9 Effects Assessment for Vegetation

9.1 Scope of the Assessment for Vegetation

9.1.1 Project-Environment Interactions and Effects

Project activities during construction, operation and final closure have the potential to affect vegetation abundance and community diversity, and vegetation quality within the Kiggavik RAA. Key issues related to effects on vegetation include:

- direct loss of vegetation and community diversity due to site clearing and pad construction, as well as construction of freshwater diversions, site drainage containment systems and water/shoreline structures
- deterioration of vegetation quality due to air emissions, including dust deposition, due to Project activities that emit particulates or contaminants, or create dust.

Refer to Table 5.5-1 for potential interactions between all Project activities and vegetation along with rationale for Project–vegetation interactions ranked as 1. Interactions ranked as 2 in Table 5.5-1 are examined further here.

Key Project activities that could affect vegetation abundance and community diversity, and vegetation quality are outlined in Table 9.1-1.

Table 9.1-1 Project-Environment Interactions and Effects on Vegetation

Project Component	Project Activities	Environmental Effect	
		Change in Vegetation Abundance and Community Diversity	**Change in Vegetation Quality**
Construction			
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	2	0
	Construct in-water/shoreline structures	2	0

Table 9.1-1 Project-Environment Interactions and Effects on Vegetation

Project Component	Project Activities	Environmental Effect	
		Change in Vegetation Abundance and Community Diversity	Change in Vegetation Quality
On-Land Construction	Site clearing and pad construction (blasting, earth-moving, loading, hauling, dumping, crushing)	2	2
	Road and airstrip construction	2	2
	Aggregate sourcing	2	2
Supporting Activities	Transport fuel and construction materials	0	2
	Industrial machinery operation	0	2
	Power generation	0	2
Operation			
Mining	Mining ore (blasting, loading, hauling)	0	2
	Ore stockpiling	0	2
	Mining special waste (blasting, loading, hauling)	0	2
	Special waste stockpiling	0	2
	Mining clean waste (blasting, loading, hauling)	0	2
	Clean rock stockpiling	0	2
	Underground ventilation	0	2
Milling	Transfer ore to mill	0	2
	Crushing and grinding	0	2
General Services	Generation of power	0	2
Transportation	Truck transportation	0	2
Final Closure			
General	Industrial machinery operation	0	2
On-land Decommissioning	Remove site pads (blasting, earth-moving, loading, hauling, dumping)	0	2
NOTE: See definitions of rankings in Table 5.5-1			

9.1.2 Measurable Parameters

Table 9.1-2 lists the measurable parameters used to assess Project effects on vegetation abundance, community diversity, and vegetation quality, as well as the rationale for their selection.

Table 9.1-2 Measureable Parameters for Vegetation

VEC	Environmental Effect	Measurable Parameters	Rationale
Vegetation	Change in vegetation abundance	Direct loss of ELC units from Project footprint (km^2)	Direct loss of vegetation may influence biodiversity, which territorial legislation aims to protect
		Direct loss of ELC units that support species of value to Inuit	
	Change in community diversity	Indirect loss from dust deposition and changes in soil chemistry	Dust deposition can influence vegetation abundance and community diversity
	Change in vegetation quality	Change in concentration of COPC in vegetation	Air emissions and dust deposition on vegetation may affect vegetation quality
			Effects on vegetation consumed by animals and people were identified during public engagement sessions

9.1.3 Residual Environmental Effects Criteria for Vegetation

Residual effects on vegetation are characterized quantitatively and qualitatively using the following attributes: direction, magnitude, geographic extent, duration, frequency, and reversibility. Table 9-1-3 provides definitions for these attributes.

Table 9.1-3 Residual Environmental Effects Criteria for Vegetation

Attribute	Rating	Definition
Direction	Positive	Improvement in vegetation abundance and community diversity, or vegetation quality relative to baseline conditions.
	Neutral	No change in vegetation abundance and community diversity, or vegetation quality relative to baseline conditions.
	Adverse	Reduction in vegetation abundance and community diversity, or vegetation quality relative to baseline conditions.
Magnitude	Negligible	No measurable change in vegetation abundance and community diversity, or vegetation quality.
	Low	Effect on one or more of the measurable parameters is detectable, but within the range of natural variation or baseline values; therefore, no change in vegetation abundance and community diversity, or vegetation quality.
	Moderate	Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values, but is unlikely to change vegetation abundance and community diversity, or vegetation quality.
	High	Effect on one or more of the measurable parameters is detectable and outside the range of natural variation or baseline values; therefore, a change in vegetation abundance and community diversity, or vegetation quality is evident.
Geographic Extent	Site	Effect confined to specific features within Project footprint.
	Local	Effect confined to the LAA.
	Regional	Effect extends beyond the LAA but within the RAA.
Frequency	Once	Effect occurs once.
	Sporadic	Effect occurs more than once, but at unpredictable intervals.
	Regularly	Effect occurs repeatedly at regular intervals.
	Continuous	Effect occurs continuously throughout the Project.
Duration	Short term	Changes in vegetation abundance and community diversity, or vegetation quality are no longer detectable at the end of construction.
	Medium term	Changes in vegetation abundance and community diversity, or vegetation quality are no longer detectable at the end of final closure.
	Long term	Changes in vegetation abundance and community diversity, or vegetation quality extend beyond the life of the Project.
Reversibility	Reversible	Effect on vegetation is reversible over human scale lifetime.
	Irreversible	Effect is not reversible, or will only reverse on geologic time line (e.g. thousands of years).
Environmental Context	Disturbed	Area has been substantially disturbed previously by human development, or human development is still present.
	Not Disturbed	Area has not been disturbed by human development.

9.1.4 Standards or Thresholds for Determining Significance

9.1.4.1 Vegetation Abundance and Community Diversity

In the absence of threshold values for changes in vegetation abundance and community diversity, the significance of Project effects is based on the number of hectares disturbed of each ELC map unit (i.e., vegetation community) within the respective LAAs. This includes determination of the amount of wetland area disturbed by the Project to comply with the Federal Policy on Wetland Conservation, which has a goal of No Net Loss of wetland function on federal lands and waters.

9.1.4.2 Vegetation Quality

Threshold values for NO_2 and SO_2 concentrations were obtained from the World Health Organization (WHO 2000). The values used in this assessment are:

- annual atmospheric concentrations of SO2 greater than 10 µg/m3/year for lichen
- annual atmospheric concentrations of SO2 greater than 20 µg/m3/year for all other vegetation
- annual atmospheric concentrations of NO2 greater than19 µg/m3/year (assuming NO2 represents 63% of NOx, which is greater than 30 µg/m3/year)

Exceedances of these threshold values have the potential to cause adverse effects in vegetation, with the potential of affecting a plant's growth and yield, as well as potentially changing a plant's sensitivity to other environmental stressors (WHO 2000).

There are no established thresholds for vegetation exposure to dust deposition; however, thresholds for dust pertaining to human health do exist. While the physical and chemical characteristics of dust can vary, the resiliency and tolerance among vegetation species to dust can also vary. For example, Spatt and Miller (1981) noted that sphagnum productivity was affected by dust deposition at a rate of 0.07 g/m^2/day. Auerbach et al. (1997) found that graminoids and deciduous shrubs have an increased biomass in dust-prone areas adjacent to roads in tundra environments; however, the dust deposition rate was not measured. Within Canada, Alberta and Ontario have air quality guidelines that address nuisance dust deposition on human health in residential areas, with threshold values of 5.3 g/m^2/30 days (AENV 2011) and 4.6 g/m^2/30 days (OMOE 2008), respectively.

Threshold values used for this assessment are based on the findings of Spatt and Miller (1981), and the Ontario air quality guidelines for dust deposition on human health (the most conservative guideline as noted above). The rates were converted from a daily and monthly rate to a cumulative total annual deposition rate for comparative purposes, as follows.

- Cumulative total of 25 g/m^2/year are predicted to have effects on vegetation quality for some vegetation species (conversion of 0.07 g/m2/day on sphagnum).
- Cumulative total of 55 g/m^2/year are predicted to cover vegetation with nuisance dust, which may further affect vegetation quality among species (conversion of 4.6 g/m^2/30days for nuisance dust).

Threshold values for PAI on vegetation do not exist. However, the critical load threshold value of 0.25 keq/ha/year for soils was used to identify areas where vegetation may potentially be exposed to high PAI. As stated in CASA (1999), exceedances above the critical load threshold do not mean environmental damage will occur; rather, there is the potential for an effect from PAI on the environment if deposition above the critical load is sustained over many years.

Threshold values for COPC phytotoxicity concentrations do not exist for all types of vegetation, or all COPCs. Where appropriate, phytotoxicity concentrations were obtained from various sources of published literature (Tier 3, Technical Appendix 8A).

A confidence rating is applied to the significance determination for any residual effects on vegetation. The rating considers the accuracy of the data used for baseline and application of analytical tools, an understanding of the effectiveness of mitigation measures, and an understanding of known responses of the measurable parameters to potential Project effects. The confidence ratings are:

- Low – not confident in prediction, could vary considerably
- Moderate – confident in prediction, moderate variability
- High – confident in prediction, low variability.

9.1.5 Influence of Inuit Qaujimajatuqangit and Stakeholder Engagement on the Assessment

Feedback received through Inuit Qaujimajatuqangit (IQ) interviews and engagement activites influenced the assessment of effects for vegetation through identification of issues (Section 5.1), selection of VECs (Section 5.4), assessment approach (vegetation quality and quantity assessed in Section 9), and design of mitigation and monitoring plans. Refer to Section 5.2 for additional discussion of the influence of IQ and stakeholder engagement on the vegetation assessment.

Comments were received about the importance of plants including berries in traditional diets (IQ-RBH 2011[148], IQ-BLE 2009[149], IQ-Mannik 1998[150]). Efforts were made to identify the Ecological Land Classification (ELC) map units that contain berry-producing plants, and Project effects to these map units are addressed in Section 9. Because of community comments received, berries and medicinal teas were included in human receptor dietary characteristics for the Kiggavik Project (Tier 3, Technical Appendix 8A).

The role of vegetation in the ecosystem (e.g. habitat and food for wildlife) demonstrates the IQ guiding principle (GN 2009) of Avatimik Kamattiarniq which is the concept of environmental stewardship: people are stewards of the environment and must treat all of nature holistically and with respect, because humans, wildlife and habitat are inter-connected (IQ-Nunavut Tunngavik Inc. 2005[151]). Plants such as lichen are important because they provide habitat for wildlife and are a food source for important species such as caribou and muskoxen, as well as for small mammals and birds (IQ-CI03 2009[152], EN-BL OH Nov 2013[153]). Changes in vegetation quantity, which may subsequently influence wildlife habitat, are assessed in this section.

Concerns were raised about the potential contamination of vegetation from Project activities (IQ-ARHT 2009[154], EN-BL OH Oct 2012[155]). People described experiences with dust from existing roads

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[148] IQ-RBH 2011: *The following plants and berries are consumed: broadleaf willow (seed pods), fireweed, dwarf fireweed (leaves and flowers), lousewort (roots), bearberries, blackberries (crowberries), blueberries, purple mountain saxafrage (flowers).*

[149] IQ-BLE 2009: *Elders said that traditional cures were no longer used, adding that crowberries, blueberries, blackberries, and 'red' berries were harvested for food.*

[150] IQ-Mannik 1998: *People started using dried ground plants and leaves such as those from the cloudberry bush, after the introduction of tea by Europeans.*

[151] IQ-Nunavut Tunngavik Inc. 2005: *the health of Inuit, of wildlife and of the environment are interconnected*

[152] IQ-CI03 2009: *Musk ox stay in an area where there is vegetation, and only move when it is gone.*

[153] EN-BL OH Nov 2013: *What about the environment? How do you know what is in the air and water and lichen that caribou eat?*

[154] IQ-ARHT 2009: *Hunters and elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

[155] EN-BL OH Oct 2012: *Will the berries and animals be protected if your mine goes ahead?*

and asked AREVA to minimize dust as much as possible (IQ-BLHT 2011[156], EN-BL EL Oct 2012[157]). Air dispersion modelling was completed to predict the dispersal patterns of dust created at the mine sites. Concerns about potential contamination of vegetation from COPCs and dust influenced the inclusion of vegetation quality as an environmental effect endpoint in this assessment. The importance of vegetation, including berries and lichen, in the Arctic foodweb was noted during IQ interviews and engagement feedback. Project-related effects associated with constituents of potential concern (COPCs) in vegetation such as berries and lichen and their potential effects on animals and humans is described in the Ecological and Human Health Risk Assessment report (Tier 3, Technical Technical Appendix 8A).

