually choose den sites within rocky boulder fields in snowdrifts where a deep insulating layer of snow will be maintained throughout the denning period (February to April); dens and den sites are often used for consecutive years (Lee and Niptanatiak 1996; Magoun and Copeland 1998). Typically, wolverine dens are built under at least 1 to 5 m of snow and consist of long, complex snow tunnels that lead down to boulder fields, rock overhangs, or large cracks in rocks, which are large enough to allow kits to move around, and provide additional protection from predators (Magoun and Copeland 1998; Inman et al. 2012; May et al. 2012). The importance of sites with delayed snow melt in spring for denning is revealed by the strong relationship of wolverine distribution with snow cover — 100% of

562 den sites in North America and Fennoscandia were in sites where snow melted later during spring (Copeland et al. 2010). A den usually consists of snow tunnels within boulder fields terminating in a crevice (Magoun and Copeland 1998). Proximity to habitat that provides small mammals prey for cubs may also an important factor in den site selection winter resting sites are an important aspect of mustelid habitat. There are few data of characteristics of resting sites on the tundra, but snow dens or burrows are probably used for resting.

Wolverines are both scavengers and predators, and feed on a wide variety of prey and carrion throughout the year. Food caching is an important survival strategy, especially in winter, and may drive reproductive rate (Magoun 1987; Mulders 2000; Thorpe et al. 2001; Inman et al. 2012). Characteristics of good cache sites are structures that prevent access by competitors, and allow cold storage to prevent rot in spring and summer. Though wolverines use a variety of habitats while ranging over large tracts of land in search of food (Mulders 2000; Thorpe et al. 2001; COSEWIC 2003), they are often associated with rocky boulder fields which provide good sites for caching food (Johnson et al. 2005; Inman et al. 2012).

Wolverines feed on ungulates, but mostly as scavengers. Scavenged caribou probably comprise a large portion of wolverine diets in the Arctic. The majority (62%) of wolverine stomachs from 277 carcasses collected in the Kitikmeot region contained caribou, while 11% of stomachs contained primarily muskox (Mulders 2000). Wolverine densities appear to be the highest where caribou are abundant and where wolf predation on caribou is high and creates scavenging opportunities (COSEWIC 2003). In fact, wolf kills appear to provide a preferred food source for wolverine, suggesting a close link between wolf and wolverine population dynamics (van Dijk et al. 2008). However, wolverines are the main predator of caribou calves in some regions (e.g. British Columbia; Gustine et al. 2006).

The summer diet of wolverines is more varied than their winter diet, and contains more freshly killed prey (Magoun 1987). It is thought that wolverine foraging strategies switch from mostly scavenging and caching during winter, to hunting for birds and small mammals during summer (Inman et al. 2012). However, scavenging likely remains a key foraging strategy during summer, and is not limited to wolf kills as wolverine have been observed stealing goose carcasses from fox dens (Samelius et al. 2002). On the tundra during the summer, wolverine hunt mainly ground squirrels, Arctic hare, ptarmigan, geese and their eggs (Magoun 1987; Samelius et al. 2002).

Female wolverine consume more small mammal prey than males during summer, possibly because their movements are more restricted due to cub-rearing (van Dijk et al. 2008). Small mammals may be especially important to females and cubs during cub-rearing; survival of young wolverines was significantly higher in years when small mammals were abundant (Pulliainen 1968). During the summer, wolverine occurrence is strongly related to the presence of sedge habitat, possibly because small mammals are usually abundant there (Johnson et al. 2005).

Grey Wolf

Wolves are the predominant predators of barren-ground caribou and rely primarily on adequate ungulate densities to maintain wolf population size (Walton et al. 2001; Paquette and Ludwig 2003; Frame 2005; Frame, Cluff, and Hik 2008; Wiebe et al. 2009). Wolves on the tundra are also the main predator of muskox, and Inuit TK confirms that wolves specialize on muskox harvesting as they are a larger prey source than caribou (KIA 2014). Alternative prey, such as birds and small mammals, can sustain wolves during periods of low ungulate availability (Heard 1992). Ducks and geese, especially during the moulting period when birds are flightless, can also comprise a significant portion (30%) of the diet of wolves (Wiebe et al. 2009). Despite being easily accessed, wolves rarely forage on goose eggs, likely because wolves can experience biotin (a B-vitamin) deficiency from consuming too much albumin in eggs (Wiebe et al. 2009).

Migratory wolves winter below the treeline and arrive at denning sites on the tundra in late April and give birth shortly thereafter (Walton et al. 2001). Less is known of the denning ecology of tundra-wintering wolves, but the timing of denning is likely similar. Wolves are territorial during denning and migratory wolves in the Kitikmeot region show strong fidelity to den sites (Walton et al. 2001).

Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually in September or October (Walton et al. 2001). Pups are usually cared for cooperatively at communal dens, thus dens usually represent the reproductive efforts of multiple wolf pairs (Frame et al. 2004).

Pups are often moved from natal den sites to rendezvous sites, which like natal dens are re-used in consecutive years (Frame, Cluff, and Hik 2007). Adults move pups when disturbed by approaching humans at the den sites; pup age is the strongest predictor of pup movement. Pups less than three weeks old are not moved, pups older than six weeks were always moved (Frame, Cluff, and Hik 2007).

Inuit TK indicates that most wolf dens are located on eskers (KIA 2012). Esker habitats are granular and sandy, likely facilitating soil excavation for dens in a landscape dominated by bedrock, boulders, standing water, and permafrost (McLoughlin et al. 2004). In the tundra of the Canadian Arctic, esker habitat only comprises 1-2% of the landscape (McLoughlin et al. 2004). Therefore, suitable denning habitat for wolves inhabiting northern tundra is likely a limiting factor and areas containing eskers should be considered particularly important (McLoughlin et al. 2004). Of the dens observed during den surveys for the Project, all 7 dens were located on eskers.

8.1.5 Baseline Data for Furbearers

Four types of baseline surveys were conducted for wolverine and grey wolf in the wildlife RSA including: 1) population-estimation using DNA mark-recapture; 2) den surveys; 3) incidental observations; and 4) habitat suitability modelling. The modelling was conducted in the wildlife RSA to evaluate the quality of habitat in the study area for wolverine habitat and grey wolf denning.

Baseline information for wolverine and grey wolf used in this section included the following reports:

- *Back River and Hackett River Projects*: *2010 Caribou and Muskox Baseline Report* (Rescan 2011a, Appendix V5-5E).
- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012, Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013e, Appendix V5-5C);
- *Back River Project: 2013 Wildlife Baseline Report* (Rescan 2014b, Appendix V5-5F).
- *Back River Project: 2012 Grizzly Bear and Wolverine DNA Baseline Report* (Rescan 2013b, Appendix V5-6A);
- *Back River Project Grizzly Bear and Wolverine DNA Baseline Report, 2013 (Rescan 2014a, Appendix V5-6B); and*
- *Back River Project*: *2013 Wildlife Habitat Suitability Baseline* (Rescan 2013a, Appendix V5-5A); and

Other sources of supplementary wildlife data used for wolverine and grey wolf in this section include:

- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) (Appendix V3-3A of FEIS);

- *Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)*(KIA 2014) (Appendix V3-3B of FEIS)
- *Bathurst Inlet Port and Road Project: Caribou and Muskox Baseline Study* (Rescan 2007a);
- *2007 Wildlife Baseline Report Hackett River Project* (Rescan 2008a);
- *2008 Wildlife Baseline Report Hackett River Project* (Rescan 2008b);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008); and
- *Bathurst Inlet Port and Road Project: Wildlife Baseline Studies, 2001-2002* (Rescan 2007b).

8.1.5.1 Methods

DNA Mark-Recapture

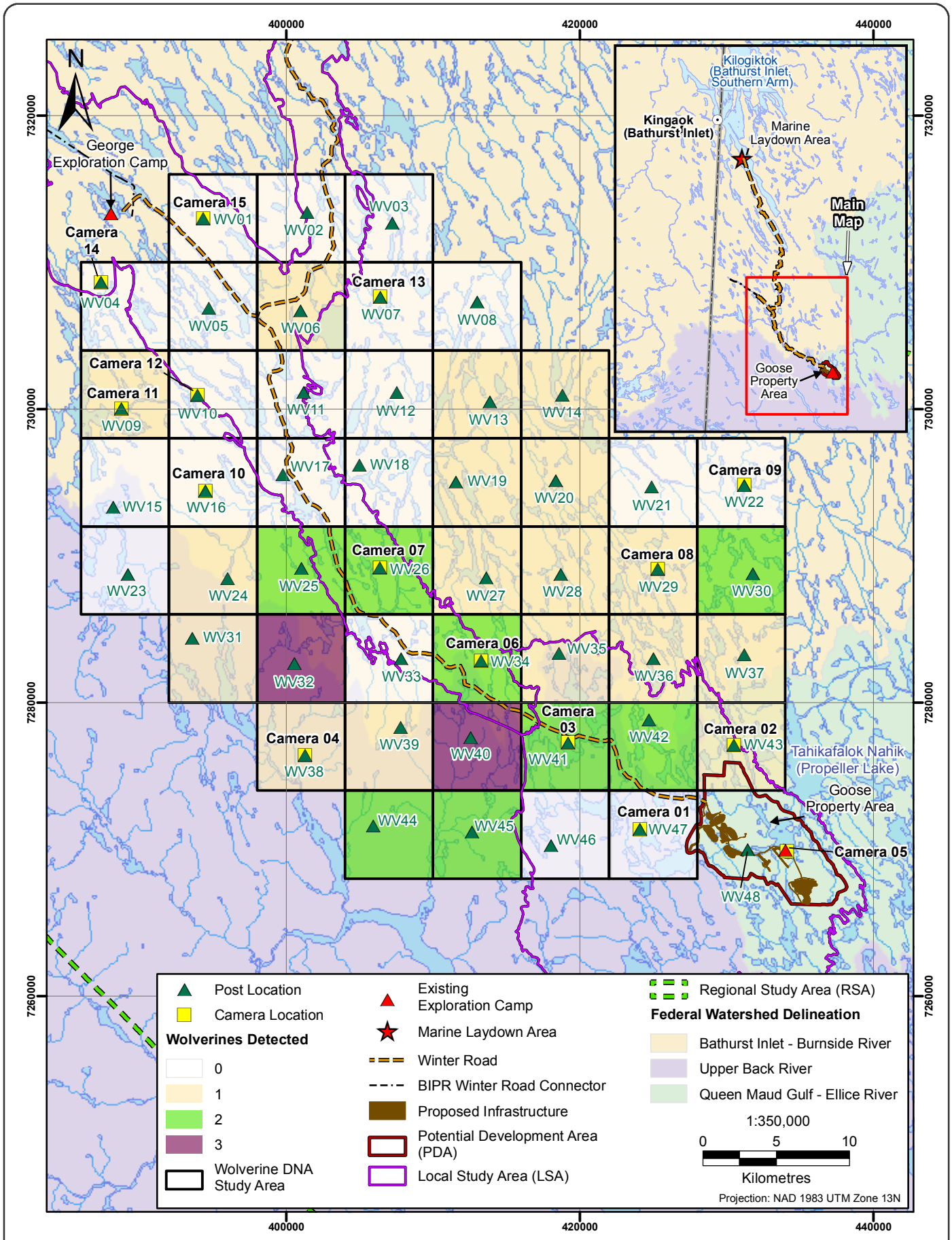
A wolverine DNA study was conducted in 2012 and 2013 for the Back River Project (Rescan 2013e, Appendix V5-5C; 2014a, Appendix V5-6B). In 2012, the study area was the south study grid, a 1,692 km^2 area roughly centered between the Goose Property Area and the George Exploration Camp (Figure 8.1-2). In 2013, two study areas were used, the south study grid and an additional north study grid; the north study grid was roughly centred on the proposed marine laydown area and totalled 1,800 km^2 (Figures 8.1-3 and 8.1-4). Each study grid was divided into 6 x 6 km cells; the south study grid was divided into 47 cells and the north study grid was divided into 50 cells. No cells were delineated overlapping existing exploration camps, to ensure that wolverine posts were not within 5 km of camps for safety reasons.

In 2012 and 2013, a 1.5 m post wrapped with barbed wire was set up within each cell and secured with rocks. A long-distance (strong-smelling) lure was used to draw in wolverines and a piece of fish was used as a food reward to provide incentive for wolverines to climb the posts. Three checks to collect hair samples were conducted in both years: these were spaced a minimum of 10 days and a maximum of 14 days apart.

DNA extracted from samples went to a multi-locus analysis of individual identity; there was no initial single-locus pre-screen for sample quality or species. This analysis used eight markers, including a ZFX/ZFY gender marker and seven microsatellite markers; the standard for wolverine projects from the Arctic. Details of the methods are reported in the 2012 and 2013 Grizzly Bear and Wolverine DNA Baseline Reports (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B).

Carnivore Den Surveys

For carnivores including wolverine and wolves, den surveys were conducted to identify the number and distribution of existing dens within the wildlife RSA, to identify dens that are active, and to identify predominant resident carnivore species utilizing the wildlife RSA (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013e). Two surveys were conducted, an occupancy survey (May/June) and a productivity survey (July). The occupancy survey identified that a den was “occupied” and used for breeding, while the productivity survey was conducted to examine if the den was successful (adults and young were present) or abandoned (indicating the pups died and the den failed for that year).



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Wolverine Post Locations and Capture Frequency in the South Study Grid, 2012

Figure 8.1-2

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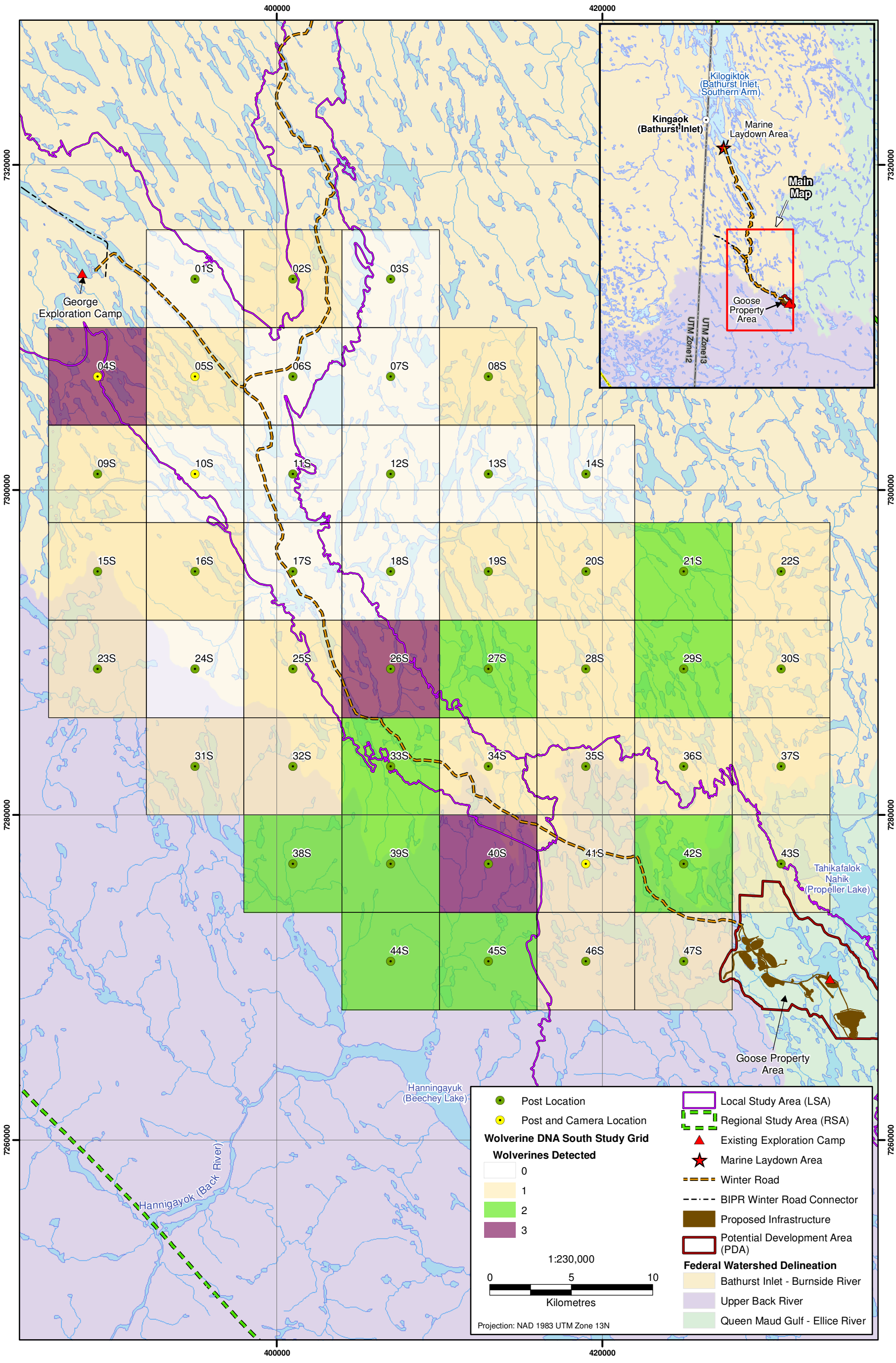

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Figure 8.1-3

Wolverine Post Locations and Capture Frequency in the South Study Grid, 2013

Rescan an ERM company

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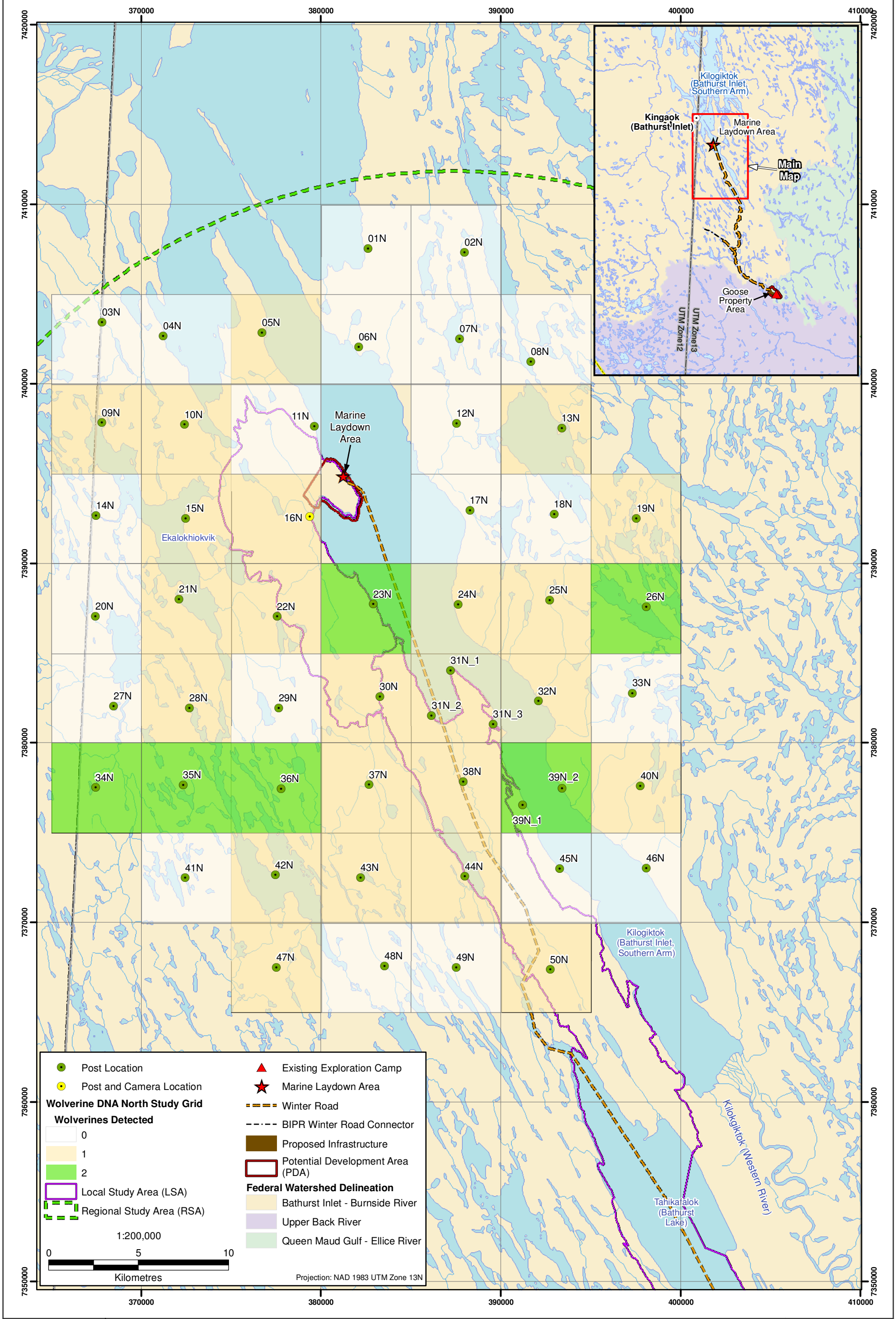

Figure 8.1-4

Wolverine Post Locations and Capture Frequency in the North Study Grid, 2013

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These surveys were carried out via low level aerial surveys in esker and glacial-fluvial habitat. Occupancy surveys were carried out in 2007 (Gartner Lee Limited 2007), while both occupancy and productivity surveys were conducted in 2011 (Rescan 2012, Appendix V5-5D) and 2012 (Rescan 2013e, Appendix V5-5C) throughout the wildlife RSA. Surveys were flown at an altitude of 50 to 100 m above the terrain and at ground speeds between 30 to 80 km/h to minimize disturbance to carnivores in the area but to maintain an effective height and speed for observers to effectively discern dens and signs of activity (i.e., animals, scat, tracks, or prey remains). Full details of the carnivore den survey methods can be found in the 2011 and 2012 Wildlife Baseline Reports (Rescan 2012, Appendix V5-5D; 2013e).

Incidental Observations

Incidental observations of wolverine and other furbearers were recorded in the wildlife RSA when observed on the tundra during other wildlife and environmental baseline surveys conducted between 2007 and 2013, and when captured by remote cameras distributed throughout the wildlife RSA for caribou studies (Chapter 5, Section 5.2.4.4) and to supplement the wolverine DNA studies (wolverine: Section 8.2.6) in 2012 and 2013. Remote cameras for the wolverine DNA study recorded observations from March to early May 2012 and 2013; cameras for the caribou baseline studies recorded observations from late May 2012 to August 2013. Images from these cameras were quality checked to remove duplicate images of the same individual and documented. Full details on data handling for the remote camera studies can be found in the 2012 and 2013 Wildlife Baseline Reports (Rescan 2013e, Appendix V5-5C; 2014b, Appendix V5-5F) and the 2012 and 2013 Grizzly Bear and Wolverine DNA Baseline Reports (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B).

Habitat Suitability

Wildlife habitat suitability studies were conducted within the wildlife LSA and RSA to inventory and rate the habitat types for wolverine and grey wolf which can be used to assess the effects of development on wildlife habitat. Habitat suitability modelling methodology was guided by BC Resource Information Standards Committee standards (RIC 1999). As defined by these standards, suitability models identify areas which, in their current condition, provide suitable (i.e., functioning) habitat for a particular species. Suitable habitat generally means that the physical attributes (e.g., elevation, slope, aspect, soil texture, and geographical location) and the biological components (e.g., vegetation species composition, structure, and age) of an area are likely appropriate for the species in question.

The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems. The WKSS mapping was completed between 1997 and 2001 using remote sensing and extensive field work (Matthews, Epp, and Smith 2001). The mapping utilized satellite imagery to classify vegetation types over roughly 200,000 km^2 of the West Kitikmeot / Slave Study Area, which stretches from the arctic coast of the Coronation Gulf in the north to the taiga treeline in the south (Matthews, Epp, and Smith 2001).

8.1.5.2 Results

Wolverine

Wolverines have been detected in the wildlife RSA between 2001 and 2013 (Rescan 2002; Gartner Lee Limited 2007; Rescan 2013e, Appendix V5-5C; 2013b, Appendix V5-6A; 2014a, Appendix V5-6B; 2014b, Appendix V5-5F). Of the three methods used to detect wolverine (DNA Mark-recapture, Carnivore Den surveys, and incidental observations during other baseline studies including remote camera studies), DNA Mark Recapture detected the largest number of wolverines and gives the best approximation of the number of wolverines that occur in the wildlife RSA.

DNA Mark Recapture

A total of 196 wolverine hair samples were collected during 2012 and submitted for DNA analysis (Rescan 2013b, Appendix V5-6A). Across the two study grids in 2013, a total of 496 hair samples were collected, of which 494 were submitted for DNA analysis (Rescan 2014a, Appendix V5-6B). Of the total number of hair samples collected, 74 (38%) were successfully extracted and assigned to 12 independent individuals in 2012, and 179 (36%) were successfully extracted and assigned to 19 independent individuals in 2013. Across the two years, a total of 23 unique individuals were recorded, which included 12 males and 11 females; eight individuals identified in 2012 (four males and four females) were recaptured in 2013. In total, fifteen individuals (eight males and seven females) were recorded within the south study grid across two years of surveys and seven (three males and four females) were recorded in the north study grid in 2013; one male was recorded in both study grids (Ref ref). While the wolverine study area does not represent a geographically closed population, in terms of individual detections, 2012 and 2013 results of the wolverine DNA study indicate that the Back River Project area does appear to support a moderately sized wolverine population (Rescan 2013b, Appendix V5-6A; 2014a, Appendix V5-6B).

A male wolverine was detected in the south study grid in both 2012 and 2013 that had previously been recorded in a DNA study conducted at Ekati approximately 225 km to the southwest of the south study grid.

The movements of wolverines within and across sampling periods were investigated by calculating the straight line distance between posts for any individual captured in more than one cell. Within a single sampling period, results suggest that males may have travelled longer distances than females. The cumulative straight line distance between multiple DNA posts where an individual female wolverine was detected ranged from 24 to 43 km in 2012, and 4 to 47 km in 2013. In contrast, cumulative straight line distances between multiple posts for males ranged from 12 to 36 km in 2012, and 5 to 140 km in 2013. The longest single straight line distance between two posts visited by an individual during the entire survey period in 2012 was 22 km. In 2013, the longest straight line distance across the entire survey period was 118 km, travelled by a male wolverine between the north and south study grids. Given the topography and presence of waterbodies between many of the cells, the actual distances travelled between points are likely considerably higher.

Minimum recorded area estimates were generated to represent the areas of use for individual wolverines; estimates were calculated by encompassing the area between all posts where individuals were recorded across the survey period. In 2012, the minimum recorded area estimates for individual wolverines ranged from 89 km^2 and 264 km^2, with an average area of 162 km^2. In 2013, minimum recorded area estimates ranged from 18 km^2 to 1,853 km^2, with an average area of 263 km^2. Across both years of study, male wolverines had slightly larger areas of use than females (166 km^2 versus 157 km^2 in 2012, and 415 km^2 versus 90 km^2 in 2013). There were several areas where the minimum recorded area estimates for individual wolverines overlapped one another. In most cases, the area of overlap was between a male and a female.

Carnivore Den Surveys

Den surveys for carnivore dens were carried out as part of surveys for wolf dens via low level aerial surveys in esker and glacial-fluvial habitat during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013e, Appendix V5-5C). Two active wolverine den sites were located near the Goose Property in 2012 (Figure 8.1-5; Rescan 2013e, Appendix V5-5C). Both wolverine dens were found in rocky boulder areas, and one was located within 1 km of proposed site infrastructure in the 'Goose Neck' of Goose Lake (Figure 8.1-5). The den in the Goose Neck was incidentally confirmed as active in 2013 during the wolverine DNA study; an adult and

a juvenile were observed at the den site in early March and on numerous occasions an adult was observed at the site throughout April and May. The den remained active (and likely successful) despite drilling, water pumping, and some snowmobile activity in the area within 200 to 300 m of the den. This suggests that wolverines which have built their dens near sources of long-term human activities can habituate to these activities. This result is important for later mitigation and management of wolverine in the Project area.

Incidental Observations

Wolverines have been rarely detected during aerial and ground surveys of the wildlife RSA between 2001 and 2013 (Figure 8.1-5). Because of their relatively small size, wolverines are probably difficult to detect from the air, except when the ground is snow-covered. Therefore, more wolverines were likely present, but not seen during aerial surveys. In 2001, one wolverine was observed in the western RSA and another observed south of the proposed marine laydown area (Rescan 2002). In 2007, two incidental observations of wolverines were recorded (Gartner Lee Limited 2007). In 2010, one wolverine was incidentally sighted east of the Goose Property Area (Rescan 2011a, Appendix V5-5E), and four wolverines were observed incidentally during the baseline studies conducted in 2012 (Figure 8.1-5; Rescan 2013e, Appendix V5-5C), one of which occurred in the Goose Property Area. No wolverines were observed in 2011 (Rescan 2012, Appendix V5-5D). In 2013, there were seven observations of wolverines within the wildlife RSA. Most wolverines were observed in the southern RSA, including an individual that was recorded at the Goose exploration camp. In addition, one individual was recorded on the ice in Bathurst Inlet, potentially scavenging for seal remains from grizzly bear kills (Figure 8.1-5).

In addition to wolverines observed during other baseline studies conducted in the wildlife RSA, remote cameras distributed within the wildlife RSA recorded numerous observations of wolverines between March 2012 and August 2013 (Rescan 2013e, Appendix V5-5C; 2014b, Appendix V5-5F). Most detections of wolverine by cameras were recorded during the winter periods, with the highest number of detections recorded in April (15 of 34 detections in 2012, 35 of 51 detections in 2013). Several cameras located near the Goose Property and one located near the proposed marine laydown area had detections of up to 10 individuals in 2012 and 2013; it is likely that some of these observations are re-counted individuals (Figure 8.1-5).

Habitat Suitability

Habitat suitability is based on identify the life requisites for a particular species. These include specific activities of an animal that are critical for sustaining and perpetuating the species and that depend on particular habitat attributes or conditions. Life requisites include feeding, cover, breeding, migration, and hibernation. The life requisites assigned to wolverine were denning characteristics for reproducing (Table 8.1-1).

Table 8.1-1. Seasonal Life Requisites of Wolverine Denning

Season	Date	Life Requisite	Habitat Preference
Denning	February to early May	Reproducing	Landscape features that provide deep, persistent snow packs.

The results of the wolverine suitability modelling indicate that slightly less than half of the wildlife LSA and RSA contained habitat features that may offer denning opportunities (Table 8.1-2; Figure 8.1-6). Due to the variable nature of wolverine denning preferences, this result should be assumed to be a coarse assessment of denning potential where the actual total area of the wildlife LSA and RSA is likely much lower.

Table 8.1-2. Area and Proportion of Suitable and Not Suitable Habitat within the Wildlife LSA for Wolverine Denning

Suitability Rating	Amount of Habitat in the LSA[1]		Amount of Habitat in the RSA[2]	
	Area (ha)	% of LSA	Area (ha)	% of RSA[2]
Suitable (Useable)	61,366.5	45.8	562,221.4	44.7
Not Suitable	72,563.8	54.2	694,931.2	55.3

[1] LSA = 134,369.3 ha, approximately 439 ha of the wildlife LSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the LSA is 133,930 ha.
[2] RSA = 1,262,004.6 ha, approximately 4,852 ha of the wildlife RSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,153 ha.

Grey Wolf

Carnivore Den Surveys

Low level aerial surveys for wolf dens in esker and glacial-fluvial habitat were conducted during the end of May or early June, and July of 2007, 2011, 2012, and 2013 (Gartner Lee Limited 2007; Rescan 2012, Appendix V5-5D; 2013e). In 2007, five active wolf dens were located within the wildlife RSA with one or two adults observed at all active wolf dens and pups recorded at four of the den sites (Gartner Lee Limited 2007). Den sites were evenly dispersed throughout the wildlife RSA (Figure 8.1-7; Gartner Lee Limited 2007). No denning activity was found at six historic wolf den locations in the wildlife RSA that were revisited in 2007 (Gartner Lee Limited 2007).

During the 2011 field season, no grey wolf dens were found (Rescan 2012, Appendix V5-5D). In 2012, two active wolf dens were recorded during carnivore den surveys with adults observed at both sites (Rescan 2013e, Appendix V5-5C). One den was located on the west side of the wildlife RSA. The other den was located approximately 30 km northwest of Goose Property (Figure 8.1-7). Productivity was recorded as "unknown" at these two dens as no kits were observed. Abundant wolf scat, prey remains, and hair were observed near the entrance to the dens indicating recent activity and potential productivity. All den sites observed during 2007 and 2012 were located in eskers.

Incidental Observations

During baseline studies conducted between 2001 and 2013, there were 86 observations of wolves recorded incidentally in the wildlife RSA (Figure 8.1-7). Four wolves were observed incidentally in 2001 and 2002 (Rescan 2002). Another nine wolves were observed incidentally outside of the den survey conducted in 2007 (Gartner Lee Limited 2007). Two wolves were observed during aerial surveys for ungulates conducted in 2010 (Rescan 2011a, Appendix V5-5E). During the 2011 field season, 10 wolves (including four yearling wolves) were observed during baseline surveys conducted in the wildlife RSA (Rescan 2012, Appendix V5-5D). In 2012, 16 wolves observed incidentally (Rescan 2013e, Appendix V5-5C). A total of 45 wolves were observed incidentally in 2013, which included a pack of six wolves recorded travelling along the Western River drainage in the northern wildlife RSA (Figure 8.1-7). It should be noted that incidental observations of wolves likely represent repeated observations of the same individuals or packs of individuals. Despite the potential for repeated observations of the same individuals, the spatial distribution of incidental observations indicates that wolves use habitat across the entire wildlife RSA (both north and south). In particular, wolves were frequently observed near the margins of lakes, along river drainages, and travelling on eskers.

In addition, remote cameras located in the wildlife RSA recorded 92 additional wolves in 2012 and 126 in 2013 (Rescan 2013e, Appendix V5-5C; 2014b, Appendix V5-5F). As noted above, these observations likely include individuals recorded more than once (Figure 8.1-7).

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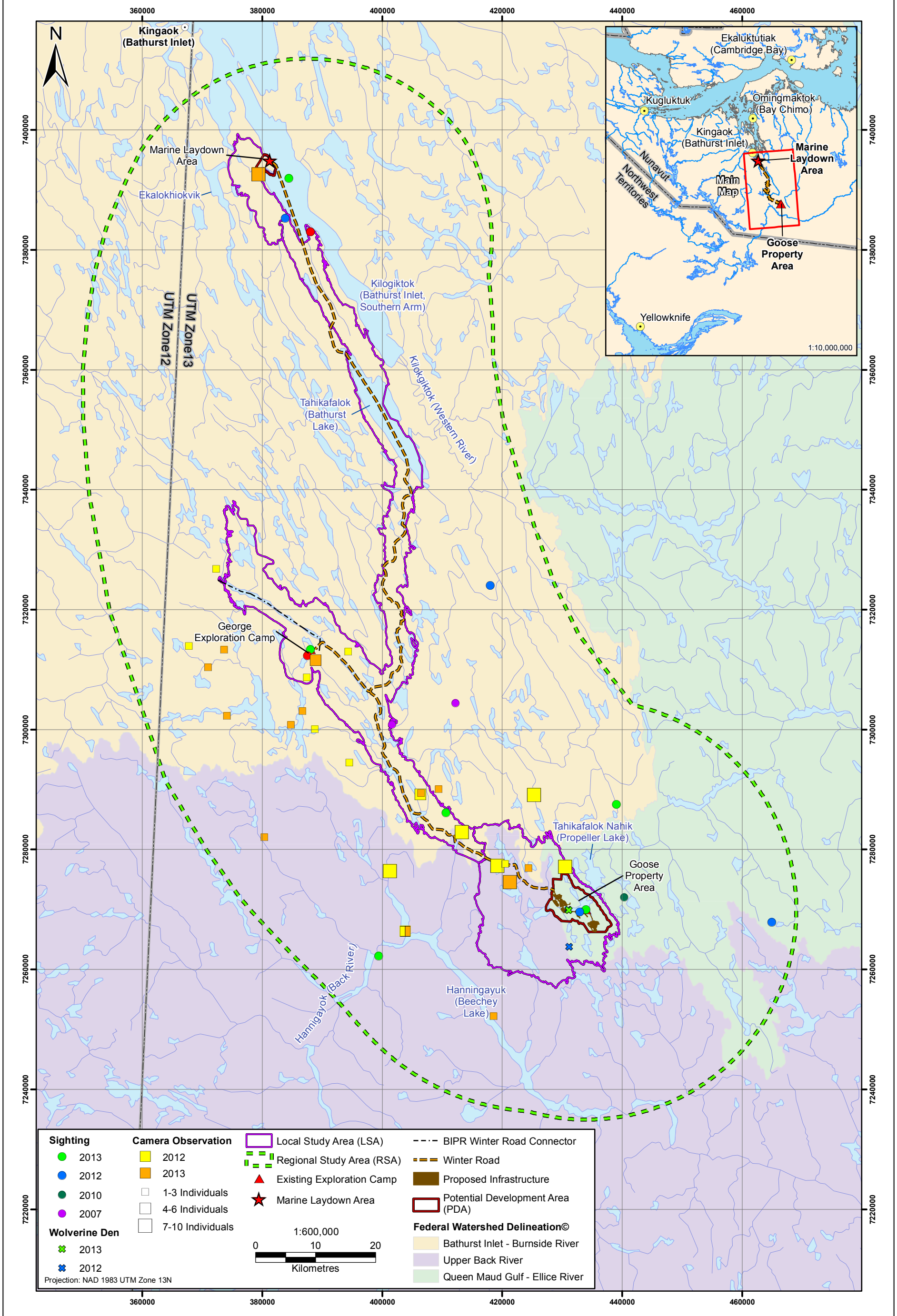

Figure 8.1-5

Den Locations and Incidental Observations of Wolverines, 2001 to 2013

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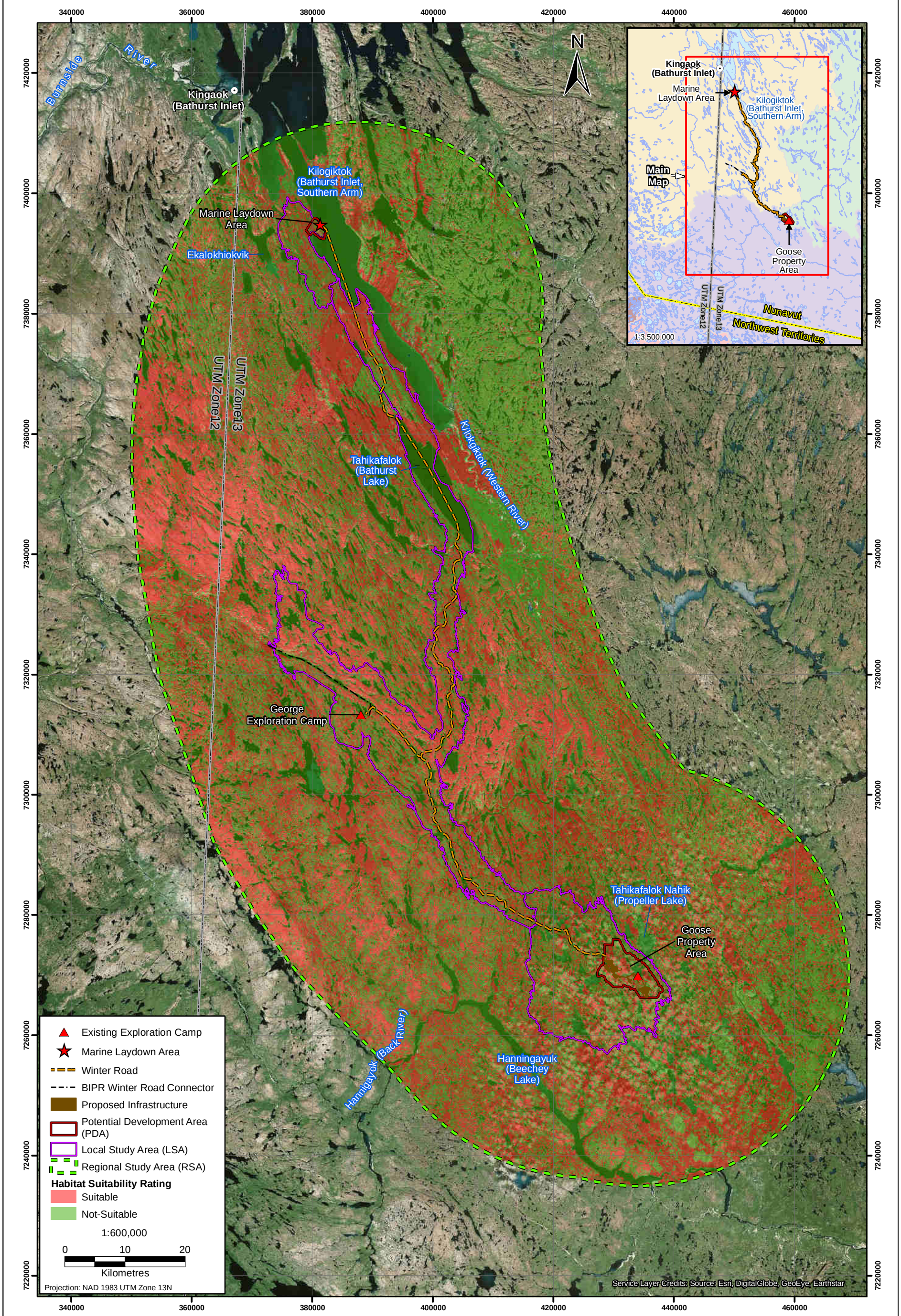

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Figure 8.1-6

Wolverine: Denning Habitat in the Local Study Area and Regional Study Area

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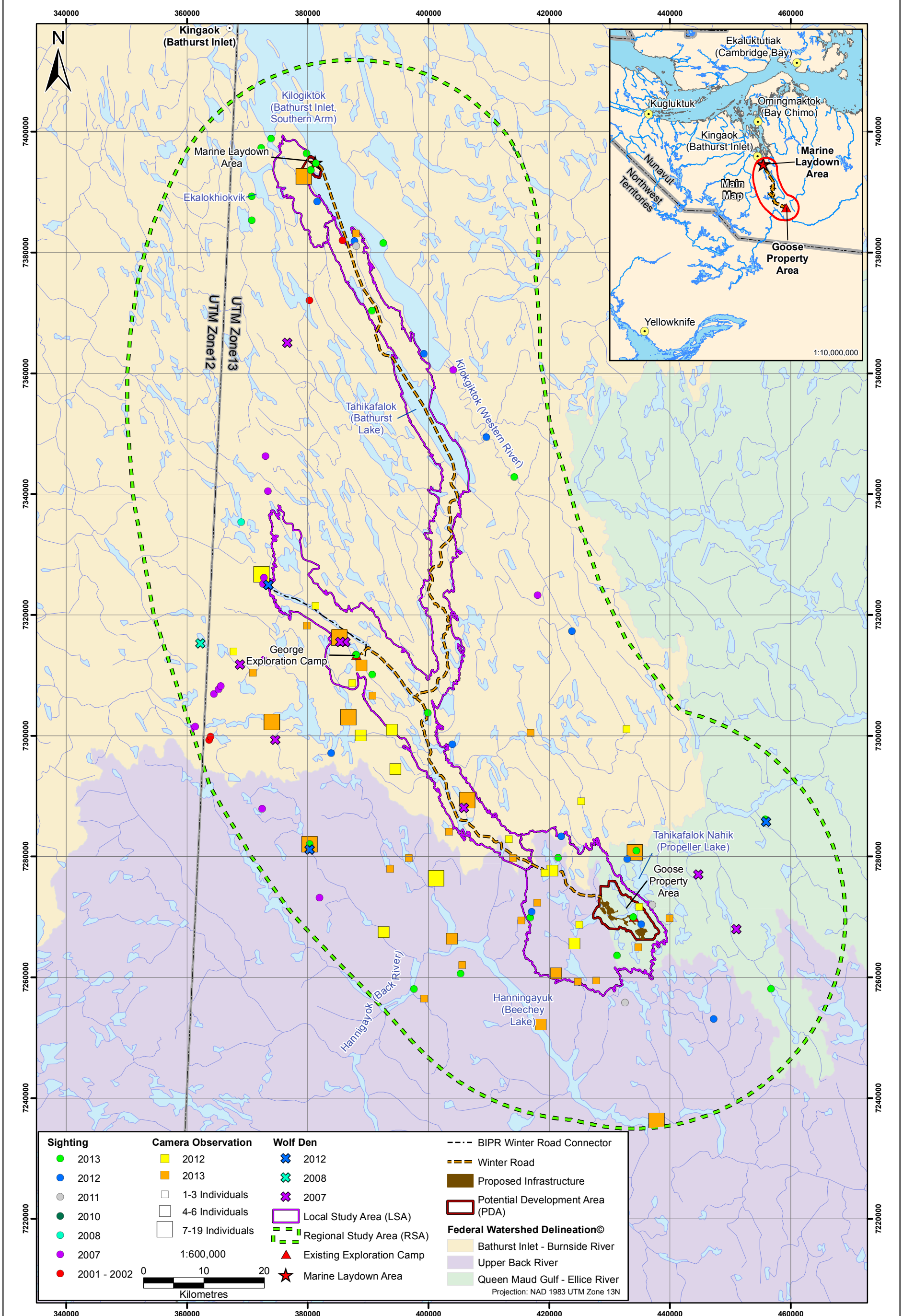

Figure 8.1-7

Wolf Sightings and Locations of Dens, 2001 to 2013

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Habitat Suitability

The life requisites being rated for habitat suitability for the grey wolf in this report are living and reproducing and the respective seasons is spring - denning (Table 8.1-3). Wolves breed once per year, typically during March or April. After a nine-week gestation period, litters remain in dens for up to two weeks. Throughout the late spring and early summer pups remain close to dens, while adults hunt nearby. By late summer to early fall they join the pack as it follows caribou and begin to participate in hunting activities.

Table 8.1-3. Seasonal Life Requisites of Grey Wolf

Season	Date	Life Requisite	Habitat Preference
Denning	Late April to September	Living and reproducing	Eskers, near prey

The results of the modelling indicate that potential denning sites in both the wildlife LSA and RSA are scarce, even when including moderate and low value sites. The combined high, moderate and low value habitat for the wildlife LSA was approximately 3%, while the wildlife RSA was somewhat higher with a combined total of less than 4% (Table 8.1-4: Figure 8.1-8). While these results appear to be representative of the study areas (where eskers and other suitable terrain features are limited in extent), it likely underestimates the total potential. Additional denning opportunities may occur in both study areas. Traditional Knowledge indicates that wolves also den on lake banks (lacustrine materials), which were not included in the modelling due to the inability to differentiate between suitable lake banks and open water (with open water comprising the vast majority of the mapped lake polygons).

Table 8.1-4. Area and Proportion of High, Moderate, Low, and Nil-rated Habitat within the Wildlife LSA and RSA for Grey Wolf

Suitability Rating	Amount of Habitat in the Wildlife LSA		Amount of Habitat in the Wildlife RSA	
	Area (ha)[1]	% of LSA[2]	Area (ha)[1]	% of RSA[2]
High	386.5	0.3	5,457.20	< 1
Moderate	8,598.2	6.4	6,616.49	< 1
Low	4,834	3.6	43,061.49	3.4
Nil	120,111.6	89.7	1,202,017.39	95.0

[1] LSA = 134,369.31 ha, approximately 439 ha of the wildlife LSA fell in the unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife LSA is 133,930 ha.
[2] RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,152.58 ha.

8.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

All identified traditional knowledge (TK) regarding wolverine and grey wolf ecology and habitat has been addressed throughout this assessment. This section summarizes the process of incorporating TK throughout the baseline studies, selection of VECs, selection of assessment boundaries, assessment of potential effects, and recommendations for mitigation and adaptive management. Inuit TK was adapted from:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012)(Appendix V3-3A of FEIS); and
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3C of FEIS).

Traditional knowledge, land user knowledge and thoughts raised by Kitikmeot Inuit Association and land users were incorporated into the effects assessment chapter in five primary ways:

1. Wolverine and grey wolf were included as a VEC for a number of reasons (Section 8.3.2), including that they are a culturally and socially important species in the Project area.
2. Land users were consulted and included on the positioning of the posts used for the DNA mark-recapture study. Land users provided insights on wolverine behaviour and habitat use and directed the installation of hair-capture posts in the best possible locations to attract wolverines (Section 8.1.5).
3. Traditional Knowledge and land user information were used to position the remote cameras to maximize capture of passing caribou, wolverines, and grey wolves. Land users worked with Rescan biologists in the field to position and install cameras in high-quality travel corridors (Section 5.1.5).
4. Habitat usage and foraging information from TK and land users was incorporated in the habitat suitability modelling report and therefore included in the environmental setting (Section 8.1.5) and effects assessment where habitat loss (Section 8.5.2.1) and disturbance (Section 8.5.2.2) is evaluated.
5. Traditional Knowledge and land user information was included in the preparation of management plans to reduce the attractiveness of the camps and other infrastructure (Volume 10, Chapter 20).

The following reports were reviewed for TK specific information related to wolverine and wolves:

- *the Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project), Results from Data Gaps Workshops, Final Report (June 2014)*(KIA 2014);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013c) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VECs selection, assessment boundaries, and recommendations for mitigation and adaptive management.

8.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds were also documented. These studies were guided by TK including the help of land users in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and Environmental Risk Assessments (Volume 8, Chapter 6) were developed.

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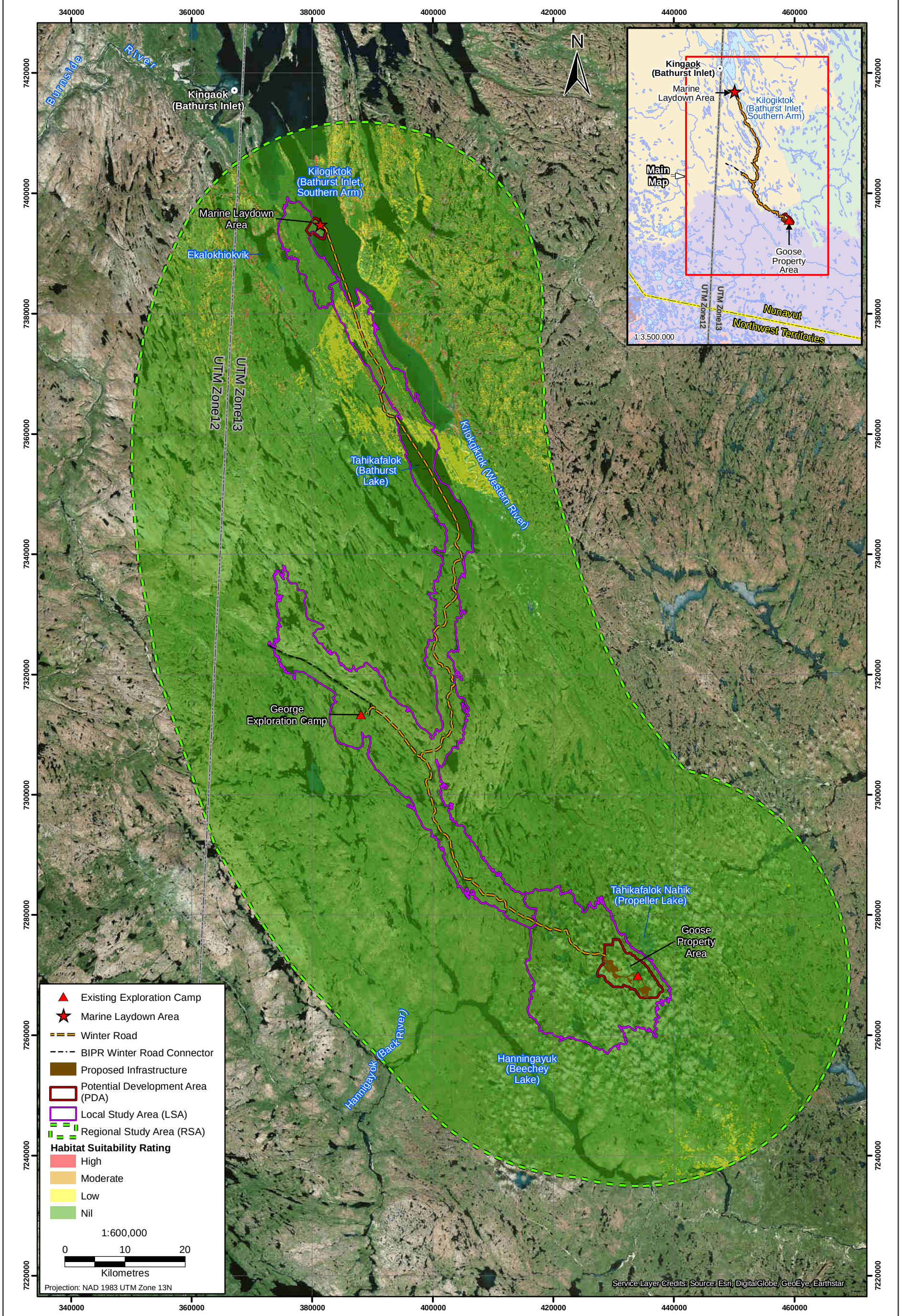


Sabina GOLD & SILVER CORP.

Grey Wolf: Denning Habitat in the Local Study Area and Regional Study Area

Figure 8.1-8

Rescan an ERM company

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, cliffs, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high-quality habitat, wherever possible.

8.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As part of this TK process, wolverine and furbearers were identified as a VEC for the DEIS and FEIS.

8.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013c). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

8.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

8.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013c), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including vegetation, and wildlife and Valued Socio-economic Components VSECs that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

8.3 VALUED COMPONENTS

8.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

The following aspects of potential wildlife VECs were also considered:

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

8.3.2 Valued Components included in Assessment

Each potential VEC was screened for inclusion in the environmental assessment through an evaluation of the results of baseline studies, conservations status, biological importance, regulatory, cultural,

social, and economic significance and the potential for each to be affected by the Project (Volume 9, Chapter 1). Furbearers were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, furbearers were selected as a VEC for the effects assessment. Wolverine and wolves were selected as representative furbearer species.

Wolverine and wolves provide an important ecological role as top predators in the Arctic food chain. Wolves are the main predator of caribou. Wolf kills provide a preferred food source for wolverine, suggesting a close link between wolf and wolverine population dynamics (van Dijk et al. 2008). Wolverine densities appear to be the highest where caribou are abundant and where wolf predation on caribou is high creates scavenging opportunities (COSEWIC 2003).

8.4 SPATIAL AND TEMPORAL BOUNDARIES

8.4.1 Spatial Boundaries

The wolverine and the grey wolf effects assessment considered two study areas for wildlife inventory for the Project: local study area (LSA) and regional study area (RSA; Figure 8.4-1).

8.4.1.1 Local Study Area

The boundaries of the Local Study Area (LSA) for wolverine and grey wolf were set to encompass the following:

- the Goose Potential Development Area (PDA), which contain all proposed Project infrastructure for the Goose Property Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The wildlife LSA covers an area of approximately 134,369 ha (Figure 8.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

8.4.1.2 Regional Study Area

The RSA for wolverine and grey wolf encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the three potential

development areas (Goose Property Area and MLA). The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 8.4-1). The wildlife RSA extends slightly more than 35 km from proposed Project infrastructure on the eastern side, to encompass the Western River.

8.4.2 Temporal Boundaries

The temporal boundaries used for the wolverine and furbearers effects assessment follow the time periods of the phases of the Project as presented in Table 8.4-1.

Table 8.4-1. Temporal Boundaries — Project Phase Durations

Phase	Duration
Construction (including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post Closure Monitoring	5 years
Other potential phases:	
Temporary Closure	Less than 2 years
Care and Maintenance	2 to 10 years
Exploration	included in Construction and Operation phases

8.5 PROJECT-RELATED EFFECTS ASSESSMENT

8.5.1 Methodology Overview

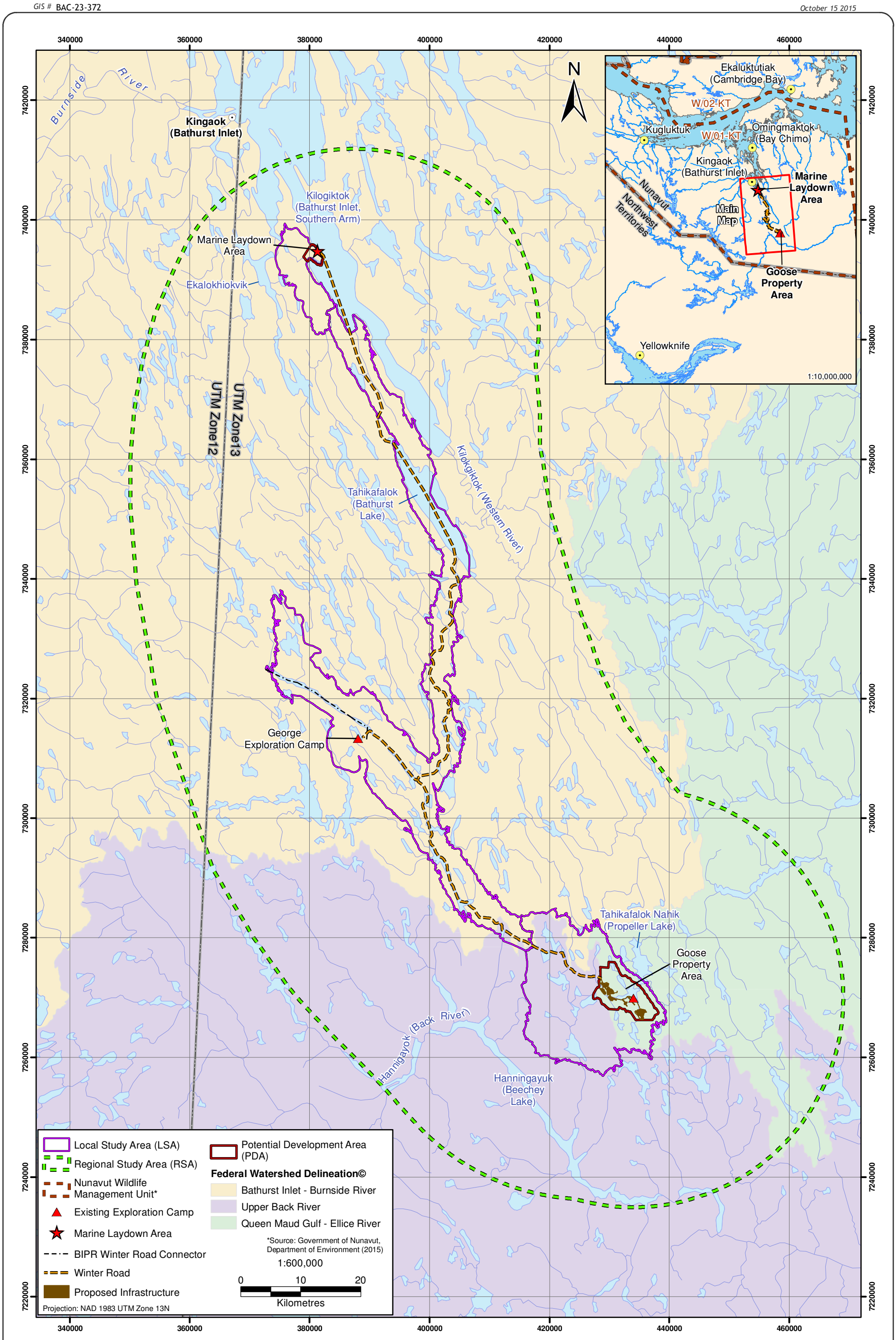
The effect assessment process comprises a step-wise method to assess the potential effects of the Project on wolverine and grey wolf as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. Identification of potential interactions between the Project and wolverines and grey wolves.
2. Characterization of the potential effects that could result from these interactions.
3. Identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects.
4. Characterization of residual effects that will likely remain after mitigation and management measures have been applied.
5. Determination of the significance of residual effects using eight attributes to rate the residual effects on wolverines and grey wolves including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on wolverine and grey wolf are evaluated for all Project phases as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, the phase associated with the worst-case scenario for the effect is evaluated and the results of the effect during all other Project phases are expected to be less than the effect rating for the worst-case phase assessed.