A number of design and management mitigation measures will be employed to reduce potential effects of air emissions on vegetation (Tier 2, Volume 6, Section 9.6.2 and Tier 3, Technical Appendix 4C). In addition, vegetation will be monitored during operations and decommissioning to address community concerns about potential contamination of or changes to vegetation communities resulting from Project activities. This includes sampling and analyzing plants (vegetation quality monitoring) as well as monitoring vegetation communities (e.g. diversity, density). Vegetation quality monitoring results will be compared to baseline values and compared to predictions from this environmental assessment (Section 9). Vegetation quality monitoring results will also be used to update the ecological and human health risk assessment as required (Tier 3, Technical Appendix 8A). Vegetation monitoring results will be considered along with air emissions and dust deposition to verify predictions for vegetation quality.

[156] IQ-BLHT 2011: *be aware that the road to Meadowbank produces a lot of dust in the summertime. Caribou feed on grass close to the road; this grass is full of dust. If you are going to build a road, try to minimize dust.*

[157] EN-BL EL Oct 2012: *Near my house there is lots of dust on the plants from traffic on the roads.*

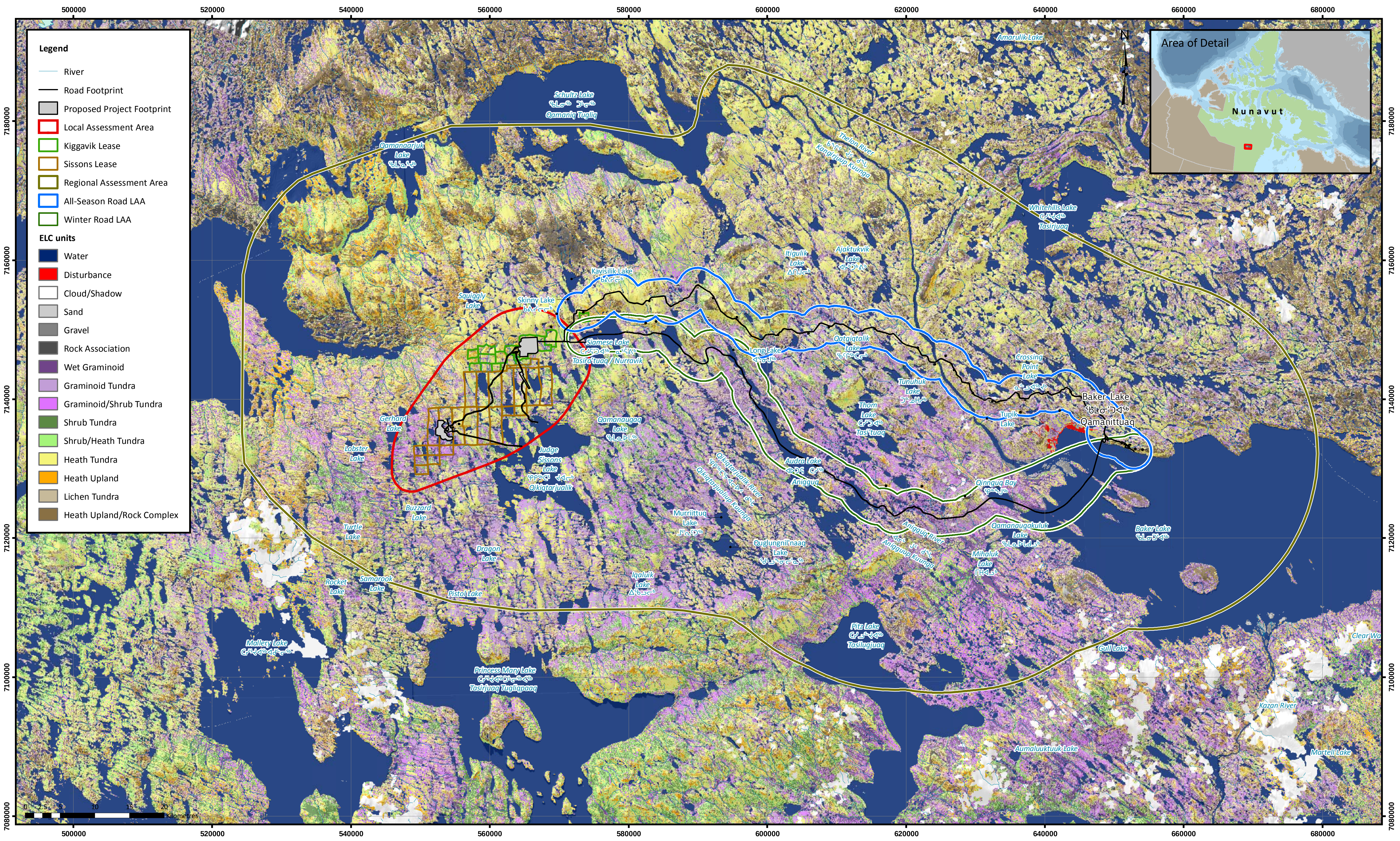
9.2 Assessment of Change in Vegetation Abundance and Community Diversity

9.2.1 Analytical Methods for Change in Vegetation Abundance and Community Diversity

Changes to vegetation abundance and community diversity will occur due to the direct effects of vegetation clearing or burying during Project construction. Dust created by Project activities can also be potentially linked to changes in vegetation abundance and community diversity. To assess the potential changes in vegetation abundance and community diversity, vegetation communities within the LAAs and RAA were identified through mapping of ELC units. The Project footprints for the different development options were overlain onto the ELC map to determine those vegetation communities potentially affected by the Project. The ELC map includes map units where vegetation is not the predominant identifier of the map unit (see Section 6.3.2.1 for ELC unit clarification); however, the majority of these ELC units likely have some vegetation occurring within them. As such, all ELC units were included in the analysis.

9.2.2 Baseline Conditions for Change in Vegetation Abundance and Community Diversity

Fifteen ELC units were identified within the LAAs and RAA during baseline surveys (Figure 9.2-1). Nine of these ELC units contain predominately vegetation communities, three ELC units contain predominately granular materials (i.e., sand, gravel, rock association), one ELC unit represents human influence on the landscape (i.e., disturbance), and one ELC unit represents water. One ELC unit represents an unclassifiable area from the satellite imagery (i.e., cloud/shadow). The most abundant ELC units identified in all of the study areas (i.e., Mine LAA, road LAAs and RAA) were heath tundra, water and graminoid tundra (Table 9.2-1).



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 08/21/2014 Scale: 1:500,000
9.2-1_ELC_in_RAA_and_LAAs.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 9.2-1
ECOLOGICAL LAND CLASSIFICATION UNITS IN THE REGIONAL ASSESSMENT AREA AND LOCAL ASSESSMENT AREAS

ENVIRONMENTAL IMPACT STATEMENT
VOLUME 6

Kiggavik Project
AREVA

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

Table 9.2-1 Distribution of ELC Units

ELC Unit	Mine LAA		Access Road LAAs: Winter South		Access Road LAAs: All-Season		Dock LAAs[1]: Option 1		Dock LAAs[1]: Option 2		Dock LAAs[1]: Agnico Eagle Meadowbank		RAA	
	ha	%	ha	%	ha	%	ha	%	ha	%			ha	%
Anthropogenic														
Disturbance	0	0.0%	0	0.0%	76	0.1%	0.0	0.0%	0.0	0.0%	23.5	100%	556	0.1%
Unclassified														
Cloud/Shadow	0	0.0%	203	0.4%	86	0.2%	0.0	0.0%	0.0	0.0%	0.0	0%	2,029	0.2%
Upland														
Sand	6	0.0%	248	0.4%	32	0.1%	0.0	0.0%	0.2	0.7%	0.0	0%	1,852	0.2%
Gravel	83	0.2%	508	0.9%	146	0.3%	0.1	0.5%	0.2	0.7%	0.0	0%	6,979	0.7%
Rock Association*	40	0.1%	172	0.3%	479	0.9%	0.1	0.2%	0.2	0.8%	0.0	0%	10,130	1.0%
Graminoid Tundra*	5,933	13.2%	8,269	14.7%	9,144	17.6%	7.0	26.7%	2.4	7.9%	0.0	0%	123,189	12.5%
Graminoid/Shrub Tundra*	4,626	10.3%	5,051	9.0%	3,087	5.9%	0.3	1.0%	0.9	2.8%	0.0	0%	79,603	8.1%
Shrub Tundra*	2,698	6.0%	1,776	3.2%	1,694	3.3%	0.2	0.8%	0.3	0.9%	0.0	0%	41,639	4.2%
Shrub/Heath Tundra*	3,716	8.3%	2,683	4.8%	3,066	5.9%	0.0	0.1%	1.0	3.3%	0.0	0%	59,255	6.0%
Heath Tundra*	16,216	36.0%	8,134	14.5%	18,146	34.9%	11.8	45.0%	15.2	49.6%	0.0	0%	241,679	24.6%
Heath Upland*	1,238	2.8%	952	1.7%	1,287	2.5%	1.4	5.4%	1.5	4.9%	0.0	0%	31,304	3.2%
Heath Upland/Rock Complex*	670	1.5%	1,097	2.0%	3,159	6.1%	3.9	14.7%	6.0	19.4%	0.0	0%	46,536	4.7%
Lichen Tundra*	578	1.3%	681	1.2%	857	1.6%	0.3	1.1%	1.5	4.7%	0.0	0%	15,820	1.6%
Upland Total	35,804	79.5%	29,570	52.7%	41,097	79.0%	25.1	95.6%	29.4	95.7%	0.0	0%	657,986	66.9%
Wetland														
Water	6,079	13.5%	20,827	37.1%	7,655	14.7%	0.2	0.9%	0.3	1.0%	0.0	0%	251,161	25.6%
Wet Graminoid*	3,126	6.9%	5,490	9.8%	3,118	6.0%	0.9	3.5%	1.0	3.3%	0.0	0%	71,126	7.2%
Wetland Total	9,205	20.5%	26,317	46.9%	10,773	20.7%	1.1	4.4%	1.3	4.3%	0.0	0%	322,287	32.8%
Total Area	45,009	100%	56,090	100%	52,032	100%	26.2	100%	30.7	100%	0.0	0%	982,858	100%

NOTES:

* ELC units containing vegetation species that are harvested by Inuit.

1 All dock options are located within the All-Season Road LAA, as well as the Winter Road LAA. Therefore, all calculated areas for each ELC unit within each dock site option are already identified within these LAAs and are not additional areas potentially affected by the Project. The existing Agnico Eagle Meadowbank dock site was assumed to be 100% anthropogenic disturbance and a detailed analysis of ELC units was not undertaken.

9.2.3 Effect Mechanism and Linkages for Change in Vegetation Abundance and Community Diversity

A number of different effect mechanisms can contribute to change in vegetation abundance and community diversity during Project development. A summary of the effect mechanisms and how the Project would cause changes in vegetation abundance and community diversity is described below.

9.2.3.1 Site Clearing

Site clearing involves the removal of vegetation from the Project development area, leading to a reduction in vegetation abundance and community diversity. Project components where site clearing will occur include in-water and on-land construction. Site clearing of vegetation will likely occur in conjunction with topsoil stripping. The mixing of vegetation with stripped topsoil will be beneficial to preventing soil erosion from wind events, as well as maintaining the vegetation seedbank within the active growth medium layer.

9.2.3.2 Vegetation Burial

Vegetation burial is the loss of vegetation due to the permanent placement of objects or other materials on top of existing vegetation. The effect of vegetation burial is the direct loss of vegetation from the landscape. Construction of some Project components will not involve clearing of vegetation from the work area; rather, materials will be deposited on top of the existing vegetation in an effort to avoid disturbing the thermal barrier that prevents thawing of the permafrost layer. As such, the vegetation (and underlying soils) will be buried. Specifically, the components where vegetation burial will occur include the Kiggavik-Sissons access road, the proposed All-Season Road, the airstrip, and maintenance roads within the Kiggavik and Sissons footprints.

Vegetation burial will likely also occur during development of the winter ice road. Portions of the winter ice road travelling over-land will likely require placement of a granular surface pad on top of the existing terrain to provide a level travel surface in areas of rugged microtopography.

9.2.3.3 Invasive Species

A non-indigenous species is an introduced species living outside of its native distributional range. An invasive species is a non-indigenous species that adversely affects the new ecosystem's structure and/or function, resulting in ecological, social or economic harm to the area. Not all non-indigenous species are considered invasive.

The biological invasion process includes a number of factors required for the establishment of a non-indigenous or invasive species into a new area (Chan et al. 2012; DFO 2012):

1. Transport - founding individuals must be taken up by, and survive conditions within, a transport vector to be moved from the source region to a new environment.
2. Survival - once released, the founding individuals must survive in the new environment.
3. Establishment - enough individuals of a species successfully arrive, survive, and form a reproductive population.
4. Expansion – established population may then spread from the initial, localized area by various means to become widespread in a region.

Similar to management plans for other invasive species (freshwater aquatic, marine), the first defence against introduction of a non-native or invasive species is to prevent successful transport into a new area. For terrestrial plant and animal species the primary transport routes into the Kiggavik Project area would be through air and ground transportation.

There is the potential for non-indigenous or invasive species to be introduced to the area if attached to equipment and supplies brought in from outside the region. Kubanis (1980) found 13 introduced plant species along the Dalton Highway, of which nine species were determined to be reproducing in the area. However, none of the introduced species were deemed to be invading native plant communities (NRC 2003). A combination of variables such as the harsh climatic conditions, short growing season, and nutrient-deficient soils found in a tundra environment reduce the potential for invasive plant species to establish and proliferate. Vegetation species that do invade the area may not be native to that particular type of vegetation community; however, the species may occur in other vegetation communities that are adaptive to disturbance within the tundra environment (e.g., coastal or dune environments). NRC (2003) noted that invasion by non-indigenous plant species to the tundra environment located adjacent to the Dalton Highway in Alaska has not been a major issue.

9.2.4 Mitigation Measures and Project Design for Change in Vegetation Abundance and Community Diversity

The following mitigation measures will be implemented to reduce Project effects on vegetation abundance and community diversity.

- Pre-construction surveys will be completed of the surveyed Project footprint boundaries for listed species to confirm their absence from the area to be disturbed.
- Where possible, access routes will be deflected to avoid any sensitive species identified during the pre-construction surveys.

- If sensitive species are located within the Project footprint, transplanting of species will occur at a suitable location. AREVA will consult with the GN regarding acceptable transplanting locations.
- Construction activities will likely be postponed during large precipitation events to prevent excessive disturbance to vegetation due to wet working conditions.
- Site clearing and vegetation burial will occur within the confines of the Project footprint to reduce the potential for additional vegetation loss and prevent unnecessary disturbance to vegetation adjacent to the Project development area.
- The vegetation seedbank will be preserved during topsoil stripping and stockpiling that will be used to facilitate natural regeneration of native vegetation in reclaimed areas.
- Waterbodies and watercourses were selected as much as possible during routing of the proposed winter roads to avoid disturbing vegetation communities.
- Rig matting may be used along the winter road in areas where granular material is not practical to prevent damaging the underlying vegetation.
- All equipment and machinery will be cleaned of foreign particles (e.g., soil, thatch) prior to initial transport to the Project to prevent the introduction of non-indigenous and/or invasive species.
- Progressive reclamation will occur throughout the Project on decommissioned areas to return disturbed areas to a natural state.

9.2.5 Residual Effects for Change in Vegetation Abundance and Community Diversity

No residual effects on vegetation abundance and community diversity are predicted to occur outside of the LAAs. A description of the predicted residual effects within each LAA is provided below.

Residual effects of site clearing and vegetation burial on the ELC units are discussed below for each LAA and the RAA, and are summarized in Table 9.2-2.

Table 9.2-2 Surface Disturbance to the Ecological Landscape Classification Map Units

	Access Road LAAs											
	Mine LAA			Winter Road			All-Season Road			RAA		
	Existing	Disturbed	Change	Existing	Disturbed	Change	Existing	Disturbed[2]	Change	Existing	Disturbed[3]	Change
ELC Unit	ha	ha	% Loss	ha	ha	% Loss	ha	ha	%Loss	ha	ha	% Loss
Anthropogenic												
Disturbance	0	0	0%	0	0	0%	76	0.0	0%	556	23.5	4.2%
Unclassified												
Cloud/Shadow	0	0	0%	203	0	0%	86	0.0	0%	2,029	0.0	0.0%
Upland												
Sand	6	0.0	0.0%	248	0.4	0.1%	32	0.0	0.1%	1,852	0.6	0.0%
Gravel	83	2.3	2.8%	508	1.7	0.3%	146	0.2	0.1%	6,979	4.5	0.1%
Rock Association*	40	1.5	3.8%	172	0.0	0.0%	479	1.6	0.3%	10,130	3.4	0.0%
Graminoid Tundra*	5,933	182.6	3.1%	8,269	18.7	0.2%	9,144	46.0	0.5%	123,189	256.6	0.2%
Graminoid/Shrub Tundra*	4,626	198.7	4.3%	5,051	9.3	0.2%	3,087	11.4	0.4%	79,603	220.5	0.3%
Shrub Tundra*	2,698	62.8	2.3%	1,776	2.9	0.2%	1,694	7.8	0.5%	41,639	73.9	0.2%
Shrub/Heath Tundra*	3,716	117.2	3.2%	2,683	7.3	0.3%	3,066	16.6	0.5%	59,255	142.1	0.2%
Heath Tundra*	16,216	660.1	4.1%	8,134	12.9	0.2%	18,146	128.5	0.7%	241,679	828.5	0.3%
Heath Upland*	1,238	44.7	3.6%	952	0.6	0.1%	1,287	11.1	0.9%	31,304	59.4	0.2%
Heath Upland/Rock Complex*	670	14.2	2.1%	1,097	0.7	0.1%	3,159	21.6	0.7%	46,536	46.4	0.1%
Lichen Tundra*	578	21.9	3.8%	681	1.1	0.2%	857	6.8	0.8%	15,820	31.5	0.2%
Upland Total	35,804	1,305.9	3.6%	29,570	55.6	0.2%	41,097	251.6	0.6%	657,986	1,667.5	0.3%
Wetland												
Water	6,079	22.1	0.4%	20,827	82.8	0.4%	7,655	0.7	0.0%	251,161	106.2	0.0%
Wet Graminoid*	3,126	49.8	1.6%	5,490	11.6	0.2%	3,118	7.1	0.2%	71,126	70.4	0.1%
Wetland Total	9,205	72.0	0.8%	26,317	94.4	0.4%	10,773	7.8	0.1%	322,287	176.6	0.1%
Total Area	45,009	1,378	3.1%	56,090	150.0	0.3%	52,032	259.4	0.5%	982,858	1,867.7	0.2%

NOTES:
* - ELC units containing vegetation species that are harvested by Inuit
1 - All dock options are located within the All-Season Road LAA, as well as the Winter Road LAA. Therefore, all calculated disturbed areas for each ELC unit within each dock site option are included within these
2 - The portion of the All-Season Road that extends from Dock Option 1 to Dock Options 2 is not included in the calculated area, as it has been included in the estimate for both Dock Options 2 (Dock impact columns hidden)
3 - The calculated area of disturbance within the RAA includes the Mine footprint, footprints for all road options (Winter Road and All-Season Road, and Dock Options 1, 2 and Meadowbank

9.2.5.1 Mine LAA

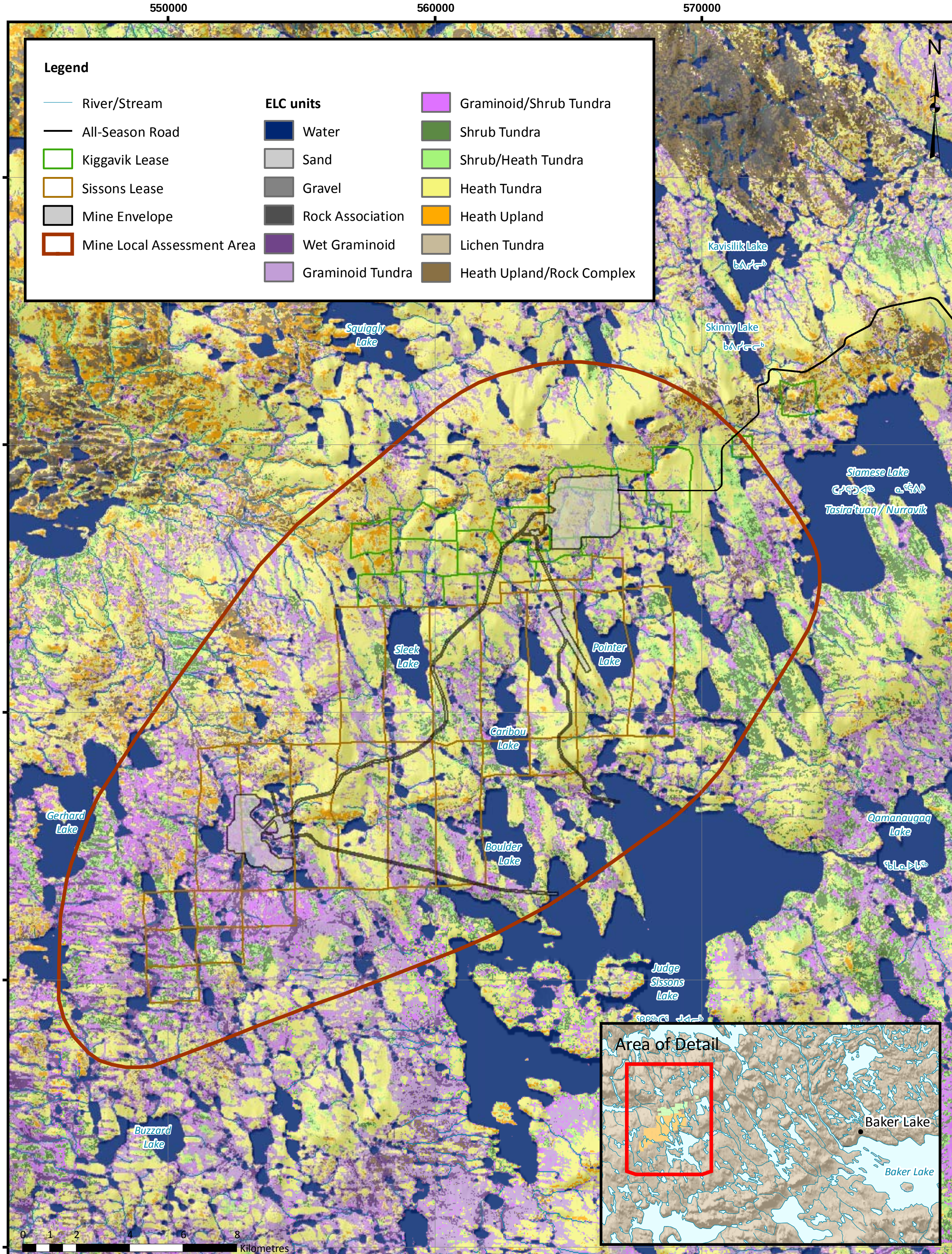
The Kiggavik and Sissons mine footprints are predicted to disturb a total area of 1,378 ha, which represents 3.1% of the Mine LAA and 0.14% of the RAA (Figure 9.2-2). The ELC map units with the greatest decrease in area within the Mine LAA are heath tundra (660.1 ha), graminoid/shrub tundra (198.7 ha) and graminoid tundra (182.6 ha). This represents relative losses to these vegetation communities of 4.1%, 4.3%, and 3.1%, respectively. Disturbance to wetland ELC units (water and wet graminoid) within the Mine LAA constitutes 22.1 ha and 49.8 ha, respectively. This represents relative losses of 0.4% and 1.6% to these map units, respectively. The total relative loss of ELC map units that contain vegetation of cultural importance to Inuit represents about 3% of the Mine LAA.

Changes in vegetation abundance and community diversity within the Mine LAA are anticipated to be low in magnitude with an approximate loss of 3.1% of the Mine LAA, residual effects will be site specific in geographic extent, likely to occur only during the construction phase of the Project, and be long term but reversible through reclamation.