GIS # BAC-23-372

October 15 2015



Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Wolverine and Grey Wolf

Figure 8.4-1

Rescan an ERM company

8.5.1.1 Indicators used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 8.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of "yes" or "no" where triggering of residual effects assessment occurred if the indicator value was "yes" (e.g., attraction of wolverines and grey wolf to mining projects has occurred elsewhere at similar projects in Nunavut or the Northwest Territories).

Table 8.5-1. Criteria, Indicators and Triggers Used to Characterize Potential Residual Effects on Wolverine and Grey Wolf

Potential Effect	Criteria	Indicator
Habitat loss	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disturbance due to noise	Change in Population Health	Amount (ha) of high-quality habitat lost or altered
Disruption to movement	Change in Population Health	Traffic timing, and traffic volume
Direct mortality and injury	Change in Population Health	Traffic timing, traffic volume, and vehicle speed
Indirect mortality	Change in Population Health	Predicted increase in human access to wildlife RSA
Attraction	Change in Population Health	Attraction occurred at similar Projects in Nunavut and Northwest Territories
Exposure to contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in reproductive productivity	Change in Population Health	Literature suggests combined residual effects on wolverine and grey wolf

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

8.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects was developed (Table 8.5-2).

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Table 8.5-2. Definitions of the Magnitude Ratings for Residual Effects Based on Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Residual Effects (Population Health Criterion)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance due to Noise were included for determining the effect on the sub-population. For all other effects professional judgement and literature review was used to determine the effect on the sub-population and thus the magnitude of the effect.

Population health can be measured using various criteria, either indirectly using measures of change in habitat and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for wolverine and grey wolf, which provide benchmark measures, as well as estimates of the natural variability. Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

8.5.1.3 Overall Significance Ratings of Residual Effects

To assess the significance of residual effects, eight attributes for evaluating residual biophysical effects including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence were used and defined in Volume 9, Chapter 1. The definitions of magnitude in Table 8.5-2 were used as part of the determination of the significance rating.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 8.5-3). For example, a residual effect receives a rating of “Not Significant” typically if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Table 8.5-3. Definitions of Significance Ratings for Residual Effects on Wolverine and Grey Wolf

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

8.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions with the VECs wolverine and grey wolf and the Project is provided in Volume 9, Chapter 1. Potential effects on wolverine and grey wolf and their respective habitats by the Project have been scoped based on professional judgement, experience at other similar projects in Nunavut and the Northwest Territories and based on scientific literature review. The effects of mining developments in the Arctic have been well-documented through monitoring programs at the Lupin gold mine (Hohnstein 1996), Ekati diamond mine (BHPB 2004), the Diavik diamond mine (DDMI 2004), and the Hope Bay mine (Rescan 2011b, 2013f).

Interactions of wolverine and grey wolf with Project components were evaluated to determine which of the following potential effects may occur (Table 8.5-4):

- habitat loss;
- disturbance due to noise (e.g., displacement from areas of habitat);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality (e.g., due to increased access and associated increase in hunting);
- attraction (e.g., altered inter-species relationships);
- exposure to contaminants; and
- reduction in reproductive productivity due to all effects of the Project combined.

Wolverine and grey wolves can experience habitat loss from developments directly where land is modified within Project footprints, particularly in areas of suitable denning and foraging habitat. For this reason, habitat loss was included and evaluated in this assessment. Wildlife habitat will be removed and replaced by infrastructure, and habitat near infrastructure will be degraded during Project development.

Table 8.5-4. Potential Project-related Effects to Wolverine and Wolves in the Goose Property Area and the Marine Laydown Area

Potential Development Area Project Component	Habitat Loss[1]	Disturbance due to Noise	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity[2]
Goose Property Area								
Open Pits (Main, Umwelt, Echo, and Llama)	x	x	x	x		x		x
Haul and access roads	x	x	x	x	x	x		x
Winter roads	x	x		x				x
Stockpiles	x	x	x					x
Waste rock storage areas	x	x	x				x	x
Explosives storage areas	x		x				x	x
Tailings Impoundment Area	x	x	x				x	x
Quarries	x	x	x			x		x
Landfill	x	x	x	x	x		x	x
Camp / Plant site	x	x	x	x	x		x	x
Airstrip	x	x	x	x				x
Other infrastructure (diversion channels, water intakes)	x		x					x
Marine Laydown Area								
Camp	x	x	x	x	x	x	x	x
Lightering Barge location	x	x	x					x
Haul and access roads	x	x		x	x	x		x
Winter roads	x		x					x
Other infrastructure (diversion ditch)	x							x

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*
[2] *Reduction in reproductive productivity is considered to be a synergistic effect resulting from all other potential effects.*

Potential effects due to sensory disturbance were evaluated for wolverine and grey wolves because noise may cause displacement of wildlife from important habitat, stress responses, and behavioural changes in some species. Researchers have documented avoidance responses of carnivores that may restrict the use of habitat that might otherwise confer reproductive or survival benefits (Thurber et al. 1994). Wolves are particularly sensitive to the effects of sensory disturbance and exhibit some of the strongest negative responses to disturbances relative to other species (Johnson et al. 2005).

Wolverines are resident on the tundra, and move within one home range throughout the year. The grey wolves are also residents have very large home ranges dictated by the movement and presence of the barren-ground caribou herds. Research has indicated that population-level consequences may arise when movements on home ranges, and movements for dispersal, are disturbed or impeded (Thurber et al. 1994; Alexander and Waters 2000; Frame, Cluff, and Hik 2007). For this reason, potential effects of disruption of movement on wolverine and grey wolf were included in this assessment.

Direct mortality is typically a result of vehicle strikes with wildlife. Frequency of mortality is often related to specific locations, traffic volume, and speed (Jalkotzy, Ross, and Nasserden 1997). It is expected, for example, that as vehicle speed increases the chance of death or injury to wildlife also increases. Since the Project will have all-weather site roads, and winter haul roads, the potential effect of direct mortality is included in the assessment.

Indirect mortality is defined as increased mortality due to hunting if access is facilitated by the proposed roads. Roads increase access and can create opportunities for illegal hunting of wildlife (McLellan and Shackleton 1988). Thus, indirect mortality was included as a potential effect in the assessment.

Camps and landfills may act as attractants to wildlife, particularly carnivores, which could subsequently lead to increased human interactions with wildlife, animals becoming nuisance wildlife, and subsequent wildlife mortality. Thus, the effect of attraction is included as a potential effect in the assessment.

Wildlife can be exposed to contaminants through ingestion of water or through the food chain. A formal risk assessment was undertaken as part of the effects assessment for wildlife including wolverine and furbearers (including wolves) detailed in the Human Health and Environmental Risk Assessment chapter (Volume 8, Chapter 6). Results of the risk assessment of contaminants in wolverine and furbearers were summarized in the assessment of the each VEC (wolverine and wolves) for determining the overall significance of Project-related residual effects to wolverine and furbearers.

Some of the environmental effects discussed above have the potential to affect the reproductive potential of wolverine and furbearers, particularly when they act in a synergistic fashion. For example, habitat loss and degradation, disturbance due to noise, and disruption to movements may result in physiological stress, lower feeding and increased travel to manoeuvre around disturbed areas, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. This cascade of effects may be of the greatest concern during sensitive periods for wolverine and furbearers (i.e., denning periods). Energy demands during these times are relatively high, and disturbances that may result in increased stress behaviours or reduced feeding time may have greater consequences on the overall fitness of individuals. Therefore, the effect of reduction in reproductive productivity is included as a potential effect in the assessment.

Each potential effect is identified for each Potential Development Area (PDA) and key infrastructure/activity in Table 8.5-4.

8.5.2.1 Habitat Loss

As part of the development of the Project, wildlife habitat will be lost and potentially degraded wherever infrastructure is built or vegetation is cleared. To minimize these effects, the location of Project infrastructure was planned to avoid wildlife sensitive areas, and the layout of infrastructure was designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. Wildlife habitat may also be indirectly lost if wildlife species avoid the Project area due to noise disturbance, which is described in Section 8.5.2.2.

Habitat loss due to site clearing will occur during the Construction and Operations phases of the Project. Wildlife habitat will be removed and degraded during Project development. Habitat degradation due to dust and compaction around Project infrastructure may also occur and is usually found within 100 m of infrastructure (Walker and Everett 1987). A dust reduction plan to ensure proper care and maintenance of all-weather roads, use of water or other dust-suppressants, covering of loads in vehicles, regular cleaning of vehicle wheels, and design of infrastructure to minimize dust generation are proposed for the Project. The assessment of habitat loss is based on the total area of lost and degraded habitat at the end of the Operation phase, which is the largest extent of the Project footprint.

To enable flexibility in siting of Project infrastructure, loss and degradation of wolverine and grey wolf habitat is assumed within the entire area of each of the two PDAs (Goose Property Area and the MLA). These areas greatly overestimate habitat loss because the Project footprint will only cover approximately 10% of the PDA area. Wherever possible, reclamation activities will be undertaken to restore habitat following closure.

The winter roads connecting the Goose PDA and the MLA are evaluated for habitat loss for wolverine. Wolverine will be active during the periods of the year when the roads are being used (January through April). The PDA for winter roads includes a 200 m corridor along each alignment (Volume 2). The grey wolf may be present in the Project area during winter. The potential effects of winter roads on wolverine were used as a proxy for effects on wolves. It was assumed that potential effects of winter roads on wolves would be less than for wolverine, because though wolves are present during winter in very low densities, the denning period of wolves does not overlap the timing of winter road operation.

Calculation of Habitat Loss

Habitat loss for wolverine and wolves was calculated by first identifying two key indicators:

1. Total area — a calculation of the expected total area of habitat lost by the mine footprint (the entire area of the PDAs).
2. High-quality habitat — a calculation of the area of high-quality habitat for wolverine and wolves that will be lost in the PDAs.

These key indicators were then compared to the total area in the wildlife LSA and the RSA. The wildlife RSA provides the more representative comparison for the total habitat loss for wolves, as the home range size of wolves is, on average, larger than the wildlife LSA. To put the Project within the context of wolverine and grey wolf habitat use, these indicators were also compared to the average home range size of a wolverines and wolves. Key indicators were also compared to the wolverine management unit (MU) that overlaps the Project area (W/01-KT) to provide context relative to wolverine population management in Nunavut following a request by the Government of Nunavut during the DEIS review.

Total Area of Loss

The total expected area lost in the PDAs was calculated by summing the areas of loss due to the entire Goose and MLA PDAs, as well as the Winter Road PDA.

The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary (the wildlife LSA and RSA). The actual area developed, and subject to loss, will be much smaller, as determined by the final design infrastructure and placement.

In order to put the Project into the context of wolverine and wolf habitat, the total area of loss is compared to home range sizes for each species with the assumption that the area lost falls entirely within one or multiple home ranges. Results of the assessment are presented as a proportion of an average home range that may be lost due to Project-related activities.

The amount of habitat loss that occurs within Nunavut wildlife management units for wolverine that interact with the Project were also estimated, to provide context for habitat loss within managed populations of wolverine.

Area of High-quality Habitat Loss

Habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A) for wolverine and grey wolf. The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA based on remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

The availability of suitable habitat for wolverine and grey wolves is detailed in the Habitat Suitability Baseline Report (Rescan 2013a, Appendix V5-5A) and summarized in the Existing Environment Section (Section 8.1.5). Habitat loss and degradation for wolverine and grey wolves was assessed for denning habitat. A two-class rating system (suitable versus not suitable) was used to map wolverine habitat (Rescan 2013a, Appendix V5-5A) and a four class rating system (High, Moderate, Low and Nil habitat suitability) was used to rate habitat in the wildlife RSA for grey wolves. Denning habitat ranked as suitable is referred to as high-quality habitat for wolverine, whereas habitat ranked as High and Moderate was considered the most suitable habitat and is referred to as high-quality habitat for grey wolf. The proportion of high-quality habitat lost due to mine development in the wildlife RSA was calculated to assess the extent of the effect of high-quality habitat loss for wolverine and grey wolf. In addition, the amount of high-quality habitat loss that occurs within Nunavut wildlife management units for wolverine that interact with the Project were also estimated, to provide context for habitat loss within managed populations of wolverine.

Evaluation of Habitat Loss

Total Area of Loss

The total area of PDAs at the Goose Property and the MLA is 6,080 ha (Table 8.5-5). During the winter, additional habitat loss will take place within the Winter Road PDA, which is approximately 3,397 ha. Thus, the total habitat loss during the winter for wolverine only is evaluated at 9,477 ha.

The Goose and MLA PDAs represents 4.5% of the wildlife LSA; during the winter when winter roads are operational, all three PDAs (Goose, MLA and Winter Road) represent 7% of the wildlife LSA. This predicted habitat loss due to the PDAs (both without and with winter roads) accounts for 0.5-0.8% of

the wildlife RSA. However, the actual loss will be much smaller as the design of the Project footprint is much smaller (approximately 10 % or less of the PDAs) relative to the PDAs assessed as lost.

Table 8.5-5. Habitat Loss due to the Potential Development Areas

Potential Development Area (PDA)	Area (ha)	Proportion of LSA (%)[1]	Proportion of RSA (%)[1]
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.4	0.1
Winter Roads	3,397	2.5	0.3
Total	**9,477**	**7.0**	**0.8**
Total without Winter Roads	**6,080**	**4.5**	**0.5**

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*

The average home range size of male wolverines is 40,000 ha, and 12,600 ha for females (Magoun 1985; Mulders 2000). Habitat loss in the wildlife RSA is predicted to be 6,080 ha during the snow free period and 9,477 ha when winter roads are operational (January to April); these areas are roughly equivalent to 15% of a male wolverine's home range during the snow free period and up to a quarter (24%) of a male's range during the winter while winter roads are operational. For females, predicted habitat loss is approximately equivalent to one-half (48%) of a home range, increasing to three-quarters (75%) of a female's home range when the loss of the Winter Road PDA is also considered.

The average home range size of wolves that migrate between the boreal forest and tundra is 202,200 ha for males and 113,000 ha for females (Walton et al. 2001). Home range sizes of wolves are much larger in winter than summer (Walton et al. 2001), thus total habitat loss relative to summer home range sizes is evaluated as a worst-case scenario. Total habitat loss during the snow-free period (i.e., due to the Goose and MLA PDA) in the wildlife RSA is equivalent to 3.0% and 5.4% of the home range size of a male and female wolf, respectively. During the winter, predicted habitat loss due to the Goose, MLA, and Winter Road PDA is equivalent to 4.7% and 8.4% of the home range size of a male and female wolf, respectively.

The total expected habitat loss in relation to MU W/01-KT is relatively minimal. MU W/01-KT completely encompasses the wildlife RSA, and is much larger than the wildlife RSA. Therefore, the loss of habitat due to the Project (both with and without the temporary loss of habitat during the winter while winter roads are operational) that occurs within W/01-KT will be much less than reported within the wildlife RSA, and thus habitat loss within managed populations of wolverine will be very low.

Area of High-Quality Habitat Loss

Some of the habitat removed in the Goose Property PDA, the MLA, and winter roads was rated as high-quality habitat for wolverine and grey wolf. The proportion of high-quality habitat loss for wolverine and grey wolf is summarized below and in Table 8.5-6.

Wolverine

Of the 61,367 ha of high-quality (rated as suitable) denning habitat for wolverine within the wildlife LSA (45.7% of the wildlife LSA), an estimated 2,865ha will be lost and degraded within the Goose and MLA PDAs, and a total of 3,604 ha will be lost in areas inclusive of winter roads (Table 8.5-6). These areas represent 4.6% and 5.9% of the suitable habitat within the wildlife LSA, respectively. Of the 562,221 ha of suitable wolverine denning habitat in the wildlife RSA, 0.5% will be lost to the Goose and MLA PDAs, and 0.6% will be lost to areas inclusive of winter roads.

Table 8.5-6. High-quality Wolverine and Grey Wolf Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project

Area/Season	High-quality Habitat (HQH)		High-quality Habitat Lost or Altered due to Project Footprint[1]		
	Area (ha)	% Total Area	Potential Development Area without Winter Roads (ha)	Potential Development Area including Winter Roads (ha)[2]	% HQH[3]
Local Study Area[4]					
Wolverine	61,367	45.7	2,865	3,604	4.6 - 5.9
Grey Wolf	8,985	6.7	66	-	0.7
Regional Study Area[4]					
Wolverine	562,221	44.7	2,866	3,626	0.5 - 0.6
Grey Wolf	12,074	0.96	67	-	0.6

[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.
[2] The inclusion of habitat loss due to winter roads accounts for winter roads that occur within the wildlife LSA or RSA, and is calculated only for wolverine denning habitat, as the denning period for grey wolf does not overlap the timing of winter roads operation and thus winter roads will not contribute to habitat loss.
[3] Range in percent is due to the exclusion and inclusion of the Winter Road PDA.
[4] A small amount of the MLA PDA extends outside of the wildlife LSA, as well as portions of the Winter Road PDA. Therefore, the amount of high-quality habitat altered within a season will be slightly different within the wildlife LSA as compared to the wildlife RSA.

The loss of potential high-quality denning habitat within MU W/01-KT is expected to be negligible. Overall, MU W/01-KT is much larger in size than the wildlife RSA, and thus the total amount of high-quality wolverine denning habitat lost due to the Project will be much less than that reported within the wildlife RSA.

Grey Wolf

Of the 8,985 ha of high-quality wolf denning habitat within the wildlife LSA (6.7% of the wildlife LSA), an estimated 66 ha will be lost and degraded within the Goose and MLA PDAs (0.7% of wildlife LSA; Table 8.5-6). Of the 12,074 ha of high-quality wolf denning habitat in the wildlife RSA, 0.6% will be lost to the Goose and MLA PDAs.

Mitigation measures to minimize habitat loss for wildlife include the design of Project infrastructure to avoid, where possible, identified wildlife sensitive areas such as identified denning habitat (e.g., eskers) and to minimize the Project footprint. Wherever possible, reclamation activities will be undertaken to restore habitat upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss for wolverine and wolves, and thus a residual effect is expected to occur.

8.5.2.2 Disturbance due to Noise

This section evaluates the potential effects of Project-related disturbances on wolverine and grey wolf, with emphasis on noise from blasting during pit construction and quarrying, general Project noise, and aircraft noise.

Noise affects wildlife species in three primary ways. The source, duration, and intensity of noise all influence the nature and magnitude of observed effects and determine if wildlife exhibit an acute response (flight), a chronic response (altering behaviour and abandoning an area), or habituation (developed tolerance). First, an acute effect of noise — in rare cases, brief, intense, localized noise (such

as blasting) — can result in physiological damage to an animal's ears or flight from adjacent habitats. Acute effects are considered rare.

Second is a behavioural response, which is more common, where animals may become disturbed and may lose time and energy from key behaviours such as feeding, breeding, or watching for predators. The loss of time devoted to essential activities can ultimately lead to reduced body condition or health (Kraabel and Miller 1997), reduced reproductive success, and/or mortality of offspring and parent — a chronic effect.

A behavioural response can also occur when animals avoid important habitats near noise disturbance sources resulting in the functional loss of that habitat (Ward et al. 1999; Gibeau et al. 2002; Bautista et al. 2004). Mild habitat loss due to noise disturbance can reduce the amount of energy that an animal can intake and result in low-level effects. Alternatively, large scale range shifts can result in large reduction in energy intake and in extreme cases mortality due to unfamiliarity with new habitat and reduced resource base. If noise disturbance from the mine decreases the quality of potential den sites near the mine, wolverine and wolves may suffer stress over finding appropriate denning locations.

Third, in some cases, habituation and adaptation can allow wildlife to accommodate, and even take advantage of, the presence of noise in their environment. Both wolverine and wolves are known to acclimate to industrial projects in the Arctic and forage near projects. Attraction of wolverine and wolves to camp infrastructure is described in Section 8.5.2.6.

Effects of sound on a species most commonly depends on amplitude (volume) and frequency (pitch). Sound levels decrease with distance from the source, and as such it is important to reference the distance between the source and the location of a sound pressure level reading. Large mammals are sensitive to infrasound below 20 Hz. Some species have been found to respond to specific levels of noise above background noise, termed a "threshold level."

Studies on the effects aircraft noise on wildlife indicate that "fright" is a common response (Bond et al. 1974), whereby the animal attempts to escape the noise by either running or flying away. Several factors influence the fright response, including type of habitat utilized (open habitat versus forested or covered habitat), and distance of the animal from the aircraft. For example, wildlife that occur in open tundra habitat may be more sensitive to disturbance due to noise than wildlife occupying forested habitats (McLellan 1990; McLoughlin and Messier 2001). A fright response can cause the animal to expend large amounts of energy to escape the perceived threat.

Potential sources of sensory disturbance to wolverine and grey wolves associated with Project activities include:

- blasting noise, and ground vibrations from mining and construction;
- general Project noise (e.g. camp noise, human presence, and vehicle traffic); and
- noise generated from aircraft.

During Construction and Operations, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads and quarrying of the open pits, while continuous Project noise includes rock crushing and stockpiling of materials for the TIA bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during the all Project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required

during Post Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15).

Wolverine

The home range of wolverine can place them in contact with humans even when developments are at a considerable distance from the center of the home. Studies conducted near the Project area in the Kitikmeot region estimated that the home range of male wolverines average 400 km^2 (Magoun 1985; Mulders 2000). Disturbance due to noise during sensitive periods including the late winter denning period may result in females and their litters relocating or abandoning dens (Magoun and Copeland 1998; Heinemeyer, Aber, and Doak 2001). Disturbances during the construction and operation phases of this Project may influence the selection of wolverine denning areas over time. Data from Norway suggest that wolverines choose den sites away from human infrastructure, suggesting that wolverines may be sensitive to noise disturbance during denning (May et al. 2012).

Wolverine feeding behaviour may be affected in areas with relatively high Project related activities and/or vehicular traffic around all work sites. Wolverines have been found to avoid areas of high human activities, which reduce the amount of suitable foraging habitat (May et al. 2006). It is also important to note that ungulates are an important food source for wolverines and any disturbance to the behaviours and movements of caribou and muskox may result in negative effects on wolverines. Any disturbance that has a negative effect on prey populations will have a negative effect on the associated predator population.

Reduced reproductive success of pregnant females may be partially influenced by human activities resulting in den disturbance and den abandonment (Heinemeyer, Aber, and Doak 2001; May et al. 2012). Natal denning sites within 3 km of human activities including infrastructure and roads may experience a reduction in reproductive productivity (May et al. 2012).

Sensitive periods for wolverine occur during the denning period from February to early April (Inman et al. 2012). Wolverines usually have natal dens, where cubs are born and maternal dens, where cubs are nursed. Cubs are weaned by late June but will stay on the mother's home range until about one year of age (Inman et al. 2012).

Grey Wolf

The home range of grey wolf can place them in contact with humans even when developments are at a considerable distance from the center of the home range due to the size. Wolves have large home ranges, from 43,000 to 65,000 km^2, which vary between seasons (Walton et al. 2001). For seven months of the year, wolf movement patterns follow those of their primary prey, the caribou.

Auditory and visual disturbances caused by construction and operations, such as blasting, may cause stress for wolves in the vicinity of these activities and lead to reduction in hunting. Since wolves prey primarily on caribou, any disturbances that affect their primary food source will have a carry-over effect to wolves. Potential effects to caribou are discussed in Chapter 5.

Research has found that some wolves seem to be tolerant of human activity near dens (Thiel, Samuel, and Mech 1998; Frame 2005) whereas other research shows that wolves may move pups to secondary den sites in response to noise disturbance (Chapman 1979; Ballard 1987). Wolves are most susceptible to disturbance during the denning period because movements are localized around den sites. Developments that disturb or displace denning wolves may have serious consequences for reproductive productivity of wolves (Walton et al. 2001). Given that the majority of pup mortalities occur within the first six months of life (Harrington, Mech, and Fritts 1983), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den will affect reproductive success of the pack.

Breeding success in wolves is strongly related to prey availability (Fuller 1989; Frame 2005), and in the central Arctic prey availability is a function of caribou migration patterns (Frame 2005). Scarce prey will also influence reproductive success, so again, the state of the caribou population are vital to the success of the wolf population. Developments that alter the distribution or timing of caribou migration may have profound effects on breeding success of wolves (Walton et al. 2001).

Sensitive periods for grey wolf coincide with wolf denning that occurs shortly after the wolves arrive at their denning sites on the tundra in April (Walton et al. 2001). Wolves are territorial during denning and migratory wolves in the Kitikmeot region show strong fidelity to den sites (Walton et al. 2001). Pups are weaned in the den and the immediate area surrounding the den. Wolves leave the den site when the young are able to travel with adults, usually in September or October.

Calculation of Disturbance due to Noise

Avoidance areas within the wildlife RSA, and resulting indirect habitat loss will be primarily due to Project-related activities at the Goose Property rather than activities at the MLA as these areas will have a greater proportion of noise, including blasting, general Project noise, and aircraft noise. Calculating an area of indirect habitat loss requires assigning an area over which this effect occurs, which is often referred to as the zone of influence. Habitat 'loss' will occur indirectly for wolverine and grey wolves that avoid the zone of influence because they are disturbed within it.

The potential effect of disturbance due to noise on furbearers was evaluated using the key indicator of indirect habitat loss due to noise avoidance. Noise contours were mapped using the noise modelling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the year when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case; this coincides with Year Three of Operation at the Goose Property. The Operational phase is also the longest Project phase, and thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature where wildlife are shown to have behavioural effects from noise.

Threshold noise values were determined from the literature, above which wildlife (including wolverine and grey wolves) are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for wolverine and wolves. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are relatively small, since the PDAs (already considered as lost habitat in Section 8.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-

quality habitat disturbed during each season calculated by habitat suitability modelling (see Baseline Habitat suitability Modeling: Section 8.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing and helicopter aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for mammals resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Blasting noise models were conducted during peak noise levels as identified in Volume 4, Chapter 2 (worst case scenario), which is Year 3 of Operations at the Goose PDA.

General Project-related noise levels, or continuous noise levels, are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). Noise modelling was conducted for aircraft and helicopter noise to assess disturbance where aircraft noise attenuates to 80 dB or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). For the Goose Property, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013d).

To quantify the amount of habitat that may be functionally lost or altered due to noise, the total area of High and Moderate rated (high-quality) wolverine and wolf seasonal habitat that falls outside of the area of direct habitat lost due to the Project in the PDA areas (Section 8.5.2.1), but within the noise level contours for blasting noise (≥120 dB representing functionally lost habitat; or ≥108 dB representing disturbed habitat), general Project noise (≥45 dBA) or noise generated from aircraft (≥80 dBA) was calculated. The area of disturbed high-quality habitat outside of the PDAs was compared to the available high-quality habitat for each VEC season within the wildlife RSA and LSA after accounting for habitat loss (Section 8.5.2.1).

The amount of habitat that may be functionally lost or altered due to noise within wolverine MU W/01 KT, both in the context of total area and area of high-quality habitat, was also estimated.

For the purposes of assessing impacts associated with the Project's noise emissions, a number of noise and vibration sources were also assessed using several ecological receptors in the region that may be classified as sensitive. Sensitive ecological receptors were identified as the closest and/or potentially most affected sites by noise in the vicinity to the site. For wolverines and grey wolves, known active den sites were used to act as sensitive receptors.

Evaluation of Disturbance due to Noise for Wolverine

After mitigation, the potential effects of disturbances due to noise from blasting activities, general Project noise, and aircraft noise is described below.

Blasting Noise

A total of 9 ha that falls outside the Goose Property PDA is predicted to be functionally lost from the noise modeling above an Lpeak of 120 dB, and 316 ha is modeled with an Lpeak above 108 dB outside of the Goose Property PDA. No blasting noise above 120 dB Lpeak overlaps with the Winter Road PDA, but a small portion of habitat (23 ha) occurs where the modeled contour for 108dB Lpeak overlaps the Winter Road PDA. Thus, during the winter, a total of 293 ha outside of the Goose and Winter Road PDA is modeled above an Lpeak of 108 dB. All blasting noise above 120 dB Lpeak is completely contained within the 108 db Lpeak contour; therefore, only 307 ha outside of the area modeled as functionally lost (≥120 dB Lpeak) will be disturbed by blasting noise above 108 db Lpeak during the snow free period, which will be reduced to 284 ha when winter roads are operational. Blasting noise, considered independently (i.e., habitat functionally lost due to blasting above 120 dB Lpeak and additional area outside of 120 dB Lpeak disturbed by blasting noise above 108 dB Lpeak) and cumulatively (i.e., all habitat disturbed by blasting noise above 108 db Lpeak which includes 120 dB Lpeak), accounts for less than 1% of the wildlife LSA and less than 0.1% of the wildlife RSA in both the snow-free period and when winter roads are operational (Table 8.5-7).

The amount of high-quality seasonal habitat in the wildlife RSA that is within the area modeled as functionally lost (≥ 120 dB Lpeak) is 6 ha (Table 8.5-8; Figure 8.5-1), which represents less than 0.1% of the available high-quality habitat in the wildlife LSA and RSA after accounting for habitat loss within the PDAs (Section 8.5.2.1). The amount of high-quality habitat that is modeled as disturbed due to blasting (≥ 108 dB Lpeak) is 139 ha, which is equivalent to 0.2% and <0.1% of the available high-quality habitat in the wildlife LSA and RSA, respectively, after accounting for habitat loss (Section 8.5.2.1). Approximately 3 ha of high-quality winter and early spring habitat within the modeled area of 108 db Lpeak overlaps the Winter Road PDA, and thus 135 ha of high-quality habitat may be disturbed by blasting above 108 db Lpeak when winter roads are operational. In all cases, the amount of high-quality seasonal habitat that is modeled as functionally lost or disturbed due to blasting outside of the Goose PDA, and outside of the Goose PDA and Winter Road PDA when winter roads are operational, represents less than 1% of the high-quality habitat available within wildlife LSA and less than 0.1% of that within the wildlife RSA (Table 7.5-8), both when considering blasting noise independently and cumulatively.

General Project Noise

The majority of sensory disturbance due to general Project noise modeled as above 45 dBA will be associated with the development and operation of the TSF, processing plant, roads and camps. Traffic noise was modeled along the winter road alignments; the results indicated that traffic noise will dissipate to 45 dBA at less than 50 m from the road alignment (Volume 4, Chapter 2). The Winter Road PDA is assumed to be a 200 m wide corridor (Volume 2). Therefore, all traffic noise above 45 dBA along winter roads will be contained within the Winter Road PDA already assessed as lost (Section 7.5.2.1) and no additional disturbance outside of the Winter Road PDA is expected.

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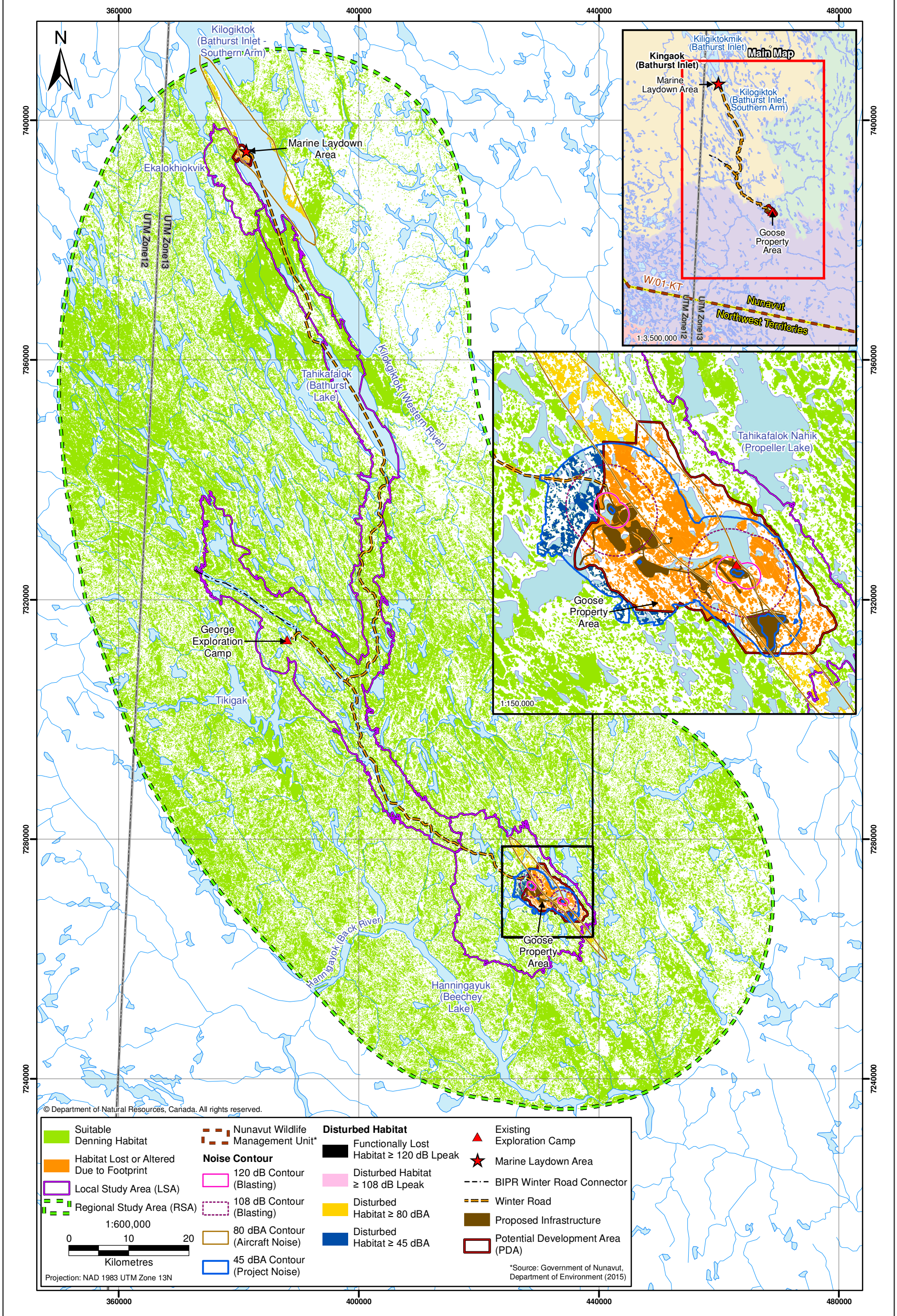

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Wolverine High-quality Habitat Lost, Altered or Disturbed due to the Project

Figure 8.5-1

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Table 8.5-7. Total Additional Area Functionally Lost or Disturbed due to Project Noise

Project Area	Area Considered Lost to PDAs			Additional Area Functionally Lost due to Blasting (120 dBA)			Additional Area Disturbed due to Blasting (108 dBA)			Additional Area Disturbed due to General Project Noise (45 dBA)			Additional Area Disturbed due to Aircraft Noise (80 dBA)		
	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA[1]	% RSA
Goose Property Area	5,427	4.0	0.4	9	<0.1	<0.1	316[a]	0.2	<0.1	1,212[b]	0.9	<0.1	1,824	1.3	0.1
MLA	653	0.5	0.1	-	-	-	-	-	-	-	-	-	12,367[c]	9.2	1
Total	**6,080**	**4.5**	**0.5**	**9**	**<0.1**	**<0.1**	**316[a]**	**0.2**	**<0.1**	1,212[b]	**0.9**	**<0.1**	**14,191[d]**	**10.5**	**1.1**

[1] Some of the area of noise disturbance falls outside of the wildlife LSA but within the wildlife RSA (see Figures 8.5-1 and 8.5-2).
[a] A total of 23 ha of habitat disturbed by blasting noise at 108 dB overlaps the Winter Road PDA exiting the Goose Property Area; therefore, only 293 ha of habitat (0.2% of LSA, < 0.1% of RSA) will be disturbed by blasting noise at 108 dB during the winter when winter roads are operational.
[b] A total of 134 ha of habitat disturbed by general project noise at 45 dBA overlaps the Winter Road PDA exiting the Goose Property Area; therefore, only 1,078 ha of habitat (0.8% of LSA, < 0.1% of RSA) will be disturbed by general project noise during the winter while winter roads are operational
[c] A total of 107 ha of habitat disturbed by aircraft noise at the MLA overlaps the Winter Road PDA in Bathurst Inlet; therefore, only 12,260 ha of habitat (9.1% of LSA, 1% of RSA) will be disturbed by aircraft noise during the winter while winter roads are operational
[d] Accounting for the overlap between aircraft noise and the Winter Road PDA, roughly 14,084 ha (10.5% of LSA, 1.1% of RSA) will be disturbed by aircraft noise during the winter when winter roads are operational

Table 8.5-8. Expected Wolverine High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas

Area	High-Quality Habitat (HQH) Available (ha)	HQH Lost or Altered due to the Project PDAs			Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project Noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
		PDAs without Winter Roads (ha)	PDAs including Winter Roads (ha)[2]	% HQH[3]	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH
Local Study Area	61,367	2,865	3,604	4.6 - 5.9	6	<0.01	139	0.2	459	0.8	541	0.9
Regional Study Area	562,221	2,866	3,626	0.5 - 0.6	6	<0.01	139	<0.1	459	<0.1	1,773	0.3

[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 8.5.2.1).

The total amount of area modeled as affected by elevated noise levels due to general Project noise (outside of the PDAs already considered to be lost; Section 8.5.2.1) is 1,212 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 1,708 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs; Table 7.5-7). All noise attributable to blasting above 108 dB Lpeak, which is an intermittent noise source, will occur entirely within the area modeled as disturbed by continuous general Project noise above 45 dBA. Therefore, wolverine will experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap when winter roads are not operational, and in 293 ha of habitat when winter roads are operational.

A breakdown of the percentage of high-quality habitat within modeled noise contours outside of the PDAs can be found in Table 8.5-8. The percentage of high-quality habitat modeled as disturbed outside of the PDAs is small (<0.1% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA both for the snow-free period and when winter roads are operational (Table 8.5-8; Figure 8.5-1). As noted above, general Project noise completely encompasses areas disturbed by blasting; the amount of high-quality habitat were wolverine may encounter multiple sources of noise accounts for less than 1% of high-quality habitat in the wildlife LSA and less than 0.1% of the wildlife RSA during the snow-free period and when winter roads are operational.

Aircraft Noise

The total amount of area modeled as affected by aircraft noise (≥80 dBA) outside of the areas already considered lost to Project footprint (Section 8.5.2.1) is 14,191 ha during the snow-free period (i.e., outside of the Goose and MLA PDA), and 14,084 ha when winter roads are operational (i.e., outside of the Goose, MLA, and Winter Road PDAs); in both cases (with and without winter roads), the percentage of habitat modeled as affected by aircraft noise within the wildlife LSA and wildlife RSA is the same, at 10.5% of the wildlife LSA and 1.1 of the wildlife RSA (Table 8.5-7). Sensory disturbance modeled due to aircraft noise is greater near the MLA (12,367 ha during the snow-free period and 12,260 ha during the winter when winter roads are operational; 1% of the wildlife RSA) relative to the Goose PDA (1,824 ha during both the snow-free period and during the winter while winter roads are operational, 0.1% of the wildlife RSA; Table 6.5-7), as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. However, it should be noted that much of the habitat modeled as disturbed by aircraft noise at the MLA is over marine habitat in Bathurst Inlet. Thus, during the snow-free periods, only 2,273 ha of terrestrial habitat along the shorelines is modeled as receiving elevated noise levels, which is equivalent to 0.2% of the wildlife RSA. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area modeled as disturbed by continuous general Project noise above 45 dBA, thus representing the area where wolverine may encounter multiple types of Project noise.

A breakdown of the percentage of high-quality habitat modeled as disturbed due to aircraft noise in the wildlife RSA can be found in Table 8.5-8. The percentage of additional high-quality habitat in the wildlife LSA and RSA modeled as disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (~1%m of wildlife LSA, <1% of the wildlife RSA) relative to the amount of available high-quality habitat in these areas (Table 8.5-8). A very small amount (5 ha) of high-quality seasonal habitat occurs near the Goose PDA where intermittent aircraft noise and general Project noise are expected to overlap, representing the area where wolverine may encounter multiple types of Project noise.

Two important elements influencing aircraft noise exposure to wildlife include overhead distance from wildlife and the frequency of overflights. At the Goose Property, a maximum of two flights per day are planned in the “worst case” years used for noise modelling (during the Operational phase), while at the MLA, when it is active, a maximum of six flights per week are planned during the “worst case”

scenario. Areas of disturbance due to noise are expected to be localized near the landing strips at the Goose Property and within Bathurst Inlet at the MLA. Thus, disturbance due to aircraft noise will only occur sporadically, and last for a short period of time while the aircraft is landing or taking off.

Wildlife Management Units

The amount of habitat that is modeled as functionally lost or disturbed due to Project-related noise outside of the PDAs and within the wolverine management unit W/01-KT is expected to be very minimal. MU W/01-KT completely encompasses the wildlife RSA, and is much larger than the wildlife RSA. Therefore, by extension, the amount of habitat (total and high-quality habitat) modeled as disturbed within MU W/01-KT will be far less than that reported within the wildlife RSA.

Receptor Noise

For wolverine, the sensitive receptors included known den sites located 1,200 m and 6,400 m from the nearest deposits at the Goose Property (Volume 4, Chapter 2). The equivalent noise value for general project noise for the den at 1,200 m was 58 dBA, while the noise value at the den site located at 6,400 m was 35 dBA. Therefore, the noise level at the den site within 1,200 m of the Goose Property Area is above the noise threshold of 45 dBA by 14 dBA, whereas the noise at the den located 6,400 m away from the Goose Property is below the threshold.

Summary of Disturbance due to Noise for Wolverine

Overall, the effect of sensory disturbance is anticipated to result in a residual effect on wolverine. There will be a minimal (~1%), but measurable area outside of the PDA that is modeled as having elevated noise levels. Note that this is a conservative estimate of the area where wolverine may be affected by noise.

The total amount of habitat that is modeled to be functionally lost or disturbed due to Project-related noise outside the PDAs is 15,388 ha during the snow-free period, and 15,147 ha during the winter while winter roads are operational. This calculation considers all noise sources from the Goose and MLA PDAs combined and accounting for overlap between noise type (i.e., overlap in blasting, general Project, and aircraft noise). The largest amount of habitat that may be affected from a single noise source is not the mine itself, but is modeled as intermittent aircraft noise. The area that is modeled as functionally lost or disturbed by noise outside of PDAs represents less 1.1% or less of the total habitat and high-quality habitat available in the wildlife RSA.

Based on home range sizes of 12,600 ha for female and 40,000 ha for male wolverines, the total amount of habitat modeled as disturbed due to noise corresponds to roughly 1.2 home ranges of a female wolverine and 38% of the home range of a male wolverine. When considering the amount of high-quality habitat modeled as disturbed due to noise (2,226 ha during the snow-free period, 2,195 ha when winter roads are operational), the proportion of habitat that could be affected within a home range is lower, at 17% of a female home range and 5% of a male home range.

Because it is much larger than the RSA, a smaller proportion of habitat is expected to be disturbed in wolverine MU W/01-KT that completely encompasses the wildlife RSA and all PDAs therein, and thus Project disturbance should not affect the wolverine population residing within this MU.

Evaluating Disturbance due to Noise for Grey Wolf

The total amount of habitat outside of the Goose PDA that is modeled as functionally lost due to blasting, or disturbed due to noise from blasting, general Project noise and aircraft noise is the same as for wolverine and is detailed in the wolverine section. Loss of high-quality denning habitat outside of

the Project PDAs due to blasting noise, general Project noise and aircraft noise is discussed below for grey wolves.

Blasting Noise

No high-quality habitat is modeled as functionally lost (≥ 120 db Lpeak) outside of the areas already considered lost to Project footprint (Section 8.5.2.1), and a negligible amount of high-quality denning habitat (0.9 ha, <0.01% of the wildlife RSA) is mapped within the area modeled as disturbed above 108 dB Lpeak (Table 8.5-9; Figure 8.5-2).

General Project Noise

A breakdown of the percentage of grey wolf high-quality habitat modeled as as disturbed due to continuous general Project noise outside of the PDAs can be found in Table 8.5-9. The percentage of high-quality habitat modeled as disturbed outside of the PDAs is small (0.01% of wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-9; Figure 8.5-2).

Aircraft Noise

A breakdown of the percentage of grey wolf high-quality habitat modeled as disturbed due to aircraft noise in the wildlife RSA can be found in Table 8.5-9. The percentage of high-quality habitat in the wildlife RSA modeled as disturbed by aircraft noise after accounting for habitat lost within the PDAs is small (~1% of the wildlife RSA) relative to the amount of available high-quality habitat in the wildlife RSA (Table 8.5-9).

Receptor Noise

Sensitive receptors for grey wolf included two known wolf dens located in the southern RSA; these two den sites are located further than 20 km of the Goose Property (Volume 4, Chapter 2). The noise levels resulting from blasting noise and aircraft were evaluated at these two den locations; the den sites were located well outside of the area influenced by general project noise. The equivalent noise value at both den locations were well below threshold values for blasting (120 dB for functional habitat loss, 108 dB for disturbed habitat), with predicted noise levels below 46 dB at both locations. Similarly, the equivalent noise value due to aircraft noise is predicted to be below threshold values (80 dBA for disturbed habitat), with predicted noise levels below 32 dBA at both site (Volume 4, Chapter 2).

Summary of Disturbance due to Noise for Grey Wolf

Overall, the effect of sensory disturbance is anticipated to result in a residual effect on grey wolf. There will be a minimal (~1%), but measurable area outside of the PDA that is modeled as having elevated noise levels. Note that this is a conservative estimate of the area where grey wolf may be affected by noise

The area that is modeled as functionally lost or disturbed by noise outside of PDAs represents less 1.1% or less of the total habitat available within the wildlife RSA, and there is a small amount (141 ha) of high-quality denning habitat within the modeled noise counters, which represents 1.2% of that available within the wildlife RSA.

Based on home range sizes annual home ranges, from 43,000 to 65,000 km^2 for female and male grey wolves respectively, the total area modeled as disturbed due to noise corresponds to roughly one third (36%) of a female home range and one quarter (25%) of a male home range, while the area of high-quality habitat modeled as disturbed corresponds to < 0.01% of the home range of a female or male grey wolf.

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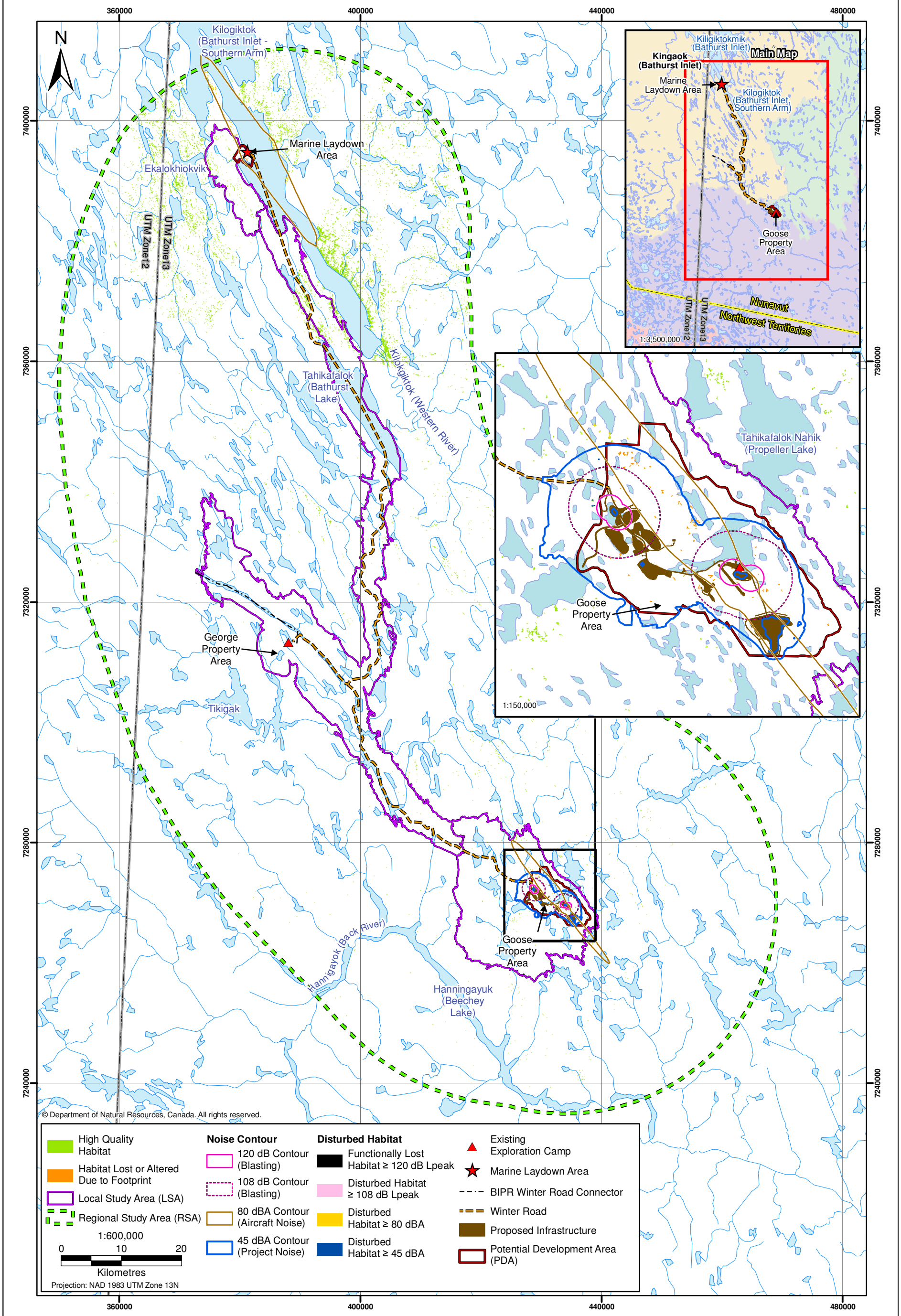
October 06 2015



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Grey Wolf High Quality Habitat Lost, Altered or Disturbed due to the Project

Figure 8.5-2

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Table 8.5-9. Expected Grey Wolf High-quality Habitat Functionally Lost or Disturbed due to Noise Outside of the Project Potential Development Areas

Area	High-Quality Habitat (HQH) Available (ha)	HQH Lost or Altered due to the Project PDAs		Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project Noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
		Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH	Area (ha)	% HQH
Local Study Area	8,985	66	0.7	0	0	0.9	0.01	1.2	0.01	8	0.09
Regional Study Area	12,074	67	0.6	0	0	0.9	<0.01	1.2	0.01	140	1.2

[1] Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥ 108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project PDAs (Section 8.5.2.1).

8.5.2.3 Disruption to Movement

Physical barriers or human activities may disrupt or impede wildlife movements, migration, and dispersal. Disruption to movement to wolverine and furbearers can result from linear corridors such as roads which may isolate seasonal habitat.

Linear developments, including roads, railways, and pipelines, have been shown to create temporary or permanent barriers to movement in many wildlife species (Jalkotzy, Ross, and Nasserden 1997). Wolverine will be present and active on the tundra all year and thus may interact with both winter roads connecting the PDAs (used from January to April) and permanent site roads within the PDAs. Therefore, the effect of disruption to movement due to linear corridors is included in the assessment.

Evaluation of Disruption to Movement for Wolverine

Wolverines prefer large, untouched areas, yet their home ranges have been found to overlap active traplines, busy logging roads and the edges of communities (COSEWIC 2003). Wolverine will also use roads to travel but avoid busy roads (Austin 1998) and generally select denning areas away from human infrastructure (May et al. 2012). Nonetheless, transportation corridors are a significant source of wolverine mortality and roads may act as semi-permeable barriers to movements and dispersal. In British Columbia, wolverines avoided areas within 100 m of the Trans-Canada Highway and preferred areas more than 1,100 m away (Austin 1998). This same study found that wolverines chose narrow crossings less than 100 m wide.

Data collected from a variety of locations suggests that road traffic on the order of 4,000 to 10,000 vehicles per day begin to impose a barrier to movement to most wildlife species, whereas roads with less than 1,000 vehicles a day are permeable to most species (Müller and Berthoud 1997). The winter roads will be used for hauling equipment, fuel and cargo from January to April across an operating window of 100 days. The projected traffic volumes to transport materials along winter roads are presented in Table 8.5-10.

Table 8.5-10. Traffic Volumes along Winter Road Corridors

	Average No. of One-way Trips*	
	Construction	Operations
Trips per Year**	1,908	4,045
Trips per Day**	19	40
per Hour**	1.2	2.5

**Average number of vehicles required during all of Construction and Operations.*
*** based on 100-day operating window between January and April and a 16 hour operating period per day.*

Traffic volumes will be on average 19 one-way truck trips per day from January to April during Construction. Assuming transits are evenly spaced across the 16 hour operating period for trucks within a day, the traffic volume translates to roughly 1 vehicle passing along any one point of the winter road per hour (Table 8.5-10). During Operations, the traffic volume will increase to an average of 40 one-way truck trips per day, with between two to three trucks passing any one point of winter road per hour. These traffic volumes are well below the threshold value for roads that are permeable (1,000 vehicles per day; Müller and Berthoud 1997). Therefore, the traffic alone on winter roads are not expected to create a permanent barrier to wolverine movement.

To mitigate effects of road traffic on wolverine, truck speeds will be 50 km/h and enforced. Drivers will also reduce speeds when wildlife are observed near the road, and drivers will stop on the road to

allow passage across the road. Specific details of these mitigation measures are listed in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20). See Section 8.5.2.4 for an evaluation of the effects of direct mortality due to vehicle strikes with wolverine.

Traffic alone on winter roads are not expected to create a barrier to wolverine movement because the planned traffic is well below thresholds (< 5% of the traffic required to create a barrier). Thus, linear developments are not anticipated to result in a residual effect for the VEC wolverine.

Evaluation of Disruption to Movement for Wolves

Wolves have large home ranges which vary between seasons (Walton et al. 2001). For seven months of the year, wolf movement patterns follow those of their primary prey, the caribou. Additionally, wolves follow caribou out the wildlife RSA in the winter and only occur in very low density in the wildlife RSA during the period when winter roads are constructed and used. Thus, linear road corridors are not anticipated to result in a residual effect on wolves, and are not assessed further.

8.5.2.4 Direct Mortality and Injury

Wolverine and grey wolf may be at risk of injury or mortality resulting from Project activities; therefore, this effect is included in this assessment. Direct mortality and/or injury to wolverine and wolves are generally anticipated to be a result of vehicle strikes. Mortality to wolverine and wolves may also result when wildlife attracted to Project infrastructure become human habituated and aggressive, and thus pose a threat to human safety. The resulting effects of attraction to the Project are evaluated in Section 8.5.2.6.

Evaluation of Direct Mortality to Wolverine

During baseline surveys, the locations of several wolverine and wolf dens have identified within the wildlife RSA. No infrastructure is planned on known den sites and it is expected that additional new dens would be detected during pre-construction surveys that may be conducted prior to construction of the Project PDAs and winter road corridors. Following these mitigation measures, no direct mortality is expected for wolverine or grey wolves during construction.

Vehicle–wildlife collisions are cited as a cause of direct mortality for a variety of wildlife species (Vieira 1996; Kerley et al. 2002; Deem and Emmons 2005). However, there are very few haul roads planned within the PDAs and all Project roads will be private and not for public use. In addition, truck speed limits will be developed. Direct mortality rates of wildlife species have been shown to drop dramatically below 70 km/h (Seiler 2005; Ng, Nielson, and St Clair 2008). Wildlife, including wolverines and wolves, on or near the road corridor may also be given the right-of-way to safely cross and exit the road corridor to lessen the probability of vehicle strikes. Therefore, mortality due to vehicle strikes is not anticipated to result in a residual effect on wolverine and grey wolf following mitigation.

8.5.2.5 Indirect Mortality

Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Back River area (Volume 8, Chapter 3). Further, road access will be in winter only and restricted to Project vehicles. In addition, hunting will not be permitted by Project employees. Thus, construction and operation of the road is not expected to cause an increase in wolverine and grey wolf mortality due to facilitation of hunter access (i.e., indirect mortality). Increased hunting is unlikely and is therefore is not anticipated to result in a residual effect on wolverine or grey wolf.

8.5.2.6 Attraction

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wolverine and grey wolf. Attractants may include physical structures that provide shelter or breeding habitat, or a travel corridor created by the road that facilitates movement through otherwise difficult terrain. Smells and food sources from incinerators, garbage, or sewage associated with the Project may also attract wolverines or wolves.

The presence of odours poses indirect risks as they can draw wolverine or grey wolves to camp areas where they come into contact with people. Habituated wildlife can pose a threat to the safety of both humans and wildlife (i.e., attacks). Nuisance animals are re-located but often if the problem persists, the animal is destroyed.

Potential project infrastructure that may contribute to attraction for wolverine and grey wolf includes:

- Camps located at the Goose and MLA PDAs;
- Landfill Areas; and
- Tailings Impoundment Area.

Evaluation of Attraction

Project activities will adhere to a strict Waste Management Plan detailed in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20), which will include mitigation measures. Mitigation measures will be implemented at all Project facilities in order to limit the attractiveness of the sites to wolverines using standard mitigation techniques; installing and maintaining wolverine barriers/skirting on buildings and infrastructure, incinerating food wastes, and managing garbage and scents, etc.

Wolverines are curious and have been found to investigate and rob food from campsites, food caches and empty cabins (COSEWIC 2003) and have been reported at similar projects in Nunavut and Northwest Territories. Attraction to Project sites increases the potential for wildlife-human interaction and therefore an increased potential for individuals to become nuisance animals. Mortality of nuisance wolverines as a result of attraction to the Project-site and infrastructure is anticipated to result in a residual effect after mitigation on wolverine.

Camps may attract wolves due to scents or when searching for food although less frequently than wolverine (McNay 2002). Wolves generally avoid areas of human activity (Thurber et al. 1994). Moreover, similar projects in Nunavut and Northwest Territories have not reported problem or food-conditioned wolves. Mortality of nuisance wolves as a result of attraction to the Project-site and infrastructure is not anticipated after mitigation.

8.5.2.7 Exposure to Contaminants

Exposure to contaminants for wolverine and wolves due to the Project was evaluated in the country foods effects assessment (Volume 8, Chapter 5) and in the Environmental Risk Assessment (Volume 8, Chapter 6). Results of these assessments indicated that all contaminant hazard quotients in soils and surface waters, and evaluation of predicted future vegetation concentrations relative to baseline, all of which are items that would be consumed by the prey of wolverine and grey wolf (e.g., fish, caribou, etc) or the animals themselves (e.g., water), were either less than one (which means future concentrations are predicted to be less than soil or water quality guidelines), or are predicted to be within the range of baseline. Therefore, risks to wolverine and grey wolf are considered to be

negligible. Thus, a residual effect due to exposure to contaminants in wolverine and grey wolf is not anticipated and is not considered further in the assessment.

8.5.2.8 Reduction in Reproductive Productivity

Reproductive productivity is usually quantified as the number of surviving young produced per year per female. With the obvious exception of mortality, all of the preceding effects may result in declines in reproductive productivity of individuals. Habitat loss and degradation, disturbance, and disruption to movements may result in physiological stress, lower feeding and increased movement rates, and displacement from preferred habitat. These effects may in turn impose a negative effect on the energetic balance of individuals, which may result in poor body condition. Individuals in poor body condition often fail to produce young, or produce young that are more susceptible to mortality. Indeed, the body condition of parturient females is thought to be the main determinant of the health and survival of their young.

Population growth is determined by three key life history parameters: adult survival; birth rate (the ratio of total live births to total adult population); the survival rate of young. Because the reproductive success of adults and the survival of juveniles are influenced by their physiological condition, Project-related effects that result in lower body condition may result in population decline. Juveniles which are often preferred prey may also experience lower survival if displaced to poor quality habitats that offer little refuge from predators.

Evaluation of Reduction in Reproductive Productivity

Wolverine

The potential for reduced reproductive productivity was evaluated as a possible result of synergistic interactions between other effects. Of the evaluated effects on wolverine, habitat loss, disturbance and attraction were evaluated as being residual effects. However, the scale of effects is expected to be small. The area of habitat removed and disturbed makes up a relatively small area of a wolverine's home range. Effective waste management and camp hygiene have been shown to reduce potential effects of attraction at other, operating mines. Therefore, the potential to affect the energetics or stress levels of wolverines whose territories may overlap the project is small. Wolverine populations surrounding large, operating mines appear to be robust elsewhere in the Arctic. However, to be cautious, a residual effect of reduction in reproductive productivity is assigned such that this potential effect can be advanced to the cumulative effects assessment.

Grey Wolf

Reproductive success in wolves is strongly related to prey availability (Fuller 1989; Frame 2005) and prey availability in the central Arctic is a function of caribou migration patterns (Frame 2005). Scarce prey will also influence reproductive success, so again, the state of the caribou are vital to the success of wolves.

Given that the majority of pup mortality occurs within the first six months of life (Harrington, Mech, and Fritts 1983), females and pups are especially vulnerable to the effects of disturbance around their den sites. Disturbances that affect den site selection and activity around the den can affect reproductive success of the pack.

The closest active wolf den to the Project site is over 10 km away to the east of the Goose site. It is not expected that any effects of the Project will interact with this den. Moreover, it is not expected that the Project will affect the populations wolves prey species. As a consequence, no residual effect is predicted for reduction in reproductive productivity.

8.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the management measures that will be in place to reduce or eliminate potential effects to wildlife including wolverine and grey wolf. In addition, a number of other mitigation and management plans will be in place to minimize potential Project-related effects to the environment and are included in Volume 10.

A residual effect of the Project on wolverine is anticipated resulting from habitat loss, disturbance due to noise, attraction, and reduced reproductive productivity. A residual effect of the Project on grey wolf is anticipated resulting from habitat loss, and disturbance due to noise. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to wolverine and grey wolf. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

8.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to wolverine and grey wolves may include the following:

- Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas such as identified denning habitat (Volume 10, Chapter 20);
- infrastructure designed to minimize the Project footprint to reduce habitat loss for wolverine and furbearers (Project Description; Volume 2, Chapter 2); and
- winter road access corridors proposed (no all-weather roads for re-supply routes), to minimize direct habitat loss, habitat degradation due to dust deposition for wolverine and grey wolf (Volume 2, Chapter 2).

8.5.3.2 Mitigation for Disturbance due to Noise

The primary mitigation and management strategies to minimize the effects of disturbance due to noise to wildlife are addressed in the Noise and Vibration Assessment (Volume 4, Chapter 2) and the Noise Abatement Plan (Volume 10, Chapter 18). Additional wildlife-specific measures to minimize the effect of disturbance due to noise to wolverine and furbearers may include:

- winter roads designed to avoid known wolverine and grey wolf dens within 1 km of the proposed alignment to ensure that works and activities do not disturb wolverine and grey wolf during denning (Volume 10, Chapter 20);
- infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities, and minimize the effects of noise disturbance to wolverine and grey wolf (Volume 10, Chapter 18);
- vehicles restricted to site roads, winter roads and quarry footprints during construction and operations to avoid unnecessary disturbance to wolverine and grey wolf habitat and not permitted on winter road corridors outside of the frozen ground period between December and April (Volume 10, Chapter 20);
- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and

- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

8.5.3.3 Mitigation for Disruption to Movement

The following mitigation measures and best management practices may be applied to minimize the possible effects of disruption to movement to wolverine and furbearers:

- winter access roads only, when wolves are not as abundant in the area, so access roads will not cause disruption of movement for grey wolves (Volume 2, Chapter 2); and
- use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination, to reduce the disruption of movement to winter occurring wildlife such as wolverine (Volume 2, Chapter 2).

8.5.3.4 Mitigation for Direct Mortality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the WMMP Plan (Volume 10, Chapter 20), and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to wolverine and furbearers may include:

- berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury (Volume 10, Chapter 20);
- speed limits for trucks, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to wolverine and furbearers (Volume 10, Chapter 20);
- wildlife given the right-of-way on all roads at all times (including within camp and marine laydown area; Volume 10, Chapter 20); and
- participation by all contractors and employees working on the Project in the Employee Wildlife Education Program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation (Volume 10, Chapter 20).

8.5.3.5 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to wolverine and furbearers may include:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project employees and contractors while on site (Volume 10, Chapter 23).

8.5.3.6 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of attraction to the Project to wolverine and furbearers and other wildlife are described in the Waste Management Plan (Volume 10,

Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11) and the Employee Education Program, described in the WMMP Plan (Volume 10, Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to wolverine and furbearers:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- wildlife-proof receptacles used for all waste and wildlife attractants, where possible, to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);

  a waste and a camp monitoring program will allow for adaptive management to eliminate attractants at the site;
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20);
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20); and
- a protocol for management of grizzly bears and wolverines on site provided as part of orientation for site personnel (Volume 10, Chapter 20).

8.5.3.7 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to mitigation for air quality (Volume 10, Chapter 17) and freshwater quality mitigation measures in the Aquatic Effects Management Plan (Volume 10, Chapter 19). Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and wildlife RSA and thus, will help to minimize the effect of exposure of contaminants to wolverine and furbearers.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife, including wolverine and furbearers from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20);

- wildlife exclusion measures implemented if wildlife are frequently accessing or attempting to access waste storage areas (Volume 10, Chapter 20); and
- adaptive management will be used to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

8.5.4 Characterization of Residual Effects

Residual adverse environmental effects are those environmental effects predicted to remain after the application of mitigation. Wherever possible, the rating for each residual adverse environmental effect integrates the cumulative environmental effects of all activities taking place during a particular Project phase. It is therefore the cumulative environmental effect of all Project activities occurring with a Project phase that could result in an adverse environmental effect on wolverine and grey wolf.

8.5.4.1 Habitat Loss

Wolverine

The direction of the residual effect is negative, as a small but measureable amount of habitat will be lost. The alteration of habitat due to Project development represents a relatively small percentage of the available high-quality seasonal habitat for wolverine in the wildlife RSA. The total area of habitat calculated as lost in the Goose Property and MLA PDAs during the snow free period is 2,865 ha of high-quality habitat (suitable rated habitat), or 0.5% of that available in the wildlife RSA. During the winter while winter roads are operational, additional areas of high-quality habitat will be temporarily removed from December to April, which combined with habitat loss within the Goose in MLA PDAs is equivalent to 3,604 ha or 0.6% of the wildlife RSA.

Habitat loss within MU W/01-KT is expected to be far less than that reported within the wildlife RSA, as MU W/01-KT is far larger than the wildlife RSA. The actual Project footprints which are designed to be as small as possible are anticipated to be much smaller than the Project PDAs which have been assumed lost in this assessment. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 8.5-2.

The extent of the effect is at the Project footprint scale, as habitat loss is generally limited to PDAs. The effect of habitat loss on wolverine habitat will have a long-term duration (beyond the life of the Project). However, the frequency of effect is sporadic, as habitat will be lost as the pits, camps, and other infrastructure are constructed, a small amount of high-quality habitat along the winter road alignments may be degraded due to compaction, but is anticipated to recover. The effect of habitat loss is irreversible, as some area will not be reclaimed during Reclamation and Closure (and thus will be permanently lost. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose MLA, and Winter Road PDAs will not be developed.

Overall, the residual effect of habitat loss for wolverine is assessed as Not Significant.

Grey Wolf

The direction of the residual effect is negative, as small but measureable amount of habitat will be lost. The alteration of habitat due to Project development represents a relatively small percentage of the available high-quality seasonal habitat for grey wolf in the wildlife RSA. The total area of habitat calculated as lost in the Goose Property and MLA PDAs is 67 ha, which represents less than 1% of the available habitat in the wildlife RSA. Thus, the magnitude of this effect is rated as low, using the quantitative thresholds for magnitude of effect in Table 8.5-2.

The extent of the effect is at the Project footprint scale, as habitat loss is generally limited to PDAs. The effect of habitat loss on grey wolf will have a long term duration, as habitat will be lost beyond the life of the Project. However, the frequency of effect is sporadic, as the majority of habitat loss or degradation will occur during construction of the pits, camps and other Project infrastructure. The effect of habitat loss is irreversible, as some area will not be reclaimed during Reclamation and Closure and thus will be permanently lost. The probability of the effect occurring is likely, and the confidence in the significance rating is high, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as the entire Goose MLA, and Winter Road PDAs will not be developed.

Overall, the residual effect of habitat loss for grey wolf is assessed as Not Significant.

8.5.4.2 Disturbance due to Noise

Wolverine

Disturbance due to Noise is considered to be a residual effect with a negative direction as the development will affect a small, but measureable amounts of high-quality habitat for wolverine outside of those areas assessed as lost. After considering the effects of habitat loss, the amount of habitat calculated as receiving an elevated noise level where a wolverine may be disturbed by noise was 1.1% or less of the total habitat and high-quality habitat available in the wildlife RSA. The largest source of noise is predicted to be aircraft, not the mine site itself. Blasting noise and continuous Project noise (generators, etc.) are predicted to be largely contained within the PDAs and occupy <0.1% of habitat within the wildlife RSA.

Because MU W/01-KT completely encompasses the wildlife RSA and is far larger than the wildlife RSA, the amount of habitat calculated as receiving an elevated noise level within MU W/01-KT is expected to be much less than that reported within the wildlife RSA. Following the quantitative thresholds for magnitude listed in Table 8.5-1, the magnitude of the effect is considered low.

The extent of the effect of disturbance due to noise is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for noise due to blasting activities and aircraft noise, thus sporadic overall, and the duration is considered medium as the effect of disturbance due to noise is expected to subside following closure. The effect is considered to be reversible as wolverines are anticipated to relocate to areas that were disturbed by noise once the effect subsides. The probability of the effect occurring is likely, and confidence is high, as wolverines are known to be sensitive to blasting activities related to mining.

Overall, the residual effect of disturbance due to noise on wolverine is assessed as Not Significant.

Grey Wolf

Disturbance due to Noise is considered to be a residual effect with a negative direction as the development will affect a small, but measureable amounts of high-quality habitat for wolverine outside of those areas assessed as lost.

After considering the effects of habitat loss, the amount of habitat calculated as receiving an elevated noise level where a muskox may be disturbed by noise was 1.2% or less of the total habitat and high-quality habitat available in the wildlife RSA. The largest source of noise is predicted to be aircraft, not the mine site itself. Blasting noise and continuous Project noise (generators, etc.) are predicted to be largely contained within the PDAs and occupy <0.1% of habitat within the wildlife RSA. Following the quantitative thresholds for magnitude listed in Table 8.5-1, the magnitude of the effect is considered low.

The extent of the effect of disturbance due to noise is local (i.e., extends beyond the footprint but for the most part is contained within the wildlife LSA), the frequency is expected to be continuous for general Project noise and sporadic for noise due to blasting activities and aircraft noise, thus sporadic overall, and the duration is considered medium as the effect of disturbance due to noise is expected to subside following closure. The effect is considered to be reversible as grey wolves are anticipated to relocate to areas that have been disturbed by noise once the effect subsides. The probability of the effect occurring is likely, and confidence is high, as grey wolves are known to be sensitive to noise from activities related to mining.

Overall, the residual effect of disturbance due to noise on grey wolves is assessed as Not Significant.

8.5.4.3 Attraction

Wolverine

With mitigation measures, the magnitude of the effect of attractants on wolverine is rated as low, following the guidance on determining qualitative magnitude in Table 8.5-1. The geographic extent is footprint, as the effect is anticipated to remain within the PDAs. This effect is anticipated to be a negative effect as wolverines that become habituated to Project-related attractants may have to be destroyed if they become nuisance animals. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used, but not after Reclamation/Closure. The frequency of wolverines being attracted to Project infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is high, and confidence is medium, as wolverines are known to be attracted to mining camps.

Overall, the residual effect of attractants on wolverine is concluded to be Not Significant.

8.5.4.4 Reduction in Reproductive Productivity

Wolverine

Reduction in reproductive productivity was evaluated as a potential result of synergies between other residual effects. The predicted residual effects of habitat loss, disturbance and attraction are each expected to be of low magnitude and wolverine populations appear to be robust surrounding existing, large mines in the Arctic. Therefore, no reduction in reproductive productivity is expected. However, this effect was considered a residual effect in order to include it in the cumulative effects assessment.

Reduction in reproduction for wolverine is expected to be of low magnitude. Mitigation for Project effects will greatly lessen the potential for reduced productivity, through Project design that limits

noise disturbance and management practices that reduces incidences that may result in mortality of injury of individuals. The effect may only be experienced by a small proportion of the local wolverine population, the extent of the effect is regional, as the home ranges of wolverine extend beyond the boundaries of the Project footprint and wildlife LSA.

With the evaluation predicting a small to negligible effect on reproductive productivity, it is not expected that the local or regional population of wolverine will be adversely affected by the Project

During the DEIS review phase, the GNWT requested that any predicted decrease in reproductive productivity be compared with the natural variability of wolverine productivity. The Project is not expected to affect the reproductive productivity of wolverine, and not in a measurable way. As a consequence, it is not expected that any Project effects would be greater than the natural variability in productivity and a low magnitude was used.

The effect will be of medium term duration, as the reproduction of individual wolverine would only occur when the Project is active and will subside at Reclamation/Closure. The frequency of the effect is anticipated to be sporadic as the likelihood of reduction in reproductive productivity are limited to events such as mortality which may cause declines in the wolverine population, or on factors such as limited resources or disturbance events which may limit the success of reproduction, births and rearing of young. Reduction in productivity is expected to be a reversible effect for wolverine, though it may take several years following the closure of the Project for wolverine to return to their baseline reproductive potential.

Overall, the effect of reduction of reproductive productivity for wolverine is assessed as Not Significant.

8.5.5 Significance of Residual Effects

Wolverine

The effects assessment for wolverine identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in reproductive productivity, due to a combination of the previous effects, rated Not Significant.

Overall, the effect of the Project on wolverine is expected to be **Not Significant**.

Grey Wolf

The effects assessment for grey wolf identified four effects as residual after mitigation as follows:

- habitat loss, rated Not Significant; and
- disturbance due to noise, rated Not Significant.

Overall, the effect of the Project on grey wolves is expected to be **Not Significant**.

The criteria used in the determination of the significance of each residual effect is detailed in Section 8.5.4 and summarized in Tables 8.5-11 and 8.5-12.

Table 8.5-11. Summary of Residual Effects on Wolverine and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	Medium	N
Disturbance due to Noise	Negative	Low	Medium	Sporadic	Local-regional	Reversible	Likely	High	N
Attraction	Negative	Low	Medium	Sporadic	Footprint	Reversible	Moderate	Medium	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

Table 8.5-12. Summary of Residual Effects on Grey Wolf and Overall Significance Rating

Description of Residual Effects	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** ***(footprint, local, regional, beyond regional)***	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	Medium	N
Disturbance due to Noise	Negative	Low	Medium	Sporadic	Local	Reversible	Likely	High	N

8.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

8.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. Following the methodology outlined in Volume 9, Chapter 1, a cumulative effects assessment is conducted as there are residual effects for the VEC wolverine and grey wolf. The following residual effects are included in the potential cumulative effects assessment for wolverine: habitat loss, disturbance due to noise, attraction, reduction in reproductive productivity. The following residual effects are included in the potential cumulative effects assessment for wolves: habitat loss and disturbance due to noise.

The cumulative effect assessment (CEA) generally follows the methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be attributed to the Project compared to other projects and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's incremental contribution to the cumulative residual effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Section 8.5.1.1).

Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 8.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary wolverine and grey wolf.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 8.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary for wolverine and grey wolf and not the wildlife RSA.

8.6.1.1 Spatial Boundaries for the Cumulative Effects Assessment

Wolverine

The spatial boundary for the cumulative effects assessment (CEA) for wolverine is the wildlife RSA, which is a 35 km diameter boundary surrounding the Project (Figure 8.6-1). This distance encompasses the distance movements typically travelled by wolverines which could interact with the Back River Project and other nearby development projects. Data from the wolverine DNA study in 2012 and 2013 (Rescan 2013b) show that cumulative, longest straight line distance movements between multiple DNA posts for females was 43 in 2012 and 47 in 2013; for males, the distance was 36 km in 2012 and 140 km in 2013. The relatively long distance recorded for males in 2013 was influenced by a single male travelling between the south and north study grids; within a single study grid, the cumulative, longest straight line distance movement between multiple DNA posts for males was 45 km. The longest straight line distance between two posts visited by an individual during the entire survey was 22 km in 2012. In 2013, the longest distance between two posts was 118 km, which again was a result of a single male travelling between the two grids. Within a single grid, the longest distance between two posts was 30 km. Therefore, it appears that the majority of the movements made by wolverine that inhabit areas in the vicinity of the Project, as recorded by the DNA studies, would occur within the boundaries of the RSA. The larger movements recorded for males in the DNA studies are expected to be rare, as only two individuals (two males) out of the 23 unique individuals identified were recorded to travel more than 45 km between multiple DNA posts in the two years of study.

The total area for the CEA boundary is 1,262,005 ha.

Grey Wolf

The spatial boundary for the CEA for grey wolf represents the summer range of the Bathurst and Beverly caribou herds due to the interrelationship between grey wolves and their main prey, caribou. The total area for the CEA boundary is 39,360,354 ha.

8.6.1.2 Temporal Boundaries for Cumulative Effects Assessment

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

8.6.2 Potential Interactions of Residual Effects with Other Projects

Wolverine

Four residual Project-related effects were identified during the wolverine effects assessment: habitat loss; disturbance due to noise; attractants; and reduction in reproductive productivity. Several additional projects or anthropogenic activities may contribute cumulatively to these residual effects if they occur within the range of wolverine that interact with the Back River Project.

A total of 3 projects in addition to the Back River Project have been identified within the CEA boundary for wolverine (Figure 8.6-1), which are all future foreseeable projects. The three Projects include the George, BIPR, and Hackett River projects. Potential interactions of these projects are described in Table 8.6-1.

Table 8.6-1. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Wolverines in the Cumulative Effects Assessment Boundary

Residual Effects from Back River Project	Magnitude of Residual Effect Rating from Back River Project	Other Project or Activity			Type of Potential Cumulative Effect
		Past	Existing	Reasonably Foreseeable Future	
Habitat Loss	Low	n/a	n/a	George, BIPR[1], Hackett River	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
Disturbance due to Noise	Low	n/a	n/a	George, BIPR[1], Hackett River	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance
Attractants	Low	n/a	n/a	George, BIPR[1], Hackett River	Additive attraction to foods and wastes resulting in attraction and negative human-wildlife interactions and destruction of nuisance animals
Reduction in Reproductive Productivity	Low	n/a	n/a	George, BIPR[1], Hackett River	Resulting reduction in reproductive productivity due to the synergistic addition of all potential cumulative effects

[1] *BIPR = Bathurst Inlet Port and Road Project*

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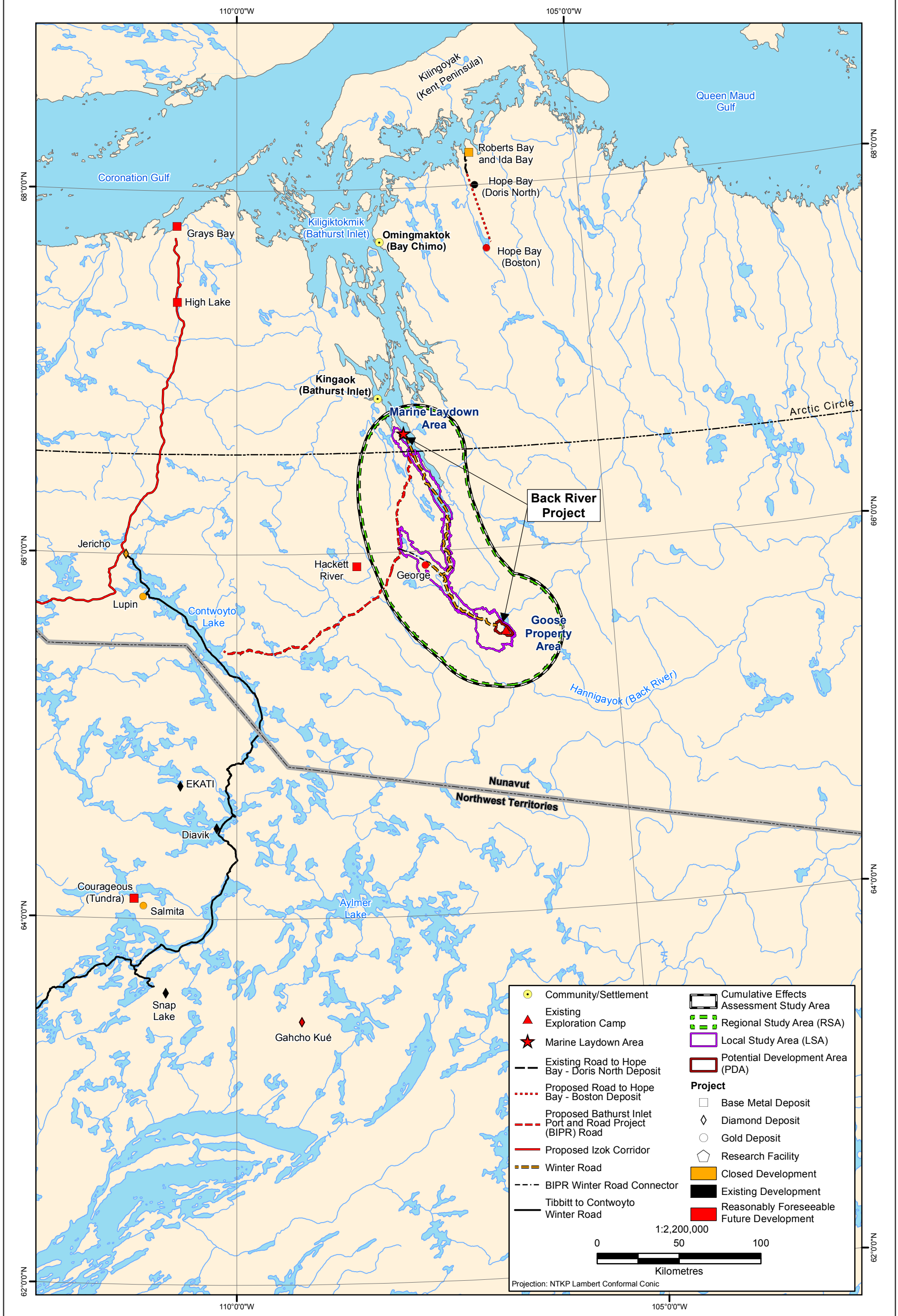

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Figure 8.6-1

Spatial Boundary for Wolverine Cumulative Effects Assessment

Rescan an ERM company

The George project was included in the original Back River DEIS submission as part of the Back River Project, but in the FEIS submission, it has been moved to a future foreseeable project. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the Exploration Camp. Should the George project proceed it will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned for George project.

Grey Wolf

Two residual Project-related effects were identified during the grey wolf effects assessment: habitat loss, and disturbance due to noise. Several additional Projects or anthropogenic activities may contribute cumulatively to these effects if they occur within the range of grey wolves that interact with the Back River Project.

A total of 14 projects in addition to the Back River Project have been identified within the CEA boundary for grey wolves (Figure 8.6-2), including five past projects (Roberts Bay and Ida Bay, Lupin Mine, Jericho Mine, Salmita Mine, and Tundra Mine projects), four existing projects (Doris North, Diavik, EKATI, Contwoyto Lake Winter Road projects), and six future foreseeable developments (George, Hope Bay (Phase 2), BIPR, Hackett River, Izok Corridor, Courageous Lake projects). Potential interactions of these projects are listed in Table 8.6-2.

As noted above, the George project was included in the original Back River DEIS submission as part of the Back River Project, but in the FEIS submission, it has been moved to a future foreseeable project. It is located within the Back River RSA. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned for George project.

8.6.2.1 Habitat Loss

The residual effect of habitat loss associated with the development of the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment for both wolverine and grey wolves. Habitat lost due to Back River Project infrastructure and infrastructure from other projects in the wolverine CEA boundary and the grey wolf CEA boundary is discussed in this section.

Habitat loss is assessed in the CEA because there will be some habitat loss due to the Back River Project that will not be reversible and the range of wolverines and grey wolves overlaps additional projects which may contribute to habitat loss. While habitat lost due to Project infrastructure will be minimal relative to the habitat available within the wildlife RSA (Section 8.5.4.1), additional habitat loss within the range wolverines and grey wolves may contribute to a nibbling effect whereby the total amount of habitat lost to all potential and current projects is additive to the point where a significant loss in habitat can occur.

Potential cumulative effects from all past, existing and future foreseeable proposed projects in each CEA boundary were assessed (Tables 8.6-1 and 8.6-2). A background on the potential effects of disturbance due to noise to wolverines and grey wolves is presented in Section 8.5.2.2.

Table 8.6-2. Residual Effects from the Back River Project and Other Human Activities with the Potential to Interact with Grey Wolves in the Cumulative Effects Assessment Boundary

Residual Effect from Back River Project	Magnitude of Residual Effect Rating from Back River Project	Other Project or Activity			Type of Potential Cumulative Effect
		Past	Existing	Reasonably Foreseeable Future	
Habitat Loss	Low	Roberts Bay and Ida Bay, Lupin, Jericho, Salmita, Tundra	Doris North, Diavik, EKATI	George, Hope Bay (Phase 2), BIPR[1], Hackett River, Izok Corridor, Courageous Lake	Nibbling loss resulting from the cumulative habitat loss of all Projects or Activities
Disturbance due to Noise	Low	n/a	Doris North, Diavik, EKATI,	George, Hope Bay (Phase 2), BIPR[1], Hackett River, Izok Corridor, Courageous Lake	Nibbling loss of habitat resulting from the additive increase in sensory disturbance due to noise and resulting functional habitat loss and disturbance

[1]*BIPR = Bathurst Inlet Port and Road Project*

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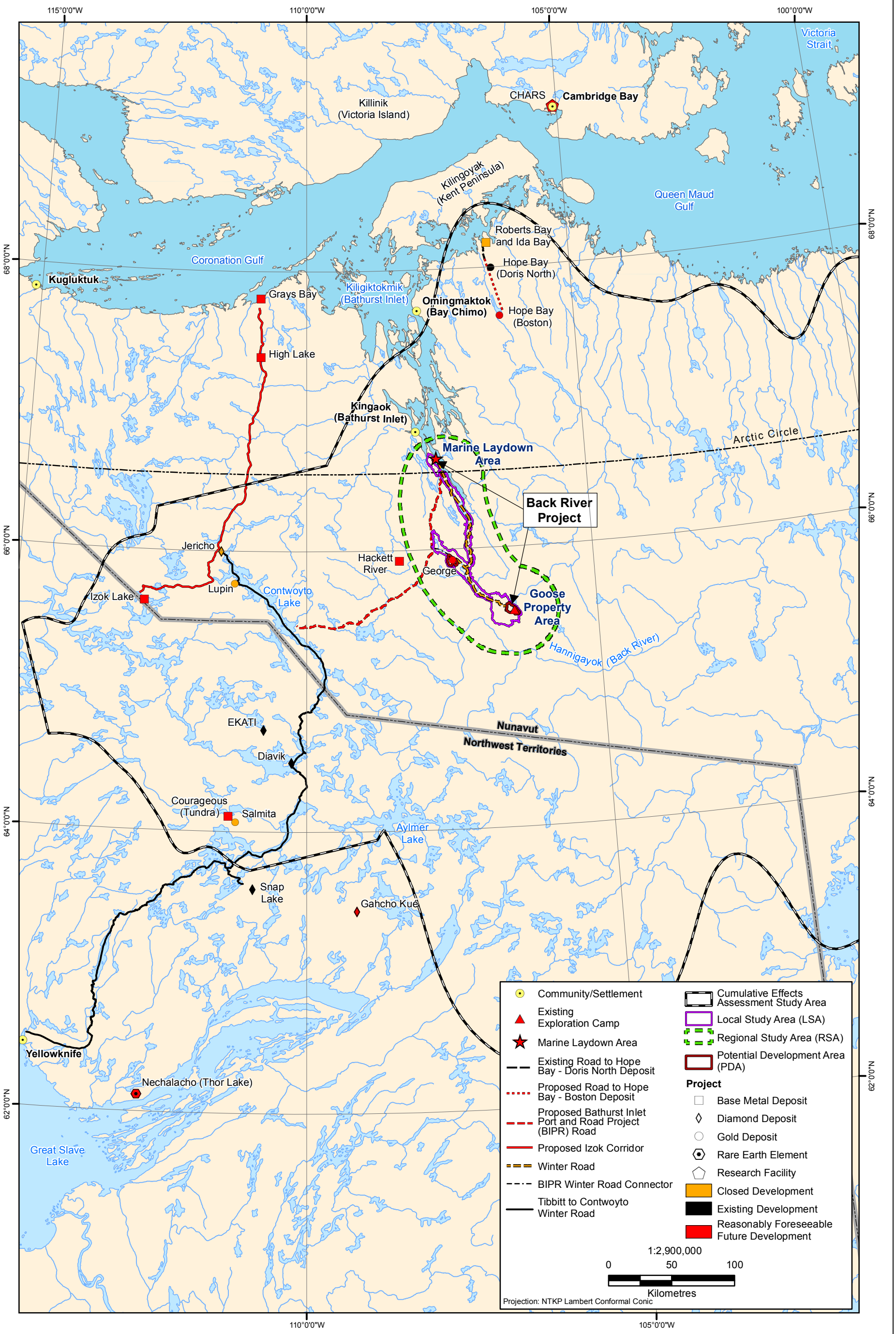

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Figure 8.6-2

Spatial Boundary for Grey Wolf Cumulative Effects Assessment

Rescan an ERM company

Calculation of Cumulative Habitat Loss

The amount of habitat removed due to projects was estimated from the generalized footprints of all projects and road corridors in the CEA assessment boundaries for wolverine and grey wolves. For all additional projects (other than the Back River Project), habitat within 100 m of removed habitat (due to Project infrastructure) was considered to be degraded habitat because 100 m is the distance within which most effects of large dust particles extend from roads and other developments (Walker and Everett 1987; Rescan 2012, Appendix V5-5D). This 100 m buffer of degraded habitat was not calculated for the Back River Project because it was assumed that the effects of habitat degradation due to dust were accounted for within the PDAs for each of the development areas (Goose Property Area and the MLA).

The areas within the project footprints plus 100 m buffer was calculated and added to the area of habitat lost due to the Back River Project and compared to the total area of the CEA assessment boundaries for wolverine and grey wolves. This calculates the total amount of area lost within the CEA boundary. In order to put the amount of habitat lost in the perspective of habitat use by individual wolverines and grey wolves, the habitat loss due to all Projects in the CEA assessment boundaries for wolverine and grey wolves are compared to home range sizes for male and female wolverines or grey wolves. This is an overestimate of the amount of habitat loss within an individual's home range but will enable a calculation of the maximum number of home ranges that could be potentially lost due to the cumulative effect of habitat loss within the CEA boundaries for wolverine and grey wolves.

Evaluation of Cumulative Habitat Loss

Wolverine

Within the CEA boundary for wolverine, the cumulative effects assessment identified 6,621 ha of removed habitat, and 2,761 ha of degraded habitat. These areas account for a total of 9,382 ha after accounting for overlap between projects (approximately 0.7% of the total area in the CEA boundary; Table 8.6-3). Additional areas will be temporarily lost when winter roads are operational, and this accounts for 12,776 ha (1.0% of CEA boundary; Table 8.6-3). The Back River Project alone will contribute 6,080 ha of the total cumulative area of habitat loss during the snow free periods (0.5% of CEA boundary), and 9,477 ha when winter roads are operational (0.8% of the CEA boundary). Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10 % or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects.

The total area of habitat loss due to all projects in the CEA boundary for wolverine is equivalent to 23 to 32% of a home ranges of a male wolverine and 74 to 100% of a home range of a female wolverine when considering cumulative loss without and including winter roads, respectively. Assuming that approximately 50% of this area consists of high-quality habitat for wolverines (similar to that identified in the wildlife RSA; Section 8.5.2.1), a total of 4,691 ha of high-quality habitat is anticipated to be lost or degraded due to infrastructure and dust if all projects within the CEA boundary for wolverines are developed, and roughly 6,388 ha of high-quality habitat lost or degraded inclusive of winter roads.

The amount of wolverine habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 8.6-3) and that of the home range of male and female wolverines. The carrying capacity of the habitat for wolverine at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to wolverine.

Table 8.6-3. Cumulative Habitat Loss in the Wolverine CEA Area

Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)	Total Lost or Degraded[2] Including Winter Roads (ha)
Back River Project[3]	6,080	n/a	6,080	9,477
Past Developments				
n/a				
Existing Developments				
n/a				
Reasonably Foreseeable Future Developments				
BIPR[4]	330	2,291	2,621	2,621
George	172	239	411	411
Hackett River	40	231	271	271
Cumulative Areas				
Total Area	6,621	2,761	9,382	12,779
Total Area Accounting for Overlap[5]	6,621	2,761	9,382	12,776
% CEA Boundary	0.5	0.2	0.7	1.0

[1] Wolverine Cumulative Effects Assessment boundary approximates 1,262,005 hectares.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] BIPR = Bathurst Inlet Port and Road Project
[5] Represents the total area of habitat loss and degradation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degradation, these were dissolved to provide a total accounting for overlap.

Grey Wolf

Within the CEA boundary for grey wolf, the cumulative effects assessment identified 20,044 ha of removed habitat, and 16,058 ha of degraded habitat. These areas account for a total of 36,102 ha after accounting for overlap between projects (totalling approximately 0.1% of the total area in the CEA boundary; Table 8.6-4). The Back River Project alone will contribute 6,080 ha of the total area of habitat loss within the CEA boundary for grey wolves which is equivalent to less than 0.1% of the total CEA boundary. Note that the actual footprint of the Project is anticipated to be much smaller (approximately 10 % or less of the PDA areas) relative to the PDA areas used in this analysis, which will reduce the proportion of area lost due to the Project compared to other projects. The total loss and degradation of wolf habitat (36,102 ha), is equivalent to 18% of an average male grey wolf summer home range or 32% of the average summer home ranges of a female grey wolf.

The amount of grey wolf habitat that will be lost as a result of Project development represents a small portion of the total amount of habitat available in the CEA boundary (Table 8.6-4) and that of the average summer home ranges of grey wolves. The carrying capacity of the habitat for grey wolf at the landscape level is therefore unlikely to be affected due to the cumulative habitat loss of all Projects in the CEA boundary. It is concluded that the potential cumulative effect of habitat loss, while small, will result in a residual effect to grey wolf.

Table 8.6-4. Cumulative Habitat Loss in the Grey Wolf CEA Boundary

Project	Habitat Lost due to Project Infrastructure (ha)	Habitat Degraded due to Dust (ha)	Total Habitat Lost or Degraded[2] (ha)
Back River Project[3]	6,080	n/a	6,080
Past Developments			
Jericho Mine	242	n/a	242
Lupin Mine	796	n/a	796
Roberts Bay and Ida Bay	3	n/a	3
Salmita	10	n/a	10
Tundra	96	n/a	96
Existing Developments			
Diavik Mine	988	421	1,409
Doris North	279	532	811
Ekati Mine	3,221	2,058	5,279
Reasonably Foreseeable Future Developments			
BIPR[4]	656	4,920	5,576
Courageous Lake	2,207	843	3,050
George	172	239	411
Hackett River	1,454	2,056	3,510
Hope Bay (Phase 2)	2,989	1,066	4,055
Izok Corridor Project[5]	851	3,922	4,774
Cumulative Areas			
Total Area	20,044	16,058	36,102
Total Area Accounting for Overlap[6]	20,044	16,058	36,102
% CEA Boundary	0.05	0.04	0.09

[1] Grey Wolf Cumulative Effects Assessment boundary approximates 39,360,354 hectares.
[2] Habitat Loss includes total area lost and does not take into account habitat suitability within the area.
[3] Habitat Removed due to the Back River Project includes the Goose Property and MLA PDAs.
[4] Bathurst Inlet Port and Road Project
[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.
[6] Represents the total area of habitat loss and degradation across all projects in the CEA boundary without any overlap between projects. Certain project features overlap one another, and thus to avoid double-counting the total amount of habitat loss and degradation, these were dissolved to provide a total accounting for overlap.

8.6.2.2 Disturbance

The residual effect of disturbance due to noise from auditory stimuli associated with the Back River Project was rated as Not Significant, with a low magnitude in the effects assessment for both wolverine and grey wolves. Habitat lost or disturbed due to Project-related noise resulting from activities at the Back River Project and other projects in the wolverine CEA boundary and the grey wolf CEA boundary is discussed in this section.

Potential cumulative effects from all existing and future foreseeable proposed projects in each CEA boundary were assessed. Closed projects were excluded from the analysis, as areas that were disturbed by noise from these developments are anticipated to be recovered to baseline conditions. A

background on the potential effects of disturbance due to noise to wolverines and grey wolves is presented in Section 8.5.2.2.

Calculation of Cumulative Disturbance

To evaluate the effects of disturbance on wolverine and wolves, the area in which wolverine and wolves may be affected by disturbance was calculated and used as a key indicator of this potential effect.

A zone of influence (ZOI) approach was taken to evaluate the cumulative effect of disturbance on the VEC. A ZOI represents the area where wolverines and wolves may avoid industrial developments or features due to noise, human presence, or altered habitat within a particular distance of that development or feature. The results of noise modeling produced in Volume 2, Chapter 4 and literature values were used to develop ZOIs for all project features occurring with the CEA boundaries for wolverines and wolves.

The ZOI of 4 km was applied to all existing and reasonably foreseeable future developments and associated infrastructure areas (e.g., port facilities). This value was chosen based on a wide range of theoretical zones of influence for large arctic mammals, which have ranged from 500 m up to 5 km (Czech 1991; Nellemann and Cameron 1998; Vistnes and Nellemann 2001; Mahoney and Schaefer 2002; Frid 2003; Johnson et al. 2005). Thus, a conservative value of 4 km was used, and is a commonly reported ZOI for large mammals such as caribou (see Sections 5.5.2.2 and 5.6.2.2).

Linear features, including all weather roads and winter roads, were assigned ZOIs primarily on the results of noise modelling. For both types of roads, the distance from the feature where noise is anticipated to attenuate to below the threshold value of 45 dBA was calculated, as per the conservative guideline for minimizing disturbance outlined in Environment Canada (2010) (Section 8.5.2.2).

All-weather roads associated all existing and reasonably foreseeable future developments with were assigned a ZOI of 1.5 km. Noise modelling in research studies have indicated that auditory disturbance due to traffic along all-weather roads during normal operation conditions could attenuate to distances of 550 m at 65 dB (Summers, Cunnington, and Fahrig 2011). Thus, by extrapolation of this study it was assumed that attenuation of traffic noise would decline below 45 dBA at a distance of approximately 1.5 km.

Winter roads for all existing and reasonably foreseeable future developments were assigned a ZOI of 200 m. The results of noise modelling produced in Rescan (2013d) indicated that traffic along winter roads would attenuate to 45 dBA at roughly 200 m from vehicle traffic and activities on these roads. No ZOI was applied to winter roads associated with the Back River Project as the results of noise modeling produced in Volume 2, Chapter 4 indicated that traffic noise above 45 dBA will be completely contained within the footprint of the Winter Road PDA, and no additional disturbance outside of the PDA was expected (Section 8.5.2.2). The winter road buffer was not used for grey wolves, as wolves are found only in very small density above tree line during the winter.

ZOIs for project features overlap one another. For example, ZOIs associated with all-weather roads exiting a development area will overlap 4 km ZOIs for that certain development, and ZOIs for all-weather roads connecting to existing winter road networks will overlap the ZOIs for those winter roads. Thus, a priority was assigned to each ZOI to account for overlaps in features. The 4 km ZOI for developments took precedence over all other ZOIs, as it was assumed that the physical presence of the development, noise (in some cases continuous noises such as generators), and other associated

activities, would cause more potential disturbance than roads which will have more infrequent disturbance during hauling periods. All-weather roads ZOIs took precedence over ZOIs for winter roads on account of the smaller predicted area of habitat above noise thresholds around winter roads relative to all-weather roads.

In some cases, ZOIs for certain projects overlap one another. In these cases, the amount of overlap was calculated and removed from the total disturbance within ZOIs to avoid double-counting areas where ZOIs overlap.

The total area of indirect habitat loss due to all projects was compared to the total area of the CEA boundary for wolverines and grey wolves and to the average home range size of a male and female wolverine or grey wolf territories.

Evaluation of Cumulative Disturbance

Wolverine

The CEA boundary for wolverine is approximately 1,262,005 ha. The area of habitat loss for the cumulative effects of disturbance due to all existing and proposed projects (including the Back River Project) in the CEA boundary for wolverines, assuming a worst case scenario whereby all projects are operational at the same time, would result in 87,750 ha of disturbed habitat, or 7% of the CEA boundary. The area of habitat altered due to disturbance from the Back River Project alone would cover 27,352 ha, or 2% of the CEA boundary for wolverines (Figure 8.6-3). Estimated areas of disturbance for each project are reported in Table 8.6-5.

Table 8.6-5. Zone of Influence due to Disturbance in the Wolverine CEA Boundary

Project	Area of Habitat within ZOIs (ha)[1][2][3]			Total	
	Winter Roads (200 m)	All-weather Roads (1.5 km)	Mine (4 km)	Without Winter Roads	Including Winter Roads
Back River Project	n/a*	n/a	27,352	27352	27352
Reasonably Foreseeable Future Developments					
BIPR[4]	n/a	24,110	8,026	32,135	32,135
George	n/a	n/a	20,348	20,348	20,348
Hackett River	n/a	0	7,909	7,909	7,909
Cumulative Areas					
Total Area	n/a	24,110	63,640	87,750	87,750
Total Area Accounting for Overlap[5]	n/a	24,110	63,640	87,750	87,750
% CEA Boundary	n/a	2	5	7	7

[1] *Wolverine Cumulative Effects Assessment boundary approximates 1,262,005 hectares.*
[2] *Disturbance includes total area in ZOI and does not take into account habitat suitability within the area.*
[3] *Habitat within ZOIs of the Goose Property and MLA PDAs.*
[4] *BIPR = Bathurst Inlet Port and Road Project*
[5] *Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.*

The cumulative effect of disturbance from all projects assuming a worst-case scenario results in the equivalent of 2.2 male wolverine home ranges or approximately 7.0 female wolverine home ranges. Despite mitigation measures, a residual effect is anticipated for disturbance to wolverines.

Grey Wolf

The CEA boundary for grey wolves is approximately 39,360,354 ha. The area of habitat loss for the cumulative effects of disturbance due to all existing and proposed projects in the CEA boundary for grey wolves, assuming a worst case scenario whereby all projects are operational at the same time, would result in 325,782 ha of disturbed habitat, or 0.8% of the CEA boundary. The area of habitat altered due to disturbance from the Back River Project alone would cover 27,352 ha, or <0.1% of the CEA boundary for grey wolves (Figure 8.6-4). Estimated areas of disturbance for each project are reported in Table 8.6-6.

Table 8.6-6. Zone of Influence due to Disturbance in the Grey Wolf CEA Boundary

Project	Area of Habitat within ZOIs (ha)[1, 2, 3]		Total
	All-weather Roads (1.5 km)	Mine (4 km)	
Back River Project	n/a	27,352	27,352
Existing Developments			
Diavik Mine	n/a	11,725	11,725
Doris North	0	17,156	17,156
Ekati Mine	4,030	32,879	36,909
Reasonably Foreseeable Future Developments			
BIPR[4]	57,207	13,714	70,921
Courageous Lake	n/a	23,079	23,079
George	n/a	20,348	20,348
Hackett River	0	36,096	36,096
Hope Bay (Phase 2)	10,409	12,378	22,787
Izok Corridor Project[5]	44,618	16,649	61,267
Cumulative Areas			
Total Area	116,264	211,378	327,642
Total Area Accounting for Overlap[6]	116,264	209,518	325,782
% CEA Boundary	0.30	0.53	0.83

[1] Grey Wolf Cumulative Effects Assessment boundary approximates 19,114,304 hectares.
[2] Disturbance includes total area in ZOI and does not take into account habitat suitability within the area.
[3] Habitat within ZOIs of the Goose Property and MLA PDAs.
[4] Bathurst Inlet Port and Road Project
[5] Izok Corridor Project includes the Izok and High Lake mine sites, a port at Gray's Bay and an all-weather road connecting the properties.
[6] Represents the total area of disturbance across all projects in the CEA boundary without any overlap between projects. Certain project features and associated ZOIs overlap one another, and thus to avoid double-counting the total amount of disturbance, these were dissolved to provide a total accounting for overlap.

The cumulative effect of disturbance from all projects assuming a worst-case scenario results in the equivalent of 1.6 male grey wolf summer home ranges or approximately 2.9 female grey wolf home ranges. Despite mitigation measures, a residual effect is anticipated for disturbance to grey wolves.

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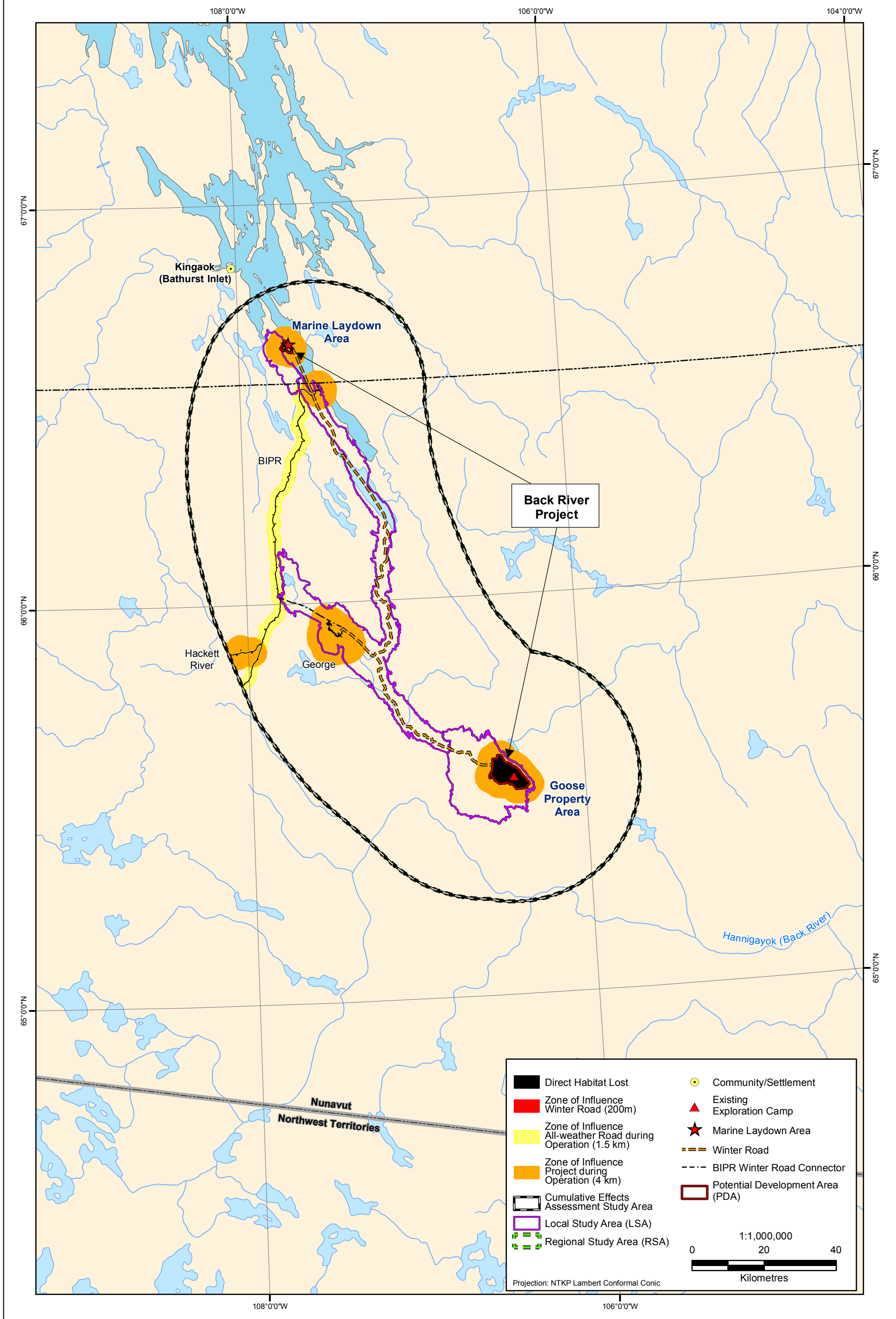

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Habitat Lost or Altered due to All Project Footprints and Disturbances in the Wolverin Cumulative Effects Assessment Boundary

Figure 8.6-3

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November 13 2015

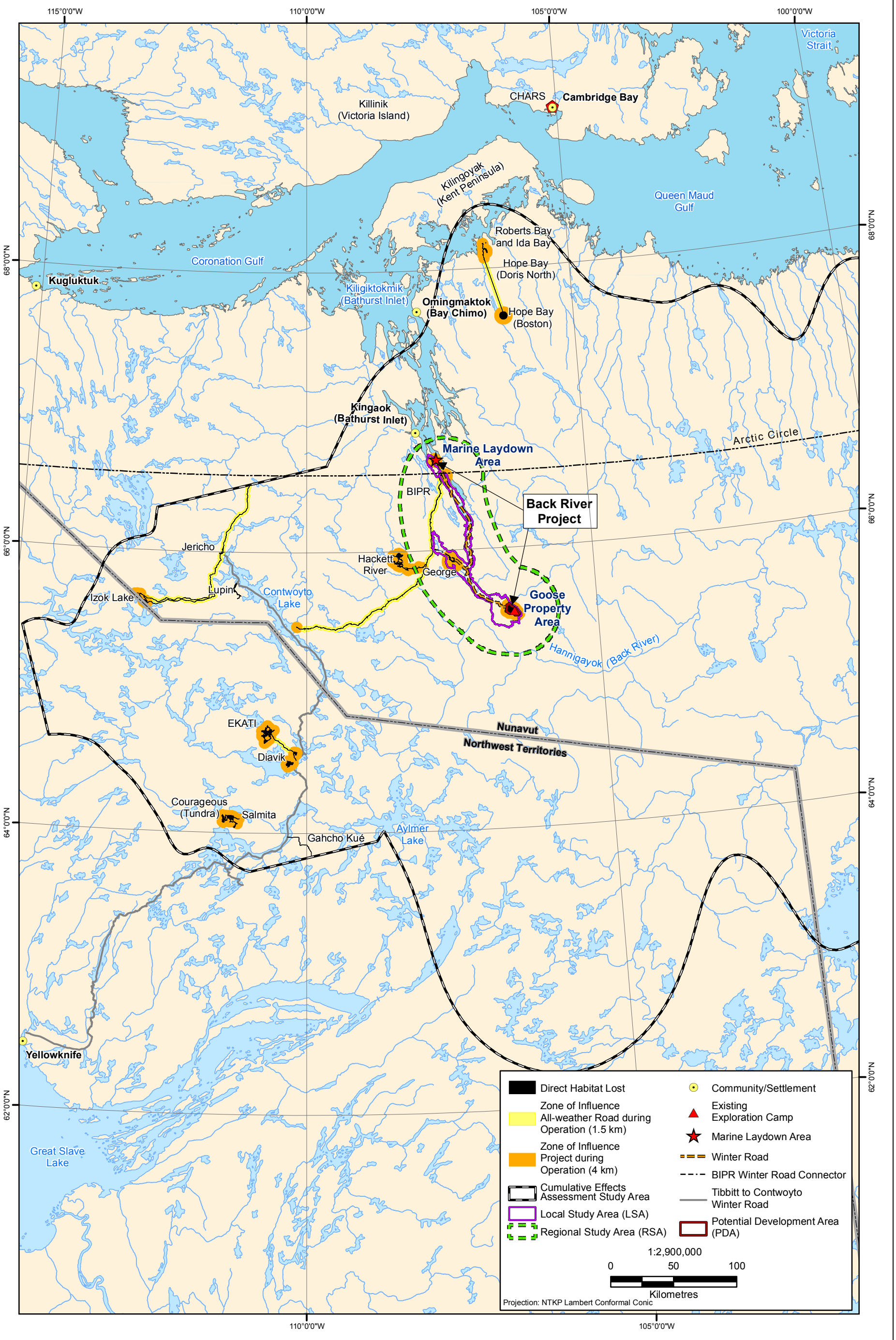

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Figure 8.6-4

Habitat Lost or Altered due to All Project Footprints and Disturbances in the Grey Wolf Cumulative Effects Assessment Boundary

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8.6.2.3 Attraction

Wolverines are often attracted to a human settlement due to curiosity and/or attraction (Section 8.5.2.6). Additional camps associated with the construction and operation that occur in the area assessed for cumulative impacts on wolverine will increase the probability of attraction of wolverines. The more areas where wolverines are attracted to scents of foods and wastes, or where they will potentially receive a reward, the greater the chance of producing nuisance animals. A crucial consideration for cumulative effects on attraction of wolverines is that one poorly managed camp has the potential to attract and create habituated wolverines that can then move into many other areas of human use; thus the probability of creating and interacting with nuisance animals increases exponentially with the number of new developments in an area.

Evaluation of Attraction

Best management practices for reducing the attractiveness of camps and infrastructure are expected to be implemented at all project sites. However, existing mines and camps in Northwest Territories and Nunavut report problem wildlife at a low level despite implementing these best management practices. Therefore a residual effect is predicted for the cumulative assessment of attractants for wolverine.

8.6.2.4 Reduction in Reproductive Productivity

This effect was evaluated as a result of other potential effects of habitat loss, disturbance due to noise, and attraction anticipated from the Project. However, the scale of these potential effects is expected to be small, and wolverine populations are known to be robust in areas with operating mines elsewhere in the Arctic. If any effect of reduction in reproductive productivity occurs, it is expected to be small and very difficult, or impossible to measure, but is rated as a residual effect based on a conservative assessment of the potential for other effects to interact and cause a reduction in reproductive productivity.

8.6.3 Identification of Mitigation and Management Measures

It is assumed that mitigation measures for all projects within the CEA boundary for wolverines will be similar to those applied for the Back River Project. For a list of these mitigation and management measures see Section 8.5.3 and Volume 10.

8.6.4 Characterization of Cumulative Residual Effects

After the application of mitigation and management measures, there are four residual effects predicted in the wolverine cumulative effects assessment area: habitat loss, disturbance, attraction, and reduction in reproductive productivity and two residual effect on grey wolf: habitat loss, and disturbance.

8.6.4.1 Habitat Loss

Wolverine

The overall loss or degradation of area due to all projects in the wolverine CEA boundary is 9,382 ha during the snow free season, and 12,776 ha when winter roads are operational, which represents 1% or less of the CEA boundary, and is equivalent to less than 0.5 home ranges of a male wolverine and 1 or less home ranges of a female wolverine assuming all habitat lost falls within one wolverine's home range. As this amount of habitat loss is minimal relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as it is expected to occur near the project footprints, the frequency is sporadic, as habitat loss would occur during construction of project infrastructure for each Project, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may be reclaimed to baseline condition. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for wolverines is concluded to be Not Significant.

Grey Wolf

The overall loss or degradation of area due to all projects in the grey wolf CEA boundary is 36,102 ha (approximately 0.2% of the total area in the CEA boundary for grey wolves) and equivalent to 18% of a summer home range of a male grey wolf and 32% of a summer home range of a female, assuming all habitat lost falls within one wolf's home range. As this amount of habitat loss is minimal relative to the amount of habitat in the CEA boundary the magnitude of the cumulative residual effect is considered low.

The extent of the effect of habitat loss is local as habitat loss is anticipated to occur near the project footprints, the frequency is sporadic, as habitat loss would occur during construction of project infrastructure for each of the projects and habitat degradation due to dusting would occur when blasting activities occur, and duration is long term (beyond the life of the Project) or permanent; and the effect is considered irreversible, as not all areas will return to existing baseline conditions, although some areas may return to baseline conditions. The probability of the effect occurring is likely as habitat will be removed for infrastructure during Construction and Operations. The confidence of the effect occurring is considered high, as the effect of habitat loss were converted into area calculations, and these areas are conservative to ensure that effects are not diluted as much as possible, although confidence in the area and proportion removed is considered medium as it is anticipated that a much smaller proportion of the area will be lost or degraded as overestimates of habitat loss were made for the Back River Project as well as for other future foreseeable projects where no published data on footprint area were available. The cumulative residual effect of habitat loss for grey wolf is concluded to be Not Significant.

8.6.4.2 Disturbance

Wolverine

The total additional area of habitat calculated as disturbed by all projects within the CEA boundary is 87,750 ha during the worst case scenario assuming all future foreseeable projects are operational at the same time. This area is equivalent to 7% of the CEA boundary for wolverine. The maximum area of disturbance is equivalent to 2.2 male wolverine home ranges or approximately 7.0 female wolverine home ranges. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for wolverine. Thus, the magnitude of the effect of disturbance due to noise to wolverine is considered low.

The extent of the effect of disturbance is local, the frequency is expected to be continuous, and the duration is considered medium as the effect of disturbance is expected to subside at closure of the

projects. The effect is considered to be reversible as wolverines are anticipated to relocate to areas disturbed by noise once the effect subsides. The probability of the effect occurring is likely. The confidence in the effect of disturbance is high. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed. The cumulative residual effect of disturbance on wolverines is concluded to be Not Significant.

Grey Wolf

The total area of habitat calculated as disturbed by all projects within the CEA boundary for grey wolves is 325,782 ha during the worst case scenario. This area of disturbance in the CEA boundary for grey wolves is equivalent to 0.8% of the CEA boundary for grey wolves. This maximum area of disturbance is equivalent to 1.6 male grey wolf summer home ranges or approximately 2.9 female grey wolf summer home ranges. These areas represent a small amount of habitat disturbed relative to that available in the CEA boundary for grey wolves. Thus, the magnitude of the effect of disturbance due to noise to grey wolf is considered low.

The extent of the effect of disturbance is local, the frequency is expected to be continuous, and the duration is considered medium as the effect of disturbance is expected to subside at closure of the projects. The effect is considered to be reversible as wolves are anticipated to relocate to areas disturbed once the effect subsides. The probability of the effect occurring is likely. The confidence in the effect of disturbance is high. However, the confidence in the actual proportion of the area that will be affected is considered medium, as it is anticipated that a much small proportion of the area will be disturbed. The cumulative residual effect of disturbance on grey wolves is concluded to be Not Significant.