9.2.5.2 Winter Road LAA

Approximately 150 ha will be disturbed as a result of clearing and vegetation burial during construction of the proposed Winter Road, which represents approximately 0.3% of the Winter Road LAA (Figure 9.2-2). It is estimated that the Winter Road will traverse about 82.8 ha of the water ELC map unit, which represents 55.2% of the area affected by the Winter Road. The ELC map units with the greatest decrease in area (other than water) within the Winter Road LAA are graminoid tundra (18.7 ha), heath tundra (12.9 ha), and wet graminoid (11.6 ha). The relative losses of each of the ELC map units within the Winter Road LAA are less than 1%. The total relative loss of ELC map units that contain vegetation of cultural importance to Inuit represents less than 1% of the Winter Road LAA.

Changes in vegetation abundance and community diversity as a result of the Winter Road are anticipated to be low in magnitude, with relative losses to the ELC map units amounting to less than 1% of the LAA. The residual effects will be site-specific in geographic extent, likely to occur only during the construction phase of the Project, and will be long term but reversible through reclamation.



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 08/21/2014 Scale: 1:200,000
File: 9.2-2_ELC_in_Mine_LAA.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 9.2-2
ECOLOGICAL LAND CLASSIFICATION UNITS WITHIN THE MINE LOCAL ASSESSMENT AREA

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9.2.5.2 All-Season Road LAA

The All-Season Road is estimated to disturb approximately 259.4 ha, which represents approximately 0.5% of the All-Season Road LAA (Figure 9.2-2). Heath tundra will be most affected by construction of the All-Season Road, with a decrease in area of about 128.5 ha, which represents 49.5% of the total area affected by the All-Season Road. Other ELC map units with substantial decreases in area include graminoid tundra (46 ha), heath upland/rock complex (21.6 ha) and shrub/heath tundra (16.6 ha). The relative losses of each of the ELC map units within the All-Season Road LAA are less than 1%. The total relative loss of ELC map units that contain vegetation of cultural importance to Inuit represents less than 1% of the All-Season Road LAA.

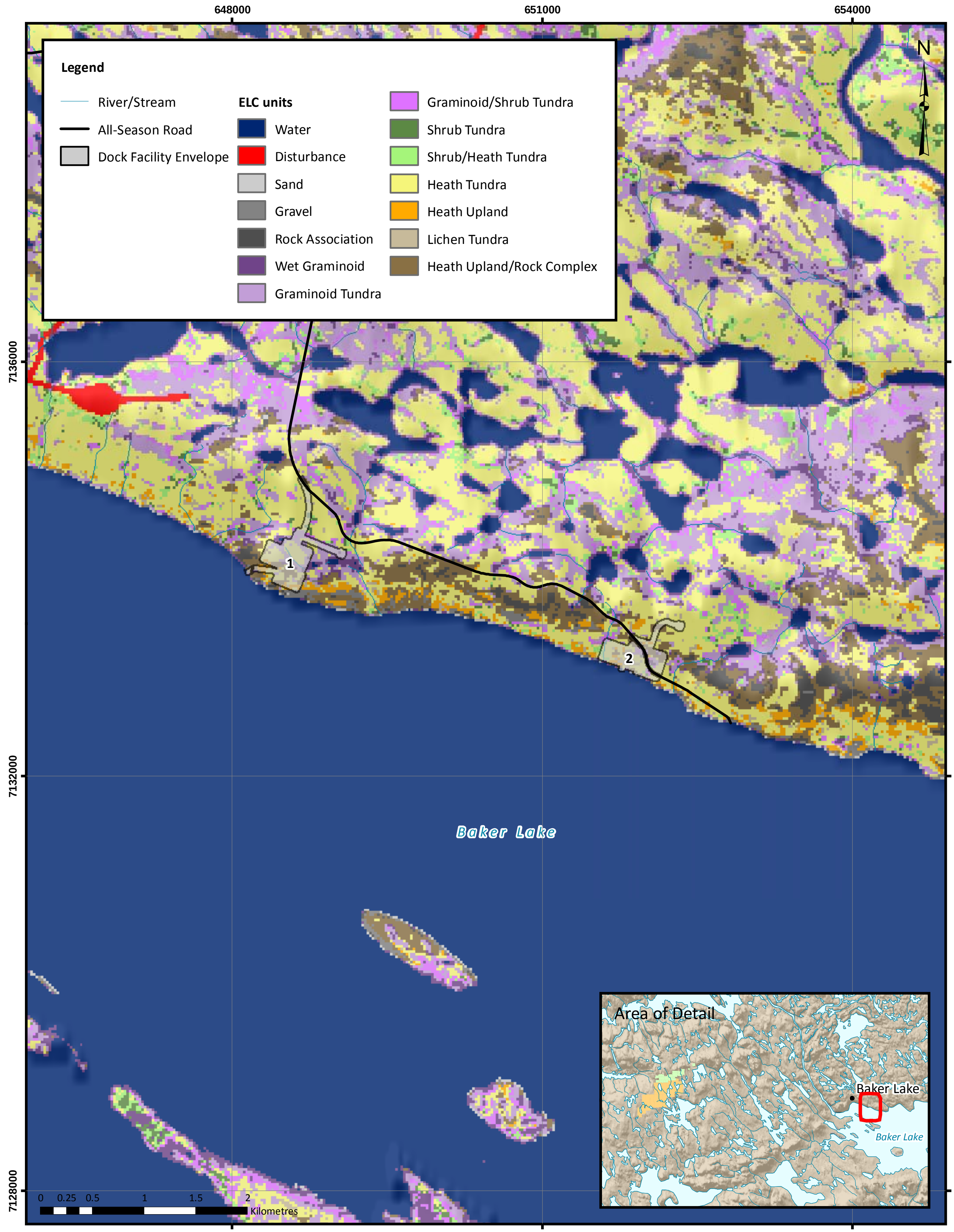
While the All-Season Road option will affect a larger area than the winter road option (i.e., 0.5% of the All-Season Road LAA compared to 0.3% of the Winter Road LAA), the relative loss of each of the ELC map units within the LAA will still be less than 1%. Therefore, the residual effect of the All-Season Road option is expected to be similar to the winter road option (i.e., low in magnitude, site-specific in geographic extent). As with the winter road option, the residual effect will likely only occur during the construction phase of the Project, and will be long term but reversible through reclamation.

9.2.5.3 Dock Site Options

The dock facility is encompassed within the All-Season Road LAA and the Winter Road LAA. As such, the estimated areas of each ELC unit affected by the site options are included within these LAAs. The segment of the All-Season Road that commences at the junction of the road segment to dock site option #1 (preferred) and travels towards dock site options #2 has been included in the calculations for dock site option #2 (Figure 9.2-3). The total area disturbed by each of the proposed dock site options is summarized in Table 9.2-2. A second alternative dock option is for AREVA to use the existing Agnico Eagle Meadowbank dock site. This may be a viable alternative if the Meadowbank dock is no longer required by Agnico Eagle when the Kiggavik Project begins operation and appropriate transfer of ownership approvals are maintained. This site is a previously disturbed, brownfield site (23.5 ha) and if used, no additional vegetation disruption is expected. The residual effect from invasive species on the existing vegetation community within all of the LAAs is anticipated to be negligible, as described in Section 9.2.3.3.

9.2.5.4 Project Development Option Combinations

As discussed in the Project Description (Tier 2, Volume 2), a winter road will be constructed to support both the construction and operation phases of the Project. An all-season road with a cable-ferry crossing the Thelon River has also been included as a viable option. As such, a comparison of the changes in vegetation abundance and community diversity under the different Project development options was completed, and are summarized in Tables 9.2-3 and 9.2-4. A discussion of the residual effects of each of the preferred development options is provided below.



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 08/21/2014 Scale: 1:50,000
File: 9.2-3_ELC_in_Dock_Vicinity.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, AREVA Resources Canada Inc., and Gebauer & Associates.*

FIGURE 9.2-3
ECOLOGICAL LAND CLASSIFICATION UNITS LOCATED AT THE PROPOSED DOCK SITE OPTIONS

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Table 9.2-3 Changes to the ELC Map Units Based on Project Development Options

ELC Unit	Local Assessment Area Scenarios								
	Mine LAA, Winter Road LAA, and Dock Site Option #1			Mine LAA, Winter Road LAA, and Dock Site Option #2			Mine LAA, Winter Road LAA, and Agnico Eagle Meadowbank Dock Site Option		
	Existing	Disturbed	Change	Existing	Disturbed	Change	Existing	Disturbed	Change
	ha	ha	% Loss	ha	ha	% Loss	ha	ha	% Loss
Anthropogenic									
Disturbance	0.0	0.0	0.0	0.0	0.0	0.0	23.5	23.5	1.0
Unclassified									
Cloud/Shadow	203.3	0.0	0.0	203.3	0.0	0.0	203.3	0.0	0.0
Upland									
Sand	253.5	0.4	0.1	253.7	0.6	0.2	253.5	0.4	0.1
Gravel	591.2	4.1	0.7	591.3	4.2	0.7	591.1	4.0	0.7
Rock Association*	211.6	1.6	0.7	211.7	1.7	0.8	211.5	1.5	0.7
Graminoid Tundra*	14,208.5	208.3	1.5	14,203.9	203.7	1.4	14,201.5	201.3	1.4
Graminoid/Shrub Tundra*	9,677.1	208.3	2.2	9,677.7	208.9	2.2	9,676.8	208.0	2.1
Shrub Tundra*	4,474.7	65.9	1.5	4,474.7	65.9	1.5	4,474.4	65.7	1.5
Shrub/Heath Tundra*	6,399.1	124.5	1.9	6,400.1	125.5	2.0	6,399.1	124.5	1.9
Heath Tundra*	24,361.9	684.8	2.8	24,365.3	688.2	2.8	24,350.1	673.0	2.8
Heath Upland*	2,191.2	46.7	2.1	2,191.3	46.8	2.1	2,189.8	45.3	2.1
Heath Upland/Rock Complex*	1,771.0	18.8	1.1	1,773.2	20.9	1.2	1,767.2	15.0	0.8
Lichen Tundra*	1,259.4	23.3	1.8	1,260.6	24.4	1.9	1,259.1	23.0	1.8
Upland Total	65,399.1	1,386.5	2.1	65,403.4	1,390.9	2.1	65,374.0	1,361.5	2.1
Wetland									
Water	26,906.4	105.2	0.4	26,906.4	105.3	0.4	26,906.1	105.0	0.4
Wet Graminoid*	8,617.0	62.3	0.7	8,617.1	62.4	0.7	8,616.1	61.4	0.7
Wetland Total	35,523.3	167.5	0.5	35,523.5	167.7	0.5	35,522.2	166.3	0.5
Total Area	101,125.6	1,554.0	1.5	101,130.1	1,558.5	1.5	101,122.9	1,551.3	1.5

NOTES:
* - ELC units containing vegetation species that are harvested by Inuit
Highlighted area represents the preferred development option combination

Table 9.2-4 Changes to the ELC Map Units Based on the Different Development Options that Include the All-Season Road

ELC Unit	Local Assessment Area Scenarios								
	Mine LAA, All-Season Road LAA, Winter Road LAA, and Dock Site Option #1			Mine LAA, All-Season Road LAA, Winter Road LAA, and Dock Site Option #2			Mine LAA, All-Season Road LAA, Winter Road LAA, and Agnico Eagle Dock Site Option		
	Existing	Disturbed	Change	Existing	Disturbed	Change	Existing	Disturbed	Change
	ha	ha	% Loss	ha	ha	% Loss	ha	ha	% Loss
Anthropogenic									
Disturbance	76	0.0	0.0	76	0.0	0	100	23.5	1.0
Unclassified									
Cloud/Shadow	289	0.0	0.0	289	0.0	0	289	0.0	0.0
Upland									
Sand	286	0.4	0.1	286	0.6	0.2	286	0.4	0.1
Gravel	737	4.3	0.6	737	4.4	0.6	737	4.2	0.6
Rock Association*	691	3.1	0.5	691	3.3	0.5	691	3.1	0.4
Graminoid Tundra*	23,353	254.2	1.1	23,348	249.6	1.1	23,346	247.2	1.1
Graminoid/Shrub Tundra*	12,764	219.6	1.7	12,765	220.2	1.7	12,764	219.4	1.7
Shrub Tundra*	6,169	73.7	1.2	6,169	73.7	1.2	6,168	73.4	1.2
Shrub/Heath Tundra*	9,465	141.1	1.5	9,466	142.1	1.5	9,465	141.1	1.5
Heath Tundra*	42,508	813.2	1.9	42,511	816.7	1.9	42,496	801.4	1.9
Heath Upland*	3,478	57.8	1.7	3,478	58.0	1.7	3,477	56.4	1.6
Heath Upland/Rock Complex*	4,930	40.5	0.8	4,932	42.6	0.9	4,926	36.6	0.7
Lichen Tundra*	2,116	30.1	1.4	2,118	31.2	1.5	2,116	29.8	1.4
Upland Total	106,496	1,638.1	1.5	106,500	1,642.5	1.5	106,471	1,613.1	1.5
Wetland									
Water	34,561	105.9	0.3	34,561	106.0	0.3	34,561	105.7	0.3
Wet Graminoid*	11,735	69.4	0.6	11,735	69.5	0.6	11,734	68.5	0.6
Wetland Total	46,296	175.3	0.4	46,297	175.5	0.4	46,295	174.2	0.4
Total Area	153,158	1,813.5	1.2	153,162	1,818.0	1.2	153,155	1,810.8	1.2

NOTES:
* - ELC units containing vegetation species that are harvested by Inuit.
Highlighted area represents the preferred development option combination.