8.6.4.3 Attractants

Wolverine

With mitigation measures applied and assumed similar among projects, the magnitude of the effect of attractants on wolverine is determined from the definitions of qualitative effects (Table 8.5-1) is rated as low. The geographic extent is local as the effect will occur near the footprints of the projects in the CEA boundary for wolverine. The effect of attraction is anticipated to result in a negative effect as wolverines that become habituated to Project-related attractants may have to be destroyed if they become nuisance animals. The duration of the effect is expected to be medium, as the effect will remain as long as the camps are being used. The frequency of wolverines being attracted to infrastructure will be sporadic and will be reversible in the long term. The probability of the effect occurring is high, and confidence is medium, as wolverines are known to be attracted to mining camps. The cumulative residual effect of attractants on wolverines is concluded to be Not Significant.

8.6.4.4 Reduction in Reproductive Productivity

Wolverine

The potential for a reduction in reproductive productivity in wolverines depends on the magnitude of all other effects (disturbances) they experience. Disturbance leading to displacement of wolverines with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young due to wolverine becoming nuisance animals as a results of being attracted to projects, could lead to effects on wolverines in the region.

The residual effects of the Project on wolverines include habitat loss, disturbance due to noise, and attraction. The highest magnitude of any of the residual effects on wolverines after mitigation was rated as low, thus the magnitude of the effect of reduction in reproductive productivity on wolverines is also rated as low.

The residual effect of reduction in reproductive productivity is considered negative, as it would result in a decrease to the population of wolverines in the regional area. The duration of the effect is expected to be medium term as reduction to reproductive productivity would be anticipated to recover once the projects in the CEA boundary for wolverine close. The frequency of the effect is anticipated to be sporadic. The effect of reduction of reproductive productivity is anticipated to be reversible in the long term as disturbances and other negative effects are reduced when the various mines are closed. The effect is anticipated to be regional as wolverines have large home ranges and may come into contact with many of the projects in the CEA boundary. The confidence in the effect rating is medium as it is unknown how the effects of the Project on reproduction of wolverines may interplay with the effects of climate change and disease vectors that may be introduced to the Arctic environment and change habitat and habitat use within the area. Overall, the cumulative residual effect of reduction of reproductive productivity is concluded to be Not Significant.

8.6.5 Significance of Cumulative Residual Effects

Wolverine

The cumulative effects assessment for wolverine identified four effects as residual after mitigation as follows and in Table 8.6-7:

- habitat loss, rated Not Significant;
- disturbance, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in reproductive productivity due to a combination of the previous effects, rated Not Significant.

Overall, the residual cumulative effect of wolverines is **Not Significant.**

Grey Wolf

The cumulative effects assessment for grey wolves identified two effects as residual after mitigation as follows and in Table 8.6-8:

- habitat loss, rated Not Significant; and
- disturbance, rated Not Significant.

Overall, the residual cumulative effect of grey wolves is **Not Significant.**

Table 8.6-7. Summary of Cumulative Residual Effects to Wolverine and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Attraction	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	N
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Regional	Reversible	Unlikely	Medium	N

Table 8.6-8. Summary of Cumulative Residual Effects to Grey Wolf and their Significance

Cumulative Residual Effects	Evaluation Criteria			Likelihood of Occurrence of Cumulative Residual Effects			Significance of Cumulative Residual Effects		
	Direction *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not Significant** *(N)*, **Significant** *(S)*, **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Local	Irreversible	Likely	High	N
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Likely	High	N

8.7 TRANSBOUNDARY EFFECTS

Residual effects of the Project on wolverine are predicted to occur in both the Project effects assessment and the cumulative effects assessment. However, wolverine inhabiting areas surrounding the project would rarely travel into the Northwest Territories. The transboundary effects that cross jurisdictional boundaries are predicted to be accounted for in the cumulative effects assessment for wolverine — all of which are rated as Not Significant. Thus, the overall transboundary effect is anticipated to be Not Significant.

For grey wolf, the CEA boundary is designed to encompass the summer range of grey wolves that follow the Ahiak and Bathurst herds and includes habitat within the Northwest Territories; the transboundary effects that cross jurisdictional boundaries are accounted for in the cumulative effects assessment for grey wolf – all of which were rated as Not Significant. Thus the overall transboundary effect on grey wolf is anticipated to be Not Significant.

8.8 MITIGATION AND ADAPTIVE MANAGEMENT

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including wolverine and grey wolf. Mitigation measures specific to wolverine and grey wolf are listed in Section 8.5.3 and summarized in Table 8.8-1 in Section 8.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including wolverine and grey wolf. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incineration Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;

- Ore Storage Management Plan: Chapter 8;
- Mine Waste Rock Management Plan: Chapter 9;
- Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosives Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Fish Offsetting Plan: Chapter 21;
- Tailings Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

8.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of wolverine and grey wolf dens. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 8.8-1 in Section 8.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on wolverines and grey wolves.

8.8.2 Best Management Practices

The WMMP Plan (Volume 10, Chapter 20) includes ten eleven components designed to eliminate or minimize effects of the Project on wildlife. The plan is focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to wolverine and grey wolf are listed in Section 8.5.3, and listed in Table 8.8-1 in Section 8.8.5.

8.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP Plan (Volume 10, Chapter 20) and scientific knowledge. Newly devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the WMMP Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The WMMP Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

8.8.4 Monitoring

As part of the WMMP Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal species monitoring.

8.8.5 Summary Table of Mitigation and Adaptive Management Measures

Table 8.8-1 includes all planned mitigation and adaptive management measures that may be applicable to mitigate the effects of the Project on wolverine and grey wolf.

Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf)

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	1. Project infrastructure designed to avoid, where possible, identified wildlife sensitive areas. 2. Infrastructure designed to minimize the Project footprint. 3. Consideration of the location of the stockpiles and windbreaks to minimize dust fall. 4. Infrastructure, waste rock storage areas, and the TSF at the Goose Property confined to the local watersheds where the deposits are located. 5. Winter road access corridors proposed (no all-weather roads for re-supply routes). 6. Winter roads designed to avoid known wolverine and furbearer dens within 1 km of the proposed alignment. 7. Infrastructure located close to deposits to keep activities confined to specific areas in order to confine noise-generating activities. 8. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and the destination. 9. Buildings designed and maintained to exclude wildlife. 10. WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA.
2. Best Management Practices	1. Pre-construction ground clearing will be conducted outside of sensitive periods for wildlife, where possible. 2. Pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats.

(continued)

Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf) (continued)

Mitigation Category	Mitigation Measures
2. Best Management Practices *(cont'd)*	
	3. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed. 4. Vehicles restricted to site roads, winter roads and quarry footprints during construction and operations and not permitted on winter road corridors outside of the frozen ground period between December and April. 5. Truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits. 6. Wildlife given the right-of-way on all roads at all times. 7. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance. 8. A policy prohibiting hunting by Project employees and contractors while on site. 9. Berms or other markers built at high walls of quarries to deflect wildlife movement and prevent falls or injury. 10. A waste management protocol will be developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants. 11. Wildlife-proof receptacles used for all waste and wildlife attractants, where possible. 12. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced. 13. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced. 14. A protocol for human-wildlife interactions developed and disseminated to all employees and contractors as part of orientation with lead management responses undertaken by identified supervisors, wildlife biologists and conservation officers. 15. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife. 16. Participation by all contractors and employees working on the Project in the Employee Wildlife Education Program in conjunction with Project orientation. Access road restrictions and operating protocols (e.g., wildlife right-of-way, speed limits, check-ins, and road-wildlife reporting programs) covered during the education/orientation.
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Program (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

(continued)

Table 8.8-1. Summary of Mitigation and Management Measures Applicable to Wolverine and Furbearers (Grey Wolf) (completed)

Mitigation Category	Mitigation Measures
4. Monitoring	
	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This program will include several monitoring plans relevant to wolverine and furbearers including: 1. Footprint monitoring to monitor habitat loss. 2. Noise monitoring to monitor disturbance to wildlife. 3. Human activity monitoring of Project site roads and winter roads. 4. Waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes. 5. infrastructure monitoring to record the status of wildlife exclusion measures, such as skirting and fencing. 6. Wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions. 7. Incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible. Focal-species monitoring program to monitor Project-related effects on wolverine and furbearers including: 1. A monitoring program for wolverine and furbearer dens including wolves and foxes. 2. Incidental reporting of wildlife to record wolverine and furbearer activity in the wildlife RSA.

8.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

Facility-specific monitoring is designed to:

- Monitor wildlife interactions with Project Infrastructure;
- Monitor mitigation actions and their efficacy; and
- Identify opportunities for adaptive management.

Focal-species monitoring is designed to:

- evaluate impact predictions in the effects assessment;
- continuously reduce uncertainty of Project effects on wildlife; and
- collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to wolverine and grey wolf are summarized in the following sections.

8.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented.

Facilities that will be monitored for wildlife effects include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10, Chapter 20):

- Footprint Monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Nests;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Infrastructure Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA;
- Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds; and
- Pre-construction Surveys for Bear Dens.

The objective of the waste management monitoring is to reduce the effects of attraction to wolverine and other wildlife. Waste disposal facilities will be monitored frequently to ensure that wastes are being properly disposed of. Waste facilities will be inspected for signs of wildlife activity (e.g., chew marks on waste, wildlife mediated waste dispersion, wildlife scat or tracks). Any incidents where wildlife have been observed to interact directly with wastes, or observations of habituated wildlife (particularly bears and wolverine) will be reported to Project environment staff and appropriate regulatory agencies and authorities. Problem wildlife may be evaluated by the Environment Team and corrective measures implemented in consultation with the Nunavut Department of Environment..

8.9.2 Focal-species Monitoring

During the DEIS review phase, the Government of Nunavut requested that the Project work with the GN to monitor wolverine at a regional scale. Hence, the monitoring plan for wolverine is to partner with the GN if the GN produces a monitoring program for this species. If no regional monitoring plan is developed, then the Project will conduct a remote camera monitoring plan.

The focal-species monitoring program is proposed to include monitoring wolverine and furbearers by remote motion-triggered cameras. Currently motion-triggered cameras are located on the tundra in strategic positions to capture caribou movements and habitat use (Rescan 2013e, Appendix V5-5C). Wolverines and furbearers along with other wildlife are often recorded by these cameras. The use of remote cameras for annual monitoring of wolverine and furbearers is currently proposed for the WEMP (Volume 10, Chapter 20). Incidental observations of wolverines and furbearers during other wildlife monitoring surveys will continue to be recorded.

The three objectives of this monitoring program are to:

1. Monitor the Project site to examine how wolverine and furbearers interact with Project facilities (e.g., waste management facilities) to determine the efficacy of mitigation activities (e.g., camp hardening and waste management procedures);
2. Monitor dens identified from denning surveys; and
3. Record the times at which wolverine and furbearers use the wildlife RSA during the year.

Methods for data management and analysis will follow those for caribou (Section 7.3.1 of the WMMP Plan, Volume 10, Chapter 20).

8.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the Construction and Operational phases of the Project for furbearers (wolverine and grey wolf). These eight potential effects are: loss of habitat, disturbance due to noise, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other proposed effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of wolverine and furbearers (grey wolves) was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on furbearers resulted in the evaluation of four potential effects as likely having residual effects for wolverine after mitigation: habitat loss, disturbance due to noise, attraction, and reduction in reproductive productivity, and two potential effects likely having residual effects for grey wolf after mitigation: habitat loss and disturbance due to noise. Each of these effects are rated with a low magnitude and are rated as Not Significant, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20).

The residual effect which could have the largest effect on the population is attributed to reduction in reproduction, which may occur due to a number of other potential or residual effects interacting with one another. However, the overall likelihood of a reduction in reproductively in wolverine is low because of the high availability of habitat of varying quality outside of the influence of the Project. It is not expected that wolverine will be displaced into lower quality habitats as a result of the Project. Displacement could lead to lower productivity due to stress or reduced foraging success, particularly during sensitive periods such as denning.

A cumulative effects assessment was conducted because residual Project effects were predicted and other projects occur within the movement area defined for wolverine and grey wolf that interact with the Project. For wolverine, four potential cumulative effects were evaluated for the cumulative effects assessment: habitat loss, disturbance due to noise, attraction and reproductive productivity. For the grey wolf, two potential cumulative effects were evaluated: habitat loss and disturbance due to noise. Key indicators were calculated for potential effects where data were available and residual cumulative effects were predicted for all potential effects. Each residual cumulative effect was rated by using threshold values and determined to have a low magnitude effect on the wolverine and grey wolf populations within their respective cumulative effects assessment areas.

It is anticipated that all projects within the CEA boundary will likely have similar mitigation measures. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on wolverines in the CEA boundary. With these mitigation measures in place and a low magnitude residual effect, an overall rating of **Not Significant** was concluded for residual cumulative effects on grey wolves in the CEA boundary.

The overall effect of the Project on the VEC furbearers is rated as **Not Significant**.

9. Migratory Birds (Upland Birds and Waterfowl)

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9. Migratory Birds (Upland Birds and Waterbirds)

9.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

9.1.1 Introduction

With the exception of a few species, the majority of bird species that breed in the Arctic migrate long distances between their summer range on the tundra, and their winter ranges at southern latitudes. For the purposes of this assessment, migratory birds are divided into three groups — waterbirds, upland birds, and seabirds. Potential effects on waterbirds and upland birds within the terrestrial wildlife Regional Study Area (RSA) of the Back River Project (the Project) are addressed in this chapter. Waterbirds are defined as birds that primarily forage within waterbodies. The Arctic waterbird community is comprised of geese and the tundra swan, several species of dabbling and diving ducks, gulls and the Arctic tern, four species of loons, and the sandhill crane. Geese eggs are an important food source to Inuit communities (KIA 2014). Some waterbird species such as greater scaup also use marine habitats during some portion of the breeding season. Potential interactions between the Project and waterbirds that use coastal habitats within the wildlife marine RSA are addressed in Volume 7, Chapter 6 (Seabirds/Seaducks). Upland birds are defined as birds that primarily forage and nest in upland areas (i.e., not waterbirds). The Arctic upland bird community is comprised of songbirds, shorebirds, ptarmigan, and jaegers.

Baseline studies confirmed that at least 25 waterbird species and 27 upland bird species occur within the wildlife Regional Study Area (RSA) during migration and breeding. Of these species, 17 waterbird and 24 upland bird species were identified as species that regularly occur within the wildlife RSA during the breeding season or during migration (Rescan 2012b, Appendix V5-5D; Rescan 2013e, Appendix V5-5C; Rescan 2014, Appendix V5-5F).

Willow and rock ptarmigan are the only upland birds that overwinter on the tundra. Some raptors overwinter on the tundra as well, which are discussed in Volume 5, Chapter 10. Ptarmigan are year-round residents on the tundra, although some ptarmigan migrate relatively short distances depending on weather conditions (e.g. Holder and Montgomerie 1993; S. J. Hannon, P. K. Eason, and K. Martin 1998). Ptarmigan are included in this assessment of Project effects on migratory birds because ptarmigan and their eggs are an important food source to Inuit communities (KIA 2012).

9.1.2 Population Trends and Conservation

Migratory birds and their nests are protected by the federal *Migratory Birds Convention Act* (1994), which prohibits killing migratory birds and their eggs, taking their nests, and also prohibits the deposition of harmful substances in waters or areas frequented by migratory birds. In addition, migratory birds and ptarmigan in Nunavut are protected under the Nunavut *Wildlife Act* (2003), which prohibits destruction of bird nests when these are being used by birds, and prohibits disturbance to a "substantial number" of birds, such as to flocks of waterbirds during spring and fall staging.

With the exception of the red knot, no species of migratory bird occurring in the wildlife RSA is legally listed as a species of conservation concern under the federal *Species at Risk Act* (SARA; 2002). The red knot subspecies *rufa* is listed on Schedule 1 of SARA as "Endangered." It was not recorded during baseline surveys, possibly because it migrates in low numbers making it difficult to detect.

Because of the difficulty in conducting standardized surveys over the vast area of the Arctic, regional estimates of population trends are not available for most species of migratory birds that breed in the Arctic (NABCI 2012). However, population trends have been estimated for some populations from counts of birds during their migration and on wintering grounds; the magnitude of trends are less certain. Regulatory organizations that track and assign conservation status based on population trend and other criteria include the North American Waterbird Conservation Plan (Kushlan et al. 2002), the North American Waterfowl Management Plan (North American Waterfowl Management Plan (NAWMP) 2004), Partners in Flight Upland bird Conservation Plan (Berlanga et al. 2010), and the Canadian Shorebird Conservation Plan (Donaldson et al. 2004).

The conservation status of migratory birds in Nunavut has been assigned by the Canadian Endangered Species Conservation Council (CESCC). Species designated as "Sensitive" by CESCC rankings are species that may require special attention to prevent population declines (CESCC 2010). CESCC rankings for species in Nunavut are administered by the Government of Nunavut, Department of Environment, and are currently in draft form until future review by the Nunavut Wildlife Management Board. These designations were used in this report to identify migratory bird species of conservation concern that occur within the wildlife RSA.

9.1.2.1 Waterbirds

Five waterbird species that occur in the wildlife RSA show declining population trends: lesser scaup, northern pintail, long-tailed duck, red-throated loon, and the Arctic tern (Kushlan et al. 2002; NAWMP 2004; Conant, Roetker, and Groves 2006). In addition, the yellow-billed loon has been identified as a species of concern because it is rare, and there are insufficient data to estimate population trends (S. Earnst et al. 2005). The following three waterbird species are listed as 'Sensitive' under the CESCC designations for Nunavut: Arctic tern, glaucous gull, and long-tailed duck (CESCC 2010).

Arctic populations of geese and the tundra swan have generally remained stable or have increased in abundance (CWS 2011). Populations of Canada geese have increased an average of 7% per year since 1998 on the mainland of the Northwest Territories (USF WS 2006).

9.1.2.2 Upland Birds

Ten upland bird species that regularly occur in the wildlife RSA are listed as "Sensitive" under the CESCC designations for Nunavut: American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris's sparrow, hoary redpoll, and white-crowned sparrow. Of the 11 shorebird species that regularly occur within the wildlife RSA, data suggest a declining global population for all species except the semipalmated plover and stilt sandpiper (Morrison et al. 2006). Of the 15 songbird species that regularly breed in the wildlife RSA, data show large scale population decline for two of these species: Harris's sparrow and horned lark (Berlanga et al. 2010) The breeding range of the Harris's sparrow is small and restricted entirely to Canada.

At local scales, populations of upland birds naturally fluctuate due to food availability, weather, and predation rates. For example, redpolls declined by 90% in 2009 near Daring Lake due to low production of birch seeds in 2008; the population recovered by 2010 (Obst 2011). Heavy snow cover late into the season can result in poor breeding (Latour, Machtans, and Beyersbergen 2005). Upland birds and their eggs and young are prey for raptors, especially the gyrfalcon and peregrine falcon, and for mammals, especially red and Arctic foxes (White et al. 2002; Samelius et al. 2007; Barichello and Mossop 2011). A recent study has found correlations in bird abundance among species preyed upon by foxes (McKinnon et al. 2013). In years of low lemming abundance, a preferred prey of Arctic fox, predation on geese nests and nearby artificial shorebird nests was high. These results suggest that local upland bird

population size may be linked to lemming abundance, mediated by the predation behaviour of mutual predators, especially red and Arctic foxes (McKinnon et al. 2013).

9.1.3 Distribution and Migration Patterns

Migratory birds arrive on the Arctic tundra from their winter ranges in the south from early to late May, and depart again in the fall, usually in late August and throughout September. Migration occurs through a series of relatively rapid movements between staging areas, where birds spend days to several weeks foraging to "refuel" (Mallory et al. 2006).

9.1.3.1 Waterbirds

Some waterbird species such as long-tailed ducks, yellow-billed loons, Canada and greater white-fronted geese nest on inland waterbodies and wetlands across the Arctic tundra, while other species such as the red-throated loon are found at highest densities along coastlines (Derksen, Rothe, and Eldridge 1981; Conkin and Alisauskas 2013). Most Arctic streams, ponds, and lakes, including those within the Project area, are relatively nutrient poor (Rescan 2012a); wetlands tend to be more productive and nutrient rich (Rescan 2012c). Thus, waterbirds tend to be patchily distributed across the Arctic tundra, according to the productivity of waterbodies and the patchy distribution of wetlands (Conkin and Alisauskas 2013). Both scientific and Inuit Traditional Knowledge report that Arctic waterbirds nest at higher densities in large wetlands including Goose Lake (KIA 2012; Conkin and Alisauskas 2013; KIA 2014).

Waterbirds can spend up to 50% of the year migrating between wintering and breeding areas, and up to 95% of migration at staging areas; thus staging areas are considered key habitats necessary to sustain populations (Petrie and Wilcox 2003). Species such as the long-tailed duck and red-breasted merganser, all of the loon species, and the glaucous gull stage at coastal sites on the ocean that become ice-free early in the spring (Dickson and Gilchrist 2002). These sites were important waterbird hunting areas for Inuit (KIA 2012). Both scientific and Inuit Traditional Knowledge show that inland waterbodies that become ice-free relatively early are important staging areas for waterbirds. Such areas include shallow and small lakes and ponds, and rivers with fast-flowing water (KIA 2012, 2014).

Spring arrival to Arctic breeding grounds is earlier (early to mid-May) for the larger-bodied waterbirds, an observation that is consistent with Inuit TK of the Kitikmeot region (KIA 2012). The smaller-bodied waterbirds, like loons and ducks arrive later, in late May to early June. Breeding occurs soon after the birds arrive on the tundra and brooding of young occurs from late June to mid-September.

Most waterbird species moult their breeding plumage during or just after breeding. The timing of moulting varies across species, gender, and reproductive status. Typically, waterbirds that are not engaged in the care of eggs or young — males of uniparental species, non-breeders, and failed breeders — congregate to moult during the incubation stage and onward (S. R. Johnson and Richardson 1982). Dabbling ducks gather in local wetlands near nesting sites, but geese, swans, seaducks and scaup usually migrate to traditional moulting areas, sometimes up to hundreds of kilometers from breeding sites (Derksen, Rothe, and Eldridge 1981; Reed et al. 2003; Larned, Stehn, and Platte 2012). Scaups use shallow, non-turbid, wind and wave sheltered coastal areas with abundant forage, such as lagoons and bays (Dickson and Gilchrist 2002; Fischer and Larned 2004). Birds are flightless for several weeks while moulting their flight feathers; though flightless, birds are capable of swimming more than 15 km between coastal moulting sites (Flint et al. 2004). Birds typically congregate at fall staging sites prior to southward migration, though these are typically smaller congregations than those that occur during spring migration (Dickson and Gilchrist 2002).

9.1.3.2 Upland Birds

With the exception of ptarmigan, upland birds breeding within the Kitikmeot region are migratory and winter in areas extending from the treeline to the southern tip of South America. The Arctic tern migrates to the Antarctic. The willow and rock ptarmigan make only short local migrations depending on weather conditions, but are otherwise resident species that over-winter on the tundra (S. J. Hannon, P. K. Eason, and K. Martin 1998; Montgomerie and Holder 2008; KIA 2012).

Upland bird species begin to arrive on the Arctic tundra to breed in late May, coincident with the emergence of insects. The exceptions to this timing include the seed-eating horned lark and hoary redpoll which arrive in early and mid-May. Most females initiate clutches in early June, which they incubate for about 10 days. Parents feed nestlings for a period for 10 to 15 days, thus fledging usually occurs by late July. Parents tend to fledglings for about two weeks, and migration occurs shortly thereafter. By mid-September most upland birds have migrated south; by October all migratory birds except ptarmigan have left the tundra (Obst 2011).

During the breeding season from May to October, the upland bird community is broadly distributed across the Arctic such that almost every hectare of tundra supports at least one individual.

9.1.4 Habitat Use and Diet

9.1.4.1 Waterbirds

The Arctic provides breeding habitat for one-third of the world's waterbird population, including two-thirds of all geese (Zöckler 1998). The habitat preferences of waterbirds during the breeding season correspond to their diets. For example, the common loon and yellow-billed loon feed almost entirely on fish, and thus select large, deep lakes for nesting, probably because these tend not to freeze to the bottom, ensuring the over-winter survival of fish (S. L. Earnst, Platte, and Bond 2006). Dabbling ducks, such as the northern pintail and green-winged teal, forage on aquatic seeds, plants, and invertebrates, and thus are found in shallow wetlands where this forage is abundant (Austin and Miller 1995; Robertson and Savard 2002). Geese and the tundra swans graze on both terrestrial and aquatic plants and geese feed on berries later in the season (Cadieux, Gauthier, and Hughes 2005), which explains their frequent detections using upland heath tundra during moulting and staging (Rescan 2013e, Appendix V5-5C). Inuit in the Kitikmeot region have also reported that Canada geese feed on berries (KIA 2012).

Waterbirds typically nest in habitat that provides protection from predators, and thus often nest within approximately 100 m of water, and on small mid-water islands since these offer protection from terrestrial predators (Sovada, Anthony, and Batt 2001). Inuit TK of the Kitikmeot region includes observations of waterbirds nesting on mid-stream islands and on cliffs (KIA 2012). Geese nest in flooded wetlands adjacent to large water bodies, which provide escape from terrestrial predators (Bart and Earnst 1991; Stickney et al. 2002). Some waterbird species, especially geese, nest on cliffs near nesting raptors where they receive protection from mutual nest predators (Bety et al. 2001). Because they are unable to walk on land, loon nests are always in emergent vegetation within 1 to 2 m of water. Individuals of many species of waterbirds exhibit fidelity to their nest sites and territories from year-to-year (Anderson, Rhymer, and Rohwer 1992).

9.1.4.2 Upland Birds

The upland bird community in most Arctic regions is dominated by songbirds, which occur up to six times more abundantly than shorebirds (Andres 2006). The Lapland longspur consistently has been found to be the most common upland bird, occurring up to three times more commonly than other upland bird species (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and

Beyersbergen 2005; Andres 2006; Rescan 2013e, Appendix V5-5C). The Lapland longspur is unique among Arctic upland birds in its relatively ubiquitous use of a wide variety of habitats across the tundra. Consistent among studies conducted across the Arctic, habitat associations of the majority of upland bird species are highly influenced by preferences for vegetation communities, which in turn are structured by the moisture regime (Brown et al. 2007; Ashenhurst and Hannon 2008).

The majority of species show preference for either moist to wet or dry vegetation communities for nesting. Upland bird species associated with moist to wet vegetation communities include the Savannah sparrow, the majority of shorebird species, and the willow ptarmigan. Species associated with dry upland heath and rocky tundra include the American pipit, Harris's sparrow, horned lark, American golden plover, and rock ptarmigan (Latour, Machtans, and Beyersbergen 2005; Brown et al. 2007; Liebezeit, White, and Zack 2011). Rock ptarmigan generally avoid shrubs during breeding, preferring dry heath tundra, whereas willow ptarmigan tend to select sites in moist areas with dense shrubs (Wilson and Martin 2008).

Across the Arctic, upland birds are more abundant and diverse in lowlands, which are usually dominated by moist to wet sedge meadows (V. H. Johnson, Gratto-Trevor, and Pepper 2000; Latour, Machtans, and Beyersbergen 2005; Liebezeit, White, and Zack 2011). Most shorebird species prefer moist to wet lowland sites (Brown et al. 2007; Liebezeit, White, and Zack 2011), but some do not — the American golden plover has been found at higher abundance in dry upland areas (Latour, Machtans, and Beyersbergen 2005; Rescan 2013e, Appendix V5-5C). Some species like the red phalarope and red-necked phalarope are generally confined to wetlands (Latour, Machtans, and Beyersbergen 2005; Brown et al. 2007; Ashenhurst and Hannon 2008), but most species do not confine their use of habitats to only wet or only dry areas. For example, though the American golden plover prefers to nest in dry upland areas, it forages at least some of the time in nearby wetlands (O. W. Johnson and Connors 2010). Thus, though lowlands typically support more upland birds, the upland bird community uses a mosaic of habitat types across the full moisture regime from dry to wet.

In addition to the moisture regime, the height of tundra vegetation provides another major gradient across which upland birds show preference. A third upland bird community can be distinguished where shrubs are tall enough to provide vertical habitat, which is primarily within riparian corridors (Rescan 2007). Tall riparian shrubs occur relatively rarely across the tundra, but provide habitat for a diverse bird community. Breeding habitat for two species, the yellow warbler and grey-cheeked thrush, appears to be restricted to riparian corridors across the Arctic (Wolfden Resources Inc. 2006). The wildlife LSA contains very small proportions of riparian areas supporting tall riparian shrubs, of which 1,405 ha (1% of wildlife LSA) occurs throughout drainages in the wildlife LSA and 440 ha (0.3% of the wildlife LSA) occurs in the marine-influenced areas at Bathurst Inlet (Volume 5, Chapter 4).

Almost all species of upland birds, even those that forage primarily on vegetation, feed on invertebrates during some stage of the nesting cycle (Tulp and Schekkerman 2008). For example, ptarmigan feed mostly on buds, leaves, and twigs of ericaceous shrubs, but protein-rich insects are important for clutch formation in egg-laying females and for the growth of young (S. J. Hannon, P. K. Eason, and K. M. Martin 1998). Invertebrates are a critical food resource for upland birds, and thus the timing of arrival and of egg-hatching is synchronized with the emergence of insects in spring. The breeding productivity of Arctic birds has been found to be negatively impacted by climate change, which has caused variability in the timing of insect emergence (Both et al. 2010).

9.1.5 Baseline Data for Migratory Birds

To generate baseline data on migratory birds, waterbirds were surveyed from helicopter, and both waterbirds and upland birds were surveyed from the ground. Incidental observations were also collected to confirm the presence of species within the wildlife RSA that were not detected during surveys.

Specific sources of baseline terrestrial wildlife information used in this section include the following reports:

- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012b; Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013e; Appendix V5-5C); and
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014; Appendix V5-5F).

Other sources of supplementary wildlife data used in this section include:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) (Appendix V3-3A of FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3B of FEIS);
- *Field Report — Back River Project: Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008);
- *Bathurst Inlet Port and Road Project*: *Wildlife Baseline Studies, 2001-2002* (Rescan 2002);
- *Bathurst Inlet Port and Road Project*: *Wildlife Songbird and Shorebird Baseline Study, 2007* (Rescan 2007);
- *Bathurst Inlet Port and Road Project*: *Upland Breeding Birds Baseline Study, 2012* (Rescan 2012d); and
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008).

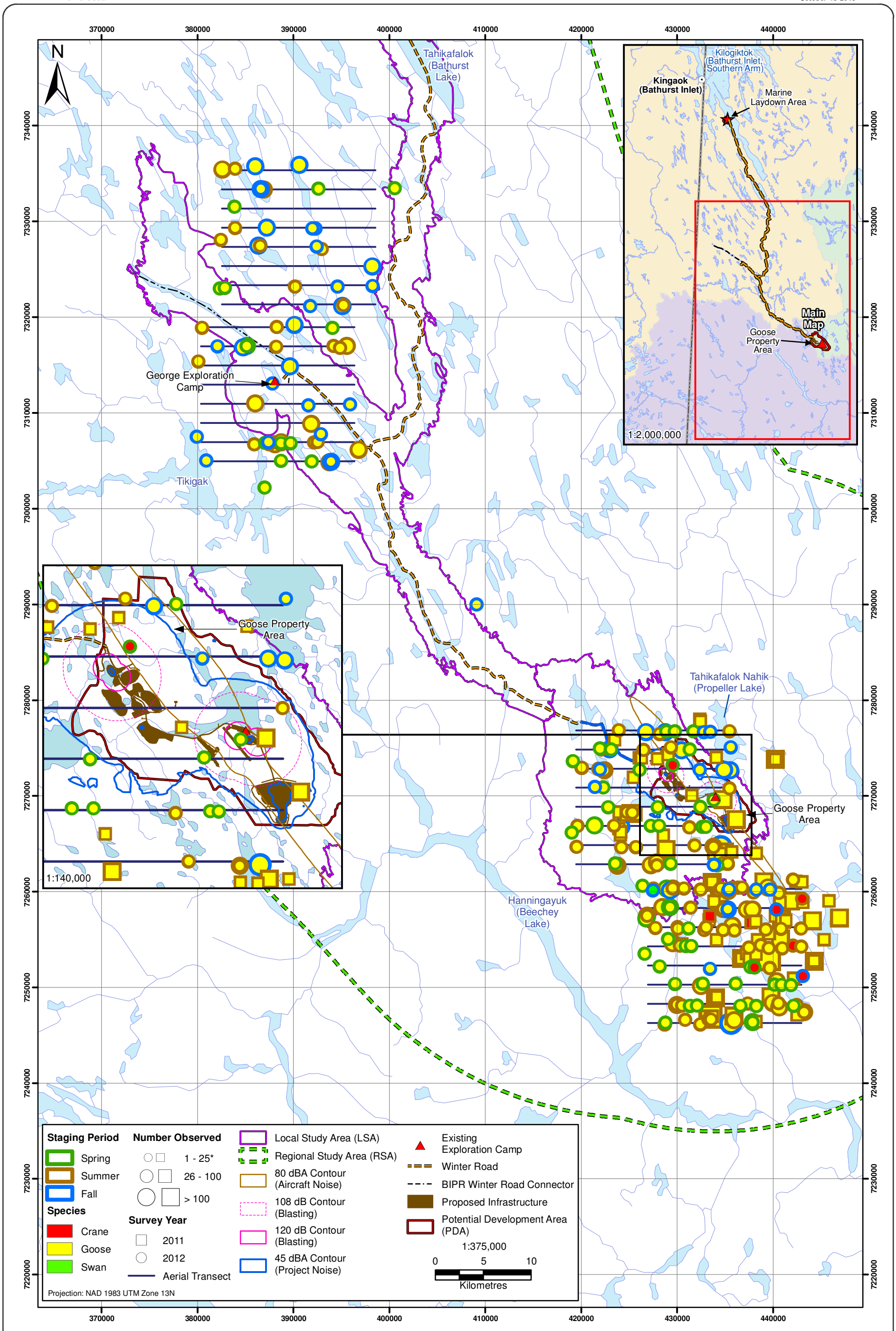
9.1.5.1 Waterbirds

Methods for Baseline Data Collection

Aerial and ground surveys for waterbirds were conducted in 2011 to 2013. To provide pre-development data while controlling for natural variability in bird distribution, waterbirds were surveyed within a focus survey block centred on each of the PDAs and the MLA, and in an adjacent reference survey block. In 2011, a focus and reference survey block was surveyed around the Goose Property PDA in the southern portion of the wildlife RSA (Figure 9.1-1a and b). In 2012, focus and reference survey blocks were surveyed around the Goose Property PDA and in the central wildlife RSA near the George Exploration Camp. In 2013, aerial surveys for waterbirds were conducted within focus and reference survey blocks near the MLA during the spring, summer, and fall periods (Figure 9.1-2). Aerial surveys followed established protocols created by the Canadian Wildlife Service (CWS) and the United States Fish and Wildlife Service (CWS and USFWS 1987). Across the three years, at least one survey was conducted during the spring migration, pre-incubation, early brooding, and fall migration stages. Ground surveys for nests were conducted in 2011 within 100 m of the shoreline at Bathurst Inlet. Migratory bird species that regularly occur within the wildlife RSA were identified from species' range maps, and the timing and frequency of detections during baseline surveys (Table 9.1-1).

GIS # BAC-23-383a

October 13 2015



Sabina GOLD & SILVER CORP.

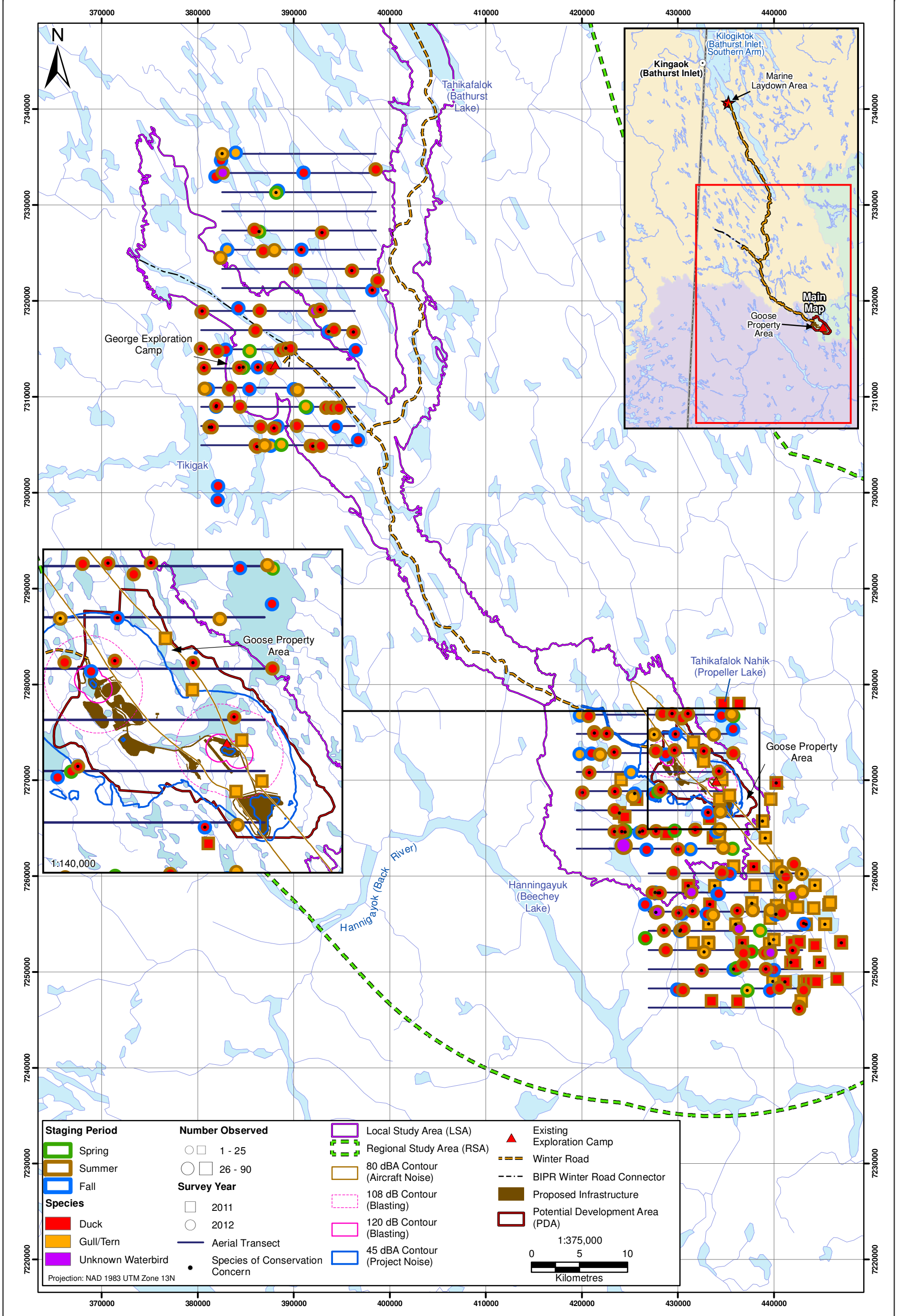
Figure 9.1-1a

Geese, Cranes, and Swans Observed Near the Goose Property Area and in the Central Regional Study Area during Aerial Surveys in 2011 and 2012

Rescan an ERM company

GIS # BAC-23-383b

October 07 2015

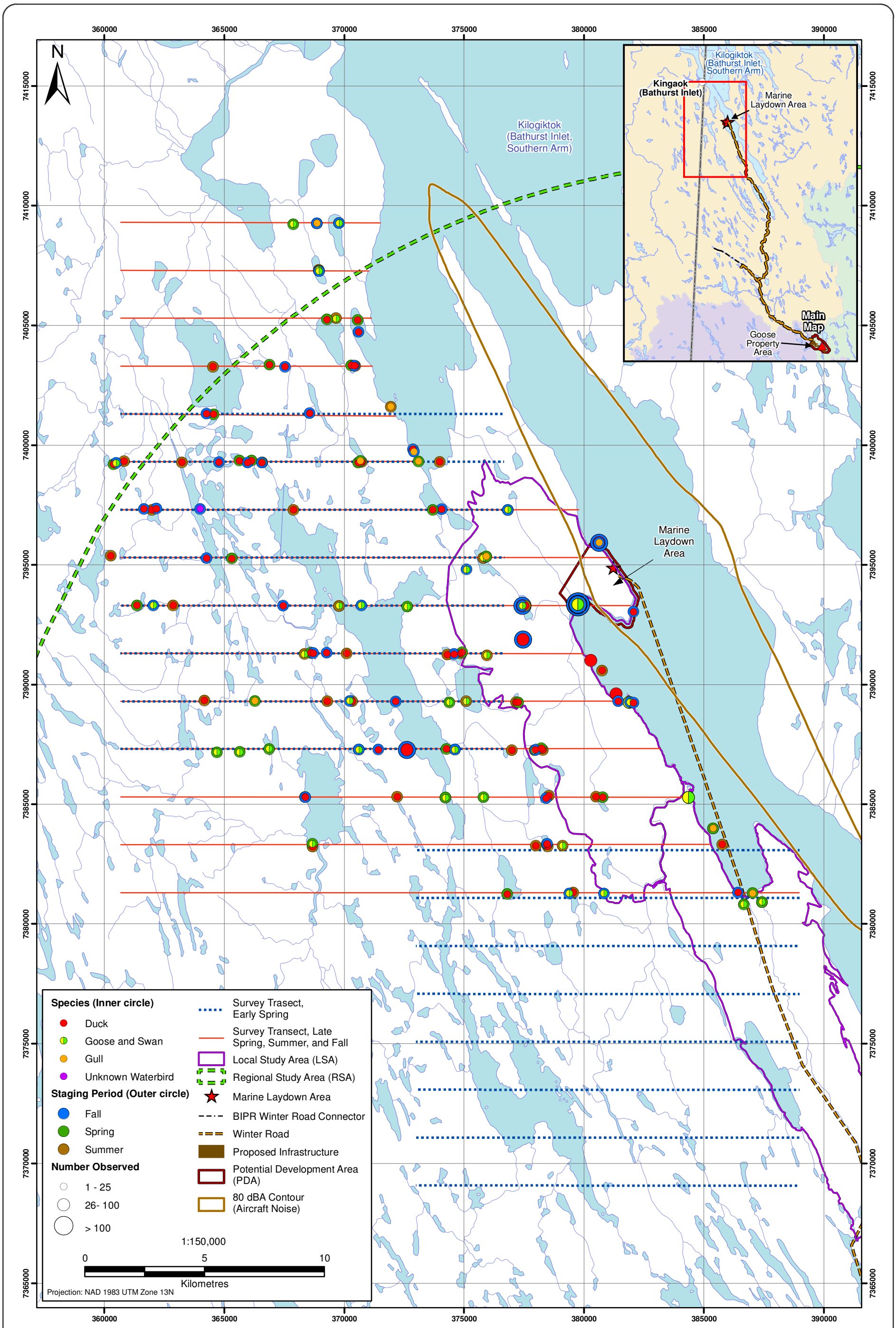


Sabina GOLD & SILVER CORP.

Ducks, Gulls, and Terns Observed Near the Goose Property Area and in the Central Regional Study Area during Aerial Surveys in 2011 and 2012

Figure 9.1-1b

Rescan an ERM company



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Waterbirds Observed near the Marine Laydown Area during Aerial Surveys in 2013

Figure 9.1-2

Rescan
an ERM company

Table 9.1-1. Regularity and Timing of Occurrence of Migratory Bird Species in the Wildlife RSA

Common Name	Scientific Name	Group	Sub-group	Regularity of Occurrence	Detected during Baseline Studies	Timing of Occurrence	Conservation Status				
							Terr. Rank	COSEWIC	SARA	Global Rank	IUCN Red List
American Golden-Plover	*Pluvialis dominica*	Upland Bird	Shorebird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Semipalmated Plover	*Charadrius semipalmatus*	Upland Bird	Shorebird	Regular	Y	Breeding	Secure			G5	Least Concern
Least Sandpiper	*Calidris minutilla*	Upland Bird	Shorebird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Semipalmated Sandpiper	*Calidris pusilla*	Upland Bird	Shorebird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Red-necked Phalarope	*Phalaropus lobatus*	Upland Bird	Shorebird	Regular	Y	Breeding	Sensitive			G4G5	Least Concern
Wilson's snipe	*Gallinago delicata*	Upland Bird	Shorebird	Regular	Y	Breeding	Undetermined			G5	Least Concern
Pectoral Sandpiper	*Calidris melanotos*	Upland Bird	Shorebird	Regular	Y	Breeding	Secure			G5	Least Concern
Stilt Sandpiper	*Calidris himantopus*	Upland Bird	Shorebird	Regular	Y	Breeding	Secure			G5	Least Concern
Long-tailed Jaeger	*Stercorarius longicaudus*	Upland Bird	Jaeger	Regular	Y	Breeding	Secure			G5	Least Concern
Parasitic Jaeger	*Stercorarius parasiticus*	Upland Bird	Jaeger	Regular	Y	Breeding	Secure			G5	Least Concern
White-rumped Sandpiper	*Calidris fuscicollis*	Upland Bird	Shorebird	Regular	N	Migrant	Secure			G5	Least Concern
Buff-breasted Sandpiper	*Tryngites subruficollis*	Upland Bird	Shorebird	Regular	N	Migrant	Sensitive			G4	Near threatened
Red Phalarope	*Phalaropus fulicaria*	Upland Bird	Shorebird	Regular	N	Migrant	Sensitive			G5	Least Concern
Baird's Sandpiper	*Calidris bairdii*	Upland Bird	Shorebird	Rare	Y	Breeding	Secure			G5	Least Concern
Lesser Yellowlegs	*Tringa flavipes*	Upland Bird	Shorebird	Rare	N	Breeding	Undetermined			G5	Least Concern
Ruddy Turnstone	*Arenaria interpres*	Upland Bird	Shorebird	Rare	N	Migrant	Sensitive			G5	Least Concern
Red Knot	*Calidris canutus*	Upland Bird	Shorebird	Rare	N	Migrant	At Risk	EN/SC		G4	Least Concern
Sanderling	*Calidris alba*	Upland Bird	Shorebird	Rare	N	Migrant	Sensitive			G5	Least Concern
Pomarine Jaeger	*Stercorarius pomarinus*	Upland Bird	Jaeger	Rare	N	Migrant	Secure			G5	Least Concern
Horned Lark	*Eremophila alpestris*	Upland Bird	Songbird	Regular	Y	Breeding	Secure			G5	Least Concern
Gray-cheeked Thrush	*Catharus minimus*	Upland Bird	Songbird	Regular	Y	Breeding	Undetermined			G5	Least Concern
American Pipit	*Anthus rubescens*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
American Tree Sparrow	*Spizella arborea*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Savannah Sparrow	*Passerculus sandwichensis*	Upland Bird	Songbird	Regular	Y	Breeding	Secure			G5	Least Concern
White-crowned Sparrow	*Zonotrichia leucophrys*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Harris's Sparrow	*Zonotrichia querula*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Lapland Longspur	*Calcarius lapponicus*	Upland Bird	Songbird	Regular	Y	Breeding	Secure			G5	Least Concern
Snow Bunting*	*Plectrophenax nivalis*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Common Redpoll	*Carduelis flammea*	Upland Bird	Songbird	Regular	Y	Breeding	Secure			G5	Least Concern
Hoary Redpoll	*Carduelis hornemanni*	Upland Bird	Songbird	Regular	Y	Breeding	Sensitive			G5	Least Concern
Yellow Warbler	*Setophaga petechia*	Upland Bird	Songbird	Regular	Y	Breeding	Undetermined			G5	Least Concern
Willow Ptarmigan	*Lagopus lagopus*	Upland Bird	Game Bird	Regular	Y	Resident	Secure			G5	Least Concern
Rock Ptarmigan	*Lagopus muta*	Upland Bird	Game Bird	Regular	Y	Resident	Secure			G5	Least Concern
Smith's Longspur	*Calcarius pictus*	Upland Bird	Songbird	Rare	N	Breeding	Secure			G5	Least Concern
American Robin*	*Turdus migratorius*	Upland Bird	Songbird	Rare	Y	Breeding	Secure			G5	Least Concern
Cliff Swallow*	*Petrochelidon phyrrhonota*	Upland Bird	Songbird	Rare	Y	Breeding	Undetermined			G5	Least Concern
Yellow-billed Loon	*Gavia adamsii*	Waterbird	Loon	Regular	Y	Breeding	Secure	NAR		G4	Least Concern
Pacific Loon	*Gavia pacifica*	Waterbird	Loon	Regular	Y	Breeding	Secure			G5	Least Concern

(continued)

Table 9.1-1. Regularity and Timing of Occurrence of Migratory Bird Species in the Wildlife RSA (completed)

Common Name	Scientific Name	Group	Sub-group	Regularity of Occurrence	Detected during Baseline Studies	Timing of Occurrence	Conservation Status				
							Terr. Rank	COSEWIC	SARA	Global Rank	IUCN Red List
Red-throated Loon	*Gavia stellata*	Waterbird	Loon	Regular	Y	Breeding	Secure			G5	Least Concern
Greater White-fronted Goose	*Anser albifrons*	Waterbird	Geese and Swans	Regular	Y	Breeding	Secure			G5	Least Concern
Canada Goose	*Branta canadensis*	Waterbird	Geese and Swans	Regular	Y	Breeding	Secure			G5	Least Concern
Tundra Swan	*Cygnus columbianus*	Waterbird	Geese and Swans	Regular	Y	Breeding	Secure			G5	Least Concern
Northern Pintail	*Anas acuta*	Waterbird	Dabbling Duck	Regular	Y	Breeding	Secure			G5	Least Concern
Green-winged Teal	*Anas crecca*	Waterbird	Dabbling Duck	Regular	Y	Breeding	Undetermined			G5	Least Concern
Greater Scaup	*Aythya marila*	Waterbird	Diving Duck	Regular	Y	Breeding	Secure			G5	Least Concern
Long-tailed duck	*Clangula hyemalis*	Waterbird	Sea Duck	Regular	Y	Breeding	Sensitive			G5	Least Concern
Red-breasted Merganser	*Mergus serrator*	Waterbird	Sea Duck	Regular	Y	Breeding	Secure			G5	Least Concern
Sandhill Crane	*Grus canadensis*	Waterbird	Crane	Regular	Y	Breeding	Secure			G5	Least Concern
Herring Gull	*Larus argentatus*	Waterbird	Gulls and Terns	Regular	Y	Breeding	Secure			G5	Least Concern
Glaucous Gull	*Larus hyperboreus*	Waterbird	Gulls and Terns	Regular	Y	Breeding	Sensitive			G5	Least Concern
Arctic Tern	*Sterna paradisaea*	Waterbird	Gulls and Terns	Regular	Y	Breeding	Sensitive			G5	Least Concern
Brant*	*Branta bernicla*	Waterbird	Geese and Swans	Regular	Y	Migrant	Secure			G5	Least Concern
Snow Goose	*Chen caerulescens*	Waterbird	Geese and Swans	Regular	Y	Migrant	Secure			G5	Least Concern
Lesser Scaup*	*Aythya affinis*	Waterbird	Diving Duck	Rare	Y	Breeding	Undetermined			G5	Least Concern
Northern Shoveler*	*Anas clypeata*	Waterbird	Dabbling Duck	Rare	Y	Breeding	Undetermined			G5	Least Concern
Common Loon*	*Gavia immer*	Waterbird	Loon	Rare	Y	Breeding	Secure	NAR		G5	Least Concern
Mallard*	*Anas platyrhynchos*	Waterbird	Dabbling Duck	Rare	Y	Breeding	Undetermined			G5	Least Concern
Gadwall	*Anas strepera*	Waterbird	Dabbling Duck	Rare	Y	Breeding	Accidental			G5	Least Concern
White-winged Scoter*	*Melanitta fusca*	Waterbird	Sea Duck	Rare	Y	Migrant	Undetermined			G5	Least Concern
Surf Scoter*	*Melanitta perspicillata*	Waterbird	Sea Duck	Rare	Y	Migrant	Undetermined			G5	Least Concern
Black (American) Scoter	*Melanitta americana*	Waterbird	Sea Duck	Rare	Y	Migrant	Undetermined			G5	Least Concern

** Observed incidentally during baseline studies*

Results of Baseline Data Collection

During baseline studies, 13 of the 17 waterbird species that regularly occur within the wildlife RSA were observed throughout the breeding season during aerial surveys: Canada and greater white-fronted geese, pacific, red-throated, and yellow-billed loon, greater scaup, long-tailed duck, red-breasted merganser, northern pintail, Arctic tern, glaucous and herring gull, and sandhill crane (Tables 9.1-1 and 9.1-2). In addition to the tundra swan and green-winged teal which were observed infrequently, and brant and snow geese which were observed during migration only, these 17 species comprise the typical waterbird community of the Kitikmeot region. Eight additional species were observed infrequently and mostly incidentally—the gadwall, northern shoveler, mallard, lesser scaup, and common loon during breeding, and the white-winged scoter, surf scoter, and black scoter during migration (Table 9.1-1).

Canada geese were the most commonly observed species across all surveys, accounting for 80% to 90% of all detections. Spring surveys conducted in the wildlife RSA revealed that large flocks of geese migrate through the wildlife RSA, especially in the area of the Goose Property, which contains several large wetlands (Figure 9.1-1a). Observations of large numbers of Canada geese observed in flocks during the summer surveys (Table 9.1-2) were likely of moulting non-breeders and failed breeders, indicating that the Project area is used as a moulting site, to which failed breeders likely migrate from other areas (Section 9.1.4.1).

Counts of waterbirds in 2012 were consistently lower in survey areas to the north of the Goose Property Area relative to those near the Goose Property Area (Figure 9.1-1a and b). Counts were particularly low in the transect block furthest to the north, which was a rocky upland area consisting of shallow meltwater ponds and few wetlands, indicating that this area provides poor habitat for waterbirds. The presence of Canada geese there during fall migration may have been because the geese were foraging on upland berries and forbs (Section 9.1.3.1).

A main objective of aerial surveys for waterbirds was to locate waterbird nesting colonies (e.g., Arctic tern) and key staging and moulting sites, identified as waterbodies that are frequently used by large numbers of waterbirds during the migration and moulting periods. Aerial surveys crossed each of the principal waterbodies in the PDAs and surrounding survey blocks. No nesting colonies of waterbirds were observed. No waterbodies were identified as key staging and moulting sites within the two PDAs. A key staging site was identified at a small shallow lake in the central wildlife RSA adjacent to the George Exploration Camp where large flocks of geese were consistently observed during both spring and fall staging surveys (Figure 9.1-1a). Large flocks of ducks were observed there incidentally. Waterbirds were well distributed on waterbodies in the survey blocks near the Goose Property in both 2011 and 2012, with regular concentrations of wattlebirds just to the south of the Goose PDA in a small wetland during staging periods.

Most waterbirds counted during aerial surveys conducted in 2013 near the MLA were ducks breeding and staging on inland ponds and lakes during summer and fall migration (Figure 9.1-2). During spring staging, no waterbirds were observed in the southern transect lines, likely because there was very little open water at that time (Figure 9.1-2).

No nests were found during ground surveys for nests conducted in 2011 within 100 m of the shoreline in the wildlife marine RSA. There were few observations of young during 2011-2013 aerial surveys in mid-July in the early brooding season. It is likely that young were detected infrequently because the surveys were conducted too early in the season, before most young had hatched and grown to a size large enough to be readily detected from the air

Table 9.1-2. Total Number of Waterbirds Observed in the Wildlife RSA during Baseline Aerial Surveys (2011-2013)

		Total Number of Individuals Observed (number of young observed in parentheses)									
		Near Goose Property PDA and in the central wildlife RSA						Near MLA			
		2011		2012				2013			
	Species	Early Brood	Fall Staging	Spring Staging	Pre-incubation	Early Brood	Fall Staging	Spring Staging	Pre-incubation	Early Brood	Fall Staging
Swans and Geese	Canada Goose	650	1,125 (5)	170	837	1,726 (24)	1,855	57	128	37	84
	Greater White-fronted Goose	12	5	197	7	5		78			
	Snow Goose			203		1		70			20
	Tundra Swan			2			2	2	7	14	25 (2)
	Sandhill Cranes	1	1	1	1	1	2				
	Unknown Goose			15				20		6	16
Gulls	Arctic Tern	21	14		6	3					
	Glaucous Gull			9				1	18		3
	Herring Gull	16	8	12	16	3	18	3			
	Unknown Gull		9			4				1	
Ducks and Loons	American Green-winged Teal							3			
	Black Scoter					14					
	Gadwall	3		2							
	Greater Scaup	10			19	8	50	14	37	53	531
	Long-tailed Duck	20			60	8	75	8	29	13 (4)	16
	Northern Pintail	4	2 (8)	6	8		20	245	7	8 (4)	42 (6)
	Pacific Loon		22			4 (1)	8		1	5	
	Red-breasted Merganser	16	3	2	14	2	64		22	29	90
	Red-throated Loon	1				7	1		2	8	9
	Yellow-billed Loon				2	4					
	Unknown Duck		17	3	3	90	19			97 (6)	24
	Unknown Loon						5			4	1
	Unknown Waterbird					61 (4)					8
Total		753	1,205 (13)	612	972	1,941 (29)	2,117	502	251	279 (14)	877

The Arctic tern, glaucous gull, and long-tailed duck are listed as "Sensitive" by CESCC rankings as species that may require special attention to prevent population declines (CESCC 2010). All three species were detected either during aerial surveys or incidentally within the wildlife LSA; the glaucous gull and long-tailed duck were detected within Goose Property PDA.

9.1.5.2 Upland Birds

Methods for Baseline Data Collection

Baseline studies for upland birds were conducted in the wildlife LSA and RSA around the Goose Property, near the George Exploration Camp, and at Bathurst Inlet (Figure 9.1-3). Upland birds were surveyed within 12 hectare plots (300 × 400 m) in June of 2011 (n = 30 plots; Rescan 2012b; Appendix V5-5D), 2012 (n = 54; Rescan 2013e; Appendix V5-5C), and 2013 (n = 8; Rescan 2014, Appendix V5-5F) using the rapid survey technique of the Program for Regional and International Shorebird Monitoring (PRISM; CWS 2010).

In 2007, upland birds were surveyed within slightly larger PRISM plots (400 × 400 m) and along 400 to 800 m line transects (Gartner Lee Limited 2007). Plots were located within reference sites and near proposed infrastructure to provide pre-development baseline data on the relative abundance and distribution of the upland bird community (Figure 9.1-3).

In 2013, upland birds were also surveyed within 60 circular point counts within a 100 m radius conducted within a 5 km area surrounding the proposed MLA, and in an ecologically similar reference site located approximately 20 km north of the MLA (Rescan 2014, Appendix V5-5F).

Deriving Density Estimates for Breeding Pairs

Density estimates for upland birds (pairs/km^2) were derived from territory counts made within 12 ha PRISM plots. While walking each plot, observers used counts of singing males (one territory per singing male), close associations of male and female birds, nests, and other observations to estimate the number of territories within each plot. Because of the large influence of the moisture regime on the composition of upland bird communities in the Arctic (Section 9.1.3.2), baseline studies in 2012 were designed to derive density estimates of upland birds in moist to wet and dry vegetation communities (Rescan 2013e; Appendix V5-5C). Lowland plots were placed so that each plot contained at least 30% wetland and 50% moist habitat. Upland plots contained at least 30% dry boulder-bedrock and heath lichen, with at least 50% additional cover by dry sparsely vegetated tundra.

The number of territories estimated per plot is an underestimate of the true number present, because observers almost never detect all birds present. For example, using the PRISM survey method, Brown et al. (2007) estimated that the detection rate for shorebirds was 77% ± 5%. The detection rate for songbirds is higher than for shorebirds, because male songbirds frequently vocalize during the egg and nestling stages of breeding. Based on expert opinion, a detection rate of 85% was used to correct territory counts to derive density estimates (pairs/km^2) of upland bird species detected per habitat type.

Results of Baseline Data Collection

Upland bird species that regularly occur within the wildlife RSA were identified from species' range maps, and the timing and frequency of detections during baseline surveys (Table 9.1-1). In total, 27 upland bird species were detected during baseline studies — 24 species that regularly occur in the wildlife RSA and 3 species that rarely occur. Three additional species identified as regularly-occurring within the wildlife RSA were not detected, likely because these are regular migrants and probably do not breed in the wildlife RSA.

Songbirds were the most commonly detected of the upland bird groups, accounting for 88% of all detections. The upland bird community in the wildlife RSA is dominated by a few common songbird species — the Lapland longspur (54% of all detections), common and hoary redpoll, savannah sparrow, and horned lark. These observations are consistent with those of other studies in the Arctic (Section 9.1.3.2).

Comparison of species richness and abundance between dry upland (e.g., rocky heath) and moist to wet lowland (e.g., sedge meadow) habitats revealed that although lowland habitat supported a richer and more abundant bird community, especially for shorebirds, the horned lark was rarely found in lowland habitats (Table 9.1-3; Rescan 2013e; Appendix V5-5C). Differences across the moisture gradient in the upland bird community measured in baseline studies reflect those found in other studies across the Arctic (Section 9.1.4.2).

Table 9.1-3. Density Estimates (Uncorrected for Detectability) of Upland Birds in PRISM Plots

	Habitat	Uncorrected Density (Pairs per km^2)	Standard Error
All Upland Birds	Moist-Wet	113	8.3
	Dry	80	5.8
Songbirds	Moist-Wet	98	7.6
	Dry	74	5.7
Shorebirds	Moist-Wet	13	1.5
	Dry	5	1.2
Ptarmigan	Moist-Wet	1	2.1
	Dry	1	0.6
Common Species*			
Lapland Longspur	Moist-Wet	42	4.1
	Dry	40	5.1
Savannah Sparrow	Moist-Wet	36	3.7
	Dry	9.4	2.3
Redpoll spp.	Moist-Wet	11	2.3
	Dry	8.3	2.2
American Tree Sparrow	Moist-Wet	5.5	1.8
	Dry	2.5	1.3
Semipalmated Sandpiper	Moist-Wet	4.6	1.0
	Dry	1.8	0.8
Horned Lark	Moist-Wet	2.3	0.8
	Dry	11	2.2
American Golden Plover	Moist-Wet	2.0	0.7
	Dry	2.2	0.8

** Detected across more than 20% of survey plots*

Patterns in the regional distribution of the upland bird community were revealed from baseline studies (Figure 9.1-4). Species richness of upland bird species was relatively lower within the mostly dry rocky uplands north of the George Exploration Camp, and higher within the wetland-dominated area to the southwest of the Goose Property and in the marine-influence habitat along the coast of Bathurst Inlet. A similar pattern was found for the waterbird community, which suggest that the rocky areas north of the George Exploration Camp in general provides relatively poor habitat for most migratory birds (Section 9.1.5.3).

GIS # BAC-23-373

September 02 2015

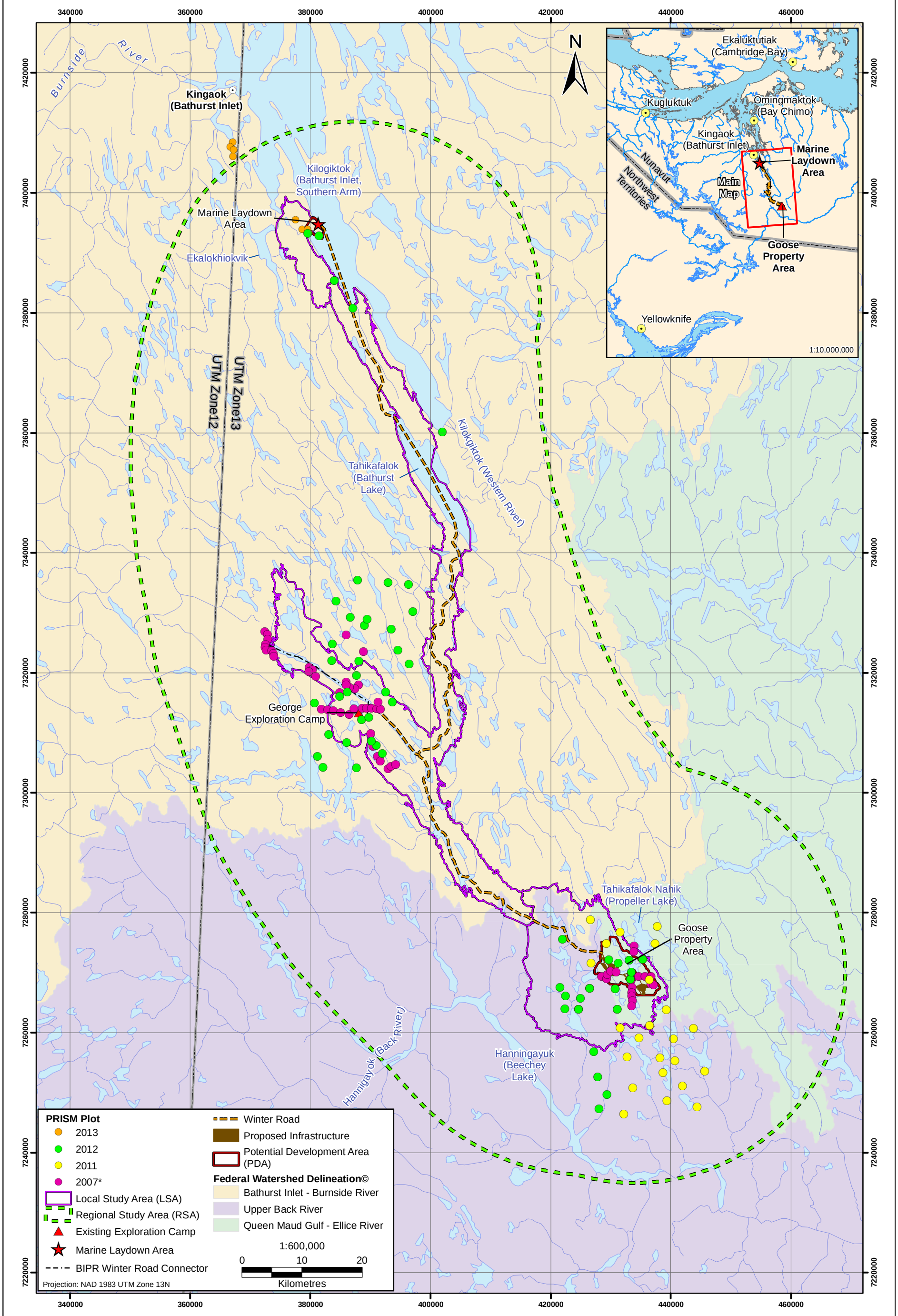

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Figure 9.1-3

Location of PRISM Plots to Survey Upland Birds within the Regional Study Area

Rescan an ERM company

GIS # BAC-23-374

September 03 2015

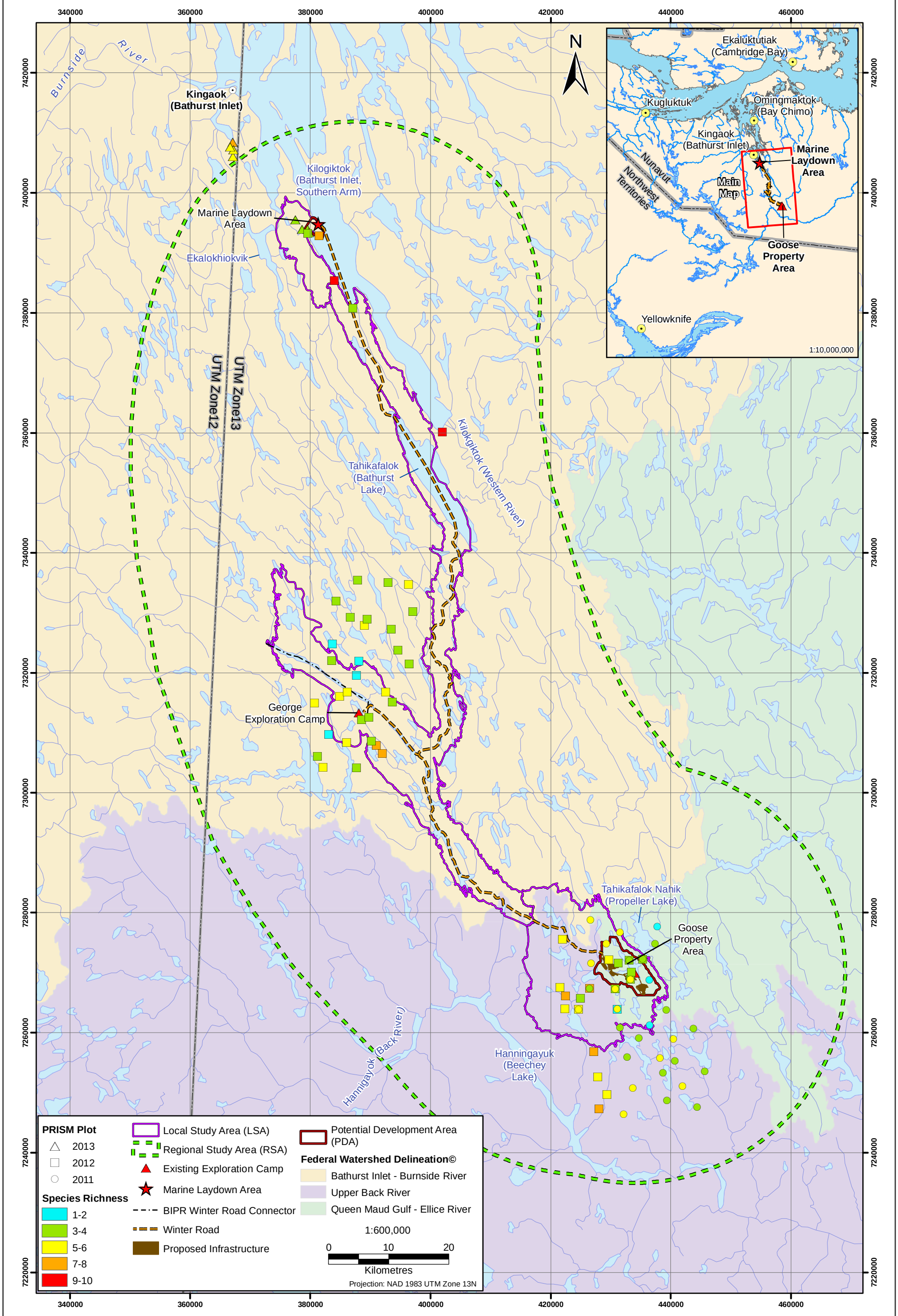

Figure 9.1-4

Species Richness of Upland Birds in PRISM Plots, 2011 to 2013

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Rescan an ERM company

Ten upland bird species that regularly occur in the wildlife RSA are listed as "Sensitive" under the CESCC designations for Nunavut: American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris's sparrow, hoary redpoll, and white-crowned sparrow. All of these species were observed with the PDAs, with the exception of the red phalarope, a regular migrant that was not observed during baseline studies (Table 9.1-1).

Deriving Density Estimates for Breeding Pairs

Estimates of the number of upland bird territories within PRISM plots (Table 9.1-3) were corrected using an estimated 85% detection rate, which resulted in a density estimate of 133 ± 9.8 upland bird pairs per km^2 in moist to wet lowland habitat, and 94 ± 6.8 upland bird pairs in dry upland habitat (Rescan 2013e; Appendix V5-5C).

Density estimates based on accurate counts of nests usually provide more accurate estimates of population density than density estimates based on counts of adult birds. The corrected density estimates based on counts of adults made during baseline studies within the wildlife RSA are comparable to density estimates derived from a study in which researchers used extensive effort to find nests within survey plots at Prudhoe Bay, Alaska (Liebezeit, White, and Zack 2011; Table 9.1-4). Density estimates derived by Liebezeit et al. (2011) represent underestimates of the density of upland birds because all songbird species were excluded from the estimate except the Lapland longspur. Because the Lapland longspur usually dominates the Arctic songbird community, this estimate is likely approximately 20-30% below the true density. Thus, it was concluded that the corrected density estimates derived from baseline studies are likely to be reliable estimates.

Table 9.1-4. Density Estimates Derived from Counts of Upland Bird Pairs and Nests in Moist to Wet and Dry Habitats

Study	All Upland Bird Species			Shorebirds			Songbirds (pairs/km^2)		
	All Habitats	Moist to Wet	Dry	All Habitats	Moist to Wet	Dry	All Habitats	Moist to Wet	Dry
Counts of Birds (pairs/km^2)									
Back River 2012 Baseline		113 (8.3)[1]	80 (5.8)		13 (1.5)	5 (1.2)		98 (7.6)	74 (5.7)
Back River 2007 Baseline[2]				25			92		
Johnson et al. 2000					27 (13)	11 (10)		39 (24)	33 (14)
Counts of Nests (nests/km^2)									
Liebezeit et al. 2011[3]		126 (19.5)	77 (8.9)		70 (16)	38 (7.5)			

[1] *Numbers in brackets are the standard error of the mean number of pairs across PRISM plots.*
[2] *Gartner Lee Ltd. (2008).*
[3] *Density estimate does not include songbird species other than Lapland longspur and therefore represents an underestimate of the density of upland bird species.*

9.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Inuit TK includes detailed knowledge on the timing of bird migration, habitat use, and the spatial distribution of waterbirds (KIA 2012, 2014). The life histories of individual species are described, particularly of waterbirds which were an important food source for Inuit, especially in coastal areas (KIA 2012). Inuit TK includes observations of the earlier migration of the snow bunting and of

large-bodied birds, such as the tundra swan and geese, and identification of ravens and ptarmigan as non-migratory, resident birds. Examples of detailed observations of bird habitat use include frequent foraging on berries by geese, nesting of waterbirds on mid-stream islands and of geese and some ducks on cliffs, and observations of higher densities of nesting waterbirds in large wetlands. Inuit TK also includes the identification of regularly-used staging sites by waterbirds as areas that become ice-free earlier than other areas, such as fast-flowing rivers. Only one staging site was identified within the wildlife RSA, an area at the outflow of Beechey Lake. This area was not surveyed for waterbirds as it was deemed too far from potential sources of Project-related effects (Figure 9.1-1). The following reports were reviewed for TK specific information related to migratory birds:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012) (Appendix V3-3A of FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3B of FEIS);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013d) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VEC selection, assessment boundaries, and recommendations for mitigation and adaptive management.

9.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds was also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

9.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used

to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As a result of this process, migratory birds were selected as a VEC for the DEIS and FEIS.

9.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013d). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

9.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of Inuit values into the list of potential effects to be considered. Distribution and habitat use information from TK were also included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

9.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013d), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;

- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

9.3 VALUED COMPONENTS

9.3.1 Potential Valued Components and Scoping

- The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information: potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

As part of the scoping process, the following aspects were also considered:

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

9.3.2 Valued Components included in Assessment

Migratory birds were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Migratory birds were selected as a VEC based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations, particularly their protected status under the *Migratory Birds Convention Act (1994)*.

Migratory birds were and continue to be an important food source for Inuit. Ptarmigan were a widely-used food source to Inuit, both within coastal areas and on the inland tundra. Hunting and egg-collecting for waterbirds primarily occurred in coastal areas. Spring staging waterbirds, especially eider ducks and loons, were hunted along coastal areas where the birds foraged in early-opening ice before migrating to nesting areas. In the summer, adult waterbirds were hunted during the flightless period when they moulted their feathers. Inuit travelled to coastal areas to collect the eggs of waterbirds, probably mostly of eiders, along the coast and on small coastal islands. Sandhill cranes were hunted

early in the spring when their fat reserves were high. Migratory birds were also important to Inuit because their movements in spring and fall were used to mark the passage of seasons (Rescan 2013b).

The following migratory bird species that regularly occur in the wildlife RSA are listed as "Sensitive" under the CESCC designations for Nunavut: waterbirds — Arctic tern, glaucous gull, and long-tailed duck; upland birds — American golden plover, least sandpiper, red-necked phalarope, red phalarope, semipalmated sandpiper, American pipit, American tree sparrow, Harris's sparrow, hoary redpoll, and white-crowned sparrow (CESCC 2010).

The red knot is the only species listed on Schedule 1 of SARA of all the non-predatory species of migratory birds that may occur within the wildlife RSA (Table 9.1-1). The red knot was not detected during baseline surveys as it probably migrates in low numbers through the wildlife RSA.

Migratory birds are effective indicators of overall ecosystem function and health (Niemi and McDonald 2004). Birds often respond rapidly to environmental change and are thus sensitive indicators of habitat degradation and other disturbances (Koch, Derver, and Martin 2011).

9.4 SPATIAL AND TEMPORAL BOUNDARIES

9.4.1 Spatial Boundaries

Project-related effects on migratory birds were evaluated within two study areas: a local study area (LSA) and a larger regional study area (RSA; Figure 9.4-1).

9.4.1.1 Local Study Area

The boundaries of the Local Study Area (LSA) for migratory birds were set to encompass the following:

- the Goose Potential Development Area (PDA), which contain all proposed Project infrastructure for the Goose and Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The wildlife LSA covers an area of approximately 134,369 ha (Figure 9.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

9.4.1.2 Regional Study Area

The RSA for migratory birds encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two Project areas. The wildlife RSA covers an area of approximately 1,262,005 ha (Figure 9.4-1). The wildlife RSA extends slightly more than 35 km from proposed infrastructure on the eastern side to encompass the Western River.

9.4.2 Temporal Boundaries

The temporal boundaries used for the migratory birds effects assessment align with the time periods of the phases of the Project as presented in Table 9.4-1.

Table 9.4-1. Temporal Boundaries — Project Phase Durations

Phase	Duration
Construction (including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post Closure Monitoring	5 years
Other Potential Phases	
Temporary Closure	Less than 2 years
Care and Maintenance	2 to 10 years
Exploration	included in Construction and Operation phases

With the exception of the willow and rock ptarmigan, all migratory bird species migrate in spring and fall, and occur in the wildlife RSA during the non-winter seasons only. The two ptarmigan species over-winter in the Arctic, and thus may interact with the Project throughout the year.

9.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

The potential effects of the Project on migratory birds within the wildlife RSA are assessed in this Section of the FEIS. Academic and monitoring studies have shown that under certain circumstances migratory birds may be susceptible to development-related disturbances, which may result in displacement of migratory birds from preferred habitat, higher rates of nest predation, and possible declines in their breeding productivity and population abundance. For this reason, potential effects of the Project on migratory birds were considered. In the following assessment of the effect of the Project on migratory birds, qualitative and quantitative information was used to characterize the potential residual effects, and predict residual effects that may remain following mitigation and management strategies.

9.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on migratory birds as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. identification of potential interactions between the Project and migratory birds;
2. characterization of the potential effects that could result from these interactions;

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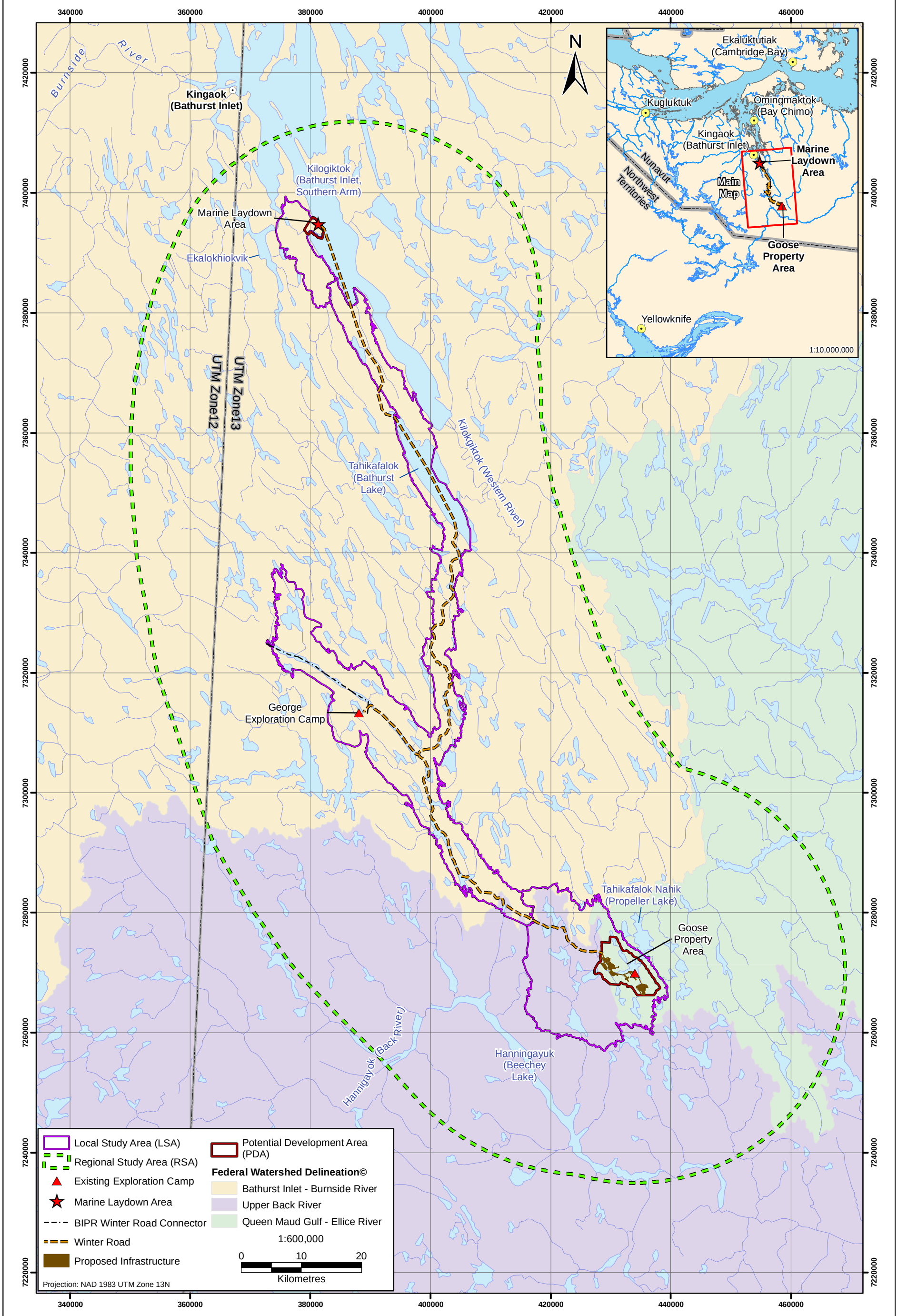

Figure 9.4-1

Local Study Area and Regional Study Area for Migratory Birds

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3. identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. determination of the significance of residual effects using eight descriptors to rate the residual effects on migratory birds including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on migratory birds is evaluated for the construction, operations, decommissioning, and post-closure periods as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, effects are evaluated for the phase associated with the worst-case scenario; lower effects are anticipated during all other Project phases.

9.5.1.1 Indicators used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 9.5-1). For each potential effect, indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger an assessment of residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of "yes" or "no" where triggering of residual effects assessment occurred if the indicator value was "yes".

Table 9.5-1. Criteria and Indicators Used to Characterize Potential Effects on Migratory Birds

Potential Effect	Criteria	Indicator
Habitat Loss	Change in Population Health	Amount (ha) of habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA and expressed as a ratio of area lost to the area of the wildlife RSA
Disturbance due to Noise	Change in Population Health	Amount (ha) of habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA and expressed as a ratio of area lost to the area of the wildlife RSA
Disruption to Movement	Change in Population Health	Presence of tall structures with lights
Direct Mortality and Injury	Change in Population Health	Collisions of migratory birds with vehicles occurs at other locations
Indirect Mortality	Change in Population Health	Indirect mortality due to nest predation occurs at other locations
Attraction	Change in Population Health	Attraction occurs at similar Projects in Nunavut and Northwest Territories
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on migratory birds

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social

construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

9.5.1.2 Magnitude Ratings for Residual Effects

Magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. Residual effects were designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects is provided in Table 9.5-2.

Table 9.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects, the effect on the sub-population and thus the magnitude of the effect was assessed using professional judgment and literature review.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in population health via alterations in habitat availability and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for migratory birds, which provide benchmark measures, as well as estimates of the natural variability.

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

9.5.1.3 Overall Significance Ratings for Residual Effects

To assess the significance of residual effects, eight descriptors for evaluating residual biophysical effects were used and defined in Volume 9, Chapter 1: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. To assess residual effects, quantitative data were used as a default approach. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 9.5-2) and reversibility were used as the primary descriptors; the extent, duration, and frequency of the effect as secondary descriptors.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as Positive, Significant, or Not Significant (Table 9.5-3). For example, a residual effect receives a rating of 'Not Significant' typically if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

Table 9.5-3. Definitions of Significance Ratings for Residual Effects on Migratory Birds

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

9.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions between the VEC migratory birds and the Project is provided in Volume 9, Chapter 1. Migratory birds may potentially interact with most Project activities during all Project phases. Interactions will vary across species depending on migratory guild. As resident species, the rock and willow ptarmigan occur in the wildlife RSA during winter, and thus may interact with traffic on the winter roads, whereas all other migratory bird species will interact with the Project during April to October only. Potential effects on wildlife from the Project have been

scoped based on NIRB guidelines. Interactions of migratory birds with Project components were evaluated to determine which of the following potential effects may occur (Table 9.5-4):

- direct habitat loss;
- disturbance (e.g., displacement, behavioural effects leading to negative energetic balance, physiological stress);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality due to increased access and associated increase in hunting;
- attraction;
- exposure to contaminants; and
- reduction in reproductive productivity due to all potential effects of the Project combined.

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated as to whether or not these are predicted to result in a residual effect after mitigation actions are implemented.

9.5.2.1 Habitat Loss

The potential for habitat loss to affect migratory birds is evaluated in this section. Migratory bird habitat will be removed and replaced by Project infrastructure. The potential for habitat near infrastructure to be degraded due to dust generated from industrial developments was assessed in Country Foods chapter (Volume 8, Chapter 5) and Environmental Risk Assessment (Volume 8, Chapter 6). This analysis did not predict any residual effects due to dust on vegetation and therefore on migratory bird habitat.

The location of infrastructure will be planned to avoid wildlife sensitive areas, and the layout of infrastructure will be designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. However, some habitat loss is unavoidable.

To enable flexibility in siting of Project infrastructure, two Project Development Areas (Goose Property and the MLA) were delineated, which contain all proposed Project infrastructure in the entire Project footprint for each area (Section 9.4.1). It was assumed that habitat loss for migratory birds will occur within the total area of each PDA. This represents an overestimate of habitat loss as only about 10% of the entire area within each PDA will be developed.

The only Project activity not contained within the PDA is the winter roads. Habitat loss within these areas is not expected for migratory birds because no migratory species are present in the wildlife RSA during winter. Ice roads are not anticipated to result in loss of habitat for ptarmigan, which are not migratory, because most of the proposed road route crosses waterbodies where ptarmigan do not occur. Ice roads are not permanent infrastructure, and thus are not anticipated to result in habitat degradation for migratory birds during the snow-free season.

Habitat of migratory birds may also be indirectly lost if migratory birds avoid the Project area outside of the PDAs due to disturbance, which is discussed in Section 9.5.2.2.

Table 9.5-4. Interactions of Migratory Birds with Project Components that May Result in Effects on Migratory Birds

Potential Development Area Project Component	Habitat Loss[1]	Disturbance	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity
Goose Property Area								
Open Pits (Goose, Umwelt, Echo, and Llama)	x	x		x	x	x		x
Haul and access roads	x	x		x	x	x		x
Winter roads		x		x	x			x
Stockpiles	x	x		x	x	x	x	x
Waste rock storage areas	x	x		x	x	x	x	x
Explosives storage areas	x	x		x	x	x	x	x
Tailings Impoundment Area	x	x		x	x	x	x	x
Quarries	x	x		x	x	x		x
Landfill	x	x		x	x	x	x	x
Camp / Plant site	x	x		x	x	x		x
Airstrip	x	x		x	x	x		x
Other infrastructure (diversion channels, water intakes)	x	x		x	x	x		x
Marine Laydown Area								
Camp	x	x		X	X	X		x
Lightering Barge location	x	x		X	X	X		x
Haul and access roads	x	x		X	X	X		x
Winter roads		x		x	x			x
Other infrastructure (interception ditch)	x	x		x	x	x		x

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*

Calculation of Habitat Loss

Assessment of the effect of habitat loss for migratory birds was based on:

1. a calculation of the total area lost to development, calculated as the sum of the PDA areas, and expressed as a proportion of the wildlife LSA and RSA; and
2. a calculation of the area of suitable habitat contained within the PDA areas, and expressed as a proportion of the area of suitable habitat for migratory birds within the wildlife LSA and RSA.

Calculating Total Area Lost

The total expected area of habitat lost or degraded by the mine footprint was calculated by summing the areas of loss due to the entire Goose and MLA PDAs and comparing this area to the total area of the wildlife LSA and RSA. The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

Calculating Area of Suitable Waterbird Habitat Lost

Suitable habitat for waterbirds was considered to be all mapped waterbodies and wetlands. The effect of loss of suitable habitat was quantitatively assessed as the amount of suitable habitat expected to be lost within the PDAs, relative to the amount of suitable habitat mapped within the wildlife LSA and RSA. Suitable habitat was identified using available ecosystem mapping for the wildlife RSA. The West Kitikmeot / Slave Study Society (WKSS) ecosystem mapping was used to identify ecosystems within the wildlife RSA based on remote sensing and extensive field work (Matthews, Epp, and Smith 2001; Rescan 2013a, Appendix V5-5A). The Geobase Land Cover data set was used to infill data gaps from the WKSS data set (Rescan 2013a, Appendix V5-5A). The WKSS and Geobase Land Cover data are summarized in the Existing Environment section of the Vegetation and Special Landscape Features (Volume 5, Chapter 4).

Calculating Area of Suitable Upland Bird Habitat Lost

Suitable habitat for upland birds was considered to be dry and moist to wet vegetation communities. To quantitatively assess the effects of habitat loss for upland birds, the amount of suitable habitat lost within the PDAs was calculated relative to the portion available within the wildlife LSA and RSA. Areas of these vegetation types were calculated separately because the bird community is different across this moisture gradient (Section 9.1.4 and 9.1.5.2). Again, suitable habitat was identified using the WKSS and Geobase Land Cover data.

Evaluation of Habitat Loss

Total Area of Loss

The total area of loss as represented by the Goose and MLA PDAs is 6,080 ha, which represents 4.5% of the wildlife LSA and 0.5% of the wildlife RSA (Table 9.5-5).

Table 9.5-5. Area of Habitat Loss within the Project Development Areas

Project Development Area (PDA)	Area Lost (ha)	Proportion of LSA (%)[1]	Proportion of RSA (%)[1]
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.5	0.1
Total Lost	**6,080**	**4.5**	**0.5**

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*

Loss of Suitable Waterbird Habitat

Waterbodies (e.g., lakes) comprise 17 % of the wildlife LSA and 18% of the wildlife RSA; wetlands comprise 18% of the wildlife LSA and 17% of the wildlife RSA (Table 9.5-6; Rescan 2013e; Appendix V5-5C). All deep water marine habitat within Bathurst Inlet was not included as a suitable 'waterbody' habitat for waterbirds because the results of baseline studies (Section 9.1.5) indicate that very few waterbirds make use of the deeper water in the middle of the inlet; the majority of waterbirds were recorded in shallow marine habitat along the shorelines. The remainder of the wildlife LSA and wildlife RSA covered ecosystems that were not considered suitable habitat for waterbirds, including barren/disturbed, dry upland vegetation communities, shrubby tundra, and unclassified habitats.

Table 9.5-6. Suitable Waterbird Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project

	Suitable Habitat		Suitable Habitat Lost[1] due to Potential Development Areas	
Area	**Amount (ha)**	**% Area**	**Area (ha)**	**% Suitable Habitat**
Local Study Area[2]				
Waterbodies	22,600	17	906	4
Wetlands	23,984	18	1,478	6
Total	**46,584**	**35**	**2,384**	**5**
Regional Study Area[2]				
Waterbodies	221,747	18	1,011	0.5
Wetlands	217,455	17	1,478	0.7
Total	**439,202**	**35**	**2,489**	**0.6**

[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.
[2] A small amount of the MLA PDA extends outside of the wildlife LSA. Therefore, the amount of suitable habitat altered will be slightly different within the wildlife LSA as compared to the wildlife RSA.
Note: Waterbodies include the Deep Water, Shallow Water, and Water ecosystem classes (excluding the deep water marine habitat within Bathurst Inlet), Wetlands include the Tussock/Hummock, Tussock graminoid tundra, Wet sedge, Wetland, and Wetland (Sedge Meadow) ecosystem classes.

In total, one-third (35%) of the wildlife LSA and wildlife RSA represent potential habitat for waterbirds. This amount is an over-estimate of habitat available to waterbirds, since some waterbodies are likely to be low quality habitat for waterbirds (Section 9.1.5).

Based on mapping of waterbodies and wetlands, 5% and 0.6% of waterbird habitat available in the wildlife LSA and RSA, respectively, will be lost within the two PDAs (Table 9.5-6). No nesting colonies or key staging sites were observed within the PDAs (Section 9.1.5.3), thus neither of these types of habitat will be lost to Project development.

Loss of Suitable Upland Bird Habitat

Moist to wet vegetation communities cover 45% of the wildlife LSA and dry upland vegetation covers 31%; the remaining quarter (24%) of the LSA was mapped as waterbodies, barren/disturbed, and unclassified habitats which were not considered as suitable habitat for upland birds (Table 9.5-7). The wildlife RSA is comprised of 43% moist to wet vegetation communities and 36% dry vegetation types, with the remaining 11% of the RSA mapped as waterbodies, barren/disturbed, or unclassified habitats (Table 9.5-7). Less than 5% of suitable upland bird habitat (across dry and moist to wet vegetation communities) in the wildlife LSA will be lost within the two PDAs; within the wildlife RSA, less than 1% of the available suitable habitat is predicted to be lost (Table 9.5-7).

Table 9.5-7. Suitable Upland Bird Habitat Lost in the Wildlife LSA and RSA due to Development of the Back River Project

Area	Suitable Habitat		Suitable Habitat Lost[1] due to Potential Development Areas	
	Amount (ha)	% Area	Area (ha)	% Suitable Habitat
Local Study Area[2]				
Dry Upland	41,675	31	894	2.1
Moist to Wet Lowland	61,056	45	3,999	6.6
Total	**102,732**	**76**	**4,894**	**4.8**
Regional Study Area[2]				
Dry Upland	449,263	36	895	0.2
Moist to Wet Lowland	542,692	43	4,009	0.7
Total	**991,955**	**79**	**4,905**	**0.5**

[1] Represents area of habitat loss due to entire PDA and not facility specific habitat loss, thus overestimating actual habitat loss.
[2] A small amount of the MLA PDA extends outside of the wildlife LSA. Therefore, the amount of suitable habitat altered will be slightly different within the wildlife LSA as compared to the wildlife RSA.
Note: Dry Upland includes the heath-boulder and heath-bedrock associations and sparsely vegetated tundra and esker habitats, and Moist to Wet Lowland habitat includes shrubby (mesic to moist) tundra, riparian areas, and wetlands.

Using density estimates derived from baseline surveys (Section 9.1.5.6), at least 120,380 ± 6,621 upland bird pairs are expected to be present within the wildlife LSA during the breeding season. This population estimate is comprised of an estimated 81,205 ± 5,984 upland bird pairs in lowland moist to wet areas (611 km^2 of moist to wet habitat × 133 ± 9.8 upland bird pairs per km^2) and 39,175 ± 2,834 upland bird pairs in dry upland areas (417 km^2 of dry upland habitat × 94 ± 6.8 upland bird pairs per km^2) within the wildlife LSA.

At least 1,144,088 ± 61,334 upland bird pairs are expected to be present with the wildlife RSA during the breeding season. This population estimate is comprised of an estimated 721,781 ± 53,184 pairs in lowland moist to wet areas (5,427 km^2 of moist to wet habitat × 133 ± 9.8 upland bird pairs per km^2) and 422,307 ± 30,550 pairs in dry upland areas (4,493 km^2 of dry upland habitat × 94 ± 6.8 upland bird pairs per km^2) within the wildlife RSA.

The estimated population size of upland birds within the two PDAs is 842 ± 61 breeding pairs of upland birds in dry habitat, and 5,332 ± 393 breeding pairs in moist to lowland habitat. Combined, an estimated 6,174 ± 398 breeding pairs of upland birds are expected to breed within the area of the two PDAs, which is 5.1% of the estimated 120,380 ± 6,621 breeding pairs within the 134,369 ha of the wildlife LSA, and 0.5% of the estimated 1,144,088 ± 61,334 breeding pairs within the 1,262,005 ha of the wildlife RSA. It is anticipated that approximately 10% of the PDAs will be developed, and thus an estimated 617 pairs of breeding upland birds will be displaced as a result of habitat loss due to Project development, which is 0.05% of the population breeding in the wildlife RSA.

Whenever possible, reclamation activities will be undertaken to restore habitat for migratory birds upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss to migratory birds, and thus a residual effect is predicted to occur.

9.5.2.2 Disturbance due to Noise

Noise and human and vehicle movements generated from developments can cause disturbance to migratory birds. Disturbance can result in behavioural changes, and changes in spatial distribution through avoidance of preferred habitats when these become disturbed (Bayne, Habib, and Boutin

2008). The intensity of behavioural responses is related to the degree to which birds perceive disturbances as a threat (Frid and Dill 2002).

Disturbance of migratory birds will occur throughout the life of the Project. Some disturbances like blasting and aircraft flights will occur intermittently, while other disturbances like the presence of humans and the movement of vehicles will occur relatively regularly. Potential disturbance to migratory birds due to the Project could result from the following activities:

- blasting (noise and ground vibrations from mining and construction activities);
- general Project noise (e.g., camp noise, vehicle traffic, human presence); and
- noise generated from aircraft traffic.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the open pits while continuous Project noise includes rock crushing and stockpiling of materials for the TSF bedding, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during all Project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required during Post Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15).

Bird densities have been found to decrease within 1 km of infrastructure, such as roads, seismic lines, and oil fields (Benitez-Lopez, Alkemade, and Verweij 2010). Studies have found lower density of territorial males, reduced total annual output of males, and reduced overall population size near roads (Clark and Karr 1979; Van Der Zande et al. 1984; Foppen and Reijnen 1994; R. Reijnen and R Foppen 1994; M. J. S. M. Reijnen 1995; M. J. S. M. Reijnen, Veenbaas, and Foppen 1995; R. Reijnen, Foppen, and Meeuwsen 1996). Effects have been observed to extend as far as 1.8 km from a busy highway and as much as 600 m from a rural road (R. Reijnen, Foppen, and Meeuwsen 1996). Studies on birds in grasslands reported that the abundance and diversity of birds began to drop when noise levels reached 47 ± 3.5 dBA near roads (R. Reijnen and R. Foppen 1994; R. Reijnen, Foppen, and Meeuwsen 1996). Noise from traffic was correlated to bird densities close to roads (M. J. S. M. Reijnen, Veenbaas, and Foppen 1995). However, these earlier studies were not designed to test for the independent effects of mortality due to vehicle strikes, and thus mortality and noise levels were confounded. More recent work shows bird densities are low near roads due to mortality; little support was found for an effect of noise on bird abundance (Summers, Cunnington, and Fahrig 2011).

Noise appears to affect bird populations in other ways. Noise can negatively affect individuals even when it is not experienced as threatening. Anthropogenic noise can mask songbird vocalizations, which they use to establish and maintain territories for breeding and communicate with young (Habib, Bayne, and Boutin 2007). In some cases, there may be few behavioural indicators of disturbance — birds may choose to nest close to human activities — yet experience physiological stress (Blickley et al. 2012). A potential concern regarding disturbance to breeding birds is that it can result in energetic imbalances that can ultimately result in reproductive failure. For example, disturbance can cause reduced rates of

food provisioning to young (Verhulst, Oosterbeek, and Ens 2001), which may lead to poor body condition of young and thus higher rates of mortality.

Quantification of Disturbance to Migratory Birds

Disturbances from multiple stressors (e.g., noise, visual, vibration) to migratory birds were quantitatively assessed by considering the spatial overlap between breeding migratory birds and Project infrastructure and activities. In addition, the effects of noise disturbance to migratory birds were quantitatively assessed based on noise modeling of the area over which noise emissions from the Project are estimated to occur (Volume 4, Chapter 2). Disturbance is described for the Project phase anticipated to result in the "worst-case" effects; all other Project phases are expected to result in less disturbance.

Flight Initiation Distance

The zone of influence for disturbance effects from multiple sources including visual disturbances and vibrations generated from the Project on migratory birds is assumed to be 300 m. Flight Initiation Distance (FID) is defined as the distance between birds and a disturbance when birds flush in response to an approaching disturbance (Ruddock and Whitfield 2007). Data on FIDs recorded for breeding waterbirds have been used to delimit the boundaries of spatial buffers to restrict human activities around nest sites and staging areas (Whitfield, Ruddock, and Bullman 2008). These studies show that most FIDs recorded for waterbirds are within 300 m from the disturbance source (Rodgers Jr. and Schwikert 2002; Ruddock and Whitfield 2007; Whitfield, Ruddock, and Bullman 2008). Studies have shown that the strongest effects of Arctic developments on upland birds are limited to within 300 m from footprints and activities (Male and Nol 2005; Smith et al. 2005).

Disturbance effects of the Project were quantitatively assessed based on numbers of migratory birds expected to occur within 300 m of proposed Project infrastructure. For waterbirds, this was estimated as the number of flocks of waterbirds expected to use this area during the staging season, when disturbances are expected to result in greater effects. For upland birds, this was estimated as 35% of the upland birds estimated to use the two PDAs (Section 9.5.2.1), based on an estimated area covered by proposed infrastructure and buffered by 300 m, which is an area approximately 35% of the PDAs.

Noise Contour Modeling to Evaluate Indirect Habitat Loss

To assess indirect habitat loss due to sensory disturbance, the area outside of the PDAs anticipated to be affected by noise was calculated. The effects due to noise beyond the existing PDA boundaries are expected to be small, because the loss of habitat within the PDAs, where most of the effect of disturbance will likely occur, was already considered in the habitat loss assessment (Section 9.5.2.1).

Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2; Rescan 2013d) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case; this coincides with Year Three of the Operational phase at the Goose Property Area. The Operational phase is also the longest Project phase, and thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was calculated by using specific noise level contours from the literature at which wildlife have shown behavioural effects from the noise.

Threshold noise values were determined from the literature, above which wildlife are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were

predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for migratory birds. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 9.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of suitable habitat disturbed during each season as calculated using the WKSS and Geobase ecosystem mapping available for the wildlife RSA (Section 9.5.2.1).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing aircraft. In general, instantaneous noises (like blasting) are measured in L_{peak}, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

L_{peak} noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries and noise due to aircraft. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB L_{peak}), and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB L_{peak}). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for wildlife resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (L_{peak}) or higher for instantaneous noise effects on migratory birds during construction and operation. Blasting noise models were conducted during peak noise levels for each of the PDAs, which is Year Three of Operations at the Goose.

General Project-related noise levels or continuous noise levels are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). A flight impact zone was delineated based on noise modeling results showing the area over which aircraft noise attenuates to 80 dBA or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). For the Goose Property Area, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013c).

To assess indirect habitat loss due to sensory disturbance for migratory birds, the total area of suitable habitat outside of the two PDAs (Section 9.5.2.1), but within noise level contours was calculated. The following noise contours were used: 120 dB for functionally-lost habitat from instantaneous blasting noise, resulting in abandonment of habitat, 108 dB for disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response, 45 dBA for general Project noise, and 80 dBA for disturbed habitat from instantaneous aircraft noise.

Noise Modelling to Evaluate Disturbance to Waterbirds Breeding near Infrastructure

The effects of noise disturbance on waterbirds were also evaluated by determining whether noise thresholds are predicted to be exceeded at sites close to proposed infrastructure where waterbirds were observed during the spring or fall migration periods during baseline studies (Dragon Lake in the central RSA and a small wetland just to the south of the Goose Property PDA)

Evaluations of Disturbance to Migratory Birds

Flight Initiation Distance

Two flocks of waterbirds (one Canada goose and one greater white-geese flock) have been observed during the staging season within the 300 m zone of influence for disturbance; both flocks were seen during the spring staging season within the Goose PDA. The estimated number of upland bird pairs exposed to disturbance effects within this zone of influence is 2,161 breeding pairs (35% of 6,174 breeding pairs, Section 9.5.2.1), which is 1.8% of the estimated population size within the wildlife LSA and 0.2% of the estimated population size within the wildlife RSA .

Noise Contour Modelling to Evaluate Indirect Habitat Loss

Blasting Noise — Less than 0.1% of the wildlife RSA beyond the PDAs is modeled to be functionally lost (9 ha) and disturbed (316 ha) due to blasting noise (Table 9.5-8). All blasting noise above 120 dB L_{peak} is completely contained within the 108 db L_{peak} contour; therefore, only 307 ha outside of the area modeled as functionally lost (≥120 dB L_{peak}) will be disturbed by blasting noise above 108 db L_{peak}. Blasting noise, considered independently (i.e., habitat modeled as functionally lost due to blasting above 120 dB L_{peak} and additional area outside of 120 dB L_{peak} modeled as disturbed by blasting noise above 108 dB L_{peak}) and cumulatively (i.e., all habitat modeled as disturbed by blasting noise above 108 db L_{peak} which includes 120 dB L_{peak}), accounts less than 0. 1% of suitable habitat available for migratory birds beyond the PDAs in the wildlife RSA (Tables 9.5-9 and 9.5-10).

General Project Noise — The total amount of area modeled as affected by elevated noise levels outside of the two PDAs is 1,212 ha or <0.1% of wildlife RSA (Table 9.5-8), of which 472 ha is mapped as suitable habitat for waterbirds (Table 9.5-9), and 906 ha is mapped as suitable habitat for upland birds (Table 9.5-10). All noise attributable to blasting above 108 dB L_{peak}, which is an intermittent noise source, will occur entirely within the area modeled as disturbed by continuous general Project noise above 45 dBA. Therefore, migratory birds will experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap; the amount of suitable habitat within the area of overlap is very minimal for both waterbirds and upland birds (<0.1% the wildlife LSA and wildlife RSA). The majority of sensory disturbance due to general Project noise modeled as above 45 dBA will be associated with the development and operation of the TSF, processing plant, roads, and camps.

Aircraft Noise — The total amount of area modeled as affected by aircraft noise (80 dBA) outside of the two PDAs represents 1.1% of the wildlife RSA (14,191 ha; Table 9.5-8). Sensory disturbance due to aircraft noise is greater near the MLA (12,367 ha, 1% of the wildlife RSA) relative to the Goose PDA (1,824 ha, 0.1% of the wildlife RSA; Table 10.5-9), as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. However, much of the habitat modeled as disturbed by aircraft noise at the MLA is over marine habitat in Bathurst Inlet and only 2,273 ha of terrestrial habitat along the shorelines is modeled as receiving elevated noise levels, which is equivalent to 0.2% of the wildlife RSA. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area disturbed by continuous general project noise above 45 dBA, thus representing the area where migratory birds may encounter multiple types of Project noise.

Table 9.5-8. Total Additional Area Functionally Lost or Disturbed due to Project Noise

Project Area	Total Area Lost to Project PDAs			Additional Area Functionally Lost due to Blasting (120 dBA)			Additional Area Disturbed due to Blasting (108 dBA)			Additional Area Disturbed due to General Project Noise (45 dBA)			Additional Area Disturbed due to Aircraft Noise (80 dBA)		
	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA[1]	% RSA
Goose Property Area	5,427	4.0	0.4	9	<0.1	<0.1	316	0.2	<0.1	1,212	0.9	<0.1	1,824	1.3	0.1
MLA	653	0.5	0.1	-	-	-	-	-	-	-	-	-	12,367	9.2	1
Total	**6,080**	**4.5**	**0.5**	**9**	**<0.1**	**<0.1**	**316**	**0.2**	**<0.1**	**1,212**	**0.9**	**<0.1**	**14,191**	**10.5**	**1.1**

[1] *Some of the area of disturbance due to noise falls outside of the wildlife LSA but within the wildlife RSA.*

Table 9.5-9. Suitable Habitat for Waterbirds Disturbed and/or Abandoned outside of the Project PDAs due to Noise

Area	Suitable Habitat Available (ha)	Suitable Lost or Altered due to the Project PDAs		Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project Noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
		Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat
Local Study Area											
Waterbodies	22,600	906	4	0.7	< 0.01	59	0.3	253	1.2	167	0.8
Wetlands	24,142	1,478	6	1.8	< 0.01	55	0.2	219	1.0	290	1.3
Total	**46,742**	**2,384**	**5**	**2.4**	**< 0.01**	**114**	**0.3**	**472**	**1.1**	**456**	**1.0**
Regional Study Area											
Waterbodies	221,747	1,011	0.5	0.7	< 0.01	59	< 0.1	253	0.1	463	0.2
Wetlands	217,455	1,478	0.7	1.8	< 0.01	55	< 0.1	219	0.1	959	0.4
Total	**439,202**	**2,489**	**0.6**	**2.4**	**< 0.01**	**114**	**< 0.1**	**472**	**0.1**	**1,423**	**0.3**

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 9.5.2.1).*

Table 9.5-10. Suitable Habitat for Upland Birds Disturbed and/or Abandoned outside of the Project PDAs due to Noise

Area	Suitable Habitat Available (ha)	Suitable Lost or Altered due to the Project PDAs		Additional Area Functionally Lost[1] due to Blasting (120 dBA)		Additional Area Disturbed[1] due to Blasting (108 dBA)		Additional Area Disturbed[1] due to General Project Noise (45 dBA)		Additional Area Disturbed[1] due to Aircraft Noise (80 dBA)	
		Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat
Local Study Area											
Dry Upland	41,675	894	2	0.7	< 0.01	54	0.1	278	0.7	427	1.0
Moist to Wet Lowland	61,056	3,999	7	7.3	< 0.1	179	0.3	628	1.1	675	1.2
Total	102,732	4,894	5	8.0	< 0.1	233	0.2	906	0.9	1,102	1.1
Regional Study Area											
Dry Upland	449,263	895	0.2	0.7	< 0.01	54	< 0.1	278	0.1	1,071	0.2
Moist to Wet Lowland	542,692	4,009	0.7	7.3	< 0.01	179	< 0.1	628	0.1	2,440	0.5
Total	991,955	4,905	0.5	8.0	< 0.01	233	< 0.1	906	0.1	3,511	0.4

[1] *Habitat that is functionally lost or disturbed are based on the noise contours provided during the noise modelling (Volume 4, Chapter 2) for blasting (≥ 120 dBA for functionally lost habitat and ≥108 dB for disturbed habitat), general Project noise (≥ 45 dBA) and aircraft noise (≥ 80 dBA), and is calculated as the amount of habitat that falls outside of the Project PDAs which are assumed lost due to the Project footprint (Section 9.5.2.1).*

In total, 1,423 ha (0.3%) of suitable waterbird habitat and 3,511 ha (0.4%) of suitable habitat for upland birds is mapped within the area modeled as disturbed by aircraft noise (Tables 9.5-9 and 9.5-10). A very small amount of suitable habitat (7 ha of suitable waterbird habitat and 10 ha of suitable upland bird habitat; <0.01% of that available in wildlife LSA and wildlife RSA) occurs near the Goose PDA where intermittent aircraft noise and general Project noise are expected to overlap, representing the area where migratory birds may encounter multiple types of Project noise.

Noise Modelling to Evaluate Disturbance to Waterbirds Staging near Infrastructure

The effects of noise disturbance on migratory birds were also evaluated by determining whether noise thresholds are predicted to be exceeded at two lakes where waterbirds were observed during spring and fall migration. No exceedances of the 45 dB night time disturbance threshold, or disturbance thresholds due blasting noise were predicted at these two staging sites (Volume 4, Chapter 2). Aircraft noise will be 1 dB in excess of the 80 dBA threshold at the small wetland just outside of the Goose PDA, and thus this staging area will experience an intermittent and minor impact of sensory disturbance during aircraft take off and landings.

Summary of Evaluations of Disturbance to Migratory Birds

The effects of noise are predicted to be confined to the PDAs for nesting upland birds and waterbirds, which have already been evaluated as lost in the habitat lost section. Since only approximately 10% of the PDAs will be developed, it is likely that less than two flocks of waterbirds and less than 2% of the population of upland birds pairs in the wildlife LSA may experience visual disturbances especially from aircraft, and vibration disturbances from blasting within the PDAs. However, for this assessment, these effects are not considered as residual effects because the areas disturbed are already considered as lost.

However, a residual effect on migratory birds resulting from disturbance due to noise is still expected to occur, as a small, but measureable amount (~1%) of habitat outside of the PDAs is modeled as having elevated noise levels. Note that this is a conservative estimate of the area where migratory birds may be affected by noise. The area that is modeled as functionally lost or disturbed by noise outside the PDAs represents approximately 1% or less of the total habitat and suitable habitat available for migratory birds in the wildlife RSA. The largest amount of habitat that may be affected from a single noise source is not the mine itself, but is modeled as intermittent aircraft noise. In addition, aircraft noise may cause an extremely minor and infrequent disturbance to waterbirds staging to the south of the Goose Property.

9.5.2.3 Disruption of Movement

Lights on tall structures are known to attract migratory birds during their nocturnal migration, especially songbirds. Birds can become exhausted while circling lights, and can collide with lit structures resulting in mortality events (T. Longcore et al. 2013). Tall structures with lights will not be constructed for the Project. Thus, the Project is not expected to effect the movements of migratory birds.

9.5.2.4 Direct Mortality and Injury

Mortality and injury of migratory birds are evaluated due to strikes with ground vehicles and aircraft, and as a result of nest destruction from vegetation clearing during Project construction and operations.

The effect of mortality and injury due to vegetation clearing is expected to be eliminated as a result of mitigation measures for the Project. To ensure that nests of migratory birds are not destroyed, ground clearing will be conducted outside of the sensitive nesting periods for migratory birds. If construction cannot be scheduled outside of the nesting period, mitigation will be triggered and will include pre-clearing

surveys conducted by qualified biologists to locate nests of bird species in areas slated for clearing. Thus, mortality and injury of migratory birds is not expected to occur as a result of ground clearing.

Despite mitigation measures, some interactions of migratory birds with Project vehicles may be unavoidable, and thus the effects are evaluated in this section.

Waterbirds

To evaluate the potential effects of mortality on waterbirds, a zone of influence for aircraft was developed based on recommendations of the Canadian Wildlife Service. Based on this guidance, a flight impact zone was delineated within 3 km along each side and 5.4 km from the ends of the proposed airstrips. This area is intended to represent the area within which aircraft servicing the Project may be travelling below 450 m (1,500 ft) during landing or takeoff and potentially the area where the collision risk may be the highest. Strikes at lower elevations (< 150 m) more often occur with geese foraging along airstrips (DeVault et al. 2011). However, evidence suggest that waterbird-aircraft collisions occur most often at high altitudes at night when birds are migrating (Dolbeer 2006). Worldwide, strikes with aircraft cause significant mortality to waterbirds, and strikes of aircraft with waterbirds comprised the majority of bird-aircraft strikes reported by the US Air Force (Bird Strike Committee USA 2000 in Erickson, Johnson, and Young Jr 2005).

Because most waterbird species migrate at night, and at high altitudes, collisions of migrating waterbirds with aircraft servicing the Project are considered unlikely. Large concentrations of waterbirds were observed during baseline studies at only one site within the flight impact zone of Goose Property airstrip (Figure 9.1-1a). This site was identified as an area where goose species aggregated during the staging periods, and is a small shallow wetland just outside the Goose Property PDA (Figure 9.1-1a). No terrestrial staging areas occur within the flight impact zone associated with the MLA, as aircraft servicing the MLA will be landing on the water in Bathurst Inlet adjacent to the MLA and thus the majority of the flight impact zone will be located over marine habitat. The effects to disturbance to marine staging areas within Bathurst Inlet are assessed in Volume 7, Chapter 6.

Given mitigation measures to restrict flights over concentrations of migratory birds, no residual effect on waterbirds is predicted of direct mortality and injury resulting from interactions of waterbirds with aircraft servicing the project.

Upland Birds

Upland birds may be exposed to risk of mortality due to strikes with vehicles along Project roads. Strikes with ground vehicles account for the mortality of over a billion birds per year worldwide, mostly of small birds like passerines and other upland birds (Erritzoe, Mazgajski, and Rejt 2003; Erickson, Johnson, and Young Jr 2005). Mortality rates of birds due to vehicle strikes increase with traffic volume and speed (Erritzoe, Mazgajski, and Rejt 2003).

Strikes of upland birds with Project ground vehicles are expected to occur very rarely. During three years of wildlife monitoring at the Hope Bay Mine (2010 to 2012), only four bird mortalities (three songbirds and one ptarmigan) were recorded, likely as a result of vehicle strikes (Rescan 2011b, 2011a, 2013f). Less than 30 km of all-weather roads will be constructed for the Project, traffic volumes will be relatively low and speeds limited to 60 km/h. No migratory birds except ptarmigan will be present in the wildlife RSA during winter. Ptarmigan may be susceptible to mortality risk due to traffic on the winter roads, but road and traffic mitigation actions are expected to eliminate this effect. Thus, no residual effect of Project traffic on migratory birds is expected.

With the application of mitigation plans, no residual effect of direct mortality and injury is predicted for migratory birds.

9.5.2.5 Indirect Mortality

Wildlife mortality may indirectly result from the Project if hunting is facilitated by easier access to game species along the proposed road. Increased hunter access to the wildlife RSA due to the Project would be only possible when the winter road is active during the winter months, when only ptarmigan are present in the wildlife RSA. Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Project area (Volume 8, Chapter 3). Road access will be restricted to Project employees, who will not be permitted to hunt. Thus, hunting of ptarmigan is unlikely, and therefore, indirect mortality of migratory birds due increased hunter access is not anticipated to occur.

Indirect mortality can also occur through increased rates of nest predation. Research has shown that the abundance of some nest predators of migratory birds—the Arctic and red fox, gulls, and the common raven—may be enhanced near industrial projects. Infrastructures and human wastes provide supplemental food, as well as structures for nesting and denning (reviewed in Liebezeit et al. 2009). Developments can also serve as a refuge to foxes from wolves, which prey upon and compete with foxes.

Previous research has not found population-level effects of Arctic developments on waterbird reproduction (Truett, Miller, and Kertell 1997), however, researchers have not tested for localized effects of augmented predator populations and the resultant effect on predation rates. Higher predation rates on songbird nests were found close to infrastructures in Prudhoe Bay, Alaska (Liebezeit et al. 2009). Despite low detection rates of foxes in bird surveys (gulls and jaegers comprised 80% of detections of nest predators) at Prudhoe Bay Alaska, most nests were predated by Arctic foxes (Liebezeit and Zack 2008).

Mitigation to reduce the possibility for indirect mortality will include proper waste management, and measures to exclude nesting and denning of bird and mammalian nest predators from Project infrastructure.