Winter Road and Dock Site Option #1 with the Mine Sites

A total of 1,554 ha is predicted to be affected by construction of the Winter Road, mine sites and dock facility at the preferred (option #1) site location (Table 9.2-3). Of this, 1,449 ha have the potential to support vegetation, as about 105 ha covers frozen waterbodies and watercourses (not including the wet graminoid ELC unit). The 1,449 ha to be affected represents approximately 1.4% of the combined LAAs.

Wetlands make up about 35,523 ha, or 35% of the LAAs (Table 9.2-3). Of this, about 37% supports vegetation (i.e., wetland graminoid ELC map unit). Approximately 168 ha (or 0.5% of the wetland area) is expected to be lost as a result of the Project. The highest percent loss for any of the ELC map units is 2.8%, represented by the heath tundra vegetation community. The total relative loss of ELC map units that contain vegetation of cultural importance to Inuit represents 2% of this development option combination. Therefore, the residual effect from this development option combination on vegetation abundance and community diversity is anticipated to be low in magnitude and site specific in geographic extent. The effect will occur during the construction phase and will be long term in duration but reversible with reclamation at decommissioning.

All-Season Road combined with the Winter Road, Dock Site Option #1 and the Mine Sites

The total area disturbed by this development option is estimated to be about 1,814 ha (Table 9.2-4). Of this, approximately 1,708 ha of upland area that likely supports vegetation will likely be lost, which represents approximately 1.5% of the combined LAAs.

The LAAs for this development option contain about 46,296 ha of wetlands; however, only about 175 ha, or 0.4% of the wetlands located within the LAAs will be affected by construction of the Project components (Table 9.2-4).

Heath tundra, graminoid tundra and graminoid/shrub tundra will be most affected by this development option, with losses of about 813 ha, 254 ha and 220 ha, respectively. These vegetation communities comprise approximately 35.8%, 19.7%, and 10.8% of the ELC map units located within the LAAs that can support vegetation, respectively. The greatest decrease in area in relation to the ELC map units will be heath tundra (1.9%), graminoid/shrub tundra (1.7%), and heath upland (1.7%). Approximately 1.5% of the ELC map units that contain vegetation of cultural importance to Inuit will be disturbed by this development option combination.

The predicted residual effects from this development option combination are anticipated to be low in magnitude and will be site specific in geographic extent. Disturbance to vegetation abundance and community diversity will occur during the construction phase and the residual effects will be long term in duration; however, the residual effects will be reversible with reclamation.

Alternate Development Options

The vegetation losses under the alternate development options and their potential combinations are similar to the preferred options in relation to vegetation abundance and community diversity, as shown in Tables 9.2-3 and 9.2-4. As such, the difference between the preferred development options and the alternate development options in relation to the residual effects are anticipated to be negligible.

9.2.6 Determination of Significance for Change in Vegetation Abundance and Community Diversity

The greatest predicted decrease among all ELC map units within the LAAs is less than 3% (with loss of wetland area representing only 0.5%). Further, the greatest total relative loss of ELC map units containing vegetation that are of cultural importance to Inuit was 3% within the Mine LAA, and no more than 2% within the combined LAAs for the development option combinations. Consequently, changes in vegetation abundance and community diversity as a result of the Project are predicted to be not significant.

Overall, confidence in this prediction is considered high for the following reasons.

- Confidence is high with respect to the determination of the area affected by the Project, and the residual effects associated with the different Project development combinations.
- The effectiveness of mitigation measures to reduce the effects of Project activities on vegetation is well understood.

9.2.7 Compliance and Environmental Monitoring for Change in Vegetation Abundance and Community Diversity

Compliance and environmental monitoring for changes in vegetation abundance and community diversity will include the following:

- An environmental monitor will be onsite during all phases of the Project to work with AREVA personnel and contractors to meet and comply with environmental regulations associated with vegetation.
- Permanent sampling plots will be established around the Project Footprint and adjacent to the proposed access roads. These sampling plots will be routinely surveyed and assessed to measure potential changes in vegetation abundance and community diversity.
- Monitoring for non-indigenous and/or invasive species will be completed throughout the duration of the Project. Observation of any non-indigenous or invasive species in the

vegetation permanent sampling plots will be communicated to Government of Nunavut Department of Environment (GN DoE 2014). Attempts will be made to remove any invasive species identified adjacent to the Project footprint.

9.3 Assessment of Change in Vegetation Quality

9.3.1 Analytical Methods for Change in Vegetation Quality

Project construction and operation activities will generate dust that contains metals and radionuclides. The COPC included in this assessment include uranium and the uranium-238 decay series (thorium-230, lead-210, radium-226, and polonium-210), arsenic, cadmium, cobalt, copper, lead, molybdenum, nickel, selenium, and zinc. Detailed modelling of concentrations of these COPC in dust was completed as part of the Atmospheric Assessment (Tier 2, Volume 4), and formed the basis for estimating changes in vegetation concentrations. The SENES INTAKE model was used to estimate COPC concentrations in soil and vegetation. This model was selected to allow an integrated approach for estimating environmental quality, ecological risk assessment and human health (see Tier 3, Technical Appendix 8A). The model has been used extensively on other uranium mining projects.

The vegetation assessment considers the effects of dust deposition on different classes of vegetation including berries, browse (e.g. willow, birch), forage (e.g. sedges, grass) and lichen. These vegetation classes were selected based on the characteristics of the area and utilization of vegetation by ecological receptors and people. Changes to vegetation COPC concentrations were estimated by applying values for uptake rates derived from site-specific information and expected deposition behaviour. The lichen model was updated to provide a more accurate representation of the expected response to deposition of airborne radionuclides and metals.

The Project will also generate air emissions from fossil fuel combustion that could affect vegetation quality. Effects from air emissions on vegetation quality can occur directly through fumigation of nitrogen oxides and sulphur dioxides, or indirectly as a result of changes in soil chemistry from PAI. Adverse effects on vegetation health due to exposure to NO_x and SO_2, as well as changes in COPC concentration within the vegetation, were evaluated based on comparisons to phytotoxicity limits. The amount of area where PAI deposition occurs on the ELC map units was estimated based on the defined critical levels.

The effects of air emission varies among vegetation species due to many variables (e.g., vascular vs. non-vascular plants, resiliency to changes in air quality). Although some species might be affected by air emissions, the response of individual species will be highly variable and relate to factors such as competition in addition to individual species sensitivity. As individual species responses are not well defined, effects of air emissions are assessed in terms of the vegetation communities (i.e., ELC map units).

9.3.2 Baseline Conditions for Change in Vegetation Quality

During baseline surveys, vegetation samples were collected to determine existing analyte concentrations. Plant tissue chemistry results for metals and radionuclide concentrations are presented in Tier 3, Technical Appendix 6B, Table 4.2-8A. Guidelines pertaining to analyte concentrations within vegetation do not exist.

Air quality sampling was also completed during the baseline surveys. A summary of the baseline air quality measurements for metals and radionuclides at the Kiggavik mine site are presented in the Air Dispersion Assessment report (Tier 3, Technical Appendix 4B). Background PAI levels were calculated based on data from the National Atmospheric Chemistry Precipitation Database (NAtChem) (NAtChem 2008). The annual average background PAI was calculated to be 0.093 keq/ha/yr.

Collection of baseline data on TSP was attempted in 2010; however, unforeseen challenges with equipment may have affected the reliability of these data (i.e., measured particulate concentration). Consequently, no useable particulate data currently exists for the Kiggavik mine site. Monitoring is currently underway.

9.3.3 Effect Mechanism and Linkages for Change in Vegetation Quality

Air emissions generated during all phases of the Project have the potential to affect vegetation quality Acidic compounds generated by the burning of fossil fuels and industrial processes, along with dust deposition generated during mining processes and vehicular movement are the predominant air emission producers that affect vegetation quality. A description of air emissions the Kiggavik Project would produce and how they may affect vegetation quality is provided below.

9.3.3.1 Acid Deposition

Acid deposition occurs when air emissions generated from the combustion of fossil fuels and other industrial processes undergo complex chemical reaction in the atmosphere and fall to the earth as either wet deposition (i.e., rain, snow, cloud, fog) or dry deposition (i.e., dry particles, gas) (ESA 2000). The main chemical precursors in acid deposition are atmospheric concentrations of sulphur dioxide (SO_2) and nitrogen oxides (NOx) (ESA 2000). PAI is the indicator used to represent acid deposition. PAI affects vegetation indirectly through acidification of soils, which can lead to defoliation, discoloration and reduced growth of vegetation (WHO 2000). Sections 8.2.3 through 8.2.5 provide an assessment of the effects of PAI on soil quality. Further details on how the chemical precursors affect vegetation are provided below.

Sulphur Dioxide (SO_2)

Effects from SO_2 fumigation include changes to plant physiology and fitness. Sulphur is a micronutrient required by plants in trace amounts. When supplied amounts of sulphur exceed a plant's needs, changes to growth and reproduction can occur. Effects that alter vegetation quality can also affect diversity through changes in community composition. Lichens are the most sensitive species to SO_2 fumigation because they get most of their nutrients from the atmosphere and lack protective structures such as thick cuticles or stomata (Geiser and Leitlich 2007; WHO 2000). Vascular plants are somewhat less sensitive to SO_2 emissions than lichens; however, several shrubs common in the LAA are affected by SO_2, including dwarf birch (*Betula glandulosa)*, bog blueberry (*Vaccinium uliginosum*), and cowberry (*Vaccinium vitis-idaea)* (Legge et al 1998).

Nitrogen Oxides (NO_x)

Nitrogen oxides can promote plant growth when added in low concentrations; however, high concentrations can result in injury to the tissue, changes in biomass production and increased susceptibility to secondary stress factors (Graham et al. 1997). Changes in nitrogen levels deposited on the landscape can create changes in competitive relationships among species, which can result in a loss of biodiversity (Graham et al. 1997).

9.3.3.2 Dust Deposition

Dust deposition can directly and indirectly affect vegetation quality. Project components that will generate dust include on-land construction, mining, milling, general services, transportation, and on-land decommissioning.

Dust deposition can directly affect vegetation quality by covering the vegetation surface. Dust cover on non-vascular plants like mosses and lichens can cause stress and inhibit their natural cycle. Dust can absorb water from non-vascular plants, thereby increasing evaporation while restricting gas exchange and blocking active light for photosynthesis (Spatt and Miller 1981). Excess nutrient intake caused by dust on non-vascular plants can become toxic (Auerbach et al. 1997). This in turn can cause a shift in the vegetation community. For example, *Sphagnum* moss (a moss species commonly observed in a tundra environment) appears to have a low tolerance to dust deposition (Auerbach et al. 1997; NRC 2003; Spatt and Miller 1981; Walker and Everett 1987). However, other moss species appear to have a higher tolerance to dust deposition, and in some instances, total moss diversity can increase (Walker and Everett 1987). Lichens are also noted to be affected by dust deposition in areas adjacent to dust sources. Walker and Everett (1987) noted that lichen occurrence on a landscape is influenced when located within 70 m of a dust source (e.g., road). Myers-Smith et al. (2006) showed that vegetation communities subject to road dusting shifted to more grasses, sedges and cloudberry (*Rubus chamaemorus*) cover, and fewer mosses, evergreen shrubs, lichens, and forbs relative to areas not subject to dusting.