Quantification of Indirect Mortality Effects on Migratory Birds

Between 2002 and 2005, research within the oil fields of Prudhoe Bay Alaska found relatively high predation rates on songbird nests within 300 m of infrastructure, despite the introduction of waste management standards. No effects on nest predation of shorebirds and waterbirds were found, but this may have been due to low sample sizes (Liebezeit et al. 2009). Based on this research, nest predation rates close to Project infrastructure were used to evaluate effects of indirect mortality. Estimates for nest predation rates for songbirds were used to evaluate nest predation rates for shorebirds and waterbirds, due to the absence of reliable estimates for these two species groups.

Evaluation of Indirect Mortality Effects on Migratory Birds

Based on the findings of Liebezeit et al. (2009), it is expected that the probability of predation of migratory bird nests may increase to 68% within 300 m of Project infrastructure, relative to a background rate of 17% at least 6 km away. Because indirect mortality effects are anticipated to be limited to the two PDAs, and the residual effect of the loss of these areas has already been assessed in Section 9.5.2.1, no residual effect of indirect mortality is predicted for migratory birds with the PDAs.

9.5.2.6 Attraction

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Attractants may include physical structures that provide habitat, or artificial waterbodies that tend to be warmer than surrounding natural ponds and lakes.

Waterbirds

Migrating waterbirds use bodies of water that open relatively early in the Arctic (Section 9.1.2.1), and thus waterbirds may be attracted to the tailing storage area (TSF) or any open pits used as water storage areas. Numerous studies have documented the use by waterbirds of artificial waterbodies associated with mines, such as sewage and tailings ponds (Read 1999 and citations therein). In some cases, mortality of waterbirds has occurred as a result of exposure to contaminants in waterbodies (Ryan and Shanks 1996; Read 1999; Donato et al. 2007).

There will be no sewage ponds generated for the Project; instead water from the Sewage Treatment Plant will be discharged to the land during Project construction, and to the TSF and other water storage areas during operation. If water quality in Project ponds does not meet water quality guidelines for wildlife, appropriate management will be conducted to exclude birds from these areas (e.g., air cannons). The effectiveness of deterrent systems will be monitored and adaptively managed if they are not successful. No residual effects of contaminants on waterbirds are anticipated due to the Project (Section 9.5.2.7). With the application of mitigation measures, no residual effect of attraction to waterbodies associated with the Project is anticipated for waterbirds.

Upland Birds

The densities of some species of upland birds have been found to be higher near Arctic infrastructure and within urban areas relative to undisturbed sites (e.g., horned larks, semipalmated plover, white-crowned sparrows; Staniforth 2002; Male and Nol 2005; Smith et al. 2005). This result has been found for species that generally prefer open or gravelled habitats. This finding suggests that a small portion of the upland bird community may be attracted to the areas close to the Project footprints for establishment of breeding territories. It is likely that attracted birds will use Project infrastructure as habitat (e.g., elevated sites for perching and singing). Due to the possibility for higher nest predation rates close to infrastructure (Section 9.5.2.5), lower breeding productivity may result for breeding pairs attracted to Project infrastructure for territory establishment. This effect is evaluated in Section 9.5.2.8.

Some forms of lighting attracts migratory birds, which can lead to avian collisions and deaths (Kerlinger 2000; Erickson, Johnson, and Young Jr 2005; Manville II 2008; T. Longcore et al. 2013). External lighting will be unlikely to have effects on migratory birds, however, due to the long photoperiod during the summer and consequent little use of external lighting during the summer. Therefore, lighting at the Project is not expected to cause a residual effect of attraction on upland birds.

It is anticipated that a small number of birds that are attracted to Project infrastructure may experience mortality and injury. Over three years of monitoring at the Hope Bay mine, only four mortalities were reported of upland birds that had become trapped in infrastructure (Rescan 2011a, 2011b, 2013f). This effect will be minimized by mitigation measures to limit access to infrastructure by birds and to remove nesting material prior to egg-laying. With the application of mitigation activities, no residual effect on upland birds is predicted to occur as a result of their attraction to Project infrastructure and activities.

9.5.2.7 Exposure to Contaminants

Exposure to contaminants in migratory birds due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6). This assessment evaluated the hazard quotients of potential contaminants and compared predicted concentrations of potential contaminants with the range of baseline values. Results of this assessment indicated that all contaminant hazard quotients in soils and surface waters were either less than one or concentrations are predicted to be within the range of baseline. Therefore, risks to migratory birds are considered to be negligible. Thus, a residual effect due to exposure to contaminants in migratory birds is not anticipated and is not considered further in the assessment.

9.5.2.8 Reduction in Reproductive Productivity

Reproductive productivity is quantified as the number of surviving young produced per year per female. The combined effects of habitat loss, disturbance, and indirect mortality may result in declines in the breeding productivity of migratory birds. Migratory birds will most likely be affected by the Project through disturbances that result in habitat avoidance, and higher nest predation rates due to the attraction of foxes and other predators to the Project area. Each effect individually or synergistically could result in lower reproductive productivity.

Because disturbance and indirect mortality effects are anticipated to be limited to the two PDAs, and the residual effect of the loss of these areas has already been assessed in Section 9.5.2.1, no residual effect of reduced reproductive productivity is predicted for migratory birds with the PDAs.

9.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10 Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including migratory birds. In addition, a number of other mitigation and management measures will be in place to minimize potential Project-related effects to the environment, and are included in Volume 10.

A residual effect of the Project on migratory birds is anticipated resulting from habitat loss and disturbance. The following sections describe the mitigation and management measures that will be conducted to minimize or eliminate potential Project-related effects to migratory birds. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this potential effect.

9.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to migratory birds may include the following:

- Project infrastructure designed to avoid, where possible, the locations of identified waterbird staging areas (Volume 10, Chapter 20);
- the TSF located to avoid sensitive areas used by migratory birds such as staging and breeding areas (Volume 2, Chapter 2); and
- winter road access corridors only (no all-weather roads for re-supply routes), to minimize effects of habitat lost to all migratory bird species, except ptarmigan which over-winter in the wildlife RSA (Volume 2, Chapter 2).

9.5.3.2 Mitigation for Disturbance

The primary mitigation and management strategies to minimize the effects of disturbance to wildlife are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement for Wildlife program (Volume 10, Chapter 20). Additional wildlife specific measures to minimize the effect of disturbance to migratory birds may include:

- pre-determined flight paths, where possible, to provide horizontal and vertical buffer distances between flight paths and sensitive habitats (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible, wherever wildlife species are observed (Volume 10, Chapter 20).

9.5.3.3 Mitigation for Mortality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to wildlife are addressed in the Project Description (Volume 2, Chapter 2), the WMMP Plan (Volume 10, Chapter 20) and the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to migratory birds may include:

- pre-construction ground clearing conducted outside of sensitive nesting periods for migratory birds. If construction cannot be scheduled outside of sensitive nesting periods, qualified biologists will conduct pre-clearing surveys for migratory birds and nests (Volume 10, Chapter 20);
- truck speed limits developed, signage installed to alert drivers of speed limits, and enforcement of speed limits to reduce vehicle-related mortality and injury to migratory birds (Volume 10, Chapter 20).

9.5.3.4 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize the effects of indirect mortality to wildlife are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Measures to minimize the effect of mortality and injury specific to migratory birds may include:

- buildings designed and maintained to exclude wildlife from entering for nesting and denning (Volume 10, Chapter 20);
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20).

9.5.3.5 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of wildlife attraction to the Project are described in the Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10, Chapter 11), the Borrow Pits and quarry Management Plan (Volume 10, Chapter 16), and the program of waterbird monitoring at ponds detailed in the WMMP (Volume 10, Chapter 20). The following mitigation measures and best management practices may be applied to minimize the effects of attraction specific to migratory birds:

- buildings designed and maintained to exclude wildlife (Volume 10, Chapter 20);
- no sewage ponds created (Volume 2, Chapter 2);
- a waste management protocol developed to ensure wildlife do not have access to camp wastes, contaminated areas, and attractants (Volume 10, Chapter 20);
- monitoring of water quality and waterbird usage of Project ponds and exclusion of waterbirds should water quality monitoring show that water quality can pose a health risk for waterbirds (Volume 10, Chapter 20);
- lighting directed into facilities and toward the ground whenever possible (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation and enforced (Volume 10, Chapter 20); and
- a policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced (Volume 10, Chapter 20).

9.5.3.6 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to migratory birds.

Mitigation and management measures have also be proposed in order to minimize the potential for effects to wildlife from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20). These measures may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TSF (Volume 2, Chapter 2);
- monitoring of water quality and waterbird usage of Project ponds and exclusion of waterbirds should water quality monitoring show that water quality can pose a health risk for waterbirds (Volume 10, Chapter 20);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10, Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

9.5.4 Characterization of Residual Effects

Residual effects are those effects predicted to remain after the application of mitigation and management. The Project is not expected to result in a residual effect on migratory birds due to disruption of movement, direct and indirect mortality, or attraction. Two potential effects were predicted to have residual effects after mitigation: habitat loss and disturbance. These effects are assessed for their significance in the sections following.

9.5.4.1 Habitat Loss

Waterbirds

The effect on waterbirds of habitat loss as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because only 0.6% of waterbodies and wetlands available in the wildlife RSA will be affected. Though habitat loss is likely and irreversible, it will be mitigated through closure planning, and this effect will be ameliorated by the relatively large amounts of habitat available in the wildlife RSA. The effect of direct habitat loss on waterbirds will occur sporadically over the long term, but will be limited to the Project footprint. Thus, the residual effect of direct habitat loss is expected to be Not Significant. Confidence is this assessment is high, because relatively few waterbirds and no key staging sites were observed within the PDAs during baseline studies, relatively few waterbirds are expected to experience habitat loss due to Project development.

Upland birds

The effect of habitat loss on upland birds, as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because only 0.5% of habitat available in the wildlife RSA will be affected. Though habitat loss will be irreversible, it will be mitigated through closure planning, and this effect will be ameliorated by the relatively large amounts of habitat available in the wildlife RSA. The effect of direct habitat loss on upland birds will occur sporadically over the long term, but will be limited to the Project footprint. Thus, the residual effect of direct habitat loss is expected to be Not Significant. Confidence is this assessment is high, because direct habitat loss is expected to occur within approximately 10% of the PDAs, causing displacement of an estimated 617 breeding pairs of the 842 ± 61 pairs within the two PDAs, which represents 0.5% of the estimated population size within the wildlife RSA.

9.5.4.2 Disturbance

Waterbirds

The effect on waterbirds of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because the amount of habitat modeled as functionally lost or disturbed outside of the PDAs is less than 1% of the suitable habitat available within the wildlife RSA. The largest source of noise is predicted to be aircraft, not the mine site itself. Disturbance effects will be mitigated with flight altitude rules and flight paths to avoid large concentrations of waterbirds. Disturbance outside the PDAs is likely to occur sporadically over the medium term within the local extent of the Project. Disturbance effects will likely be reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because baselines studies showed only one key staging site within disturbed areas outside the PDAs, and studies elsewhere found no measurable effects on the movements or

distribution of waterbirds due to disturbances from industrial developments and activities (Truett, Miller, and Kertell 1997; S. R. Johnson 1998).

Upland Birds

The effect on upland birds of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because the amount of habitat modeled as functionally lost or disturbed outside of the PDAs is less than 1% of the suitable habitat available within the wildlife RSA. The largest source of noise is predicted to be aircraft, not the mine site itself.. Disturbance effects will be mitigated with flight altitude rules and flight paths. Disturbance outside the PDAs is likely to occur sporadically over the medium term within the local extent of the Project. Disturbance effects will likely be reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because studies elsewhere have found few effects of Artic developments on upland birds outside of a 300 m zone of influence (Male and Nol 2005; Smith et al. 2005), which is encompassed within the two PDAs which were assessed as lost habitat.

9.5.5 Significance of Residual Effects

Considering the Project and the distribution of migratory birds within the wildlife RSA, the assessment of residual effects resulted in a Not Significant rating for the two residual Project effects (Tables 9.5-11 and 9.5-12):

- Direct Habitat Loss, rated Not Significant;
- Disturbance, rated Not Significant.

Contingent on the implementation of mitigation measures outlined in the WMMP Plan (Volume 10, Chapter 20), the combined significance of residual effects for migratory birds is predicted to be **Not Significant** (Tables 9.5-11 and 9.5-12).

9.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

9.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities. The cumulative effect assessment (CEA) general methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

Table 9.5-11. Summary of Residual Effects Assessment for Waterbirds Resulting in Overall Significance Rating

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effects	**Direction** *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**(Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*)
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	High	**N**
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Likely	High	**N**

Table 9.5-12. Summary of Residual Effects Assessment for Upland Birds Resulting in Overall Significance Rating

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effects	**Direction** *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	High	**N**
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Likely	High	**N**

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other project and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's potential incremental contribution to the potential cumulative effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Table 9.5-2). Magnitude ratings for cumulative effects were based on the same criteria used to rate the magnitude of Project-related effects (Section 9.5.1.2) with the exception that for habitat-based indicators, values were compared to the amount of habitat available within the CEA boundary.

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 9.5.1.3). The only exception is for the attribute "geographic extent" whereby the definitions are related to the CEA boundary and not the wildlife RSA.

9.6.1.1 Spatial Boundary

The CEA boundary is different for each VEC species for which a CEA assessment was conducted because it was based on knowledge of each species' movement patterns and home range size.

9.6.1.2 Temporal Boundary

The temporal boundaries used for the cumulative effects assessment are the timescale of past, present, and reasonably foreseeable future projects as described in Volume 9, Chapter 1.

9.6.2 Potential Interactions of Residual Effects with Other Projects

Residual effects of the Project on migratory birds are predicted for habitat loss and disturbance (Section 9.5.2, Tables 9.5-11 and 9.5-12). Most residual Project effects on waterbirds and upland birds are expected to result from habitat loss.

To determine the potential for cumulative effects on migratory birds, it was determined whether migratory birds expected to interact with the Project are likely to regularly interact with nearby past, existing and future projects during spring, summer, and fall when they occur on the tundra. The zone of influence of the Project on migratory birds was assumed to be limited to within the two PDAs (Section 9.5.2).

The nearest project to the Goose Property is the proposed George project, located approximately 62 km to the northwest of the Goose Property. The George project was included in the Back River DEIS as a part of the Back River Project, but is considered in the FEIS as a reasonably foreseeable project. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the Exploration Camp. The George project, should it proceed, will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned

for the George project. The closest project to the MLA is the Proposed Bathurst Inlet Port and Road (BIPR) project, a proposed all-weather road 75 km from the Goose Property, with a port site approximately 15 km from the MLA (Volume 9, Table 1.3-1).

Both the George and the Bathurst Inlet Port and Road projects are located outside the zone of influence of the Project PDAs. Thus, no cumulative effects of the Project on migratory birds are expected to occur, because it is expected that migratory birds interacting with the Project will not regularly interact with other nearby projects.

9.7 TRANSBOUNDARY EFFECTS

All Project residual effects were confined to the wildlife LSA, and there were no residual cumulative effects. The wildlife LSA lies completely within Nunavut, therefore no transboundary effects are expected.

9.8 MITIGATION AND ADAPTIVE MANAGEMENT

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the wildlife mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including migratory birds. Mitigation measures specific to migratory birds are listed in Section 9.5.3 and summarized in Section 9.8.5, Table 9.8-1.

In addition, mitigation and management plans will be in place to minimize potential effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including migratory birds. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2 — the Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1 — the Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incineration Management Plan can be found in Volume 10, Chapter 11; and
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7 — the Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Environmental Management Plan: Chapter 1.
- Environmental Protection Plan: Chapter 2.
- Risk Management and Emergency Response Plan: Chapter 3;
- Fuel Management Plan: Chapter 4;
- Spill Contingency Plans: Chapter 5;
- Oil Pollution Emergency Plan: Chapter 6;
- Site Water Monitoring and Management Plan: Chapter 7;
- Ore Storage Management Plan: Chapter 8;

- Mine Waste Rock Management Plan: Chapter 9;
- Waste Management Plan: Chapter 10;
- Hazardous Materials Management Plan: Chapter 12;
- Explosives Management Plan: Chapter 13;
- Road Management Plan: Chapter 14;
- Shipping Management Plan: Chapter 15;
- Borrow Pits and Quarry Management Plan: Chapter 16;
- Fish Offsetting Plan: Chapter 21;
- Tailings Management Plan: Chapter 22;
- Socio-economic Monitoring Plan: Chapter 23; and
- Mine Closure and Reclamation Plan: Chapter 29.

9.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of water bird staging sites. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 9.8-1 in Section 9.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on migratory birds.

9.8.2 Best Management Practices

The WMMP Plan (Volume 10, Chapter 20) includes eleven sections of the WMMP plan designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to migratory birds are listed in Section 9.5.3, and in Table 9.8-1 in Section 9.8.5.

9.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP Plan (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and available. The WMMP Plan may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or

- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The WMMP Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

9.8.4 Monitoring

As part of the WMMP Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring — facility-specific monitoring and focal species monitoring.

9.8.5 Summary Table of General Wildlife Mitigation and Adaptive Management Measures

Table 9.8-1 includes all planed mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on migratory birds.

Table 9.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife — including Migratory Birds

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	1. Project infrastructure designed to avoid, where possible, the locations of identified waterbird staging areas. 2. Infrastructure designed to minimize the Project footprint. 3. Winter road access corridors only (no all-weather roads for re-supply routes). 4. All-weather roads restricted to PDAs. 5. Use of large haul trucks for ore and waste transport to minimize the number of trips required between the source and destination. 6. The preferred Tailings Storage Facility (TSF) located to avoid sensitive areas used by migratory birds such as staging and breeding areas (Volume 2, Chapter 2). 7. No sewage ponds created. 8. Buildings designed and maintained to exclude wildlife. 9. WAD cyanide destruction inside the mill.
2. Best Management Practices	1. Pre-construction ground clearing may be conducted outside of sensitive periods for migratory birds. 2. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining a minimum prescribed altitude, when possible. 3. Vehicles restricted to site roads, winter roads and quarry footprints during Construction and Operations. 4. Truck speed limits used, signage installed to alert drivers of speed limits, and speed limits enforced. 5. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic. Road use restricted only to persons required for Project construction, operations and maintenance. 6. A waste management protocol in place.

(continued)

Table 9.8-1. Summary of Mitigation and Management Measures Applicable to Terrestrial Wildlife — including Migratory Birds (completed)

Mitigation Category	Mitigation Measures
2. Best Management Practices *(cont'd)*	7. Lighting directed into facilities and toward the ground, whenever possible. 8. A policy of no feeding and no intentional attraction of wildlife developed, and disseminated to all Project and contractor employees during employee orientation, and enforced. 9. A policy of no littering developed and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced. 10. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to the health of migratory birds. 11. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures. 12. Excluding waterbirds from Project ponds if water quality monitoring indicates that water quality may pose a health risk for waterbirds and waterbirds are present in the ponds.
3. Adaptive Management	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may include: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife. 2. The Wildlife Effects Monitoring Plan (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.
4. Monitoring	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This plan will include several mitigation measures relevant to migratory birds including:: 1. footprint monitoring to monitor habitat loss; 2. human activity monitoring of Project site roads and winter roads; 3. pre-clearing surveys for nests to identify active bird nests (raptor, waterbirds, and upland bird) at risk of disturbance from vegetation clearing; 4. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes; 5. infrastructure monitoring to record the status of wildlife exclusion measures, such as skirting and fencing; 6. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; 7. incidental wildlife reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible; 8. noise monitoring to monitor disturbance to wildlife; 9. monitoring of water quality in Project ponds; and 10. if water quality monitoring indicates that water quality may pose a health risk for waterbirds, then Project ponds will be monitored for waterbird use. Focal-species monitoring program to monitor Project-related effects on migratory birds within a zone of influence of the PDAs, in comparison reference areas. 1. Aerial and/or ground surveys for migratory birds to document Project-related changes in the distribution of migratory birds in the wildlife RSA.

9.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to migratory birds are summarized in the following sections.

9.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife effects include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10, Chapter 20):

- Footprint Monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Nests;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Skirting/Fencing Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA;

- Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds; and
- Pre-construction Surveys for Bear Dens.

The objective of pre-clearing surveys for nests is to identify active nests of migratory birds that may be at risk of disturbance from vegetation clearing. Site clearing is planned for outside of bird sensitive periods; pre-clearing surveys may be conducted if some clearing is scheduled during bird nesting periods. If bird nesting activity is identified in areas slated for clearing, pre-clearing surveys will be used to:

- document birds nesting in areas slated for clearing;
- document locations and habitat where active nesting is occurring; and
- identify opportunities for protecting established nests using a reduced work buffer.

9.9.2 Focal-species Monitoring of the WEMP

As a component of the WEMP, migratory birds will be monitored on a yearly basis during Project construction and every two years during operations (Volume 10, Chapter 20). Staging areas for waterbirds will be monitored from the air to identify important areas and to determine whether the Project is resulting in changes in the distribution of staging waterbirds. From the ground, the breeding productivity of the waterbird population within a zone of influence of the Project will be monitored and compared to breeding productivity within reference sites.

The relative abundance and species composition of the upland bird community may be monitored using a combination of PRISM and point count surveys. Surveys will be conducted within a zone of influence of the Project, and within reference areas. Baseline data will be integrated into the analyses to derive statistical tests for Project effects on the migratory bird community.

9.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the construction and operation of the Project. These eight potential effects are: loss of habitat, disturbance, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of migratory birds was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on migratory birds resulted in the evaluation of two potential effects as likely having residual effects after mitigation: habitat loss and disturbance. Each of these effects are rated with a low magnitude and are rated as Not Significant, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20).

Disruption of movement is not anticipated to result from the interactions of migratory birds with the Project. Direct mortality and injury, attraction to infrastructure, and exposure to contaminants are not anticipated to result in a residual effect upon implementation of mitigation measures. Based on empirical research in the western Arctic (Liebezeit et al. 2009), the effect of indirect mortality via nest predation due to the attraction of nest predators to Project infrastructure is expected to be limited to within approximately 300 m of Project infrastructure. In addition to the majority of disturbances, the effects of indirect mortality are expected to be contained within the PDAs. Thus, the synergistic effects of disturbance and indirect mortality resulting in reduced reproductive productivity are also expected to be confined to the PDAs. Because the PDAs were assessed as lost, indirect mortality and reduced reproductive productivity are not anticipated to result in a residual effect on migratory birds.

Relative to disturbance effects, the effect of habitat loss is expected to result in the largest residual effect on the migratory bird community within the wildlife RSA. This magnitude of this effect is rated low for waterbirds and upland birds. Disturbance effects are primarily expected to occur to staging waterbirds during the migration period as a result of aircraft servicing the Goose Property Area. Mitigation measures which will include restrictions of flight altitudes to above 650 m from large concentrations of migratory birds will minimize this effect. However, it is expected that weather and other factors may require lower altitude flights, which may cause disturbance to waterbirds. Ongoing monitoring as part of the WEMP will determine the magnitude of disturbance effects, and whether further mitigation measures are needed. Overall, Project effects on migratory birds are rated as **Not Significant**.

It is expected that migratory birds interacting with the Project will not regularly interact with the two foreseeable future project located in the wildlife RSA (the George and BIPR projects), and thus cumulative effects of the Project on migratory birds are not expected to occur.

10. Raptors

Sabina
GOLD & SILVER CORP.

10. Raptors

10.1 EXISTING ENVIRONMENT AND BASELINE INFORMATION

10.1.1 Introduction

Arctic raptors can be divided into two guilds based on migration and nesting patterns. The gyrfalcon, snowy owl, and common raven are Arctic residents that overwinter in the Arctic. All other species migrate south in the fall and return in the spring to breed. Arctic-breeding raptors nest either on steep faces of rock outcrops, or on the ground. Bald eagles (*Haliaeetus leucocephalus*), which have been observed in the wildlife Regional Study Area (RSA), nest in both types of habitat at more southerly latitudes, but so far there have been no confirmed records of bald eagles breeding on the tundra.

Baseline studies have confirmed that four species of cliff-nesting raptors regularly breed in the wildlife RSA: peregrine falcon (*Falco peregrinus tundrius*), gyrfalcon (*Falco rusticolus*), rough-legged hawk (*Buteo lagopus*), and golden eagle (Aquila chrysaetos; Rescan 2012a, Appendix V5-5D; 2013f, Appendix V5-5C; 2014, Appendix V5-5F). Common ravens (*Corvus corvax*) which are considered to be 'functional raptors' also breed in the wildlife RSA (Rescan 2012a, Appendix V5-6D; 2013f, Appendix V5-6C; 2014, Appendix V5-5F) and are thus included in this assessment. Common ravens use similar food and breeding resources as cliff-nesting raptors, and construct stick nests that are used by raptor species for nesting (Poole and Bromley 1988; Poole 2011).

Three ground-nesting raptor species were observed in the wildlife RSA: snowy owl (*Bubo scandiacus*), short-eared owl (*Asio flammeus*), and northern harrier (Circus cyaneus; Rescan 2012a, Appendix V5-5D; 2013f, Appendix V5-5C; 2014, Appendix V5-5F). One short-eared owl nest was found within the wildlife RSA; breeding within the wildlife RSA was not confirmed for the other two ground-nesting species. Ground-nesting species were detected infrequently during baseline studies, likely because these species occur rarely within the wildlife RSA. Snowy and short-eared owls naturally occur at low densities, while northern harriers within the wildlife RSA represent individuals at the extreme northern limit of the species' range (Parmelee 1992; Wiggins, Holt, and Leasure 2006; Smith et al. 2011).

10.1.2 Population Trends and Conservation

Raptors are protected under the *Nunavut Wildlife Act* (2003) and the *Canada Wildlife Act* (1985; on National Wildlife Refuges and Migratory Bird Sanctuaries). Though most raptors are long distance migrants, raptors are not protected under the *Canadian Migratory Bird Convention Act* (1994).

Four cliff-nesting species and one ground-nesting species are of conservation concern. Golden eagle, gyrfalcon, and rough-legged hawk are listed as "Sensitive" in Nunavut by the Canadian Endangered Species Conservation Council (CESCC). Peregrine falcon, *tundrius* subspecies, while listed as Secure in Nunavut by the CESCC (2010), is federally listed on Schedule 1 as a population of Special Concern under *SARA* (Government of Canada 2015). The ground-nesting short-eared owl is also listed as Sensitive in Nunavut and is listed on Schedule 1 as a species of Special Concern under *SARA* (CESCC 2010; Government of Canada 2015).

As top predators in the food chain, raptors can bio-accumulate environmental toxins (Newton 1995). Hatching failure of eggs with thin shells caused population crashes in some raptor species globally, which led to worldwide banning of DDT organochlorine pesticides (Newton 1995). Species such as the peregrine falcon *tundrius* subspecies declined dramatically in the 1970s as a result of bio-accumulation

of toxins like DDT (Hickey and Anderson 1968). The estimated 1,500 to 2,000 pairs currently occurring in the Canadian Arctic is similar to pre-collapse numbers, indicating that the subspecies has recovered (COSEWIC 2007). However, the population is relatively small, making *tundrius* peregrine falcons vulnerable to natural and human disturbances.

Golden eagle populations are relatively stable in Canada and Alaska but declining elsewhere, whereas bald eagle populations appear to be increasing in the Arctic (Buehler 2000; Kochert and Steenhof 2002).

There is no evidence that the abundance of North American populations of gyrfalcons and rough-legged hawks have changed over the long term (Bechard and Swem 2002; Booms, Cade, and Clum 2008). However, local populations of both species are known to fluctuate in response to weather, and to prey availability, particularly where these species specialize on prey that show strong cyclical trends in abundance (Gunn 2003; Barichello and Mossop 2011). Gyrfalcon reproductive productivity and population abundance is strongly tied to 3-4 year cycles in abundance of ptarmigan, which form the majority of their prey early in the breeding season (Barichello and Mossop 2011; Nielsen 2011). Similarly, the reproductive performance of rough-legged hawks at Bathurst Inlet was positively correlated with the abundance of lemmings (Poole and Bromley 1988), which typically have a population cycle of high to low abundance every three to four years (Krebs 1964).

Similar to the rough-legged hawk, Arctic populations of ground-nesting raptors are known to fluctuate cyclically in response to the abundance of lemmings and other small mammals (Parmelee 1992; Wiggins, Holt, and Leasure 2006). In addition to cyclical fluctuations, the short-eared owl has shown a widespread declining trend in North America since the 1970s (COSEWIC 2008). Canadian populations of the short-eared owl appear to have decreased by 43% from 1966 to 1989 (GNWT ENR 2012), and by 23% over the past decade (COSEWIC 2008). The snowy owl was designated as Not at Risk by COSEWIC in 1995 because this species is widespread and there is no evidence of population declines. Approximately 30,000 pairs of snowy owls occurred in Canada in the early 1900s (Kirk, Hussell, and Dunn 1995); current population trends for the wildlife RSA are unavailable.

10.1.3 Distribution and Migration Patterns

During the breeding season, cliff-nesting raptors are distributed throughout the Arctic in areas where steep cliffs provide suitable habitat for breeding. The cliffs along Bathurst Inlet may be an area of high quality raptor habitat, indicated by a high density of peregrine falcon nests (data from the Northwest Territories and Nunavut Raptor Data Base (COSEWIC 2007). Inuit Traditional Knowledge (TK) has identified two areas along the eastern shore of Bathurst Inlet where cliff-nesting raptors are known to breed (KIA 2012); one of these areas is within the wildlife RSA.

Of the four cliff-nesting raptor species that regularly breed in the Project area, three species (golden eagle, peregrine falcon, and rough-legged hawk) are long-distance migrants and leave the Arctic to over-winter at more southern latitudes, although TK input suggested that the rough-legged hawk stay in winter (KIA 2014). These species typically arrive in May, and initiate egg-laying soon thereafter and then leave in October (Poole and Bromley 1988). The golden eagle and rough-legged hawk have a holarctic distribution, and are found in North America and Eurasia (Bechard and Swem 2002; Kochert et al. 2002), while the peregrine falcon is widely distributed across the globe from the Arctic to the tropics (White et al. 2002).

The gyrfalcon and common raven migrate short or long distances, but both species spend the winter in the Arctic (KIA 2014). Some gyrfalcon populations make short movements between breeding cliffs and wintering areas, while some populations migrate thousands of kilometers over the Arctic ocean to ensure access to abundant prey during winter (Burnham and Newton 2011). Because they spend the

winter in the Arctic, gyrfalcons and common ravens initiate breeding earlier than the other raptor species, usually beginning in April, though clutch initiation has been observed as early as late March (Poole and Bromley 1988; Barichello and Mossop 2011).

Like migratory cliff-nesting raptors, the ground-nesting short-eared owl and northern harrier typically arrive on the tundra from southern latitudes in May, and leave before late October. The short-eared owl is found throughout the Eastern and Western hemispheres (Wiggins, Holt, and Leasure 2006), and the northern harrier is widely distributed in North and Central America and the Caribbean (Smith et al. 2011).

Snowy owls are both migratory and resident species – some individuals migrate south for the winter, and some over-winter in the Arctic, especially in years when prey are abundant (Therrien, Gauthier, and Bety 2011). Inuit TK includes observations of snowy owls and common ravens occurring in the Project region in winter (KIA 2012, 2014). Recent satellite tracking has revealed that over-wintering snowy owls migrate across the sea ice to access prey, such as seabirds using open water areas (Therrien, Gauthier, and Bety 2011). Snowy owls are distributed around the world throughout the northern hemisphere (Parmelee 1992).

In winter, gyrfalcons and snowy owls migrate to open water areas during winter to access marine resources, and therefore are expected to occur in low densities in the wildlife RSA in winter (Burnham and Newton 2011; Therrien, Gauthier, and Bety 2011).

10.1.4 Habitat Use and Diet

According to scientific research and Inuit Traditional Knowledge, cliff-nesting raptors in the Arctic select sites on cliffs and rocky outcrops for nesting, which occurs from April through August (Poole and Bromley 1988; KIA 2012, 2014). To provide protection from mammalian predators, nests are usually located on steep ledges at heights that make the ledges inaccessible from the bottom or top of the cliff. Cliffs also provide protection from the weather – the majority of raptors across all cliff-nesting species select south-facing cliffs within the wildlife RSA, probably because these are warmer (Poole and Bromley 1988; Rescan 2013f, Appendix V5-5C). Overhang is an important habitat characteristic for gyrfalcons and common ravens, because they initiate breeding early in the year, when weather can limit breeding productivity (Poole and Bromley 1988; Cade and Bird 2011). The availability of high quality cliff sites is likely an important determinant of breeding success, indicated by occupancy of the same cliff sites by breeding raptors for millennia (Sinclair et al. 2003; Burnham, Burnham, and Newton 2009).

Peregrine falcons and gyrfalcons do not construct nests, but instead make ‘scrapes’ of exposed soil on cliff ledges, or lay eggs in stick nests constructed by other species, frequently those of common ravens (Burnham, Burnham, and Newton 2009). Rough-legged hawk pairs usually build a new nest each year on exposed cliff ledges with little overhang (Poole and Bromley 1988), whereas golden eagles add to existing nests each year, such that their nests are usually distinguishable as a thick platform of sticks (Kochert et al. 2002).

Cliff-nesting raptors in the Arctic can be divided roughly into diet specialists and generalists, dependent on both the availability of prey and the selectivity of raptors for certain prey. The diet of rough-legged hawks is comprised almost entirely of lemmings and voles in years when these are abundant, whereas rough-legged hawks consume a wider range of prey when small mammals are scarce (Bechard and Swem 2002). Similarly, due to the timing of prey availability, the diet of gyrfalcons is comprised almost entirely of ptarmigan during winter and early spring; ptarmigan and Arctic hare comprise the majority of their diet during brood-rearing (Barichello and Mossop 2011). Peregrine falcons actively select birds as prey, primarily birds small enough for them to capture in flight, which on the tundra are mostly passerines, shorebirds, and ptarmigan (White et al. 2002).

Golden eagles consume primarily ground squirrels, Arctic hare, and ptarmigan but are considered to be prey generalists relative to other raptor species in the Arctic (Poole and Bromley 1988; Mcintyre and Schmidt 2012). Common ravens, golden eagles, and bald eagles on the tundra will also feed on carcasses of animals killed by mammalian carnivores (Sellers et al. 2003).

Raptors can make long distance movements from nests to search for food during the breeding season (e.g., up to approximately 50 km), but more typically forage within about 12 km from nest sites (Table 10.1-1). Thus, in addition to suitably tall and steep cliffs that provide protection from weather and exposure to the sun, raptors also select nest sites within habitats that provide abundant prey. For example, peregrine falcons more often hunt from a perch location, and need good 'look-outs' over areas such as wetlands with abundant small birds (White et al. 2002).

Table 10.1-1. Average Home Range Size of Cliff-nesting Raptor Species

Species	Breeding Home Range (ha)	Maximum Breeding Home Range Radius (km)	Average Foraging Distance during Breeding (km)	Maximum Ranging Distance during Breeding (km)	Source
Golden Eagle	900 to 13,000	< 11	Few data	51	Kochert et al. 2002
Rough-legged Hawk	Few data	Few data	Few data	Few data	
Gyrfalcon	14,000 to 120,000	< 11	Few data	35	Booms et al. 2008
Peregrine Falcon	35,000 to 150,000	< 12	5 (3 to 8)	43	White et al. 2002

In the Arctic, ground-nesting raptors during the breeding season are associated with wetland habitat, where their small mammal prey is more abundant. Observations of ground-nesting raptors associated with wetland habitats is a component of Inuit Traditional Knowledge for the Project region (KIA 2012). Snowy owls choose dense, hummocky, dwarf shrub meadows for nesting (Parmelee 1992). Short-eared owls frequently choose a nesting site adjacent to wetlands where they forage for small mammals (Wiggins, Holt, and Leasure 2006; COSEWIC 2008). The northern harrier nests near grassy wetlands (Smith et al. 2011).

10.1.5 Baseline Data for Raptors

Aerial surveys by helicopter were conducted in the wildlife RSA to locate raptor nests on cliffs. In addition, habitat suitability modeling was conducted for cliff-nesting and ground-nesting raptors to estimate and map the availability of suitable nesting habitat in the wildlife RSA.

Densities of ground-nesting raptor species are expected to be very low within the wildlife RSA (Section 10.1.1). Data on ground-nesting raptor species was collected while walking line transects within 12 ha plots surveyed for upland birds (Volume 5, Chapter 9), and incidentally during baseline surveys for all wildlife VECs.

Specific sources of baseline terrestrial wildlife information used in this section include the following reports:

- *Back River Project*: *2011 Wildlife Baseline Report* (Rescan 2012a, Appendix V5-5D);
- *Back River Project*: *2012 Wildlife Baseline Report* (Rescan 2013f, Appendix V5-5C);
- *Back River Project*: *2013 Wildlife Habitat Suitability Baseline Report* (Rescan 2013a, Appendix V5-5A); and
- *Back River Project*: *2013 Wildlife Baseline Report* (Rescan 2014, Appendix V5-5F).

Other sources of supplementary wildlife data used in this section include:

- *Bathurst Inlet Port and Road Project*: *Wildlife baseline studies, 2001-2002* (Rescan 2002);
- *Field Report – Back River Project Wildlife and Wildlife Habitat 2007* (Gartner Lee Ltd. 2008);
- *Hackett River Project: Wildlife Baseline Report 2008* (Rescan 2008);
- *Inuit Traditional Knowledge of Sabina Gold & Silver Corp. Back River (Hannigayok) Project Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) (Appendix V3-3A of FEIS); and
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014) (KIA 2014). (Appendix V3-3B of FEIS).

10.1.5.1 Methods for Baseline Data

Raptor Nest Surveys and Incidental Observations

Baseline surveys were conducted in 2002 (Rescan 2002), 2007 (Gartner Lee Limited 2007), 2008 (Rescan 2008) , 2011 (Rescan 2012a, Appendix V5-5D) , 2012 (Rescan 2013f, Appendix V5-5C), and 2013 (Rescan 2014, Appendix V5-5F) to estimate the relative abundance, distribution, and breeding performance of cliff-nesting raptor species within the wildlife RSA (Figure 10.1-1). A survey in July 2002 was conducted in the northern portion of the wildlife RSA along the proposed BIPR road (within a 3 km buffer of the BIPR road alignment; Figure 10.1-1). Surveys conducted in 2007 covered the majority of the wildlife RSA with the exception of the cliffs along the Western River and tributaries, and the eastern side of Bathurst Inlet. In 2008, one survey was conducted in early June in the northern portion of the wildlife RSA (along the northern portion of the BIPR road and port site). Surveys in 2011 were concentrated (within a 30 km buffer) around the Goose Property, and in 2012, surveys were extended to an area 30 km surrounding the Goose Property and the George Exploration Camp. Surveys conducted in 2013 were focused in the northern portion of the wildlife RSA near the proposed MLA, near the Goose Property Area and in a reference area along the Western River drainage (Figure 10.1-1).

During each survey, nest sites identified during previous surveys within the survey area were re-visited, and data were collected at any new nest sites found. Two aerial surveys were conducted each year: 1) a spring occupancy survey to determine whether historical and newly-found nest sites were occupied by breeding raptors; and 2) a summer productivity survey to determine the reproductive performance of raptors, measured as the proportion of occupied nests at which breeding pairs produced young, and the mean brood size among nests at which accurate counts of young could be made.

A database was compiled containing all nest locations collected from previous surveys conducted in the study area since 2002. A unique ID was assigned to each individual nest site, defined as a cliff site where one adult or a pair was observed displaying territorial behaviour during the breeding season. Nest sites typically contain more than one nest. The database contains the data collected at each nest visit, during both occupancy and productivity surveys, across baseline studies for the Project and for other projects.

A nesting territory is a confined locality within the home range of a breeding pair containing one or more nests where no more than one pair is known to have bred at one time (Steenhof and Newton 2007). Without several years of monitoring data, is difficult to identify distinct nest sites (i.e., on different cliffs) belonging to the same territory. Without banded individuals, nests sites belonging to the same territory are identified based on the occupancy history of nest sites, such that only

one breeding pair of a particular species can use a territory in a given year (e.g., (Nielsen 2011). Applying this method, clusters of nests belonging to the same species found across multiple baseline survey years were mapped as distinct nest sites. If an adjacent nest site was unoccupied in one year, but occupied by another pair of the same species in a subsequent survey year, then these two adjacent nest sites were then labelled as two distinct nesting territories. Thus, the database of nest sites probably represents the majority of breeding territories found within the surveyed areas of the wildlife RSA, though some portion of nest sites likely belong to the same breeding territories.

Observations of ground-nesting raptors generally occurred during upland bird surveys conducted in the wildlife RSA using the Program for Regional and International Shorebird Monitoring (PRISM) methodology (CWS 2010), and incidentally during other baseline studies conducted in the wildlife RSA between 2007 and 2013 (Gartner Lee Ltd. 2008; Rescan 2012a, Appendix V5-5D; 2013f, Appendix V5-5C; 2014, Appendix V5-5F). All ground-nesting raptor species observed on the ground or while flying were recorded.

Habitat Suitability Modeling

To estimate the availability of suitable habitat for cliff-nesting raptors, habitat suitability mapping was conducted for the spring nesting season using two methods (Rescan 2013a, Appendix V5-5A). Suitable nesting habitat was defined as areas within a one kilometre radius from raptor nests. A one-kilometer radius around active nests was assumed to be large enough to encompass most alternate nests sites within the territory of a breeding pair. Thus, a one kilometer radius around active nests was assumed to represent core nesting habitat for raptors within the wildlife RSA. All other areas were designated as unsuitable habitat. Secondly, suitable habitat was considered to be south-facing rock faces taller than 10 m and within 1 km of water; all other areas were considered to be unsuitable (Rescan 2013a, Appendix V5-5A). To calculate the total amount of suitable habitat, areas mapped as suitable using these two methods were summed, and areas of overlap were excluded.

To estimate the availability of suitable habitat for ground-nesting species, the short-eared owl was selected as the representative species because it is a species of conservation concern (Rescan 2013a, Appendix V5-5A). Habitat suitability modeling was conducted for the spring nesting season. The summer (brood rearing) season was not modeled as it was assumed that the majority of the terrestrial portion of the wildlife LSA and wildlife RSA would be suitable for hunting. Suitable habitat for ground-nesting raptors was considered to be areas with high cover of low to tall shrubs and no surface water. All other areas were considered unsuitable nesting habitat for ground-nesting raptors (Rescan 2013a, Appendix V5-5A).

10.1.5.2 Results of Baseline Data Collection

Baseline Raptor Nest Surveys and Incidental Observations

The distribution of raptor nest sites found during baseline surveys is highly correlated with the location of cliffs, mapped within the wildlife RSA from slope classification based on Digital Elevation Modeling (Figure 10.1-1). Cliffs within the wildlife RSA are found primarily along large rivers and their tributaries, such as the Western River in the eastern half of the wildlife RSA, where approximately half of the nest sites were found (Figure 10.1-1). Within the wildlife LSA, land slope rarely exceeds 15%, and thus relatively few nest sites were found in the wildlife LSA (Rescan 2013c, Appendix V5-3A). Most of the nest sites observed during baseline surveys were found on cliffs that faced south or south-west (Rescan 2013f, Appendix V5-5C). With the exception of one common raven and one short-eared owl nest, no raptor nests were found within the southeast portion of the wildlife RSA during baseline studies, where very few cliffs are found (Figure 10.1-1).

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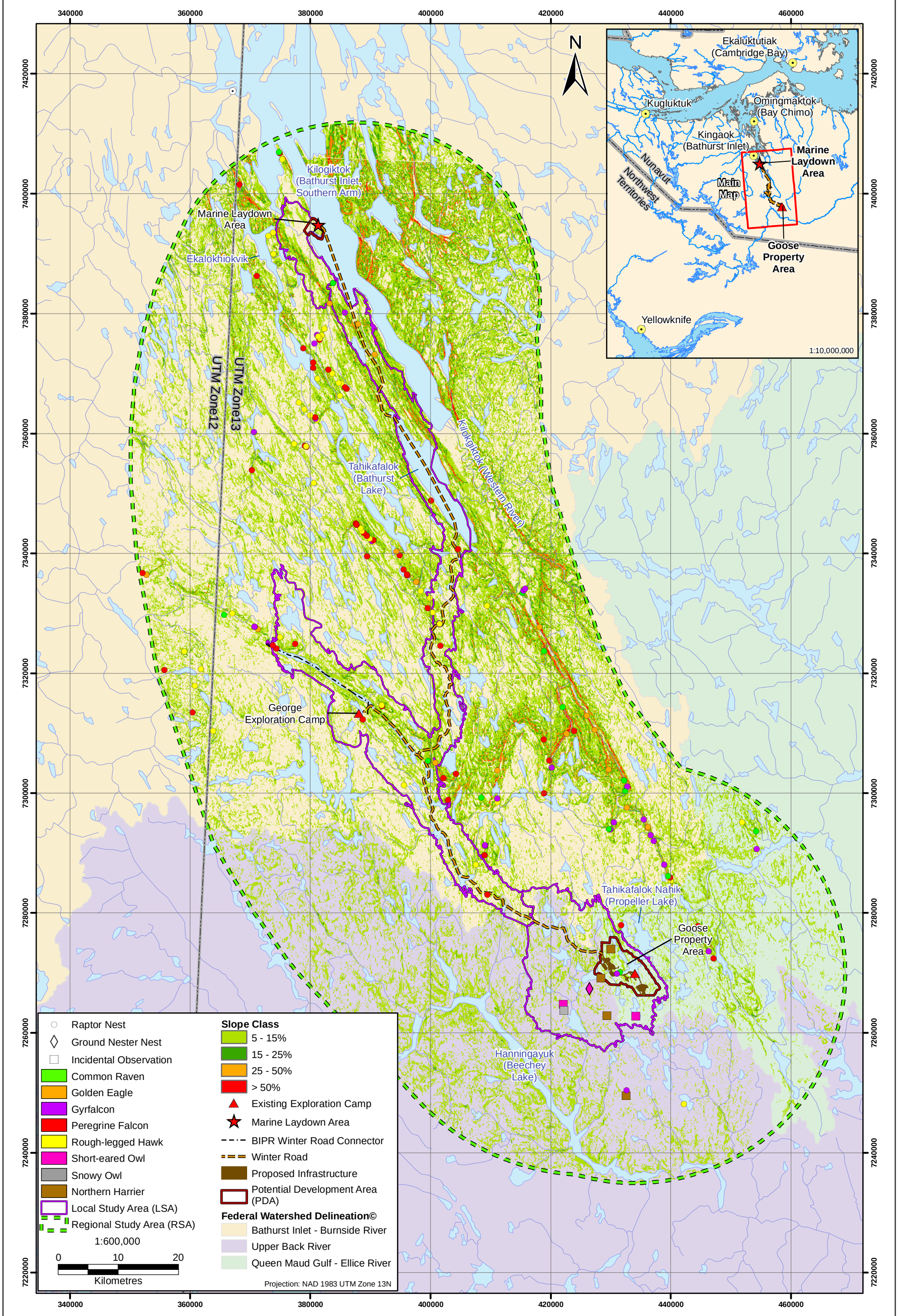

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Nest Site Locations of Raptors and Incidental Observation of Ground-nesting Raptors in the Regional Study Area, 2002 to 2013

Figure 10.1-1

Rescan an ERM company

The largest cliffs within the wildlife RSA, reaching up to 610 m, are found along the eastern shoreline of Bathurst Inlet and were identified as important cliff-nesting habitat by Inuit Traditional Knowledge (TK; KIA 2012). A second area for raptor habitat was identified by Inuit TK near the outflow of Beechey Lake (KIA 2012). These areas were not surveyed because they are more than 1.5 km from any potential sources of Project-related effects, and thus raptors nesting there are not expected to regularly interact with the Project.

A total of eight raptor species as well as the common raven were observed either during aerial raptor nest surveys or incidentally during other field surveys (Table 10.1-2). Of the eight raptor species, breeding was confirmed for peregrine falcon, gyrfalcon, rough-legged hawk, golden eagle, short-eared owl, and common raven (Table 10.1-3). The peregrine falcon was the most frequently observed raptor within the wildlife RSA (Table 10.1-2), and based on the relative frequency with which it occupied nest sites, the peregrine falcon was likely the most abundant cliff-nesting raptor species in the wildlife RSA (Table 10.1-3).

Table 10.1-2. Total Number of Raptors Observed in the Wildlife RSA during 2007, 2011, 2012, and 2013 Surveys

	Total Number of Raptors Observed in the RSA during 2007, 2011, 2012, and 2013 Surveys (incidental observations in heses)			
Raptor Species	**2007**	**2011**	**2012**	**2013**
Peregrine Falcon[1]	6 (1)	5 (1)	25 (4)	27 (4)
Gyrfalcon[1]	(1)	12 (1)	17 (4)	20 (2)
Rough-legged Hawk[1]	(1)	5	14 (5)	27 (6)
Golden Eagle[1]	6 (1)	1 (3)	7 (8)	11 (5)
Bald Eagle	-	-	(7)	(12)
Common Raven	(6)	2	4 (10)	10 (2)
Northern Harrier	-	(2)		(3)
Short-eared Owl[1]	(1)	1	(2)	(4)
Snowy Owl	-		(1)	(1)
Unknown Falcon	-	5	-	7 (5)

[1] *Species of Conservation Concern*

Table 10.1-3. Total Number of Occupied Nest Sites Detected in the Wildlife RSA during Baseline Surveys 2002 to 2013

	Total Number of Nests by Survey Year (number of nests with eggs or nestlings in parentheses)					
Raptor Species	**2002***	**2007**	**2008****	**2011[1]**	**2012**	**2013**
Peregrine Falcon[2]	9 (8)	39 (28)	11 (0)	1 (0)	14 (7)	16 (11)
Gyrfalcon[2]	2 (1)	2 (2)	5 (0)	4 (0)	11 (9)	10 (6)
Rough-legged Hawk[2]	8 (8)	27 (24)	2 (0)	4 (0)	11 (11)	16 (10)
Golden Eagle[2]	0 (0)	9 (9)	3 (1)	1 (0)	7 (7)	7 (5)
Bald Eagle	-	-		-	-	-
Common Raven	1 (1)	4 (3)		-	5 (5)	9 (8)
Northern Harrier	-	-		-	-	-

(continued)

Table 10.1-3. Total Number of Occupied Nest Sites Detected in the Wildlife RSA during Baseline Surveys 2002 to 2013 (completed)

	Total Number of Nests by Survey Year (number of nests with eggs or nestlings in parentheses)					
Raptor Species	**2002***	**2007**	**2008****	**2011[1]**	**2012**	**2013**
Short-eared Owl[2]	-	-		1[3] (unknown)	-	-
Unknown Falcon	-	-		2 (0)	-	-
Snowy Owl	-	-		-	-	-

[1] *Survey conducted within a 30 km radius around Goose Property only*
[2] *Species of Conservation Concern*
[3] *Nest found during upland bird survey*
** no occupancy survey was conducted so a high proportion of nests found had eggs or young (most adults who did not breed had likely moved away from nest site)*
*** no productivity survey so no confirmation of breeding (most nests found prior to egg laying or actual nest not found so no eggs confirmed in most cases)*

Across all baseline surveys, the location of a total of 147 raptor nest sites have been mapped in the areas surveyed within the wildlife RSA (Figure 10.1-1). In 2012, a year with relatively high survey coverage, 48 of 87 nest sites were occupied by raptors (Table 10.1-3), resulting in an estimated occupancy rate of 55% of available nest sites. Extrapolation of this estimated rate of occupancy results in an estimated 81 pairs of raptors that attempt to breed within approximately 80% of the wildlife RSA each year (excluding the eastern side of Bathurst Inlet). This number represents a rough estimate of the breeding population within the surveyed area, and is expected to vary from year to year, dependent primarily on food and weather conditions.

In contrast to cliff-nesting species, ground-nesting raptors only rarely re-nest in the same site, though up to 30% of pairs may be faithful to the general area of breeding home ranges (Parmelee 1992; Wiggins, Holt, and Leasure 2006; Smith et al. 2011). No short-eared owls were observed during 2012 at or within 2 km of the nest site found in 2011. Ground-nesting species were relatively infrequently observed (Figure 10.1-1).

Habitat Suitability Modeling

Cliff-nesting Raptors

By superimposing a 1 km radius buffer on all active raptor nests, an estimated 3.6% of the wildlife LSA and 3.6% of the wildlife RSA contains suitable habitat for cliff-nesting raptors (Table 10.1-4; Figure 10.1-2). Modeling of cliffs taller than 10 m and within 1 km of water resulted in smaller estimates of habitat amount, comprising 0.4% of the wildlife LSA and 2.6% of the wildlife RSA. In total, 4% of the wildlife LSA and 6.2% of the wildlife RSA is estimated to contain suitable habitat for cliff-nesting raptors. The remainder of the wildlife LSA and RSA (96% and 93.8%, respectively) was mapped as unsuitable habitat (Table 10.1-4; Figure 10.1-2).

Ground Nesting Raptors - Short-eared Owl

Approximately half of the wildlife LSA (51.9%) and one third (32.1%) of the wildlife RSA was mapped as suitable nesting habitat for ground-nesting raptors, based on the habitat requirements of the short-eared owl (Table 10.1-5; Figure 10.1-3). These results are based on the portion of both study areas that contain tall or dense shrubby areas.

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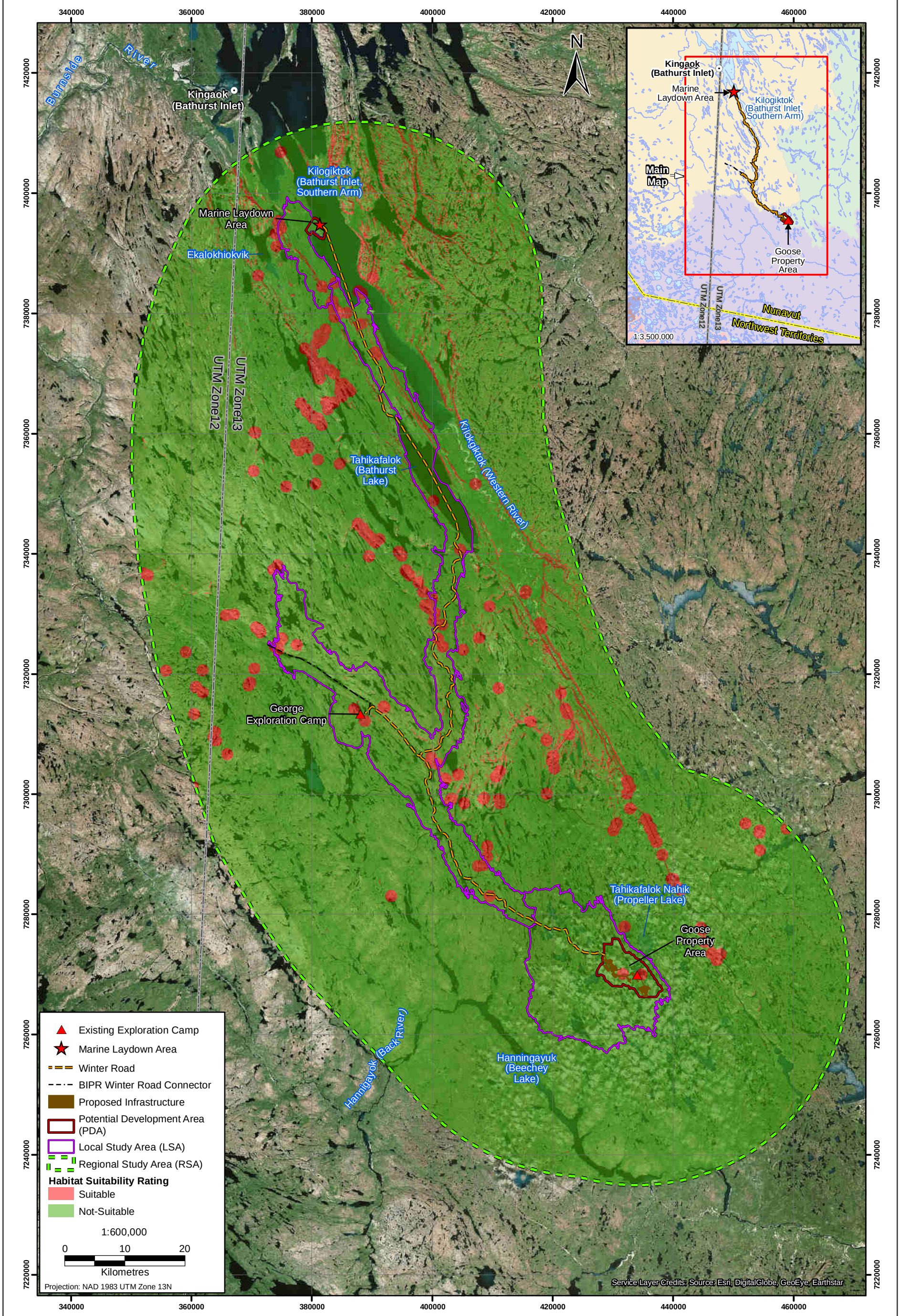

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Cliff-nesting Raptors: Nesting Habitat in the Local Study Area and Regional Study Area

Figure 10.1-2

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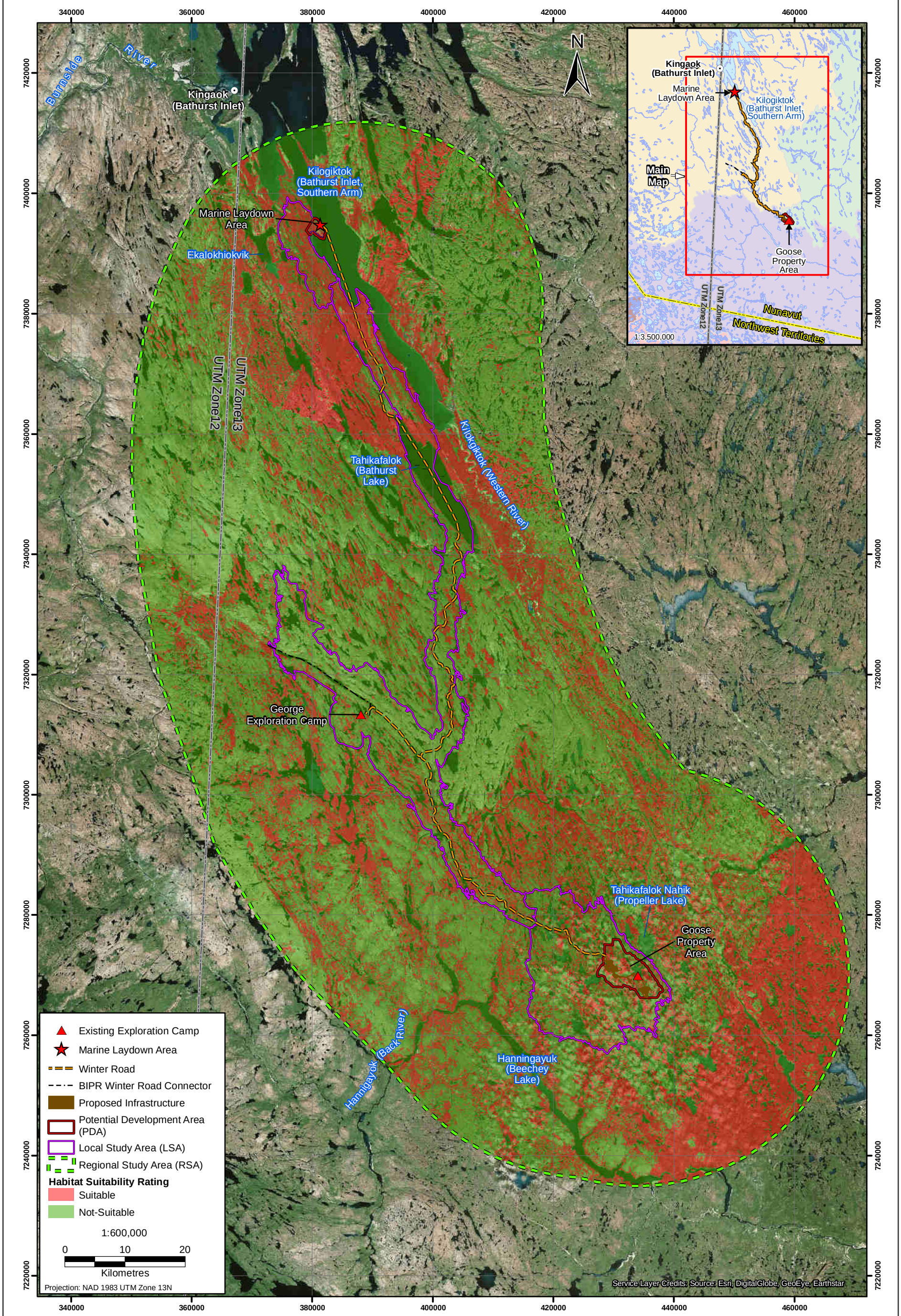

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Short-eared Owl: Nesting Habitat in the Local Study Area and Regional Study Area

Figure 10.1-3

Rescan an ERM company

Table 10.1-4. Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA for Cliff-nesting Raptors

Suitability Rating	Model Type	Amount of Habitat in the LSA[1]		Amount of Habitat in the RSA[1]	
		Area (ha)	% of LSA[2]	Area (ha)[3]	% of RSA[2]
Suitable	Active Nests with 1 km Radius Buffer	4,790	3.6%	45,674	3.6%
	Cliff-Nesting Habitat	643	0.4%	33,413	2.6%
Not Suitable		128,973	96%	1,182,917	93.8%

[1] LSA = 134,370 ha, RSA = 1,262,005 ha. Approximately 4,852 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,153 ha.
[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).
[3] Includes area of Local Study Area (LSA)

Table 10.1-5. Area and Proportion of Suitable and Not Suitable Habitat within the LSA and RSA or Short-eared Owl

Suitability Rating	Amount of Habitat in the LSA[1]		Amount of Habitat in the RSA[1]	
	Area (ha)	% of LSA[2]	Area (ha)[3]	% of RSA[2]
Suitable	69,805	51.9%	404,975	32.1%
Not Suitable	64,565	48.1%	852,178	67.5%

[1] LSA = 134,369.31 ha, RSA = 1,262,004.63 ha. Approximately 4,852.05 ha of the wildlife RSA fell in the Unclassified class and was not included in modelling, thus the total amount of habitat modelled in the wildlife RSA is 1,257,152.58 ha.
[2] For ease of presentation, percentages are rounded up or down to the next whole number. However, due to the large number of decimal places, some percentages may not add to 100% (e.g., 99% or 101%).
[3] Includes area of Local Study Area (LSA)

10.2 INCORPORATION OF TRADITIONAL KNOWLEDGE (TK)

Traditional Knowledge provides insight into the importance of cliffs to nesting raptors including eagles, falcons, and hawks, citing that raptor nests are located on high cliffs, and in fact, most cliffs will have nesting raptors (KIA 2012, 2014). Cliff nesting habitat identified by Inuit in the wildlife RSA includes areas west of Goose Property on the northern shores of Beechey Lake, near Kingaok, as well as on the eastern shores of Bathurst Inlet near Omingmaktok (KIA 2012). Inuit also recognize that ground-nesting raptors prefer areas around wetlands or non-cliff areas as they hunt mainly small rodents. This knowledge was used to prioritize areas to search for raptor nests during baseline studies.