An indirect effect of dust deposition on vegetation quality involves changes in soil nutrient regime and soil pH. COPCs and other analytes can become airborne through particle suspension and be transported to areas distant from their source. Deposition of the suspended particles can cause an increase in analyte concentrations in soils, facilitating potential uptake by vegetation. During operation, dust from the mine, airstrip and roads may also contribute to acidification of soils, which can affect vegetation quality and community structure (Myers-Smith 2006). A discussion regarding the effects of dust deposition on soil quality is provided in Section 8.2.5.

Another indirect effect of dust deposition on vegetation involves changes in surface albedo. Surface albedo refers to the ability to reflect solar radiation (Smith 1996). The less solar radiation reflected, the warmer a surface becomes. The presence of dust on a surface decreases its albedo, causing the dust-covered surface to become warmer. A decrease in surface albedo caused by dust deposition indirectly influences vegetation through its effect on snowmelt. Snowmelt occurs at a faster pace when the snowpack contains particulate matter from dust deposition, allowing earlier vegetation exposure from the snowpack. This earlier exposure could cause a change in the competitive regime among species, thereby causing an alteration in the vegetation community due to the longer growing season (Auerbach et al. 1997).

9.3.4 Mitigation Measures and Project Design for Change in Vegetation Quality

The following are mitigation measures that will be implemented to reduce Project effects on vegetation quality.

- Industrial machinery and equipment (including the diesel-powered generators) will meet federal air emission standards.
- Low sulphur diesel fuel will be used to reduce SO_2 fumigation.
- Scrubbers will be installed on exhaust stacks to remove particulates, acid mist and excess SO_2 from air emissions prior to discharge.
- Where practical, non-calcareous materials from quarry sites will be used during road construction to reduce the amount of dust-prone aggregate used.
- During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust.
- Where possible, blasting may be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds.
- Dust suppression will occur continuously during the Project in dust-prone mine site areas by spraying water from a tanker truck affixed with either a spray nozzle or spray bar.
- If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focusing on additional dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines.
- Speed limits around the mine site and along all Project roads will be strictly adhered to, to reduce airborne dust from vehicular and other equipment traffic.

9.3.5 Residual Effects for Change in Vegetation Quality

No residual effects on vegetation quality are predicted to occur outside of the LAAs. A description of the predicted residual effects within each LAA is provided below.

9.3.5.1 Mine LAA

The maximum predicted mean and 95th percentile for COPC concentrations that are associated with phytoxicity in lichen, browse, forage, and berries are presented in Tables 9.3-1 to 9.3-4, respectively. Predicted COPC concentrations in browse and forage species are expected to be below the minimum available phytotoxic concentrations, with the exception of zinc in browse and forage and cobalt and copper in browse (Tables 9.3-1 and 9.3-2). Baseline levels of zinc, cobalt, and copper were found to naturally occur at the upper critical level for pytotoxicity concentrations. However, there is not expected to be a significant change in the concentration of COPC in these species relative to baseline, and concentrations will not exceed upper thresholds. Therefore, no adverse effects on vegetation quality are expected to occur.

There is a lack of phytoxicity concentration values available for COPC in berries and lichen, as well as for some COPC in browse and forage. With the exception of uranium at the Kiggavik camp site, there is expected to be little change in the concentrations in browse, forage and berries between baseline values and the predicted changes in concentrations caused by the Project. In addition, all predicted soil concentrations will be below the available soil quality guidelines, which are set to protect vegetation. Consequently, no change in vegetation quality is expected to occur as a result of COPC emissions from the Project.

Table 9.3-1 Maximum Predicted Mean and 95th Percentile COPC Concentrations in Lichen

COPC	Units	Phytotoxic Concentration[a]		Baseline	Predicted Lichen Concentrations							
					Kiggavik Camp		LSA*		RAA*		Baker Lake	
		dw	ww		Mean	95th	Mean	95th	Mean	95th	Mean	95th
U	ug/g ww	-	-	0.03	43.9	121	3.5	9.7	0.7	2.0	0.1	0.2
Th-230	Bq/g ww	-	-	0.001	0.10	0.27	0.008	0.02	0.002	0.01	0.001	0.002
Pb-210	Bq/g ww	-	-	0.37	1.0	2.3	0.42	1.0	0.38	0.9	0.37	0.9
Ra-226	Bq/g ww	-	-	0.001	0.22	0.53	0.02	0.04	0.00	0.01	0.001	0.00
Po-210	Bq/g ww	-	-	0.61	2.9	7.7	0.79	2.1	0.65	1.68	0.61	1.57
As	ug/g ww	-	-	0.23	0.3	0.9	0.3	0.6	0.2	0.6	0.2	0.6
Cd	ug/g ww	-	-	0.27	7.0	17.8	1.7	4.2	0.6	1.4	0.3	0.7
Co	ug/g ww	-	-	0.53	4.2	10.5	0.9	2.2	0.6	1.5	0.5	1.3
Cu	ug/g ww	-	-	2.3	2.4	6.0	2.3	5.9	2.3	5.8	2.3	5.8
Pb	ug/g ww	-	-	0.44	0.9	2.4	0.5	1.2	0.4	1.2	0.4	1.2
Mo	ug/g ww	-	-	0.09	0.3	0.7	0.1	0.3	0.1	0.2	0.1	0.2
Ni	ug/g ww	-	-	1.3	8.0	21.1	2.1	5.3	1.4	3.4	1.3	3.1
Se	ug/g ww	-	-	0.24	0.4	1.2	0.3	0.7	0.2	0.7	0.2	0.7
Zn	ug/g ww	-	-	22.4	27	76	23	64	22	63	22	63

NOTE:
a = no applicable phytotoxic concentrations available for lichen.
* The LAA and RAA boundaries used in the Ecological and Human Health Risk Assessment report differ from the Terrestrial Environment boundaries. See Tier 3, Technical Appendix 8A, Figure 3.1-1 for boundary clarification.

Table 9.3-2 Maximum Predicted Mean and 95th Percentile COPC Concentrations in Browse

COPC	Units	Phytotoxic Concentration		Baseline	Predicted Browse Concentrations							
					Kiggavik Camp		LSA*		RAA*		Baker Lake	
		dw	ww a		Mean	95th	Mean	95th	Mean	95th	Mean	95th
U	ug/g ww	-	-	0.001	0.020	0.044	0.003	0.005	0.002	0.004	0.001	0.004
Th-230	Bq/g ww	-	-	0.0003	0.0006	0.0011	0.0004	0.0007	0.0003	0.0007	0.0003	0.0007
Pb-210	Bq/g ww	-	-	0.04	0.04	0.07	0.04	0.07	0.04	0.07	0.04	0.07
Ra-226	Bq/g ww	-	-	0.001	0.0017	0.003	0.0014	0.003	0.0014	0.003	0.0014	0.003
Po-210	Bq/g ww	-	-	0.04	0.04	0.08	0.04	0.07	0.04	0.07	0.04	0.07
As	ug/g ww	3 b	1.4	0.20	0.2	1.0	0.2	1.0	0.2	1.0	0.2	1.0
Cd	ug/g ww	5 b,c	2.3	0.44	0.4	1.1	0.4	1.1	0.4	1.1	0.4	1.1
Co	ug/g ww	3 d	1.4	0.60	0.60	**2.4**	0.60	**2.4**	0.60	**2.4**	0.60	**2.4**
Cu	ug/g ww	25 b	10.5	6.7	6.8	**15.1**	6.8	**15.1**	6.8	**15.1**	6.8	**15.1**
Pb	ug/g ww	20 d	9.3	0.25	0.3	0.6	0.2	0.6	0.2	0.6	0.2	0.6
Mo	ug/g ww	10 c	4.7	0.46	0.5	1.9	0.5	1.9	0.5	1.9	0.5	1.9
Ni	ug/g ww	50 b	21	1.7	1.7	6.1	1.7	6.1	1.7	6.1	1.7	6.1
Se	ug/g ww	-	-	0.01	0.01	0.04	0.01	0.04	0.01	0.04	0.01	0.04
Zn	ug/g ww	100 c	47	**170**	**170**	**390**	**170**	**390**	**170**	**390**	**170**	**390**

NOTES:
BOLD SHADED values exceed the phytotoxic levels.
a = dry weight (dw) concentrations converted to wet weight (ww) concentrations using an assumed moisture content of 53%.
b = Phytotoxic conc. In plant foliage. Langmuir, D., P. Chrostowski, B. Vigneault and R. Chaney 2004. Issue Paper on the Environmental Chemistry of Metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC. ERG, Lexington, MA.
c = Leaf tissue concentration in plants that are neither sensitive nor tolerant McBride, M.B. 1994 Environmental Chemistry of Soils. Oxford University Press Inc. New York, NY.
d = Upper Critical Level in leaves and shoots of spring barley associated with reduced yield. Davis, R.D., P.H.T. Beckett and E. Wollan 1978. Critical Levels of Twenty Potentially Toxic Elements in Young Spring Barley. Plant Soil 49: 395-408.
* The LAA and RAA boundaries used in the Ecological and Human Health Risk Assessment report differ from the Terrestrial Environment boundaries. See Tier 3, Technical Appendix 8A, Figure 3.1-1 for boundary clarification.

Table 9.3-3 Maximum Predicted Mean and 95th Percentile COPC Concentrations in Forage

COPC	Units	Phytotoxic Concentration dw	Phytotoxic Concentration ww a	Baseline	Predicted Forage Concentrations: Kiggavik Camp Mean		LSA* Mean		RAA* Mean		Baker Lake Mean	
					Mean	95th	Mean	95th	Mean	95th	Mean	95th
U	ug/g ww	-	-	0.08	0.10	0.3	0.08	0.3	0.08	0.3	0.08	0.3
Th-230	Bq/g ww	-	-	0.01	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.03
Pb-210	Bq/g ww	-	-	0.15	0.15	0.54	0.15	0.54	0.15	0.54	0.15	0.54
Ra-226	Bq/g ww	-	-	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02
Po-210	Bq/g ww	-	-	0.07	0.07	0.21	0.07	0.21	0.07	0.21	0.07	0.21
As	ug/g ww	3 b	1.4	0.07	0.07	0.3	0.07	0.3	0.07	0.3	0.07	0.3
Cd	ug/g ww	5 b,c	2.3	0.08	0.08	0.2	0.08	0.2	0.08	0.2	0.08	0.2
Co	ug/g ww	3 d	1.4	0.21	0.21	0.7	0.21	0.7	0.21	0.7	0.21	0.7
Cu	ug/g ww	25 b	10.5	3.0	3.1	7.5	3.1	7.5	3.1	7.5	3.1	7.5
Pb	ug/g ww	20 d	9.3	0.36	0.36	1.2	0.36	1.2	0.36	1.2	0.36	1.2
Mo	ug/g ww	10 c	4.7	0.66	0.66	2.3	0.66	2.3	0.66	2.3	0.66	2.3
Ni	ug/g ww	50 b	21	1.3	1.3	4.2	1.3	4.2	1.3	4.2	1.3	4.2
Se	ug/g ww	-	-	0.20	0.20	0.4	0.20	0.4	0.20	0.4	0.20	0.4
Zn	ug/g ww	100 c	47	19.4	19.4	**49.9**	19.4	**49.9**	19.4	**49.9**	19.4	**49.9**

NOTES:
BOLD SHADED values exceed the phytotoxic levels.
a = dry weight (dw) concentrations converted to wet weight (ww) concentrations using an assumed moisture content of 53%.
b = Phytotoxic conc. In plant foliage. Langmuir, D., P. Chrostowski, B. Vigneault and R. Chaney 2004. Issue Paper on the Environmental Chemistry of Metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC. ERG, Lexington, MA.
c = Leaf tissue concentration in plants that are neither sensitive nor tolerant McBride, M.B. 1994 Environmental Chemistry of Soils. Oxford University Press Inc. New York, NY.
d = Upper Critical Level in leaves and shoots of spring barley associated with reduced yield. Davis, R.D., P.H.T. Beckett and E. Wollan 1978. Critical Levels of Twenty Potentially Toxic Elements in Young Spring Barley. Plant Soil 49: 395-408.
* The LAA and RAA boundaries used in the Ecological and Human Health Risk Assessment report differ from the Terrestrial Environment boundaries. See Tier 3, Technical Appendix 8A, Figure 3.1-1 for boundary clarification.

Table 9.3-4 Maximum Predicted Mean and 95th Percentile COPC Concentrations in Berries

COPC	Units	Phytotoxic Concentration[a]		Baseline	Predicted Berry Concentrations							
					Kiggavik Camp		LSA*		RAA*		Baker Lake	
		dw	ww		Mean	95th	Mean	95th	Mean	95th	Mean	95th
U	ug/g ww	-	-	0.002	0.1	0.4	0.01	0.04	0.004	0.01	0.002	0.004
Th-230	Bq/g ww	-	-	0.001	0.003	0.008	0.001	0.006	0.001	0.006	0.001	0.006
Pb-210	Bq/g ww	-	-	0.002	0.004	0.008	0.002	0.004	0.002	0.004	0.002	0.004
Ra-226	Bq/g ww	-	-	0.0002	0.002	0.005	0.0004	0.0008	0.0002	0.0007	0.0002	0.0007
Po-210	Bq/g ww	-	-	0.001	0.003	0.007	0.001	0.002	0.001	0.002	0.001	0.002
As	ug/g ww	-	-	0.03	0.03	0.09	0.03	0.09	0.03	0.09	0.03	0.09
Cd	ug/g ww	-	-	0.02	0.04	0.07	0.02	0.06	0.02	0.05	0.02	0.05
Co	ug/g ww	-	-	0.04	0.04	0.10	0.04	0.09	0.04	0.09	0.04	0.09
Cu	ug/g ww	-	-	1.5	1.6	4.7	1.6	4.7	1.6	4.7	1.6	4.7
Pb	ug/g ww	-	-	0.05	0.06	0.1	0.05	0.1	0.05	0.1	0.05	0.1
Mo	ug/g ww	-	-	0.08	0.09	0.3	0.08	0.3	0.08	0.3	0.08	0.3
Ni	ug/g ww	-	-	0.60	0.61	2.0	0.60	2.0	0.60	2.0	0.60	2.0
Se	ug/g ww	-	-	0.004	0.004	0.013	0.004	0.013	0.004	0.013	0.004	0.013
Zn	ug/g ww	-	-	14.9	14.9	49.2	14.9	49.2	14.9	49.2	14.9	49.2

NOTE:
a = no applicable phytotoxic concentrations available for berry.
* The LAA and RAA boundaries used in the Ecological and Human Health Risk Assessment report differ from the Terrestrial Environment boundaries. See Tier 3, Technical Appendix 8A, Figure 3.1-1 for boundary clarification.

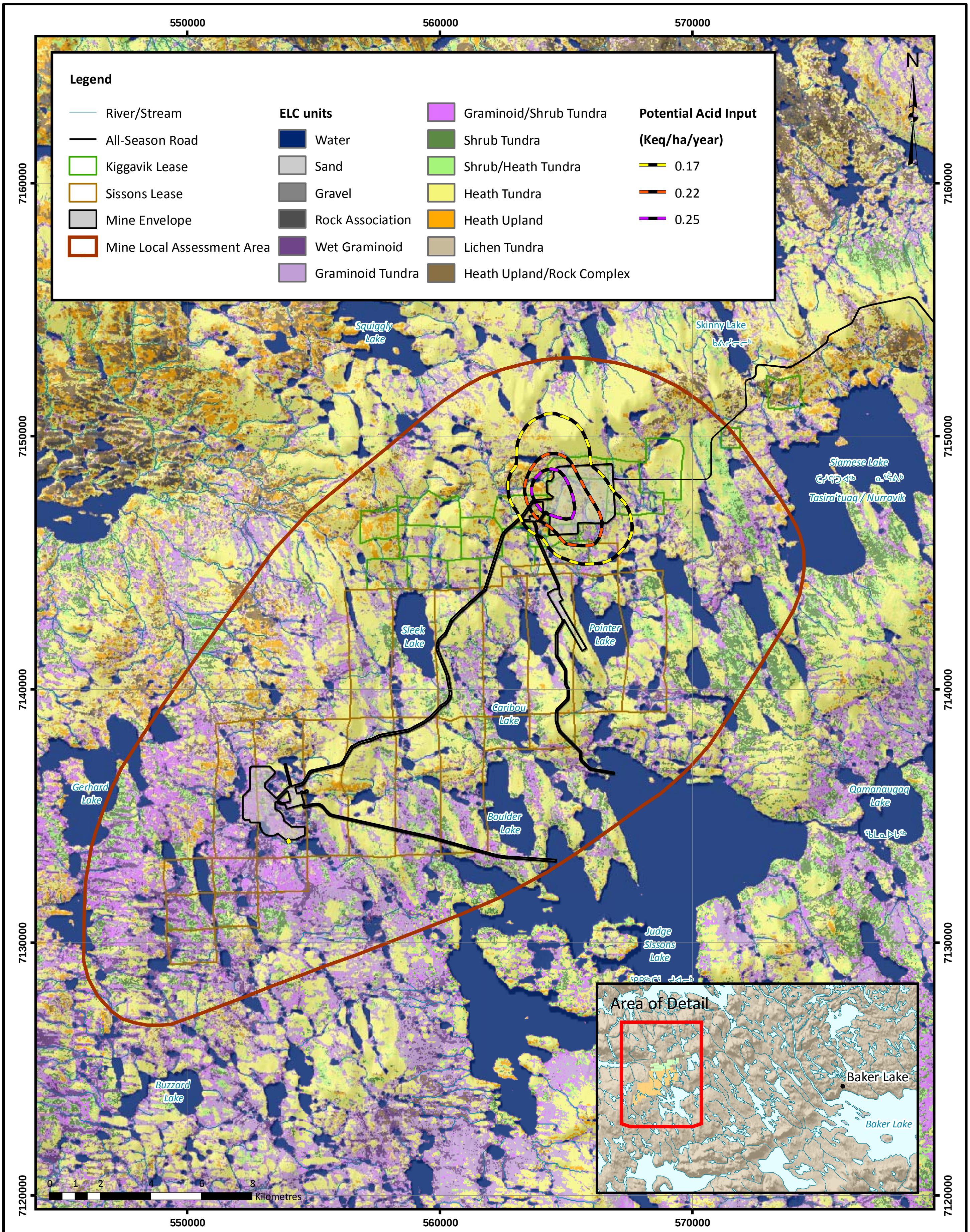
For lichen, there is the potential for a measureable change in concentrations of several COPC at the Kiggavik camp (used to represent on-site vegetation). Unfortunately, there are no appropriate benchmarks for assessing this effect. Lichens exhibit a range of tolerances to metals. Some species of Cladonia, Peltigera, and Stereocaulon can tolerate high levels of metals, and may even be found growing on mining spoils or other metal-enriched substrates (USDA Forest Service 2011). To place the results in context, the estimated lichen concentrations were compared to measurements collected from exposed areas near another uranium mine site (McClean Lake Operation, Saskatchewan, Canada). In general, with the exception of on-site locations, the estimated concentration is either close to baseline or within the range experienced at other sites (Table 9.3-5). A formal evaluation of the health of lichen at the McClean site has not been undertaken but there is a relative abundance of reindeer lichen at exposure sites and environmental technicians at the McClean site have not reported any obvious signs of stress. Based on the available information, it is not expected that there would be widespread effects on lichen; however, it is uncertain whether there will be any effects on lichen quality and health on the Kiggavik Project site due to metal accumulation. This would not result in population-level effects as effects would be detectable only within the LAA. The biological mean residence time is two to five years for most elements in lichens (Walther et al. 1990); therefore, any effects on lichen are not expected to extend far beyond the life of the Project. The potential food-chain effects for animals that consume lichen are addressed in the Ecological and Human Health Risk Assessment report (Tier 3, Technical Appendix 8A).

Based on air quality modelling, PAI values are predicted to be below 0.5 keq/ha/year (Table 9.3-6). PAI emissions generated from the Kiggavik mine site are expected to be within the threshold values of 0.17, 0.22 and 0.25 keq/ha/yr (Figure 9.3-1). A summary of the amount of ELC map units potentially exposed to the PAI emissions for each threshold value at the Kiggavik mine site is presented in Table 9.3-6. PAI values greater than 0.25 keq/ha/year are predicted to occur over 81 ha of the Kiggavik mine site. The proportion of the Mine LAA potentially exposed to PAI values greater than 0.25 keq/ha/year outside of the Project footprint is approximate 0.2%.

Results of the air quality modelling indicate that PAI emissions from the Sissons mine site will be within the threshold value of 0.17 keq/ha/year. These emissions are predicted to occur near the south boundary of the Project footprint. Only about 1.6 ha outside of the Sissons mine site is expected to be exposed to PAI emissions.

Table 9.3-5 Comparison of Predicted Lichen Concentrations to Other Locations

COPC	Units	Average Estimated Lichen Concentration					Average Measured Lichen Concentration		
		Baseline	Kiggavik Camp	LAA	RAA	Baker Lake	JEB	McClean	Sue
U	µg/g ww	0.03	43.9	3.5	0.7	0.1	1.3	3.2	8.4
Th-230	Bq/g ww	0.001	0.10	0.008	0.002	0.001	0.015	0.04	0.1
Pb-210	Bq/g ww	0.37	1.0	0.42	0.38	0.37	0.19	0.21	0.3
Ra-226	Bq/g ww	0.001	0.22	0.02	0.00	0.001	0.018	0.05	0.2
Po-210	Bq/g ww	0.61	2.9	0.79	0.65	0.61	0.17	0.18	0.3
As	µg/g ww	0.23	0.3	0.3	0.2	0.2	0.3	2.4	4.9
Cd	µg/g ww	0.27	7.0	1.7	0.6	0.3	0.03	0.05	0.06
Co	µg/g ww	0.53	4.2	0.9	0.6	0.5	0.04	0.1	0.2
Cu	µg/g ww	2.3	2.4	2.3	2.3	2.3	0.5	0.9	1.0
Pb	µg/g ww	0.44	0.9	0.5	0.4	0.4	0.2	1.8	3.2
Mo	µg/g ww	0.09	0.3	0.1	0.1	0.1	0.1	0.3	0.7
Ni	µg/g ww	1.3	8.0	2.1	1.4	1.3	0.5	3.1	6.0
Se	µg/g ww	0.24	0.4	0.3	0.2	0.2	0.04	0.05	0.06
Zn	µg/g ww	22.4	27	23	22	22	6.7	7.0	7.7



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 08/21/2014 Scale: 1:200,000
File: 9.3-1_ELC_in_PAI_Isopleth.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, SENES Consultants Ltd. AREVA Resources Canada Inc., Gebauer & Associates.*

FIGURE 9.3-1

ECOLOGICAL LAND CLASSIFICATION UNITS AFFECTED BY POTENTIAL ACID INPUT AT THE KIGGAVIK AND SISSONS MINE SITES

ENVIRONMENTAL IMPACT STATEMENT

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Kiggavik Project

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Table 9.3-6 ELC Map Units Located within the Predicted Potential Acid Input Isopleths at the Kiggavik Mine Site

ELC Unit	Potential Acid Input (PAI) Keq/ha/year				Proportion of Mine LAA (%)
	0.17	0.22	0.25	Total	
	(ha)	(ha)	(ha)	(ha)	
Anthropogenic					
Disturbance	0.0	0.0	0.0	0.0	0.0
Unclassified					
Cloud/Shadow	0.0	0.0	0.0	0.0	0.0
Upland					
Sand	0.1	0.2	0.4	0.6	0.0
Gravel	3.7	3.7	2.3	9.7	0.0
Rock Association*	0.5	0.3	0.0	0.8	0.0
Graminoid Tundra*	82.5	30.9	3.1	116.6	0.3
Graminoid/Shrub Tundra*	49.9	22.9	1.4	74.2	0.2
Shrub Tundra*	25.0	10.4	0.3	35.6	0.1
Shrub/Heath Tundra*	53.8	14.1	0.2	68.1	0.2
Heath Tundra*	603.8	112.8	39.9	756.6	1.7
Heath Upland*	45.8	18.3	21.2	85.3	0.2
Heath Upland/Rock Complex*	17.4	8.0	1.6	26.9	0.1
Lichen Tundra*	25.1	10.9	4.1	40.1	0.1
Upland Total	907.6	232.5	74.4	1,214.5	2.7
Wetland					
Water	40.6	4.2	3.9	48.7	0.1
Wet Graminoid*	23.9	9.2	2.4	35.5	0.1
Wetland Total	64.5	13.4	6.3	84.2	0.2
Total Area	972.1	245.9	80.7	1,298.7	2.9

NOTE:
* - ELC units containing vegetation species that are harvested by Inuit.