The following reports were reviewed for TK specific information related to raptors:

- Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River Project, Naonaiyaotit Traditional Knowledge Project (NTKP) report, commissioned by Kitikmeot Inuit Association (KIA 2012)(Appendix V3-3A of FEIS);
- Naonaiyaotit Traditional Knowledge Project - Hannigayok (Sabina Gold & Silver Corp. Proposed Back River Project). Results from Data Gaps Workshops, Final Report (June 2014)(KIA 2014) (Appendix V3-3B of FEIS);
- *The Nunavut Impact Review Board (NIRB) Public Scoping Meetings Summary Report* (NIRB 2013b). This report summarizes the public scoping meetings within five Kitikmeot communities, including residents/families from Bathurst Inlet and Bay Chimo as well as a public scoping meeting in Yellowknife, Northwest Territories; and
- Focus Group Sessions (Rescan 2013b) with hunters from the Kitikmeot communities.

The following section summarizes the process of incorporating TK in the baseline studies, VEC selection, assessment boundaries, and recommendations for mitigation and adaptive management.

10.2.1 Incorporation of TK for Existing Environment and Baseline Information

Baseline studies were designed to characterize wildlife identified as culturally important to Inuit people and to characterize important wildlife habitat, which form the foundation of the environment. The baseline programs conducted between 2010 and 2013 included the collection and analysis of data on the relative seasonal and annual trends in abundance and distribution of wildlife identified as important to Inuit, along with estimated productive capacity where practical, migratory patterns, and associated corridors and travel routes. Wildlife habitat use within the wildlife LSA and RSA, including the identification of critical habitat features such as crossing points for caribou, raptor nest and carnivore den locations, and important staging areas for migratory birds were also documented. These studies were guided by TK including the help of landusers in the field to assist with placement of remote cameras on the tundra in areas deemed as important habitat for wildlife, particularly caribou. This information was also used as baseline information around which the human and environmental risk assessments (Volume 8, Chapter 6) were developed.

Ecosystems of traditional and cultural importance due to their value as wildlife habitat, including eskers, sedge wetlands, cliffs, marine shores and riparian ecosystems were incorporated into a habitat suitability model and mapped as high quality habitat, wherever possible.

10.2.2 Incorporation of TK for VEC and VSEC Selection

The results of the *Inuit Traditional Knowledge of Sabina Gold & Silver Corp., Back River (Hannigayok) Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* report (KIA 2012) were used for scoping and refining the potential VEC/VSEC list (see Volume 9, Chapter 1). The TK report presents maps of valued animal species, environmental components, and traditional land use activities. This information was used to determine if these valued aspects potentially interacted with the proposed Project, and if so, they were included in the initial VEC/VSEC list. This information, along with information from public consultation, consultation with regulatory agencies, and regulatory considerations, was used to determine the final VEC/VSEC list. The final list was submitted to NIRB on April 8, 2013 and posted on the NIRB FTP site. As a result of this process, raptors were included as a VEC for the DEIS and FEIS.

10.2.3 Incorporation of TK for Spatial and Temporal Boundaries

Wildlife field studies and habitat suitability modelling were completed during the baseline program within a study area that will encompass the measurable effects on wildlife resulting from development of infrastructure and other activities and equipment associated with the Project. The wildlife LSA and RSA overlaps with Inuit hunting locations and travel routes (see Country Foods Volume 8, Chapter 5). Caribou is the most harvested terrestrial mammal in the Kitikmeot region and many families from the region supplement their diet with caribou or rely on it as a main food source (Rescan 2013b). Inuit TK on caribou indicated that caribou migration paths in spring and fall and calving areas overlap with the country foods LSA (Volume 8, Chapter 5). In addition, other terrestrial wildlife species such as grizzly bears, muskox, wolverine and furbearers, raptors, and migratory birds that are highly regarded by Inuit cultures were considered when deriving the spatial boundaries for the effects assessment. The wildlife RSA encompasses an area large enough to account for species with large home ranges which may come into contact with the Project or Project-related activities, during their lifetime.

10.2.4 Incorporation of TK for Effects Assessment

TK was considered in the Effects Assessment through the incorporation of thoughts from Inuit into the list of potential effects to be considered. Distribution and habitat use information from TK were also

included when assessing the potential for effects to wildlife by determining the potential overlap of wildlife in the spatial boundaries for the Project. TK was considered when determining where potential wildlife receptors may be located and the spatial and temporal overlap of the Project with these areas.

10.2.5 Incorporation of TK for Mitigation and Adaptive Management

Outlined within the Socio-economic and Land Use Baseline (Rescan 2013b), thoughts from Inuit people regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during Focus Group Sessions with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on terrestrial wildlife and wildlife habitat. Mitigation and management strategies will be in place for a number of Valued Ecosystem Components (VECs) including wildlife and Valued Socio-economic Components (VSECs) that will serve to minimize the potential effects of the Project on wildlife and wildlife habitat. In particular, the design utilizes winter access roads, preferentially crossing large lakes and thereby reducing potential for disruption to movement for caribou, grizzly bear, and other wildlife during summer movements, loss and degradation of vegetation due to physical clearing, deposition of airborne dustfall and surface compaction.

Direct and indirect mitigation and adaptive management strategies for wildlife VECs, and the ways in which TK was incorporated into the development of these strategies, are detailed elsewhere in the FEIS. The information can be found in the following volumes and chapters:

- Air Quality: Volume 4, Chapter 1;
- Freshwater Water Quality: Volume 6, Chapter 4;
- Vegetation: Volume 5, Chapter 4;
- Fish and Fish Habitat: Volume 6, Chapters 6 and 7; Volume 7, Chapters 4 and 5;
- Terrestrial Wildlife: Volume 5, Chapter 5 (caribou), Chapter 6 (grizzly bear), Chapter 7 (muskox), Chapter 8 (wolverine and furbearers), Chapter 9 (migratory birds), and Chapter 10 (raptors);
- Marine Wildlife: Volume 7, Chapter 6 (seabirds/seaducks) and Chapter 7 (ringed seals); and
- Land Use: Volume 8, Chapter 4.

10.3 VALUED COMPONENTS

10.3.1 Potential Valued Components and Scoping

The VECs and VSECs for the EIS were selected based on the potential list provided by the Nunavut Impact Review Board (NIRB) in the EIS guidelines (Sections 7.6.1 and 7.6.2; NIRB 2013a) and other information and processes as described below. The VECs were selected based on the following information:

- potential Interaction with the proposed Project;
- consultation with communities;
- available Traditional Knowledge information;
- consultation with regulatory agencies;
- regulatory considerations; and
- practicality of measuring and monitoring.

As part of the scoping process, the following aspects were also considered:

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

10.3.2 Valued Components included in Assessment

Raptors were included in the scoping and refining process with all other potential VECs/VSECs (see Volume 9, Chapter 1). Raptors were selected as a VEC based on Sabina-led public consultation, the TK report (KIA 2012), consultation with regulatory agencies, and regulatory considerations.

Of the nine raptor species occurring in the region, four cliff-nesting and one ground-nesting species are of conservation concern. The *tundrius* subspecies of the peregrine falcon that occurs in the wildlife RSA, while listed as Secure in Nunavut by the CESCC (2010), is federally listed on Schedule 1 as a population of Special Concern under the *Species at Risk Act* (CESCC 2010; Government of Canada 2015). The golden eagle, gyrfalcon, and rough-legged hawk are listed as Sensitive in Nunavut by the Canadian Endangered Species Conservation Council (CESCC). The short-eared owl is listed as Sensitive in Nunavut and is also listed on Schedule 1 of SARA as a species of Special Concern (Government of Canada 2015).

Raptors provide an important ecological role in Arctic ecosystems as top predators in the food chain. Raptors can serve as indicator species, because the breeding dynamics of raptors can influence the breeding of other bird species (e.g., geese), which nest in close proximity to raptors to seek protection from mutual nest predators, such as wolves and foxes (Bety et al. 2001). Fluctuations in breeding productivity of some Arctic-breeding raptor species appear strongly tied to changes in prey populations (e.g., rough-legged hawk and lemmings; Bechard and Swem 2002), and thus, declines in raptor productivity can indicate effects on predator-prey dynamics.

Breeding raptors can serve as indicators of the effects of human activities on ecosystem health - as top predators in the food chain they are sensitive to environmental conditions (Sergio et al. 2008). Raptors bio-accumulate environmental toxins, which in previous decades caused hatching failure of eggs and subsequent major population crashes in some species, resulting in the worldwide banning of DDT organochlorine pesticides (Newton 1995).

10.4 SPATIAL AND TEMPORAL BOUNDARIES

10.4.1 Spatial Boundaries

Project-related effects on raptors were evaluated within two study areas: a Local Study Area (LSA) and a larger Regional Study Area (RSA; Figure 10.4-1).

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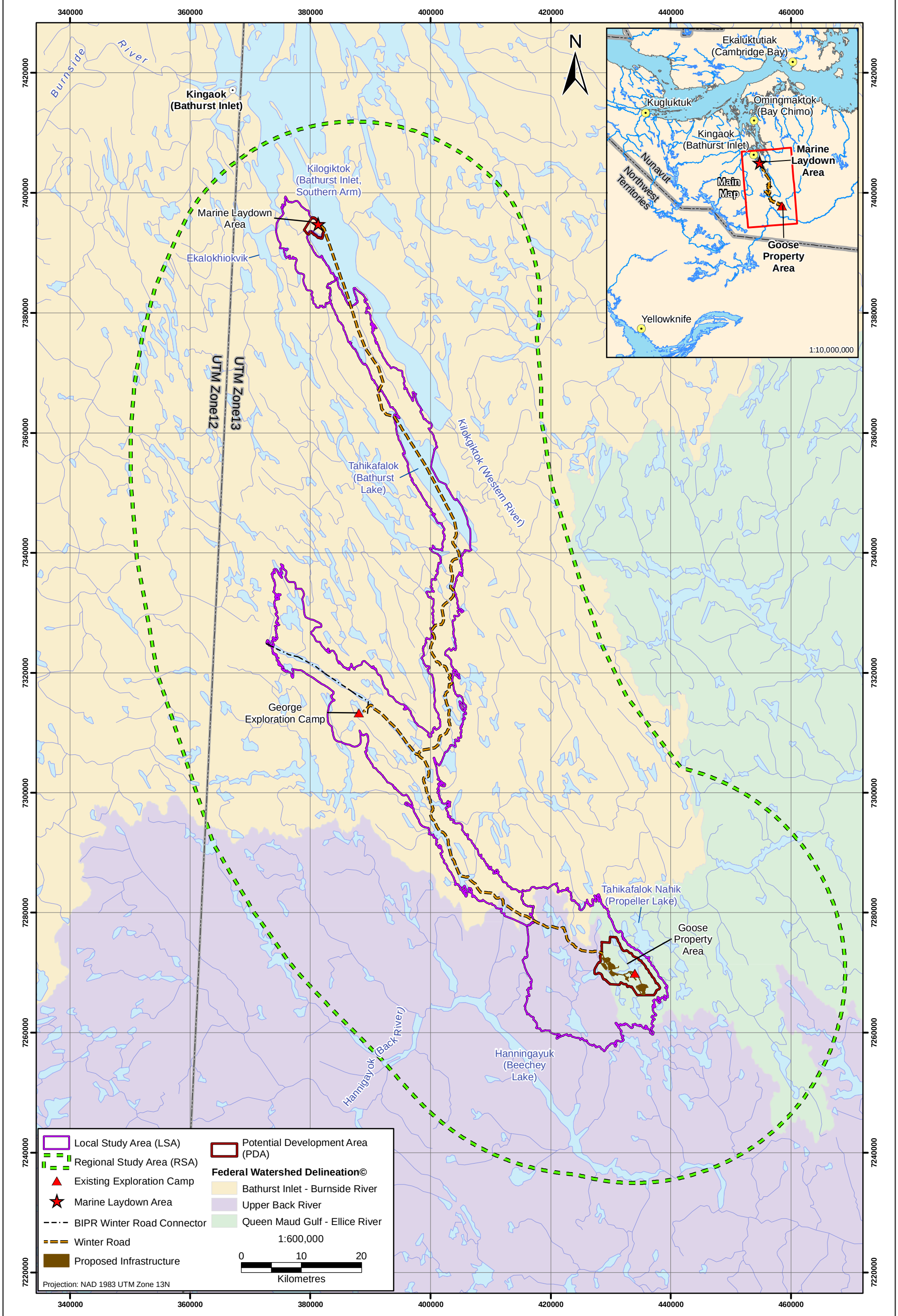
September 01 2015



Sabina GOLD & SILVER CORP.

Local Study Area and Regional Study Area for Raptors

Figure 10.4-1

Rescan an ERM company

10.4.1.1 Local Study Area

The boundaries of the LSA for raptors were set to encompass the following:

- the Goose Property Potential Development Area (PDA), which contain all proposed Project infrastructure for the Goose Property Area;
- the Marine Laydown Area (MLA) PDA; and
- the winter roads connecting the Goose Property and MLA PDAs.

The wildlife LSA was the same as the Vegetation and Special Landscape Features LSA (Volume 5, Chapter 4) and is defined by a combination of sub-watershed boundaries and buffers surrounding proposed Project components, including infrastructure and connecting winter roads. A one-kilometre buffer was mapped surrounding the outer boundary of the PDAs. The wildlife LSA covers an area of approximately 134,369 ha (Figure 10.4-1). This boundary was selected based on empirical data and expert opinion regarding the scale at which immediate and localized disturbances to wildlife species typically occur.

For the FEIS, Sabina has realigned the winter road north of Tahikafflok Lake (Bathurst Lake) to the MLA in order to address potential impacts to riparian zones identified during two local focus group workshops (Cambridge Bay Hunter Focus Group 2012; Kugluktuk Hunter Focus Group 2012). The realigned portion of the winter road is located primarily on lakes or ocean (30 km of the total 45 km of realigned road). The DEIS road alignment was 47 km long with 25 km located on lakes or ocean. A small section (5.5 km) of the winter road alignment is outside the LSA, but 5.3 km of this are located on lakes. This deviation of the winter road alignment outside of the LSA is not expected to change the evaluation of effects nor the identification of potential effects for any of the terrestrial wildlife VECs.

10.4.1.2 Regional Study Area

The RSA for raptors encompasses the PDAs, the wildlife LSA, and a 35 km buffer on either side of all proposed Project infrastructure and winter road corridors between the two Project areas (Goose Property Area and MLA). The RSA covers an area of approximately 1,262,005 ha (Figure 10.4-1). The wildlife RSA extends slightly more than 35 km from proposed infrastructure on the eastern side to encompass the Western River.

10.4.2 Temporal Boundaries

The temporal boundaries used for the raptor effects assessment follow the time periods of the phases of the Project as presented in Table 10.4-1.

Table 10.4-1. Temporal Boundaries – Project Phase Durations

Phase	Duration
Construction (Including Mobilization)	4 years
Operational	10 years
Reclamation and Closure	8 years
Post-Closure Phase	5 years
Other Potential Phases	
Temporary Closure	Less than 2 years
Care and Maintenance phase	2 to 10 years
Exploration	included in Construction and Operational phases

The majority of raptor species migrate in spring and fall, occurring in the wildlife RSA during the non-winter seasons only. The gyrfalcon, snowy owl, and common raven over-winter in the Arctic and thus may interact with the Project throughout the year.

10.5 POTENTIAL PROJECT-RELATED EFFECTS ASSESSMENT

The potential effects of the Back River Project (the Project) on raptors within the wildlife Regional Study Area (RSA) are assessed in this Section of the FEIS. Academic and monitoring studies have shown that under certain circumstances raptors may be susceptible to development-related disturbances, which may result in displacement of raptors from preferred habitat, and possible declines in their breeding productivity and population abundance (Steidl and Anthony 2000; Whittington and Allen 2008). For this reason, potential effects of the Project on raptors were considered. In the following assessment of the effect of the Project on raptors, qualitative and quantitative information was used to characterize the potential residual effects, and predict residual effects that may remain following mitigation and management strategies.

10.5.1 Methodology Overview

The effect assessment process comprises a step-wise method to assess the potential effects of the Project on raptors as described in the General Assessment Methodology (Volume 9, Chapter 1), and as follows:

1. identification of potential interactions between the Project and raptors;
2. characterization of the potential effects that could result from these interactions;
3. identification and description of design, mitigation and management measures that will be taken to eliminate or reduce the potential effects;
4. characterization of residual effects that will likely remain after mitigation and management measures have been applied; and
5. determination of the significance of residual effects using eight attributes to rate the residual effects on raptors including: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence.

The potential effects of the Project on raptors is evaluated for the construction, operations, decommissioning, and post-closure periods as described in the General Assessment Methodology (Volume 9, Chapter 1). In most cases, effects are evaluated for the phase associated with the worst-case scenario, which for raptors is anticipated to be during blasting at open pits throughout Project operations. Lower effects are anticipated during all other Project phases.

10.5.1.1 Indicators Used to Characterize Potential Residual Effects

Sustained population health of wildlife VECs was used as the key criterion to assess potential residual Project-related effects (Table 10.5-1). For each potential effect, various indicators were used to assess the potential for changes to population health. For some potential effects, quantitative threshold values for these indicators were identified that were used to trigger an assessment of potential residual effects (e.g., habitat loss > 0 ha). For other potential effects, indicator values were qualitative in nature in the form of ‘yes’ or ‘no’ where triggering of residual effects assessment occurred if the indicator value was “yes.”

Table 10.5-1. Criteria and Indicators Used to Characterize Potential Effects on Raptors

Potential Effect	Criteria	Indicator
Habitat Loss	Change in Population Health	Amount (ha) of high-quality habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA
Disturbance due to Noise	Change in Population Health	Amount (ha) of high-quality habitat lost or altered and expressed as a ratio of area lost to the area of the wildlife RSA
Disruption to Movement	Change in Population Health	Presence of tall structures
Direct Mortality and Injury	Change in Population Health	Collisions of raptors with vehicles occurs in other locations
Indirect Mortality	Change in Population Health	Predicted increase in human access to wildlife RSA
Attraction	Change in Population Health	Attraction occurs at similar projects in Nunavut and Northwest Territories
Exposure to Contaminants	Change in Population Health	Predicted Hazard Quotients for metals in environmental media and wildlife
Reduction in Reproductive Productivity	Change in Population Health	Literature suggests combined residual effects on raptors

Population health can be defined sensu Stephen (2014) as: 1) the set of interacting biologic, social and environmental determinants that promote and maintain health as a capacity to cope with change over time, 2) the characteristics of the animals and their ecosystem that affect their vulnerability and resilience to a suite of interacting social and environmental harms, and 3) a dynamic human social construct based on social expectations and scientific knowledge. From a practical perspective, change in population health is defined in this assessment as: a change in the population of the wildlife VEC or its ability to maintain a population size through alterations in one of the indicators, e.g., habitat loss, disturbance, mortality, attraction, exposure to contaminants or reduction in reproductive productivity.

In some cases, the assessment is conducted on a sub-population of the VEC. The populations of some wildlife VECs are continuous over very large areas – in those cases, the sub-population is defined as the portion of the population that occupies the RSA.

10.5.1.2 Magnitude Ratings for Residual Effects

The magnitude is defined as the amount or degree of change in a measurable parameter or variable relative to existing conditions. The effect is designated as having either a negligible, low, moderate, or high magnitude rating (Volume 9, Chapter 1). A wildlife-specific definition for magnitude ratings of residual effects is provided in Table 10.5-2.

Project-related residual effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline.

Population health can be measured using various criteria, either indirectly using measures of change in population health via alterations in habitat availability and habitat use, or directly through measures of distribution, and abundance. Data on these measures were collected during baseline studies for raptors, which provide benchmark measures, as well as estimates of the natural variability.

Professional judgement included a hierarchy of approaches. The default approach is the use of quantitative data. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

Table 10.5-2. Definitions of the Magnitude Ratings for Population Health Criterion

Magnitude Rating	Magnitude Descriptor of Criteria (Population Health)
Negligible	No detectable effect on the sub-population of the wildlife VEC, or a small detectable effect that recovers to baseline conditions within the lifespan of the Project. For a quantifiable effect such as habitat loss, a negligible magnitude would occur if the ratio of area lost to the area of the wildlife RSA was < 0.1%.
Low	Effect may result in a slight decline or improvement in VEC condition during the life of the Project, within the bounds of natural variation. For a quantifiable effect such as habitat loss, a low magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 0.1 to 4.9%.
Moderate	Effect could result in a decline or improvement in the VEC sub-population condition to stable but lower or higher levels, respectively, relative to the baseline in the study area into the foreseeable future after project closure. Change in the sub-population of the VEC is outside of the boundaries of natural variation for the area, but will recover when the effect is removed at closure. For a quantifiable effect such as habitat loss, a moderate magnitude would occur if the ratio of area lost to the area of the wildlife RSA was 5 to 20%.
High	Effect could result in declines or improvements in VEC condition to lower or higher levels, respectively, relative to the baseline in the study area, and outside of the boundaries of natural variation into the foreseeable future after project closure. Adverse effects could threaten the sustainability of the sub-population of the VEC. For a quantifiable effect such as habitat loss, a high magnitude would occur if the ratio of area lost to the area of the wildlife RSA was > 20%.

Note: Quantitative indicator thresholds for Habitat Loss and Disturbance were included for determining the effect on the sub-population. For all other effects, the effect on the sub-population and thus the magnitude of the effect was assessed using professional judgment and literature review.

10.5.1.3 Overall Significance Ratings for Residual Effects

To assess the significance of residual effects, eight descriptors for evaluating residual biophysical effects were used and defined in Volume 9, Chapter 1: direction, magnitude, duration, frequency, geographic extent, reversibility, probability and confidence. To assess residual effects, quantitative data were used as a default approach. In the absence of quantitative data, the potential for changes to population health were surmised from observed results at other, similar projects, or predicted from knowledge on life history attributes gathered from the scientific literature.

First, the direction of a residual effect was determined to be positive, neutral or negative. Negative effects were then assessed according to several criteria. The magnitude of the effect (Table 10.5-2) and reversibility were used as the primary criteria; the extent, duration, and frequency of the effect as secondary criteria.

Combined with the probability that the residual effect will occur, the significance of the residual effect on wildlife VECs was rated as positive, not significant, or significant (Table 10.5-3). For example, a residual effect receives a rating of 'not significant' typically if it is expected to be one of the following: negligible or low magnitude, confined to LSA, moderate to high reversibility, or short duration (Volume 9, Chapter 1). However, given the qualitative nature of the assessment, these ratings are evaluated for wildlife VECs on a case by case basis.

Table 10.5-3. Definitions of Significance Ratings for Residual Effects on Raptors

Significance	Descriptor of Significance
Positive	Residual effect could result in improvements in population health, relative to the baseline within the wildlife RSA into the foreseeable future.

(continued)

Table 10.5-3. Definitions of Significance Ratings for Residual Effects on Raptors (completed)

Significance	Descriptor of Significance
Significant	Residual effect is expected to result in a decline in sub-population health that is long-lasting or permanent within the zone of influence of the Project relative to reference conditions; levels may be variable or stable over years, but significantly lower on average than the natural variation of the population and compared to reference sites elsewhere. Regional management actions such as research, monitoring, and recovery initiatives may be required should changes to population health be deemed likely to occur.
Not Significant	Residual effect may result in a decline in population health within the zone of influence of the Project relative to reference conditions during the life of the Project, but population health should return to baseline conditions in the shorter-term after Project closure. Monitoring may be initiated to confirm the ratings of the effects assessment.

Finally, the degree of uncertainty in the rating was provided as a qualifier.

10.5.2 Potential Interactions with Project and Characterization

An interaction matrix showing the potential interactions between the VEC raptors and the Project is provided in Volume 9, Chapter 1. Raptors may interact with most Project activities during all Project phases. Interactions will vary across species depending on migratory guild. As resident species, the gyrfalcon, common raven, and snowy owl occur in the wildlife RSA during winter, and thus may interact with traffic on the winter roads, whereas all other raptor species are migratory and do not occur in the wildlife RSA during winter.

Interactions will also depend on the distance between infrastructure and the nest sites and home ranges of individual raptors. Raptors nesting close to infrastructure (e.g., within the 1.5 km zone of influence for disturbance based on Flight Initiation Distance, Section 10.5.2.2) may be susceptible to disturbance, injury, and mortality, especially from blasting and aircraft. Removal of rock from quarries with steep cliff faces may remove good raptor habitat, but may also create sites for raptor nesting (e.g., Moore et al. 1997). Raptors have also been observed colonizing walls of open pit mines for nesting (Rescan 2012b).

Based on the maximum values for average home range sizes of Arctic-breeding raptors reported in the literature, raptors that nest up to approximately 12 km away from infrastructure may also interact with the Project (Table 10.1-1). Raptors on foraging forays to feed incubating females or young sometimes make long distance movements up to 50 km from nests. However, these movements are expected to be relatively infrequent.

Potential effects on wildlife from the Project have been scoped based on NIRB guidelines. Interactions of raptors with Project components were evaluated to determine which of the following potential effects may occur (Table 10.5-4):

- direct habitat loss;
- disturbance (e.g., displacement, behavioural effects leading to negative energetic balance, physiological stress);
- disruption to movement;
- direct mortality and injury from Project activities;
- indirect mortality due to increased access and associated increase in hunting;
- attraction;
- exposure to contaminants; and
- reduction in reproductive productivity due to all potential effects of the Project combined.

Table 10.5-4. Interaction of Raptors with Project Components that May Result in Effects on Raptors

Potential Development Area Project Component	Habitat Loss[1]	Disturbance	Disruption to Movement	Direct Mortality and Injury	Indirect Mortality	Attraction	Exposure to Contaminants	Reduction in Reproductive Productivity[2]
Goose Property Area								
Open Pits (Main, Umwelt, Echo, and Llama)	x	x		x		x		x
Haul and access roads	x	x		x		x		x
Winter Roads		x		x				x
Stockpiles	x	x		x			x	x
Waste rock storage areas	x	x		x			x	x
Explosives storage areas	x	x		x			x	x
Tailings Impoundment Area	x	x		x			x	x
Quarries	x	x		x		x		x
Landfill	x	x		x			x	x
Camp / Plant site	x	x		x				x
Airstrip	x	x		x				x
Other infrastructure (diversion channels, water intakes)	x	x		x				x
Marine Laydown Area								
Camp	x	x		X				x
Lightering Barge location	x	x		X				x
Haul and access roads	x	x		X				x
Winter roads		x		x				x
Other infrastructure (diversion ditch)	x	x		x				x

[1] *It was assumed that the entire PDA was lost for the effects assessment. All Project infrastructure lies within the PDA.*
[2] *Reduction in reproductive productivity is considered to be a synergistic effect resulting from all other potential effects.*

Each potential effect is described below, and then evaluated as to whether or not it will occur. Potential effects that will likely occur are then evaluated as to whether or not these are predicted to result in a residual effect after mitigation actions are implemented.

10.5.2.1 Habitat Loss

The potential for habitat loss to affect raptors is evaluated in this section. Raptor habitat will be removed and replaced by Project infrastructure. The potential for habitat near infrastructure to be degraded due to dust generated from industrial developments was assessed in the Country Foods chapter (Volume 8, Chapter 5) and Environmental Risk Assessment (Volume 8, Chapter 6). This analysis did not predict any residual effects due to dust on vegetation and therefore on raptor habitat.

The location of infrastructure will be planned to avoid wildlife sensitive areas, and the layout of infrastructure will be designed to minimize the number of individual infrastructure footprints as well as the overall size of the Project footprint. However, some habitat loss and degradation is unavoidable.

To enable flexibility in siting of Project infrastructure, two Project Development Areas (Goose Property and the MLA) were delineated, which contain all proposed Project infrastructure in the entire Project footprint for each area (Section 10.4.1). It was assumed that habitat loss for raptors will occur within the total area of each PDA. This represents an overestimate of habitat loss as only about 10% of the entire area within each PDA will be developed.

The only Project activity not contained within the PDA is the winter roads. Habitat loss within these areas is not expected for raptors because construction of ice roads will not result in loss of any cliff habitat. The gyrfalcon, common raven, and snowy owl are the only raptors present in the wildlife RSA during winter, but these are expected to occur at very low densities (Section 10.1.3). Ice roads are not permanent infrastructure, and thus are not anticipated to result in habitat degradation for ground-nesting raptors during the snow-free season.

Raptor habitat may also be indirectly lost if raptor species avoid the Project area outside of the PDAs due to disturbance, which is discussed in Section 10.5.2.2.

Calculation of Habitat Loss

Assessment of the effect of habitat loss for raptors was based on:

1. Total area - a calculation of the expected total area of habitat lost to development, calculated as the sum of the PDA areas, and expressed as a proportion of the wildlife LSA and RSA; and
2. Suitable habitat - a calculation of the area of suitable habitat contained within the PDA areas, and expressed as a proportion of the area of suitable habitat for raptors within the wildlife LSA and RSA.

Total Area of Loss

The total expected area of habitat lost or degraded by the mine footprint was calculated by summing the areas of loss due to the entire Goose and MLA PDAs and comparing this area to the total area of the wildlife LSA and RSA. The total area of loss is assessed as a net change (in hectares) and expressed as a percentage of area within each spatial boundary. The actual area developed, and subject to habitat loss, will be much smaller, as determined by the final design infrastructure and placement.

Area of Suitable Habitat Loss

Raptor habitat within the wildlife RSA was mapped using habitat suitability modelling (Rescan 2013a, Appendix V5-5A). The effect of loss of suitable habitat was quantitatively assessed as the amount of

suitable raptor habitat expected to be lost within the PDAs, relative to the amount of suitable habitat mapped within the wildlife LSA and RSA. A two class rating system (suitable versus not suitable) was used to map raptor habitat (Rescan 2013a, Appendix V5-5A).

Evaluation of Habitat Loss for Raptors

Total Area of Loss

The total area of loss as represented by the Goose and MLA PDAs is 6,080 ha, which represents 4.5% of the wildlife LSA and 0.5% of the wildlife RSA (Table 10.5-5). Based on a maximum breeding home range radius of 12 km (Table 10.1-1), the total habitat loss represents approximately 13% of a home range of a single raptor.

Table 10.5-5. Area of Habitat Loss within the Project Development Areas

Project Development Area	Area Lost (ha)	Proportion of LSA (%)[1]	Proportion of RSA (%)[1]
Goose Property Area	5,427	4.0	0.4
Marine Laydown Area	653	0.5	0.1
Total Lost	**6,080**	**4.5**	**0.5**

[1] *LSA = 134,369 ha, RSA = 1,262,005 ha*

Loss of Suitable Habitat

Of the 5,433 ha of suitable habitat mapped within the wildlife LSA (4,790 ha mapped around active raptor nests, and 643 ha of cliffs, Table 10.1-4), an estimated 634 ha will be lost and degraded within the two PDAs, which represents 11.7% of the suitable habitat within the wildlife LSA, and 0.8% of suitable habitat mapped within the wildlife RSA (Table 10.5-6).

Table 10.5-6. Suitable Habitat Lost for Cliff-nesting Raptors in the LSA and RSA due to the Project PDAs

	High-quality Habitat (HQH)		High-quality Habitat Lost[1] due to Potential Development Areas	
Area	Amount (ha)	% Area	Area (ha)	% HQH
Local Study Area	5,433	4.0	633.5	11.7
Regional Study Area	79,087	6.3	633.5	0.8

Based on habitat suitability modeling for the short-eared owl (Table 10.1-5), 2,806 ha of suitable habitat for ground-nesting raptors will be removed within the two PDAs (Table 10.5-7). This represents 4% of the wildlife LSA and 0.7% of the wildlife RSA (Table 10.5-7).

Table 10.5-7. Short-eared Owl Suitable Habitat Lost in the Wildlife LSA and RSA due to the Project PDAs

	High-quality Habitat (HQH)		High-quality Habitat Lost[1] due to Potential Development Areas	
Area	Amount (ha)	% Area	Area (ha)	% HQH
Local Study Area	69,805	52.0	2,805.6	4.0
Regional Study Area	404,975	32.1	2,806.4	0.7

Placed within the context of the maximum breeding home range radius of 12 km (Table 10.1-1), the largest amount of suitable habitat loss for raptors (2,806 ha) represents 6.2% of one raptor home range. Wherever possible, reclamation activities will be undertaken to restore habitat upon Project closure. Mitigation is expected to lower but not completely eliminate the effect of habitat loss to raptors, and thus a residual effect is predicted to occur.

10.5.2.2 Disturbance due to Noise

Developments can result in disturbance to raptors through noise, especially from blasting and aircraft, the movement of vehicles, and the close proximity of humans to nest sites. Disturbance can result in behavioural changes, and changes in spatial distribution through avoidance of preferred habitats when these become disturbed (Martínez-Abraín et al. 2010). In some cases, there may be few behavioural indicators of disturbance even though disturbance may affect reproduction. For example, habituated raptors may choose to nest close to human activities yet experience enough physiological stress that contributes to reproductive failure (Strasser and Heath 2013). A concern regarding disturbance to breeding raptors is that it can result in energetic imbalances to eggs or chicks, particularly due to decreased nest attendance by adults (Martínez-Abraín et al. 2010), which can ultimately result in reproductive failure.

Disturbance of raptors will occur throughout the life of the Project. Some disturbances like blasting and aircraft flights will occur intermittently, while other disturbances like the presence of humans and the movement of ground vehicles will occur relatively regularly. Potential disturbance to raptors due to the Project could result from the following activities:

- blasting (noise and ground vibrations from mining and construction activities);
- general project noise (e.g., camp noise, vehicle traffic, human presence); and
- noise generated from aircraft.

During Construction and Operation, potential sources of instantaneous noise includes construction blasting of quarries to build all-weather site roads, and quarrying of the open pits while continuous Project noise includes rock crushing and stockpiling of materials for the TSF, vehicle traffic, and infrastructure construction and maintenance (including power generation). Intermittent aircraft noise will also occur during all Project phases. At the Goose Property, approximately four flights per week will be required during Construction, decreasing to a maximum of two per week during the Operations and Reclamation and Closure phases. Approximately one flight per week may be required during Post-Closure Monitoring. Helicopter support at the Goose Property may be required during Operations, with one to two flights per day sourcing from the Goose Property. At the MLA, up to four flights per week may be required during Construction, increasing to a maximum of six flights per week during Operations. Up to two flights per week may be required at the MLA during Reclamation and Closure. Aircraft servicing the MLA will land on an ice strip constructed in Bathurst Inlet during the ice-covered season and small turboprop aircraft equipped with floats will service the MLA during the open water season when the MLA is operational (which may span all or part of the period between July 15 and October 15).

Raptors typically display behaviours that signal they are disturbed by human activities near their nests. The intensity of responses to disturbance varies across species (Holmes et al. 1993). For example, rough-legged hawks frequently flush from nests during aerial research surveys (Rescan 2014), but golden eagles rarely do (Kochert and Steenhof 2002). Thus, findings of behavioural effects of disturbance to one species (e.g., few effects of helicopter disturbance to nesting golden eagles; Kochert and Steenhof 2002; Grubb et al. 2010) may not be applicable to other species (e.g., high response of bald eagles to disturbance from helicopters; Stalmaster and Kaiser 1997). In addition, a

lack of a behavioural response to a disturbance event does not necessarily indicate a species is relatively undisturbed. For example, golden eagles are considered to be among the raptors with the lowest tolerance to human disturbance (Whittington and Allen 2008) and rarely flush from nests in response to helicopters, likely because they rarely exhibit nest defense behaviours (Pagel, Whittington, and Allen 2010).

The intensity of behavioural responses is related to the degree to which raptors perceive disturbances as a threat (Frid and Dill 2002). Because behavioural responses vary across species, the magnitude of any subsequent negative effects is also expected to show considerable variation across species. Extreme signs of disturbance include nest abandonment, sudden flight of startled adults resulting in mortality of eggs and chicks knocked from nests, or premature fledging of juvenile birds. More moderate responses include increased vigilance and nest defense behaviour, which in most species frequently involves initiation of flight by incubating or brooding adults (reviewed in Whittington and Allen 2008; Pagel, Whittington, and Allen 2010). Extreme behaviors have primarily been observed in response to frequent and very close proximity of humans, such as humans walking or camping within 100 m of nest sites (Steidl and Anthony 2000; Martínez-Abraín et al. 2010; Pagel, Whittington, and Allen 2010). In general, approach of nest sites by humans on foot is probably the most disturbing component of well-managed developments to nesting raptors. For example, raptor species including the rough-legged hawk and golden eagle were observed to flush from nests 100% of the time in response to approaching humans, but less than 40% of the time in response to vehicles (Holmes et al. 1993).

Studies have shown relatively minor effects of noise and vibration from blasting on the behaviour of nesting raptors; effects on reproduction have not been studied as frequently. For example, though peregrine falcons in Ireland showed high selection rates of active and inactive quarries as nesting habitat, effects of blasting on subsequent reproductive output were not measured at the active quarries (Moore et al. 1997). In general, most research suggests that some raptor species are able to habituate to blasting (e.g., successful nesting within 500 m of firing ranges; Lehman et al. 1999; Schueck, Marzluff, and Steenhof 2001; e.g., use of active military ranges).

Raptors successfully fledge young each year from nests sites on the walls of all the open pits at the Ekati diamond mine in the Northwest Territories, including those with active blasting and hauling operations (e.g., Rescan 2012b, 2013h). In Idaho, prairie falcons changed their behaviour after blast events 68% of the time when blasts were on average 130 m away, but only 16% of the time when blasts were 560 m to 1 km away (Holthuijzen et al. 1990). Similarly, perched prairie falcons flew after blasts 58% versus 7% of the time for close blasts versus more distance blasts, respectively. Incubating and brooding falcons left their eggs or young for brief flights 39% and 13% of the time, respectively, but when blasts were greater than 560 m away, responses were minor and infrequent (< 10% of the time).

Despite behavioural responses to blast events, effects on reproduction were low – three of four pairs exposed to nearby blasting (< 130 m) successfully fledged young (Holthuijzen et al. 1990). Blasting may have affected territory occupancy in the subsequent year, but sample sizes were too low to make inferences – one of four exposed territories was re-occupied, versus two of three un-exposed territories. Similar to observations of raptor responses to simulated sonic booms and military jet overflights (Ellis, Ellis, and Mindell 1991), incubating or brooding adults did not dislodge eggs or young when flushed from nests in response to blasts (Holthuijzen et al. 1990). These results indicate that blasts 1 km away may influence raptors, but the effects are likely to be minor.

Quantification of Disturbance to Raptors

Disturbances from multiple stressors (e.g., noise, visual, vibration) to raptors were quantitatively assessed by considering the spatial overlap between breeding raptors and Project infrastructure and

activities. In addition, the effects of noise disturbance to raptors were quantitatively assessed based on noise modeling of the area over which noise emissions from the Project are estimated to occur (Volume 4, Chapter 2). Disturbance is described for the Project phase anticipated to result in the 'worst-case' effects; all other Project phases are expected to result in less disturbance.

Flight Initiation Distance and Home Range Size

Studies investigating the levels and types of activities which result in disturbance to breeding raptors have used flight initiation distances as a measure of the intensity by which raptors experience threat from disturbance (see references in Martínez-Abraín et al. 2010). The flight initiation distance is defined as the distance between a disturbance and an individual bird when it is flushed from a perched position (Holmes et al. 1993). Data on flight initiation distances (FIDs) recorded for incubating or brooding raptors have been used to delineate the boundaries of spatial buffers to restrict human activities around nest sites (e.g., Keeley and Bechard 2011). It is important to note that raptors may be disturbed by activities occurring beyond this distance, and display nest defence behaviours such as vocalization, but FIDs are thought to represent the minimum distance raptors require to feel relatively safe while at the nest site.

Recommendations for the size of spatial buffers more often have been derived using expert opinion, rather than empirical data on FIDs (Richardson and Miller 1997). Depending on raptor species and type of disturbance, recommendations based on expert opinion and FIDs vary from 200 m to 1,600 m (Richardson and Miller 1997; Whittington and Allen 2008; Aboriginal Affairs and Northern Development Canada (AANDC) 2011; Keeley and Bechard 2011). These recommendations closely match the finding through meta-analysis of 25 datasets that raptors place nests 200 m to 1,400 m away from roads (Martínez-Abraín et al. 2010). Thus, 1.5 km is likely a robust estimate of the distance from activities at which raptors may experience threat from disturbances that is severe enough to initiate flight as a form of nest defense. This distance (1.5 km) mirrors the recommended set back distance for limiting disturbance to raptor nests within the Northern Land Use Guidelines for seismic operations (Aboriginal Affairs and Northern Development Canada (AANDC) 2011)

Disturbance effects of the Project were quantitatively assessed based on numbers of raptors expected to nest within the zone of influence for disturbance. For disturbance at the nest site, 1.5 km was used as the radius of the zone of disturbance effects, which are most likely due to aircraft and blasting. The zone of influence of disturbance to raptors while foraging on their home ranges was assumed to be 12 km, which is the largest radius of the average home range size reported in the literature (Table 10.1-1). Based on a 12 km radius home range, raptors nesting within 12 km of the Project would be anticipated to encounter Project infrastructure and activities during foraging forays from the nest to feed nestlings, or during the post-fledging period when fledglings are learning to hunt for prey.

Noise Contour Modeling to Evaluate Indirect Habitat Loss

To assess indirect habitat loss due to sensory disturbance, the area outside of the PDAs anticipated to be affected by noise was calculated. The effects due to noise beyond the existing PDA boundaries are expected to be small, because the loss of habitat within the PDAs, where most of the effect of disturbance will likely occur, was already considered in the habitat loss assessment (Section 10.5.2.1).

Noise contours were mapped using the noise modeling conducted for the Noise and Vibration Assessment (Volume 4, Chapter 2) during the years when overall noise (sum of blasting noise, general Project noise, and aircraft noise) is anticipated to be worst case, which coincides with Year Three of the Operations phase at the Goose Property Area. The Operational phase is also the longest Project phase, thus would have the greatest impact to wildlife. All other Project phases are expected to have less overall disturbance due to noise. The results of noise modelling resemble a topographic map with decreasing sound contours with increasing distance from the source. The area of affected habitat was

calculated by using specific noise level contours from the literature at which wildlife have shown behavioural effects from the noise.

Threshold noise values were determined from the literature, above which wildlife are known to abandon areas or display disturbed behaviours in response to noise. Where no thresholds were available, conservative values from similar species or human health were used. The area where noise levels were predicted to exceed the thresholds were then considered as "functional habitat loss" and "disturbed habitat" for raptors. The areas of functional habitat loss and disturbed habitat outside of the PDAs were then reported, and are typically small, since the PDAs (already considered as lost habitat in Section 10.5.2.1) are quite large. Habitat areas disturbed outside of the PDA were calculated as total area disturbed as well as the amount of high-quality habitat disturbed during each season calculated by habitat suitability modeling (see Baseline Habitat Suitability Modeling; Section 10.1.5).

Three common sources of noise were chosen for modelling including: 1) instantaneous noise due to blasting, 2) general Project noise also known as continuous noise, and 3) intermittent noise generated from fixed-wing aircraft. In general, instantaneous noises (like blasting) are measured in Lpeak, which is a measure of sound pressure while continuous general Project noise is measured in dBA. Noise due to aircraft overflights is measured as a sound exposure level (LAE) in dBA.

Lpeak noise level (dBZ) is a measure of the maximum instantaneous noise "pressure" caused by brief noises, such as from blasting at quarries and noise due to aircraft. Two values were chosen for the blasting noise assessment: 1) a value where wildlife are expected to avoid habitat ("functional habitat loss"; 120 dB Lpeak); and 2) a value where wildlife are expected to be disturbed and respond behaviourally ("disturbed habitat"; 108 dB Lpeak). The threshold of 120 dB was selected to represent "functional habitat loss," and was selected based on a range of threshold values (120 dB to 128 dB) identified as physiologically harmful to humans (Environment Canada 2010). The blasting noise level threshold of 108 dB (Lpeak) represents "disturbed habitat" and was selected based on a range of threshold values (85 to 108 dB) identified for wildlife resulting in flight response, freezing, or strong startle response (Manci et al. 1988; Weisenberger et al. 1996; Reimers and Colman 2006). Noise modelling considered areas where blasting noise attenuates to 108 dB and 120 dB (Lpeak) or higher for instantaneous noise effects on raptors during operations. Blasting noise models were conducted during peak noise levels at the Goose Property, which is Year 3 of Operations.

General Project-related noise levels or continuous noise levels are presented as "A-weighted" decibels (dBA), which incorporates the noise frequencies that are audible to the human ear. The 45 dBA distance category was selected based on the Environment Code of Practice for Metal Mines (Environment Canada 2010) recommendation that ambient noise from mining operations and its effect on wildlife should meet the objectives for residential areas; the sound pressure level from mining activities should not exceed 55 dBA during the day and 45 dBA at night. Therefore, this assessment has taken a conservative approach and modelled the area where the sound pressure level occurs at 45 dBA and higher in wildlife habitat.

Noise generated by aircraft, or intermittent noise, are also presented as "A-weighted" decibels (dBA). A flight impact zone was delineated based on noise modeling results showing the area over which aircraft noise attenuates to 80 dBA or higher. The aircraft noise level threshold of 80 dBA was selected based on threshold values identified for wildlife resulting in flight responses (Knight and Gutzwiller 1995; Efroymson and Suter 2001). For the Goose Property Area, modelling was conducted for in-air sound levels for an Avero RJ85 approaching the airstrip from the south and departing to the north (Volume 4, Chapter 2). For the MLA, noise modelling was conducted for in-air sound levels from de Havilland Canada DHC-6 Twin Otter aircraft that was produced in Rescan (2013d).

To assess indirect habitat loss due to sensory disturbance for raptors, the total area of suitable raptor habitat (Rescan 2013a, Appendix V5-5A) outside of the two PDAs (Section 10.5.2.1), but within noise level contours was calculated. The following noise contours were used: 120 dB for functionally-lost habitat from instantaneous blasting noise, resulting in abandonment of habitat, 108 dB for disturbed habitat from instantaneous blasting noise potentially resulting in behavioural response, 45 dBA for general Project noise, and 80 dBA for disturbed habitat from instantaneous aircraft noise.

Noise Modeling to Evaluate Disturbance to Raptors Breeding Near Infrastructure

The effects of noise disturbance on raptors were also evaluated by determining whether noise thresholds are predicted to be exceeded at nest sites where raptors attempted to breed during baseline surveys within the PDA (Rescan 2013e; Table 10.5-8). Raptors at three nest sites were used as receptors for this evaluation, which included a gyrfalcon/common raven nest site located 163 m from haul and access roads at the Goose property, and two other nest sites belong to a peregrine falcon and rough-legged hawk in the central RSA well away from the Goose Property. The latter two nest sites were included as reference sites for aircraft noise that may extend further away from the Goose Property area.

Evaluation of Disturbance to Raptors

Flight Initiation Distance and Home Range Size

One to two pairs of raptors nested within 1.5 km of proposed infrastructure during baseline studies (two pairs were recorded nesting in close proximity to one another within the Goose PDA in 2013, in all other years one nesting pair had been recorded in the area surveyed), and thus up to two pairs are expected to be affected by disturbance due to the Project while at their nest sites (Table 10.5-8). An additional nine raptor nest sites were occupied in at least one year since 2002 within 12 km of proposed infrastructure, which is 6.1% (9 of 147 nest sites) of the number mapped within the wildlife RSA (Table 10.5-8). Thus nine breeding pairs of raptors are expected to be affected by disturbance while foraging on their home ranges. Overall, raptors that nest at 6.8% (10 of 147 nest sites) of the total number of nest sites mapped in surveyed areas are expected to be exposed to disturbance at regular intervals from the Project during the breeding season.

Noise Contour Modeling to Evaluate Indirect Habitat Loss

Blasting Noise: Less than 0.1% of the wildlife RSA (Table 10.5-9) beyond the PDAs will be functionally lost (9 ha) and disturbed (316 ha) due to blasting noise (Table 10.5-9, Figures 10.5-1 and 10.5-2). All blasting noise above 120 dB Lpeak is completely contained within the 108 db Lpeak contour; therefore, only 307 ha outside of the area functionally lost (≥120 dB Lpeak) will be disturbed by blasting noise above 108 db Lpeak. These areas overlap less than 0.1% of suitable habitat available for raptors beyond the PDAs in the wildlife RSA (Tables 10.5-10 and 10.5-11).

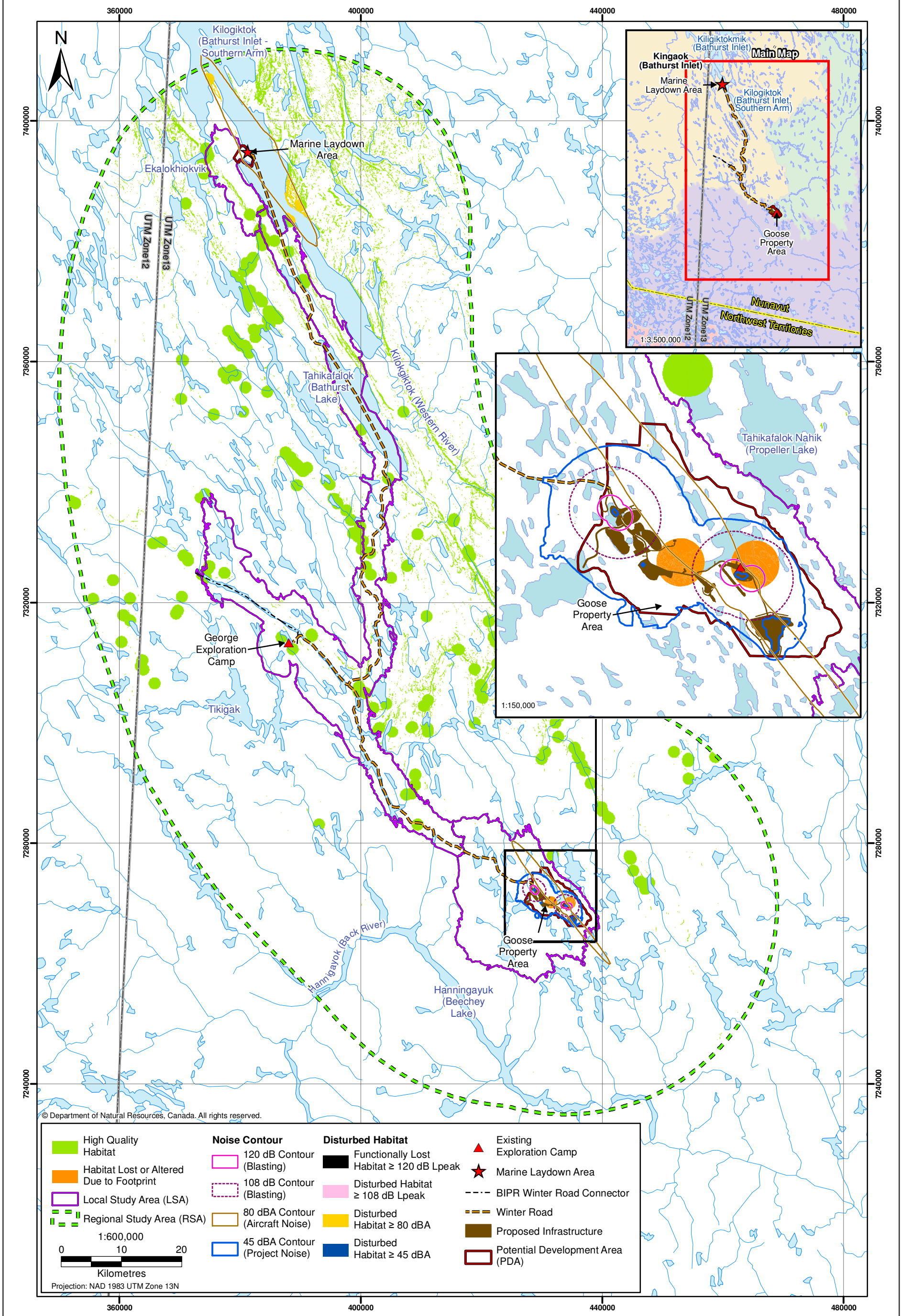
General Project Noise: The total amount of area affected by elevated noise levels outside of the two PDAs is 1,212 ha or <0.1% of wildlife RSA (Table 10.5-9), of which 0.4 ha is mapped as suitable habitat for cliff-nesting raptors (Table 10.5-10), and 432 ha is mapped as suitable habitat for short-eared owls (Table 10.5-11). All noise attributable to blasting above 108 dB Lpeak, which is an intermittent noise source, will occur entirely within the area disturbed by continuous general project noise above 45 dBA. Therefore, raptors will experience multiple sources of Project noise in roughly 316 ha of habitat where blasting noise and general Project noise overlap; the amount of suitable habitat within the area of overlap is very minimal for both cliff-nesting raptors and short-eared owl (<0.1% of the wildlife LSA and RSA). The majority of sensory disturbance will be associated with the development and operation of the TSF, processing plant, roads and camps.

Table 10.5-8. Raptor Nests within 1.5 km and 12 km of Proposed Infrastructure

Project Area	Nearest Component	Distance to Nearest Component (m)	Distance to Airstrip (m)	Distance to Nearest Pit (m)	Inside PDA	2002	2007	2008	2011	2012	2013
Goose Property	Haul and Access Road	163	1,400	1,400 m (Umwelt)	Yes	Not surveyed	Peregrine Falcon with Eggs (Failed)	Not surveyed	Gyrfalcon with Young	Gyrfalcon Adults (no eggs at occupancy, no young)	Common Raven Adults (no eggs at occupancy, no young) and Gyrfalcon Adults (no eggs at occupancy, no young)
Goose Property	Water Diversion Ditch	5,755			No	Not surveyed	Peregrine Falcon Adults	Not surveyed	Inactive	Inactive	Inactive
Goose Property	TSF Dam Embankment	11,956				Not surveyed	Peregrine falcon adults (with eggs)	Not surveyed	Not surveyed	Peregrine Falcon Adults	Inactive
Goose Property	TSF Dam Embankment	11,729				Not surveyed	Golden eagle adults (with eggs)	Not surveyed	Gyrfalcon Adults	Rough-legged hawk adults (with eggs)	Gyrfalcon Adults (incubating eggs at occupancy, failed)
Goose Property	TSF Dam Embankment	11,824				Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Common Raven Adults (incubating eggs at occupancy, assumed productive)
MLA	MLA Infrastructure slope	6,927			No	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Rough-legged Hawk Adults
MLA	Diversion Ditch	7,794			No	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Rough-legged Hawk with 4 Young
MLA	Diversion Ditch	7,964			No	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Rough-legged Hawk with 4 Young
MLA	MLA Infrastructure	8,860			No	Common Raven with Young	Peregrine Falcon with Eggs (Failed)	Not surveyed	Not surveyed	Not surveyed	Peregrine Falcon with 4 Young
MLA	MLA Infrastructure	8,860			No	Inactive	Common Raven Adult	Not surveyed	Not surveyed	Not surveyed	Inactive

GIS # BAC-23-382b

October 06 2015



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Suitable Cliff-nesting Raptor Habitat Lost, Altered, or Disturbed due to the Project

Figure 10.5-1

Rescan an ERM company

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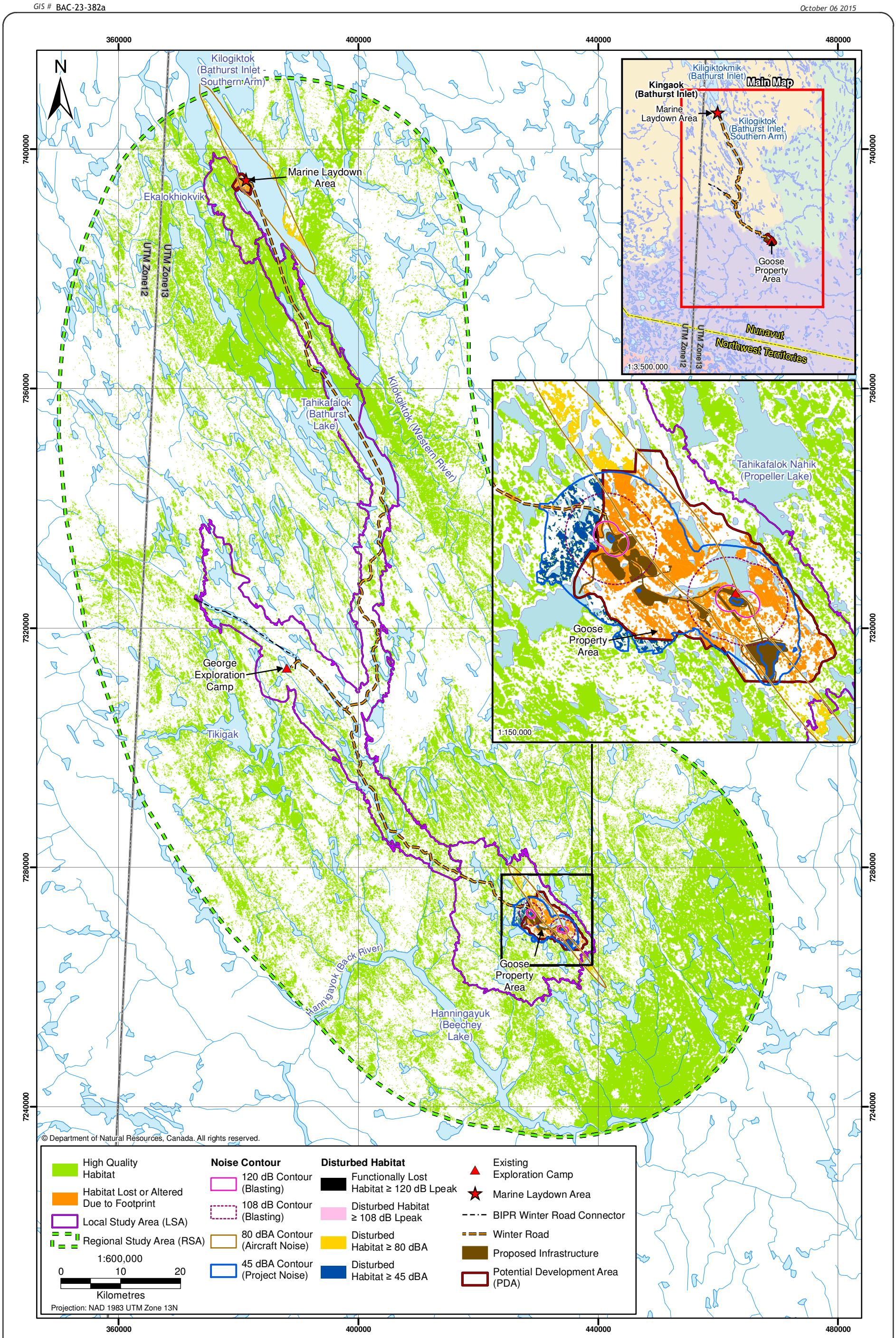

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Suitable Short-eared Owl Habitat Lost, Altered, or Disturbed due to the Project

Figure 10.5-2

Rescan an ERM company

Table 10.5-9. Total Additional Area Functionally Lost or Disturbed due to Project Noise

Project Area	Total Area Lost to Project PDAs			Additional Area Functionally Lost due to Blasting (120 dBA)			Additional Area Disturbed due to Blasting (108 dBA)			Additional Area Disturbed due to General Project Noise (45 dBA)			Additional Area Disturbed due to Aircraft Noise (80 dBA)		
	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA	% RSA	Area (ha)	% LSA*	% RSA
Goose Property Area	5,427	4.0	0.4	9	<0.1	<0.1	316	0.2	<0.1	1,212	0.9	<0.1	1,824	1.3	0.1
MLA	653	0.5	0.1	-	-	-	-	-	-	-	-	-	12,367	9.2	1
Total	**6,080**	**4.5**	**0.5**	**9**	**<0.1**	**<0.1**	**316**	**0.2**	**<0.1**	**1,212**	**0.9**	**<0.1**	**14,191**	**10.5**	**1.1**

Table 10.5-10. Suitable Habitat for Cliff-nesting Raptors Disturbed and/or Abandoned outside of the Project PDAs due to Noise

Study Area	Amount of Suitable Habitat Available (ha)	Suitable Habitat Lost or Altered due to the Project PDA		Additional Area Functionally Lost due to Blasting (120 dB)		Additional Disturbed due to Blasting (108 dB)		Additional Area Disturbed due to General Project noise (45 dBA)		Additional Area Disturbed due to Aircraft Noise (80 dBA)	
		Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat
Local Study Area	5,433	634	11.7	0	0	0.2	<0.1	0.4	<0.1	0.6	<0.1
Regional Study Area	79,087	634	0.8	0	0	0.2	<0.1	0.4	<0.1	1,136	1.5

Table 10.5-11. Suitable Habitat for Short-eared Owls Disturbed and/or Abandoned outside of the Project PDAs due to Noise

Study Area	Amount of Suitable Habitat Available (ha)	Suitable Habitat Lost or Altered due to the Project PDA		Additional Area Functionally Lost due to Blasting (120 dB)		Additional Area Disturbed due to Blasting (108 dB)		Additional Area Disturbed due to General Project noise (45 dBA)		Additional Area Disturbed due to Aircraft Noise (80 dBA)	
		Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat	Area (ha)	% Suitable Habitat
Local Study Area	69,805	2,806	4.0	6	<0.1	135	0.3	432	1.1	420	1.1
Regional Study Area	404,975	2,806	0.7	6	<0.1	135	<0.1	432	0.1	1,646	0.4

Aircraft Noise: The total amount of area affected by aircraft noise (80 dBA) outside of the two PDAs represents 1.1% of the wildlife RSA (14,191 ha, Table 10.5-9). Sensory disturbance due to aircraft noise is greater near the MLA (12,367 ha, 1% of the wildlife RSA) relative to the Goose PDA (1,824 ha, 0.1% of the wildlife RSA; Table 10.5-9), as Twin Otter aircraft will service the MLA, which is a noisier aircraft than the Avero RJ85 that will service the Goose Property. A total of 15 ha of habitat that will be disturbed on an intermittent basis by aircraft noise at the Goose Property occurs within area disturbed by continuous general project noise above 45 dBA, thus representing the area where raptors may encounter multiple types of Project noise. However, no blasting noise overlaps areas disturbed by aircraft noise.

In total, 1,136 ha of suitable cliff-nesting raptor habitat (1.5% of the wildlife RSA) and 1,646 ha of suitable habitat for short-eared owls (0.4% of the wildlife RSA) owls is mapped within the area disturbed by aircraft noise (Tables 10.5-10 and 10.5-11). The majority of suitable habitat affected by aircraft disturbance is attributable to aircraft servicing the MLA for both cliff-nesting raptors (99% of the 1,136 ha) and short-eared owl (66% of 1,646 ha). There is no area where aircraft noise and general project noise are expected to overlap suitable cliff-nesting habitat, as little cliff-nesting habitat occurs in the vicinity of the Goose PDA. A total of 5 ha of suitable short-eared habitat occurs near the Goose PDA where intermittent aircraft noise and general Project noise are expected to overlap, representing the area where short-eared owl may encounter multiple types of Project noise. The combined effect of noise disturbance from blasting, general Project noise, and aircraft is anticipated to have a residual effect on raptors outside the PDAs.

Across all noise sources combined (and accounting for overlap), a total 1,136 ha of suitable cliff-nesting raptor habitat and 2,072 of suitable nesting habitat for short-eared owls may be affected, which represents less than 1.5% of the suitable habitat available in the wildlife RSA for both groups. The largest amount of habitat that may be affected from a single noise source will be that disturbed by intermittent aircraft noise. The total amount of habitat disturbed by all noise sources combined accounts for approximately 3% of a 12 km radius breeding home range for cliff-nesting raptors, and 5% of a 12 km radius breeding home range for short-eared owl. The majority of the area assessed as being above noise guidelines for wildlife is within the Goose PDA, which is assessed as lost habitat in Section 10.5.2.1.

Noise Modeling to Evaluate Disturbance to Raptors Breeding Near Infrastructure

Based on the results of noise modeling, raptors nesting at a gyrfalcon/common raven nest site 440 m from proposed haul and access roads at the Goose Property are predicted to experience an exceedance of 12 dBA of noise above the night time disturbance threshold of 45 dBA. Noise from blasting is not predicted to exceed the threshold for disturbance at 108 dB at the gyrfalcon/common raven nest site, nor is aircraft noise expected to exceed the disturbance threshold of 80 dBA at this site. Noise disturbance from any source is not predicted to exceed threshold levels for any raptors breeding at the peregrine falcon nest site and rough-legged hawk nest site located in the central RSA (Volume 4, Chapter 2).

Summary of Evaluations of Disturbance to Raptors

One raptor nest sites occurs within the Goose PDA and up to two raptor pairs may nest in this general nesting area. Since the entire PDAs will not be developed, it is likely that this nesting area will not be lost. Raptors nesting at this site are predicted to experience minor exceedances of noise thresholds, and may experience visual disturbances especially from aircraft, and vibration disturbances from blasting. The residual effect of the loss of this nest site has already been assessed in Section 10.5.2.1, thus no residual effect of disturbance is predicted for raptors nesting within the Goose PDA. An additional nine raptor nest sites occur within a 12 km radius of infrastructure contained within the PDAs. Raptors nesting at these sites may encounter Project disturbances while foraging from nest sites, or during the fledgling period.

Mitigation to limit disturbance to raptors nesting within 12 km of the Project include a minimum flight elevation of 300 m for aircraft service the Project area (with except of take-off and landing). Mitigation is expected to lower but not completely eliminate the effect of disturbance to raptors. Thus, a residual effect of disturbance on raptors is predicted for raptors nesting outside of the PDAs within a 12 km radius.

10.5.2.3 Disruption to Movement

Developments can impede the movements of raptors due to mortality from collisions with tall structures such as communication towers and wind turbines (Erickson, Johnson, and Young Jr 2005). No tall structures will be constructed for the Project and thus interactions of raptors with the Project are not expected to result in any effects on the movements of raptors on their home ranges. Raptors migrate during the daylight hours, and due to the high altitudes at which migratory raptors fly, it is unlikely that migrating raptors will interact with the Project. Thus, no effects of the Project are expected on the home range or migratory movements of raptor species and this effect is rated as not residual.

10.5.2.4 Direct Mortality and Injury

Raptors may be at risk of injury or mortality resulting from Project activities; therefore, this effect is included in this assessment. Specifically, potential sources of direct mortality and injury could include collisions with vehicles and blasted rock, and as a result of nest destruction during vegetation clearing for ground-nesting raptors (e.g., short-eared owl).

The effect of mortality and injury due to vegetation clearing is expected to be eliminated as a result of mitigation measures for the Project. To ensure that nests of ground-nesting raptors are not destroyed, ground clearing will be conducted outside of the sensitive nesting periods for ground-nesting raptors. If construction cannot be scheduled outside of the nesting period, mitigation will be triggered and will include pre-clearing surveys conducted by qualified biologists to locate nests of bird species in areas slated for clearing, including nests of all ground-nesting raptors. Thus, mortality and injury of raptors is not expected to occur as a result of ground clearing.

<u>Calculation of Mortality and Injury of Raptors</u>

Mortality and injury of raptors was quantitatively assessed based on the number of raptors and the relative frequency with which they are expected to occur within the zone of influence for mortality and injury. Published accounts of raptor injury or mortality as a result of collisions at other operating mines in the Arctic were evaluated to assess the likelihood of occurrence of injury or mortality from different sources.

The zone of influence for collisions with blast rock is assumed to be 200 m surrounding open pits, as rock from blasting sites can fall 100 to 200 meters from the site of the blast. The footprint of all Project haul roads and winter roads represent the zone of influence in relation to potential vehicle-related injury or mortality. The zone of influence for aircraft was developed ased on recommendations of the Canadian Wildlife Service. Based on this guidance, A flight impact zone was delineated within 3 km along each side and 5.4 km from the ends of the proposed airstrips. This area is intended to represent the area within which aircraft servicing the Project may be travelling below 450 m (1,500 ft) during landing or takeoff. Research indicates that raptor collisions with aircraft occur more frequently at lower altitudes (< 150 m above ground level; e.g., red-tailed hawks, Blackwell and Wright 2006), which implies that birds were hunting and thus distracted when struck. Thus, the airstrip zone of impact represents the area where the risk of a collision may be at the highest as the aircraft is passing through the zone where hunting and flying raptors may be more frequently encountered.

Evaluation of Mortality and Injury of Raptors

Potential collisions with blast rock are expected to be rare and likely non-existent, as no published accounts of raptor mortality or injury due to blasting at quarries and pits were found in the literature. However, it is possible that this potential source of mortality is underreported due to the cryptic nature of some species nesting habits (e.g., peregrine falcon). Therefore, this potential source of injury or mortality was evaluated further. Blasting will occur at all resource pits and quarries associated with the Project, and areas within 100 to 200 m of resource pits may be subject to occasional rock fall from blasting events. No raptor nests were identified during baseline studies that were within 200 m of resource pits or quarries. The closest known raptor nest, which was occupied by peregrine falcons, gyrfalcons, and common raven from 2007 to 2013, is located approximately 1,400 m from the Umwelt Pit. Therefore, it is extremely unlikely that blast rock could affect known nesting habitat within the Goose PDA because the extent of travel of blast rock will be managed for site safety reasons. Furthermore, mitigation measures will be employed to reduce the potential for raptors that may be attracted to open pits for nesting to be affected by blasting and flying blast rock (also see Attraction, Section 10.5.2.6). Monitoring of pit and quarry walls for evidence of nesting raptors will be conducted as part of the Wildlife Mitigation and Monitoring Program. If birds are attempting to nest within areas of active blasting and may be at risk from injury, mitigation will be triggered and deterrents will be used to dissuade raptors from nesting within open pits, which could include noise deterrence, removal of nesting material prior to egg laying, of physical deterrents placed over established nest sites without eggs or attractive nesting ledges (see Section 10.5.3 and Volume 10, Chapter 20 for further details). Similar programs employing a suite of noise and physical deterrents have been employed at the Ekati mine with success in preventing establishment of nests within active pits (ERM 2015b).

Raptor collisions with ground vehicles servicing the Project are expected to occur very rarely or not at all. The majority of roads for the Project will only be operational during the winter, when the only raptor species expected to occur are gyrfalcon, common raven, and snowy owl, and at very low densities (Section 10.1.3). Furthermore, traffic along the winter roads is expected to be infrequent and at a low speed (60 kph), with one truck per hour passing along any given point along the road during Construction, increasing to roughly two to three per hour during Operations (Section 7.5.2.3). Therefore, the likelihood of raptor-vehicle interactions along winter roads is low. This conclusion is supported by evidence from operating mines in the Arctic, many of which have all-weather road routes with higher traffic volumes year round. Only one rough-legged hawk and one common raven has been struck by a vehicle at the Ekati mine in nearly 20 years of operation ((ERM Rescan 2014b), and other operating mines such as Snap Lake, Diavik, Jericho, and Meadowbank have reported no vehicle-related mortality of raptors in recent years (Golder 2008; Gebauer 2010; Golder 2014, 2015). Each of these operating mines have wildlife carcass removal policies along all road routes, and prompt carcass removal has been attributed to the low frequency of raptors-vehicle encounters. Wildlife carcass removal will also be employed at the Project (Volume 10, Chapter 20), which will lessen the potential for scavenging raptors to be in close proximity to haul and winter road routes, thereby limiting the potential for interactions.

One nest site is located within the flight impact zone associated with the Goose Property airstrip. This nesting area was occupied by nesting pairs of two species (gyrfalcon and common raven) in 2013; in all other year, a single species occupied the nesting area (Table 10.5-8). Therefore, it is possible that up to two breeding pairs of raptors and their fledglings will be exposed to the risk of injury or mortality from collisions with aircraft servicing the Goose Property airstrip. Aircraft servicing the MLA will be landing on the water in Bathurst Inlet adjacent to the MLA, and thus the majority of the flight impact zone will be located over marine habitat. The closest known raptor nest site to the MLA is roughly 6.6 km to the west of the MLA, which is well outside a potential flight impact zone should it extent into

terrestrial habitat along the western shoreline. Thus there is no predicted interaction between the flight impact zone for the MLA and known raptor nesting habitat.

The overall likelihood of raptors being stuck by aircraft servicing the Goose Property is expected to be very low, as several operating mines in the region (e.g., Ekati, Snap Lake, Diavik) have not recorded a single incidence of a raptor-aircraft collision (ERM Rescan 2014b; Golder 2014; ERM 2015b; Golder 2015). The potential for aircraft collisions likely increases with increasing traffic volume. In urban areas where traffic is concentrated, collisions with aircraft and other vehicles result in reported annual mortality and injury to raptors (Blackwell and Wright 2006; Hager 2009).

Bird strikes is an important safety issue for air crews and passengers and all aircraft will have monitor and avoid raptors prior to landing or take-off. This monitoring for safety reasons will also mitigate potential effects on raptors. This type of monitoring is done at the Ekati mine (ERM Rescan 2014b), and has been implicated in the success in preventing wildlife-aircraft interactions at the runway. In flight raptor-aircraft collisions are expected to be very rare, as all aircraft associated with the Project will avoid raptors (and other birds) and maintain minimum flight altitudes above 300 m wherever possible (with the exception of take-off and landing), which is well above the altitude where the majority of collisions are known to occur at <150 m (Blackwell and Wright 2006).

Mitigation is anticipated to greatly lower and likely eliminate the effect of mortality and injury on raptors; however, due to interest from CWS in this potential effect, it is carried forward as a residual effect in the assessment.

10.5.2.5 Indirect Mortality

Wildlife mortality may indirectly result from the Project if hunting is facilitated by easier access to game species along the proposed winter roads. However, raptor species are rarely hunted. Socio-economic studies conducted in the Kitikmeot Region report that an increase in human immigration and hunting is unlikely in the Project area (Volume 8; Chapter 3). Road access will be restricted to Project employees, who will not be permitted to hunt. Thus, hunting of raptors is unlikely, and therefore, indirect mortality of raptors due to the Project is not anticipated to occur.

10.5.2.6 Attraction

Wildlife attractants refer to Project-related human activities, infrastructures, or environmental changes that are of interest or provide resources to wildlife. Attractants may include physical structures that provide habitat, or a high density of raptor prey species attracted to and thus concentrated at waste sites.

Raptors are primarily attracted to developments in the following ways:

- attraction to prey species that are attracted to domestic food waste;
- attraction to carrion at road kill sites; and
- attraction to pit walls and rock faces at quarry sites for nesting.

Once mitigation measures for proper domestic waste storage and incineration have been implemented, raptors are not expected to be attracted to waste sites.

The rough-legged hawk, golden eagle, and bald eagle eat carrion, and thus may be attracted to roadsides with a relatively high density of road kill, which may increase the potential for collisions of these raptors with vehicles (Whittington and Allen 2008). This potential effect will be reduced by the

use of winter haul roads only, and the removal of any road kill from access and haul roads. Thus, no residual effect on raptors of attraction to Project roadsides is predicted to occur.

The walls of the open pits and rock faces created at quarries may provide attractive nesting habitat for cliff-nesting raptor species. At the Ekati Diamond Mine, at least one raptor pair successfully produces fledglings on the rock faces of open pits each year (Rescan 2012b, 2013h; ERM Rescan 2014b; ERM 2015b). Similarly, nesting and successful fledging of young has been recorded at open pits and quarries at the Diavik and Meadowbank mines (Gebauer 2010; Golder 2014). Frequent observations of raptors nesting on cliff-faces of active quarries reveals high selection rates of quarries by raptors – 30% of surveyed quarries in Ireland were occupied by peregrine falcons, with no signs of avoidance of active quarries (49% of active quarries were occupied compared to 50% of inactive quarries; Moore et al. 1997).

The pits will become progressively deeper through operation, and thus the open pit walls may begin to resemble steep-sided cliffs with attractive nesting ledges for cliff-nesting raptors. The use of open pits and quarries by nesting raptors (and common ravens) has the potential to affect operation, as the *Nunavut Wildlife Act* prevents the destruction of nests occupied by a bird or its eggs. In addition, the common raven will likely be attracted to any tall vertical Project infrastructure for nesting. Therefore, the attraction of raptors to open pits for the purposes of nesting was further quantified and evaluated.

Calculation of Attraction Effects for Raptors

Attraction was quantitatively assessed based on the number of raptor pairs expected to colonize pit and quarry walls for nesting. Results of wildlife monitoring at Ekati were summarized to derive an estimated number of raptor pairs that may be attracted to the Project as nesting habitat. Open pits for the Project are expected to be smaller than those at Ekati, thus, estimates of the number of raptor pairs expected to colonize Project pit and quarry walls are considered to be a maximum.

Evaluation of Attraction Effects for Raptors

Monitoring of raptor nesting within the open pits at the Ekati mine shows that up to three breeding pairs will attempt to nest in one open pit in any given year (e.g., Rescan 2012b, 2013h). Open pits at the Ekati mine are more than three times larger than those planned for the Project. Thus, as a conservative estimate, roughly one pair may attempt to breed in each of the four open pits associated with the Project. The size of the largest proposed quarry relative to the Project open pits suggests that no more than one breeding pair is expected to be attracted to the quarry walls. Thus, the total number of nesting attempts that may be made in open pits and the quarry site is five when all pits and quarries are constructed. However, this number is likely an overestimate as some pits will be infilled and used as water storage areas, thereby reducing availability of suitable nesting habitat depending on the water level.

Monitoring of pit and quarry walls for evidence of nesting raptors will be conducted as part of the Wildlife Mitigation and Monitoring Program. If birds are attempting to nest within areas of active blasting, mitigation will be triggered and deterrents will be used to dissuade raptors from nesting within open pits, which could include noise deterrence, removal of nesting material prior to egg laying, of physical deterrents placed over established nest sites without eggs or attractive nesting ledges (see Section 10.5.3 and Volume 10, Chapter 20 for further details). Similar programs employing a suite of noise and physical deterrents have been employed at the Ekati mine with success in preventing establishment of nests within active pits, although potential nesting pairs (including peregrine falcon, common raven, and rough-legged hawk) continually returned to attempt to nest within an active pit and deterrence measures were required on numerous occasions throughout the breeding season to deter these individuals (ERM 2015b).

Mitigation cannot wholly eliminate the effect of attraction to pit walls by cliff-nesting raptors, as evidence recorded at the Ekati mine indicates that birds continually return to attractive nesting sites within open pits and deterrence measures are required throughout the breeding season to ensure that nests sites are not established. Mitigation will however ensure that raptors attracted to pits for the purposes of nesting will not be at elevated risk of mortality or injury (Section 10.5.3.4). Considering the above, a residual effect of attraction, albeit small, is expected to occur.

10.5.2.7 Exposure to Contaminants

Exposure to contaminants in raptors due to the Project was evaluated in the environmental risk assessment (Volume 8, Chapter 6) by evaluating the environmental media to which raptors may be exposed. Results of these assessments indicated that Project-related activities are not anticipated to alter the quality of vegetation, freshwater fish or small mammals at the Project site. Therefore, risks to raptors are considered to be negligible. Thus, a residual effect due to exposure to contaminants in raptors is not anticipated and is not considered further in the assessment.

10.5.2.8 Reduction in Reproductive Productivity

Reproductive productivity is quantified as the number of surviving young produced per year per female. Therefore, any Project-related effects that may affect the ability of females to produce and care for young, or reduce the survivorship of young could theoretically affect reproductive productivity. The effect of reduction in reproductive productivity was evaluated qualitatively as the number of breeding pairs that may be affected by Project-related effects acting synergistically.

The Project is expected to have residual effects on raptors through habitat loss, sensory disturbance, direct mortality, and attraction. The results of these assessments indicate that overall suitable habitat loss represents a relatively minor proportion (<5%) of the overall home range of a single raptor (based on a 12 km radius), and that noise disturbance may affect up to eleven breeding pairs using seven nest sites located 12 km from infrastructure areas at the Goose Property and the MLA. One of the aforementioned nests is within the Goose PDA and within the flight impact zone of the Goose Property airstrip, and up to two nesting pairs could be at a very low risk for injury or mortality as a result of an aircraft collision. The results of the evaluation of attraction suggest that five nesting attempts could occur within open pits and quarries in the Goose PDA.

The proceeding analysis identified up to 16 nesting pairs that are in an area where they could be affected by disturbance and attraction, with two of these nesting pairs at a very low risk of injury or mortality as a result of an aircraft collision. The salient question is then; what is the likely response of these birds to disturbance or attraction. In most cases, raptors appear to be robust to some low-level disturbance. In areas with greater disturbance, there are reports that disturbance can affect reproduction through nest abandonment, though the most common pathway is through increased vigilance and nest defense behaviours, leading to decreased nest attendance and provisioning of food and warmth to young (Steidl and Anthony 2000; Martínez-Abraín et al. 2010; Pagel, Whittington, and Allen 2010). The potential cumulative effects of mining developments on raptor nesting occupancy and hatch success was investigated surrounding the Ekati and Diavik mines utilizing raptor monitoring data collected from 1998 to 2010 (Coulton, Virgl, and English 2013). Hatch success was lower within an area 5.9 km from mine sites relative to areas further away, though the relationship was weak and potentially explained more by natural factors operating at a regional scale (e.g., weather) than more localized effects from the activity the mines (Coulton, Virgl, and English 2013). At the nearby Hope Bay Project, there appeared to be no effect of the mining project on raptor occupancy (use of nest sites) and productivity (young produced), with higher or equal occupancy and productivity near the project compared to control sites at a great distance (Rescan 2013g; ERM Rescan 2014a; ERM 2015a).

The effects of climate change on raptors are poorly understood, but one key concern is that climate change may have a large effect on breeding productivity. Observations captured using cameras at nests have revealed the possibility for large and detrimental impacts of climate change on reproductive productivity (Arctic Raptor Project 2010). Researchers have observed reproductive failure at the egg and chick stage for peregrine falcons in Nunavut due to unusually heavy rain events – a female was unable to incubate eggs at a flooded nest site, and at another nest, the rain-soaked nestlings died during a rain storm, probably due to hypothermia (Arctic Raptor Project 2010). As top predators in a harsh environment, Arctic-breeding raptors are specialist species and thus may have relatively little inherent flexibility to adapt to the rapid environmental change induced by climate warming. Alternatively, as specialist species, raptors may respond to environmental change with a high degree of sensitivity. Initial research has indicated that in general, raptor species are delaying fall migration later than other birds, and this effect is greatest in Arctic breeders (van Buskirk 2012). Of 15 raptor species studied to determine shifts in migration timing, the golden eagle, rough-legged hawk, and bald eagle showed the largest shifts to a later fall migration. Due to their more northerly distribution relative to the other species, this effect may indicate that the magnitude of climate-related effects on Arctic-breeding raptors may be larger relative to species with more southerly distributions (van Buskirk 2012). Monitoring of raptor population health throughout the life of the Project will be designed to distinguish Project-related effects from those occurring due to climate change (e.g., by ongoing monitoring in reference areas in addition to areas within the zone of influence of the Project).

Mitigation will reduce synergistic effects of multiple stressors on raptors, such that only a small portion of 16 pairs exposed to these stressors will experience declines in reproductive productivity. However, since the results of raptor monitoring at different mining projects is somewhat variable, following the cautionary approach a residual effect of reduction in reproductive productivity has been assigned to this effect.

10.5.3 Identification of Mitigation and Management Measures

The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10 Chapter 20) contains the mitigation and management actions that will be in place to reduce or eliminate potential effects to wildlife including raptors. In addition, there are a number of other mitigation and management plans in place to minimize potential Project-related effects to the environment in Volume 10.

A residual effect of the Project on raptors is anticipated resulting from habitat loss, disturbance due to noise, mortality and injury, attraction, and reduced reproductive productivity. The following sections describe the mitigation and management measures that may be conducted to minimize or eliminate potential Project-related effects to raptors. Since reduction in reproductive productivity is considered a potential consequence of the other potential effects, no mitigation or management is included specifically for this residual effect.

10.5.3.1 Mitigation for Habitat Loss

The primary mitigation and management strategies to minimize the effects of loss and degradation of vegetation are addressed in the Vegetation and Special Landscape Features chapter (Volume 5, Chapter 4) and are applicable to the loss of habitat for wildlife. Mitigation measures specific to minimizing the effects of habitat loss to raptors may include the following:

- Project infrastructure designed to avoid, where possible, the locations of identified cliff nests (Volume 10, Chapter 20); and
- Clearing and construction at sensitive locations for raptors (nest sites) to occur outside of the sensitive time periods (breeding period) (Volume 10, Chapter 20).

10.5.3.2 Mitigation for Disturbance

The primary mitigation and management strategies to minimize the effects of disturbance to raptors and other wildlife VECs are addressed in the Noise and Vibration Chapter (Volume 4, Chapter 2) and the Noise Abatement for Wildlife program (Volume 10, Chapter 20). Additional wildlife specific measures to minimize the effect of disturbance to raptors may include:

- Identification of raptor nests and instructions and maps for pilots to avoid nest areas (along with other sensitive wildlife features) (Volume 10, Chapter 20);
- if an active raptor nest is located within an area scheduled for clearing and construction during the wildlife sensitive period for raptors, then an appropriate no, or reduced work buffer will be set up and the nest will be monitored until the chicks fledge. Sabina will liaise with the Department of Environment, Nunavut to communicate that a nest has been found, the mitigation measures in place, and the results of monitoring (Volume 10, Chapter 20); and
- pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitudes when possible wherever wildlife species are observed.

10.5.3.3 Mitigation for Mortality and Injury

The primary mitigation and management strategies to minimize the effects of mortality and injury to raptors and other wildlife VECs are addressed in the Project Description (Volume 2, Chapter 2) and in the Road Management Plan (Volume 10, Chapter 14). Additional wildlife specific measures to minimize the effect of mortality and injury to raptors may include:

- conducting ground clearing outside of sensitive nesting periods for ground-nesting raptors (northern harrier and snowy and short-eared owls). Qualified biologists may conduct pre-clearing surveys for ground nesting raptor species if construction cannot be scheduled outside of sensitive nesting periods (Volume 10, Chapter 20).

10.5.3.4 Mitigation for Indirect Mortality

The primary mitigation and management strategies to minimize effects of indirect mortality to raptors and other wildlife VECs are described in the Socio-economics chapter (Volume 8, Chapter 3) the Socio-economic Monitoring Plan (Volume 10, Chapter 23). The following mitigation measures may apply to raptors:

- all Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance (Volume 10, Chapter 20); and
- a policy prohibiting hunting by Project personnel while on duty at the Project site (Volume 10, Chapter 23).

10.5.3.5 Mitigation for Attraction

The primary mitigation and management strategies to minimize effects of attraction to the Project to raptors and other wildlife are described in the Waste Management Plan (Volume 10, Chapter 10), the Incineration Management Plan (Volume 10 Chapter 11), and the Borrow Pits and quarry Management Plan (Volume 10, Chapter 16). The following mitigation measures may be applied:

- the open pits will be monitored for raptors attempting to nest in the pits. If a raptor attempts to nest adaptive management will be used to exclude raptors from the pit, with examples

including: the raptor will be deterred from the pit, the nest materials removed (if no egg has been laid) and the ledges where they attempted to nest will be covered with appropriate material to prevent further use by raptors (Volume 10, Chapter 20); and

- roadkill regularly removed along all-weather roads (Volume 10, Chapter 20).

10.5.3.6 Mitigation for Exposure to Contaminants

The primary mitigation and management strategies to minimize effects to the terrestrial environment (soil and vegetation) are already described in relation to air quality or freshwater quality mitigation measures. Mitigation measures intended to control fugitive dust or air pollution will also serve to limit deposition of contaminants to soil and vegetation. Mitigation and management strategies intended to control liquid effluents such as treatment of sewage, collection of site contact water into water management structures, and control of discharge from water management structures (only if water quality criteria in the future water license are met) will also serve to minimize potential effects to the quality of soil and vegetation within the wildlife LSA and RSA and thus, will help to minimize the effect of exposure of contaminants to raptors.

Mitigation and management measures to minimize the potential for effects to raptors from contaminants due to Project infrastructure, activities, or emissions (Volume 10, Chapter 20) may include:

- buildings designed and maintained to exclude wildlife, to minimize exposure to chemicals that may be stored inside (Volume 10, Chapter 20);
- WAD cyanide destruction inside the mill, to decrease the levels of cyanide that may be found in the TIA (Volume 2, Chapter 2);
- site roads and winter roads closed to the public and restricted to only persons required for the constructions, operation, and maintenance of the Project (Volume 10, Chapter 20);
- a policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees (Volume 10, Chapter 20);
- a no-littering policy developed, to minimize exposure of wildlife to contaminants that may be found in either the product or packaging (Volume 10, Chapter 20); and
- appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to wildlife (Volume 10 Chapter 20).

The wildlife mitigation and management strategies (WMMP Plan, Volume 10, Chapter 20), taken together with those outlined for air and water quality, will decrease the potential for contaminant exposure in wildlife.

10.5.4 Characterization of Residual Effects

Residual effects are those effects predicted to remain after the application of mitigation and management. Five potential effects were predicted to have residual effects after mitigation: direct habitat loss, disturbance, direct mortality, attraction and reduction in reproductive productivity. These effects are assessed for their significance in the section following.

10.5.4.1 Direct Habitat Loss

The effect on raptors of habitat loss and degradation as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because less than 1% of the cliff nesting habitat and ground nesting habitat available in the wildlife RSA will be affected.

Though habitat loss will be irreversible, this effect may be ameliorated by the expected creation of raptor nesting habitat on pit and quarry walls. The effect of direct habitat loss will occur sporadically over the long term, but will be limited to the Project footprint. Habitat loss is likely to occur, given that one nesting area that may be used by up to two nesting pairs is contained within the Goose PDA and is assessed as lost and the home ranges of an estimated six additional breeding pairs overlap the PDAs. However, habitat loss is assessed across the entire PDA, though actual loss of habitat will be less (roughly 10% or less of the PDA). Moreover, cliff sites are generally poor infrastructure building locations, so the Project will inherently avoid higher quality nesting sites for raptors. Therefore, it is unlikely that the nest site contained within the Goose PDA will be permanently lost.

The residual effect of direct habitat loss is expected to be Not Significant because of the relatively small area and low number of raptors (2 nests) potentially affected in the Project footprint and due to the mitigation measures planned for those raptors who may nest near the project site. Confidence is this assessment is high, because baseline surveys were thorough and thus there is a high degree of confidence that breeding home ranges of only a small proportion of the breeding population in the wildlife RSA overlap with the Project footprint.

10.5.4.2 Disturbance

The effect on raptors of disturbance as a result of construction and operation of the Project will be direct and negative. The magnitude of the effect is rated as low, because up to two pairs of raptors are expected to experience disturbances regularly within the Goose PDA, which represent less than 3% of the expected size of the breeding population in the wildlife RSA (of more than 81 breeding pairs annually, Section 10.1.5.2). Further, noise effects are predicted to extend over less than 1.5% of the suitable habitat available for raptors within the wildlife RSA. An additional nine pairs are expected to breed within 12 km of Project activities, but are expected to experience disturbance only while on foraging forays.

Indirect loss of raptor nest habitat may occur if these nest sites are abandoned due to disturbance, which is the most likely for the nest site located within the Goose PDA. As mentioned above, suitable nest sites may not be directly replicable by nearby unoccupied nest sites, and thus nest sites abandoned in response to sensory disturbance may not be replaceable by nearby unoccupied sites outside of the influence of disturbance. However, elsewhere raptors showed few behavioural responses to blasting beyond 550 m (Holthuijzen et al. 1990); thus, nest abandonment is not expected to occur. If it does occur, which is expected to be the largest effect of disturbance on raptors by the Project, the effect on the local population size of raptors is predicted to be of low magnitude.

Disturbance effects will be mitigated with flight altitude rules. Disturbance effects will be local, and limited to the breeding ranges of raptors experiencing disturbance, which is likely to be within approximately 12 km of Project activities. For the one to two pairs expected to breed within 1.5 km of the PDAs, disturbance effects are expected to be continuous for general Project noise, and sporadic for blasting and aircraft noise, with overall Project disturbance rated as sporadic and occurring over the medium term for all expected six raptor pairs that may interact with Project activities on their home range. Disturbance effects are likely to occur, given that raptor nesting has been recorded within the Goose PDA and this nest site will experience an exceedance of 12 dB as a result of general project noise; the effect of disturbance on raptors is reversible upon Project closure. Thus, the residual effect of disturbance is expected to be Not Significant. Confidence is this assessment is high, because raptors have been found to habituate to disturbances, and because there is a high degree of confidence that only a small proportion of the breeding population in the wildlife RSA will interact with the Project.

10.5.4.3 Direct Mortality and Injury

The effect of mortality and injury on raptors due to blasted rock and strikes with ground and air vehicles could be direct and negative. The magnitude of the effect is rated as low, because it is expected that only two breeding pairs of raptors and their fledglings (< 5% of the minimum population size of breeding raptor pairs in the wildlife RSA) have their nests in the fixed-wing aircraft approach and departure zones. The risk of mortality and injury may be mitigated by deterring raptors from nesting on pit and quarry walls, and flight altitude rules. Mortality and injury effects will be local and limited to the breeding ranges of affected raptors, which is likely to be within approximately 12 km of Project activities. Mortality and injury effects are expected to be sporadic over the medium term and reversible. As a conservative rating, the likelihood of occurrence was rated as moderate, given that up to two breeding pairs may nest within the flight impact zone of the Goose Property airstrip but that evidence collected at existing mines in the Arctic that have similar mitigation strategies as the Project indicate that incidences of raptor-vehicle interactions are very low and that there are no known accounts of aircraft-related mortality. Thus, the residual effect of direct mortality and injury is expected to be Not Significant. Confidence is this assessment is high, due to the evidence collected at existing mines in the Arctic that indicate that raptor mortality as a result of Project activities is very low.

10.5.4.4 Attraction

The effect of attraction to pit and quarry walls for nesting by breeding raptors may be direct and negative, for raptors that attempt to breed in active pits and quarries may subsequently experience stress, injury, or reduced productivity. The magnitude of the effect is rated as low, because though a maximum of five breeding pairs of raptors may be attracted to pit and quarry walls in one year, it is expected that a high proportion of these pairs would reproduce successfully. At Ekati mine, raptors have successfully reproduced at all pits, including those with active blasting and hauling (Rescan 2012b). However, to prevent contravention of the Nunavut *Wildlife Act*, raptors will be deterred from nesting on pit and quarry walls. For those that successfully colonize walls and initiate egg-laying, further mitigation measures will be undertaken to ensure these raptors are not physically injured in conjunction with advice from the GN DOE and other applicable authorities. Attraction effects are likely to occur sporadically within the Project footprint over the medium term, because the adverse effects of attraction will only occur during the life of the Project. These effects will be reversible when the project is closed. Thus, the residual effect of attraction is expected to be Not Significant. Confidence is this assessment is high, because other, similar, projects have not reported mortality due to raptors attempting to nest in pits.

10.5.4.5 Reduction in Reproductive Productivity

The effect of reduction of reproductive productivity of raptors may be direct and negative. The magnitude of the effect is rated as negligible, because only a small portion of the 16 breeding pairs that may be exposed to Project-related effects are expected to experience declines in reproductive productivity. Effects on reproductive productivity of these breeding pairs are expected to be infrequent and of low magnitude.

The largest effect of the Project will likely be a combination of sensory disturbance and attraction to pit and quarry walls (which then may cause subsequent disturbance to these pairs attempting to nest in these areas). The net effect of the Project on reproductive productivity may be positive based on observations of raptors successfully producing young from nest sites on pit walls at Ekati. Thus, negative effects on reproductive productivity are rated as unlikely, but should these occur, the effects are expected to occur locally and continuously over the medium term, but will be reversible upon Project closure. Thus, the residual effect of reproductive productivity is expected to be Not Significant. Confidence is this assessment is high, because raptors have been observed reproducing successfully in close proximity to industrial infrastructures and activities elsewhere in the Arctic and throughout North America.

10.5.5 Significance of Residual Effects

Considering the Project and the distribution of breeding raptors within the wildlife RSA, the assessment of residual effects resulted in a Not Significant rating for all five residual Project effects (Table 10.5-12):

- habitat Loss, rated Not Significant;
- disturbance due to noise, rated Not Significant;
- direct mortality and injury, rated Not Significant;
- attraction, rated Not Significant; and
- reduction in Reproductive Productivity, rated Not Significant.

Contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10; Chapter 20), the combined significance of residual effects for raptors is predicted to be **Not Significant** (Table 10.5-12).

10.6 POTENTIAL CUMULATIVE EFFECTS ASSESSMENT

10.6.1 Methodology Overview of Cumulative Effects

The potential for cumulative effects to occur arises when the residual effects of a Project affect (i.e., overlap and interact with) the same VEC that is affected by the residual effects of other past, existing or reasonably foreseeable projects or activities.

The cumulative effect assessment (CEA) general methodology is detailed in Volume 9, Chapter 1, and is comprised of the following activities:

1. Undertaking a scoping exercise to identify the potential for Project-related residual effects to interact with residual effects from other human activities and projects within a specified CEA boundary. For wildlife, this boundary is typically defined by the home range of a wildlife VEC within the particular life cycle season which the Project may influence the VEC.
2. Identifying and predicting potential cumulative effects that may occur and implementing additional mitigation measures to minimize the potential for cumulative effects where possible.
3. Identifying cumulative residual effects after the implementation of mitigation measures.
4. Determining the significance of any cumulative residual effects.

In addition, the contribution of the Project to the overall cumulative effect on the VEC is assessed to identify how much of the cumulative effect can be apportioned to the Project as compared to other projects and activities within the CEA boundary for the VEC. Two assessment scenarios are analyzed to understand the Project's potential incremental contribution to the potential cumulative effect: 1) Future case without the Project; and 2) Future case with the Project (Volume 9, Chapter 1).

The cumulative residual effects are rated for only those including the Future case with the Project using the same criteria applied in the Project-related effect assessment methodology (Volume 9, Chapter 1). Indicators and ratings used for assessing the magnitude of residual cumulative effects were the same as those used for assessing the magnitude of Project-related residual effects (Table 10.5-2).

The overall significance of the cumulative residual effect was determined based on the same eight attributes used for rating the significance of Project-related effects: direction, magnitude, duration, frequency, geographic extent, reversibility, probability of occurrence, and confidence in the analyses and conclusions (Volume 9, Chapter 1) and wildlife specific definitions (Section 10.5.1.3).

Table 10.5-12. Summary of Residual Effects Assessment for Raptors Resulting in Overall Significance Rating

	Significance Criteria			Likelihood of Occurrence			Overall Significance Rating		
Description of Residual Effects	**Direction** *(positive, neutral, negative)*	**Magnitude** *(negligible, low, moderate, high)*	**Duration** *(short, medium, long)*	**Frequency** *(once, sporadic, continuous)*	**Geographic Extent** *(footprint, local, regional, beyond regional)*	**Reversibility** *(reversible, reversible with effort, irreversible)*	**Probability** *(unlikely, moderate, likely)*	**Confidence** *(low, medium, high)*	**Not significant** *(N)*; **Significant** *(S)*; **Positive** *(P)*
Habitat Loss	Negative	Low	Long	Sporadic	Footprint	Irreversible	Likely	High	**N**
Disturbance	Negative	Low	Medium	Sporadic	Local	Reversible	Likely	High	**N**
Direct Mortality and Injury	Negative	Low	Medium	Sporadic	Local	Reversible	Moderate	High	**N**
Attraction	Negative	Low	Medium	Sporadic	Footprint	Reversible with effort	Likely	High	**N**
Reduction in Reproductive Productivity	Negative	Low	Medium	Sporadic	Local	Reversible	Unlikely	High	**N**

10.6.1.1 Spatial Boundary

The spatial boundary used for the raptor potential cumulative effects assessment was a circle extending 12 km from all Project PDAs; each circle is contained within the boundaries of the wildlife RSA. Twelve km is the maximum width of a home range for reported for raptor species occurring in Nunavut (Section 10.5.2.2) and was used to determine if a raptor home range may overlay projects adjacent to the Project and be subject to potential cumulative effects.

10.6.1.2 Temporal Boundary

The temporal boundary used for the potential cumulative effects assessment was past, present, and reasonably foreseeable projects. A list of potential projects is included in the general assessment methodology (Volume 9; Chapter 1).

10.6.2 Potential Interactions of Residual Effects with Other Projects

Residual effects of the Project on raptors are predicted for habitat loss, disturbance, direct mortality and injury, attraction, and reduction in reproductive productivity (Section 10.5, Table 10.5-12). Based on observations of raptors colonizing the walls of open mine pits and quarries elsewhere, most residual Project effects are expected to result from attraction of raptors to Project quarry and open pit walls during Project construction and operation. Given observations of successful reproduction of raptors within industrial blasting zones and at nest sites on pit walls at Ekati mine, the magnitude of this effect on the local raptor population is expected to be low, and no declines in raptor population abundance are expected.

To determine the potential for cumulative effects on raptors, it was determined whether raptors expected to interact with the Project are likely to regularly interact with nearby past, existing and future projects. The zone of influence of the Project on raptors is estimated to be 12 km in radius, corresponding to the maximum expected home range radius of breeding raptors (Section 10.1.4, Table 10.1-1).

The nearest project to the Goose Property is the proposed George project, located approximately 62 km to the northwest of the Goose Property. The George project was included in the Back River DEIS as a part of the Back River Project, but is considered in the FEIS as a reasonably foreseeable project. It is located within the RSA and the construction and operation phases will add accommodations for up to 150 workers to the 58 that currently exist at the Exploration Camp. The George project, should it proceed, will require waste rock storage areas (WRSAs), bulk fuel storage tanks, diesel power plant, laydown yards, all weather airstrip, maintenance shop, accommodations camp, water and domestic waste management facilities, and satellite communications. All processing of ore for the George project is planned to be done at Goose Site, only mining and activities in support of mining are planned for the George project.

The closest project to the MLA is the Proposed Bathurst Inlet Port and Road (BIPR) project, a proposed all-weather road 75 km from the Goose Property, with a port site approximately 15 km from the MLA (Volume 9, Table 1.3-1).

Therefore, both the George and the Bathurst Inlet Port and Road projects are located outside the zone of influence of the Project. Thus, no cumulative effects of the Project on raptors are expected to occur, because it is expected that raptors interacting with the Project will not regularly interact with other nearby projects.

10.7 TRANSBOUNDARY EFFECTS

All Project residual effects were confined to the wildlife LSA, and there were no residual cumulative effects. The wildlife LSA lies completely within Nunavut; therefore, no transboundary effects are expected.

10.8 MITIGATION AND ADAPTIVE MANAGEMENT

Many mitigation and management plans will be in place to minimize or eliminate potential effects on the VEC raptors in Volume 10. The Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10, Chapter 20) contains the management measures that will be in place to reduce or eliminate potential effects to wildlife including raptors. Mitigation measures specific to raptors are listed in Section 10.5.3, and summarized in Table 10.8-1 in Section 10.8.5.

In addition, a number of mitigation and management measures will be in place to minimize potential Project-related effects to air quality, water/sediment quality, and soil. These mitigation and management measures will also serve to protect wildlife including raptors. Details of these strategies can also be found in the following chapters:

- Vegetation: Volume 5, Chapter 4;
- Noise and Vibration: Volume 4, Chapter 2. The Noise Abatement Plan can be found in Volume 10, Chapter 18;
- Air Quality: Volume 4, Chapter 1. The Air Quality Monitoring and Management Plan can be found in Volume 10, Chapter 17 and the Incineration Management Plan can be found in Volume 10, Chapter 11;
- Freshwater Water, Sediment, and Fish: Volume 6, Chapters 4, 5, 6, and 7. The Aquatic Effect Management Plan can be found in Volume 10, Chapter 19.

Other management plans will also be implemented to protect the environment, details of which are found in the following chapters of Volume 10:

- Risk Management and Emergency Response Plan: Chapter 3.
- Fuel Management Plan: Chapter 4.
- Spill Contingency Plans: Chapter 5.
- Oil Pollution Emergency Plan: Chapter 6.
- Site Water Monitoring and Management Plan: Chapter 7.
- Ore Storage Management Plan: Chapter 8.
- Mine Waste Rock Management Plan: Chapter 9.
- Waste Management Plan: Chapter 10.
- Hazardous Materials Management Plan: Chapter 12.
- Explosives Management Plan: Chapter 13.
- Road Management Plan: Chapter 14.
- Shipping Management Plan: Chapter 15.
- Borrow Pits and Quarry Management Plan: Chapter 16.
- Fish Offsetting Plan: Chapter 21

- Tailings Management Plan: Chapter 22.
- Socio-economic Monitoring Plan: Chapter 23.
- Mine Closure and Reclamation Plan: Chapter 29.

10.8.1 Mitigation by Project Design

Mitigation for potential effects of the Project on wildlife was taken into consideration in the design of the Project. A key mitigation strategy is the use of baseline data on the distribution and movements of wildlife to ensure that Project infrastructure avoids key wildlife habitat, such as the location of raptor nest sites. The process of Project design and avoidance was conducted during the preparation phase for the DEIS, during the regulatory review of the DEIS, and preparation of the FEIS, and the FEIS evaluates the potential for effects given the locations of Project infrastructure and timing of Project activities in the redesign of Project elements. Table 10.8-1 in Section 10.8.5 lists mitigation measures that have been incorporated into the Project design to minimize effects on all wildlife species including raptors.

10.8.2 Best Management Practices

The WMMP Plan (Volume 10, Chapter 20) includes eleven separate plans designed to eliminate or minimize effects of the Project on wildlife. The plans are focused on distinct sources of effects on wildlife, including roads, noise, wastes, and aircraft, and on strategies to minimize attractants and ensuing problem wildlife. Best management practices to mitigate effects to raptors are listed in Section 10.5.3, and listed in Table 10.8-1 in Section 10.8.5.

10.8.3 Adaptive Management

Wildlife management for the Project will be undertaken using an adaptive management approach. Mitigation and management strategies reflect current best management practices, but these may need to be reviewed periodically to ensure they remain effective in minimizing effects to wildlife. This review process will be guided by information gathered from the Wildlife Effects Monitoring Program (WEMP) detailed in the WMMP (Volume 10, Chapter 20) and scientific knowledge. Newly-devised best management guidelines from collaborating organizations or regulators will be integrated should they be appropriate and become available. The mitigation and management strategies in the WMMP may be amended pending further literature reviews, scientific findings and management needs. An adaptive management approach will allow timely response to concerns as they arise throughout the life of the Project.

The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may occur:

- if negative wildlife interactions become a concern; or
- if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.

The Wildlife Mitigation and Monitoring Plan will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

10.8.4 Monitoring

As part of the WMMP Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in

reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring: facility-specific monitoring, and focal-species monitoring.

10.8.5 Summary Table of General Wildlife Mitigation and Adaptive Management Measures

Table 10.8-1 includes all planed mitigation and adaptive management measures that may be applied to mitigate the effects of the Project on raptors.

Table 10.8-1. Summary of Mitigation and Management Measures Applicable to Raptors

Mitigation Category	Mitigation Measures
1. Mitigation by Project Design	
	1. Project infrastructure designed to avoid, where possible, the locations of identified cliff nests.
	2. Winter road access corridors only (no all-weather roads for re-supply routes).
	3. Buildings designed and maintained to exclude wildlife.
	4. WAD cyanide destruction inside the mill.
2. Best Management Practices	
	1. Pre-construction ground clearing conducted outside of sensitive periods for ground-nesting raptors, where possible.
	2. Identification and avoidance of sensitive raptor habitats by helicopters, where possible.
	3. Minimum flight elevations established within 1.5 km of known active raptor nests, provided safety and weather conditions allow.
	4. Pilot education to instruct pilots as to the negative effects of overflights on wildlife species and maintaining minimum prescribed altitudes when possible wherever wildlife species are observed.
	5. All Project roads closed to the public including private vehicles (snowmobile, all-terrain vehicles, etc.) and all foot traffic and road use restricted only to persons required for Project construction, operations and maintenance.
	6. Roadkill regularly removed along roads.
	7. Exclusion of raptors from open pits when in use to prevent nesting in the pits.
	8. A policy of no feeding and no intentional attraction of wildlife developed and disseminated to all Project and contractor employees.
	9. A no-littering policy developed, and disseminated to all Project and contractor employees during employee orientation, continued throughout the life of the Project, and enforced.
	10. A policy prohibiting hunting by Project employees and contractors while on site.
	11. Wildlife exclusion measures implemented if raptors are frequently accessing or attempting to access waste storage areas.
	12. Appropriate measures taken to exclude wildlife from areas where water or waste could pose a risk to health of raptors.
	13. An Employee Wildlife Education Program developed for all site staff and contractors to ensure awareness of applicable wildlife sensitive issues and mitigation measures.
3. Adaptive Management	
	1. The need for any corrective actions to on-site management or installation of additional control measures will be determined on a case-by-case basis. Indications of the need for corrective actions and additional control measures may be included: • if negative wildlife interactions become a concern, or • if results from the WEMP, which will monitor wildlife around the mine infrastructure and activities, show adverse effects to wildlife.
	2. The Wildlife Mitigation & Monitoring Plan (which outlines the monitoring program) will be updated as needed following changes to current standards as defined by community, scientific, or regulatory bodies.

(continued)

Table 10.8-1. Summary of Mitigation and Management Measures Applicable to Raptors (completed)

Mitigation Category	Mitigation Measures
4. Monitoring	Facility-specific monitoring program to assess the effectiveness of mitigation measures used to minimize effects of the Project on wildlife. This program will include several monitoring plans relevant to raptors including:: 1. footprint monitoring to monitor habitat loss; 2. noise monitoring to monitor disturbance to wildlife; 3. human activity monitoring of Project site roads and winter roads; 4. pre-clearing surveys to identify active bird nests at risk of disturbance from vegetation clearing; 5. pit and quarry monitoring to identify raptors at active nests that may be at risk of disturbance from blasting activities; 6. waste management monitoring to ensure that wastes are being properly disposed of and that wildlife do not have access to these wastes; 7. wildlife-vehicle interaction monitoring to document wildlife-vehicle collisions, to identify sections of road where wildlife might be at risk of collisions and to develop mitigation measures to minimize wildlife-vehicle interactions; and 8. incidental raptor reporting to record general wildlife activity in the Project area and identify unexpected or potential conflicts posed by the Project facilities to wildlife and adaptively manage conflicts where possible. Focal-species monitoring program to evaluate predictions in the effects assessment on raptors. This plan may include: 1. monitoring raptor nests in the wildlife RSA for occupancy and productivity; and 2. incidental reporting of raptors when observed during other wildlife and environmental monitoring programs.

10.9 PROPOSED MONITORING PROGRAMS

As part of the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10; Chapter 20) that was developed for the Project, a Wildlife Effects Monitoring Program (WEMP) will be implemented to evaluate the effectiveness of mitigation in reducing residual effects on wildlife VECs. The proposed WEMP will be comprised of two types of monitoring:

1. Facility-specific monitoring is designed to:
   - monitor wildlife interactions with Project Infrastructure;
   - monitor mitigation actions and their efficacy; and
   - identify opportunities for adaptive management.
2. Focal-species monitoring is designed to:
   - evaluate impact predictions in the effects assessment;
   - continuously reduce uncertainty of Project effects on wildlife; and
   - collaborate with other industry parties, government, and Inuit peoples in the event that long-term wildlife monitoring programs are initiated in the Kitikmeot Region of Nunavut.

Details specific to these monitoring programs can be found in the WMMP Plan (Volume 10, Chapter 20). Strategies specific to raptors are summarized in the following sections.

10.9.1 Facility-specific Monitoring

Certain Project facilities, structures, and activities pose potential obstacles and hazards for wildlife. These facilities will be monitored to determine whether wildlife effects are occurring and to ensure that mitigation commitments are being implemented and are effective.

Facilities that will be monitored for wildlife effects include:

- Project site roads and winter roads (when actively used or when road construction is taking place);
- active mine sites: Goose Property Area;
- the Marine Laydown Area; and
- areas with exploration drilling activities.

The facility-specific monitoring program will include the following and is detailed in the WMMP Plan (Volume 10, Chapter 20):

- Footprint Monitoring;
- Human Activity Monitoring;
- Pre-clearing Surveys for Nests;
- Pit and Quarry Wall Nest Monitoring;
- Waste Management Monitoring;
- Infrastructure Monitoring;
- Wildlife-vehicle Interactions Monitoring;
- On-ice Monitoring at the MLA;
- Incidental Wildlife Monitoring;
- Noise Monitoring;
- Waterbird Monitoring in Ponds; and
- Pre-construction Surveys for Bear Dens.

10.9.2 Focal-species Monitoring of the WEMP

The proposed focal-species monitoring program will include monitoring of raptors within the wildlife RSA (Volume 10, Chapter 20). The WEMP outlines proposed monitoring for raptors every year during construction, and every three years in during operations. Raptor breeding sites in the wildlife RSA will be monitored to determine distribution, occupancy, and productivity at historic and new nest sites in the wildlife RSA. The survey methods will follow previously established protocols used during baseline surveys. Analyses will be conducted to determine trends over time in the distribution, occupancy rate, and productivity rate of raptors in relation to mine infrastructure. Nests within 1.5 km of Project infrastructure will be a priority for monitoring in addition to nests in an undisturbed reference area located within 10 km of the Project the wildlife RSA (Figure 10.1-1).

10.10 IMPACT STATEMENT

A review of the Project activities identified eight potential effects that may occur due to the construction and operation of the Project. These eight potential effects are: loss of habitat,

disturbance, disruption of movement, direct mortality and injury, indirect mortality, exposure to contaminants, attraction to infrastructure, and reduction in reproductive productivity. This last potential effect was included to evaluate additive interactions between the other potential effects.

Project-related effects can occur at the scale of individuals, resulting in changes to behaviour, physiological condition, reproductive productivity, and survival. Effects on individuals can have population-level consequences, such as changes in population size, spatial distribution, and reproductive and mortality rates. Effects that result in population-level consequences are of greater concern than effects on individuals, especially if these result in population decline. Thus, sustained population health of raptors was used as the key criterion to assess potential residual effects.

Consideration of the mitigation and management activities planned to reduce potential effects on raptors resulted in the identification of five potential effects as likely having residual effects after mitigation: habitat loss, disturbance, direct mortality and injury, attraction and reduced reproductive productivity. Each of these residual effects were rated with a low magnitude and are rated as **Not Significant**, contingent on the implementation of mitigation measures outlined in the Wildlife Mitigation and Monitoring Program (WMMP) Plan (Volume 10; Chapter 20).

Relative to other residual effects, the effect of sensory disturbance and attraction on raptors is expected to result in the largest residual effect on the raptor population within the wildlife RSA. These effects may manifest in up to 16 breeding pairs or 20% of the expected breeding population. However, evidence from existing mines in the Arctic indicate that raptors can and do successfully nest in areas of disturbance, which suggests that the effects of disturbance may not always translate into reductions in productivity. Further, the mitigation measures included in Volume 10, Chapter 20 to reduce attraction to open pits and quarries have been proven successful at the Ekati mine to prevent successful establishments of nests, although such measures cannot wholly eliminate the potential for attraction. Therefore, the magnitude of this effect on the local raptor population is expected to be low. Ongoing monitoring will measure this effect to determine whether further mitigation measures are needed. Overall, Project effects on raptors are rated as **Not Significant**. It is expected that raptors interacting with the Project will not regularly interact with the two foreseeable future project located in the wildlife RSA (the George and BIPR projects), and thus no cumulative effects of the Project on raptors are expected to occur.

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Sabina
GOLD & SILVER CORP.

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Acronyms and Abbreviations section.

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