Table 9.3-7 summarizes the maximum incremental concentrations of NO_2 and SO_2 from the Project relative to phototoxicity benchmarks for vegetation (WHO 2000). These results indicate that exposure to NO_2 or SO_2 is not expected to exceed these benchmark and cause adverse effects on vegetation.

Table 9.3-7 NO_2 and SO_2 Emissions Relative to Phytotoxicity Benchmarks for Vegetation

Receptor Name	NO_2 (µg/m³)	SO_2 (µg/m³)	
	Incremental Annual Maximum	**Incremental 24-hr Maximum**	**Incremental Annual Maximum**
Accommodation Complex	10.4	15.4	0.6
Judge Sissons Lake Cabin	0.80	0.8	0.03
Community of Baker Lake	0.04	0.04	0.001
Phytotoxicity Benchmark (µg/m³)	19*	100	20[a] 10

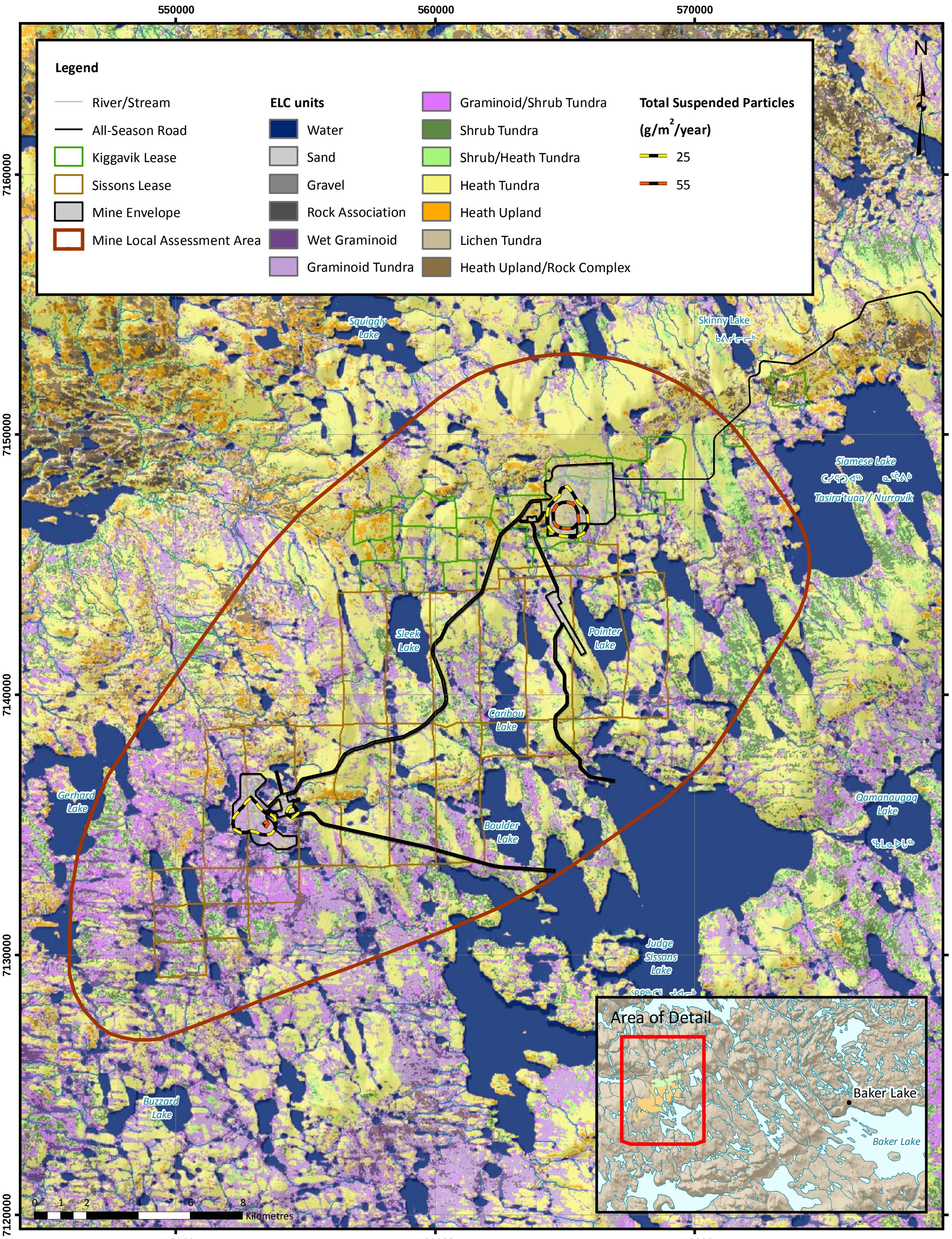
NOTE:

Annual concentrations were obtained from Period 2, which had the highest SO_2 and NO_x emission rates. During this period, there is open pit mining of Main Zone West Pit at Kiggavik and Andrew Lake at Sissons as well as the milling of ores from East Zone, Centre Zone and Main Zone pits.

* The phytotoxicity value for NOx (annual average of 30 µg/m³) has been converted to a NO_2 concentration (assuming NO_2 represents 63% of NOx) for comparison to model results.

[a] 20 µg/m³ is selected for forests and natural vegetation; 10 µg/m³ is selected for lichen

Air quality modelling for dust deposition (i.e., Total Suspended Particle [TSP]) predicts that nuisance dust (i.e., 55 g/m²/year) will only be generated at the Kiggavik mine site, and will likely be confined to the Project footprint (Figure 9.3-2). Dust deposition of 25 g/m²/year is expected to be confined primarily at both the Kiggavik and Sissons mine sites; however, approximately 20 ha and 16 ha of vegetation located outside of the Project Footprint at each mine site will likely receive dust deposition at this level, respectively (see Table 9.3-8 for ELC map units to be affected). The proportion of the ELC map units located adjacent to the Project footprint that is expected to be exposed to the dust threshold level of 25 g/m²/year is approximately 0.08%.



Projection: NAD 1983 UTM Zone 14N
Creator: CASLYS CONSULTING LTD.
Date: 08/21/2014 Scale: 1:200,000
File: 9.3-2_ELC_in_TSP_Isopleth.mxd
Data Sources: *Natural Resources Canada, GeoBase®, National Topographic Database, SENES Consultants Ltd. AREVA Resources Canada Inc., Gebauer & Associates.*

FIGURE 9.3-2
ECOLOGICAL LAND CLASSIFICATION UNITS AFFECTED BY TOTAL SUSPENDED PARTICLES AT THE KIGGAVIK AND SISSONS MINE SITES
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Table 9.3-8 ELC Map Units Located within the Predicted Total Suspended Particulate Matter Isopleths

ELC Unit	Total Suspended Particulate Matter (TSP) $g/m^2/year$					
	Kiggavik Mine Site			Sissons Mine Site		
	25	55	Total	25	55	Total
	ha	ha	ha	ha	ha	ha
Anthropogenic						
Disturbance	0.0	0.0	0.0	0.0	0.0	0.0
Unclassified						
Cloud/Shadow	0.0	0.0	0.0	0.0	0.0	0.0
Upland						
Sand	0.0	0.0	0.0	0.0	0.0	0.0
Gravel	0.4	0.0	0.4	0.1	0.0	0.1
Rock Association*	0.0	0.0	0.0	0.0	0.0	0.0
Graminoid Tundra*	0.6	0.0	0.6	2.4	0.0	2.4
Graminoid/Shrub Tundra*	1.7	0.0	1.7	2.0	0.0	2.0
Shrub Tundra*	3.0	0.0	3.0	0.1	0.0	0.1
Shrub/Heath Tundra*	3.1	0.0	3.1	0.3	0.0	0.3
Heath Tundra*	9.9	0.0	9.9	4.8	0.0	4.8
Heath Upland*	0.4	0.0	0.4	0.6	0.0	0.6
Heath Upland/Rock Complex*	0.1	0.0	0.1	0.1	0.0	0.1
Lichen Tundra*	0.5	0.0	0.5	0.4	0.0	0.4
Upland Total	19.7	0.0	19.7	10.9	0.0	10.9
Wetland						
Water	0.0	0.0	0.0	2.2	0.0	2.2
Wet Graminoid*	0.0	0.0	0.0	3.1	0.0	3.1
Wetland Total	0.0	0.0	0.0	5.2	0.0	5.2
Total Area	19.7	0.0	19.7	16.1	0.0	16.1

Based on the modelling predictions, the residual effects of PAI and dust deposition on vegetation quality within the mine LAA is anticipated to be low in magnitude during the construction and final closure phases, but will likely increase to moderate during the operation phase due to an increase in Project activities associated with open pit mining, and vehicular movement (e.g., ore haul trucks) within the open pits and around the mine sites.

Residual effects of PAI and dust deposition on vegetation quality are anticipated to be long term but will be reversible once Project activities that generate acidifying air emissions and dust are discontinued.

Project residual effects associated with COPC, NO_2, and SO_2 concentrations on vegetation quality are anticipated to be low in magnitude but have the potential to be regional in geographic extent. These residual effects will likely occur during the construction, operation and final closure phases of the Project, and are expected to be long term in duration. However, the residual effects will be reversible following discontinuation of Project activities.

9.3.5.3 Road LAAs

Air quality modelling of dust deposition associated with the All-Season Road predicts a rate of less than 0.1 g/m^2/year. Dust deposition associated with the winter roads is expected to be less than the All-Season Road, as the amount of dust generated by vehicle traffic on a frozen ground surface will be negligible. Because of the low dust deposition rates associated with the access roads, COPC concentrations in vegetation will be below concentrations predicted for the Mine LAA, and are predicted to be negligible.

Predicted maximum incremental NO_2 and SO_2 concentrations for each of the proposed access road options are presented in Table 9.3-9. The predicted concentrations are below the threshold values for vegetation (Section 9.1.4). As such, the residual effects on vegetation quality due to increases in NO_2 and SO_2 concentrations along each proposed access road is anticipated to be negligible.

Table 9.3-9 Overall Maximum NO_2 and SO_2 Concentrations Predicted for Access Road Options

Access Road Option	Overall Maximum Incremental Concentration					
	NO_2 (µg/m^3)			SO_2 (µg/m^3)		
	1-hr Maximum	24-hr Maximum	Annual	1-hr Maximum	24-hr Maximum	Annual
All-Season Road	1.40E-01	7.00E-02	8.80E-03	1.00E-02	5.40E-03	6.70E-04
Winter Road	6.50E-01	4.30E-01	1.70E-02	5.60E-02	3.70E-02	1.40E-03
Air Quality Criteria (µg/m^3)	400	200	100	450	150	30

NOTES:

NO_2 AQ criteria adopted from the Government of NWT (2011) Natural Resources Guideline for Ambient Air Quality Standards.

SO_2 criteria based on GN (2002) Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates.

9.3.5.4 Dock Site Options

Predicted incremental increases in concentrations of TSP, NO_2 and SO_2 as a result of the dock facility are presented in Table 9.3-10. Predicted concentrations for NO_2 and SO_2 are below the World Health Organization (WHO) threshold values for vegetation (Section 9.1.4). Similarly, predicted concentrations for TSP are below the threshold values identified in the Government of Nunavut's (2002) Environmental Guideline for Air Quality – Sulphur Dioxide and Suspended Particulates. Further details regarding TSP are presented in the Atmospheric Environment report (Tier 2, Volume 4). Based on the air quality modelling predictions for the preferred dock site option (i.e., option #1), residual effects on vegetation quality are anticipated to be low in magnitude and local in geographic context. These residual effects will likely occur during construction, operation and final closure, and will be long term in duration but reversible following discontinuation of Project activities.

Table 9.3-10 Incremental Concentrations Predicted for the Preferred Dock Site Option

Receptor	Incremental Concentration							
	TSP ($\mu g/m^3$)		NO_2 ($\mu g/m^3$)			SO_2 ($\mu g/m^3$)		
	24-hour Maximum	Annual	1-hour Maximum	24-hour Maximum	Annual	1-hour Maximum	24-hour Maximum	Annual
Dock Site Option	8.80E-01	7.70E-05	59.86	11.7	0.19	5.51	1.11	0.02
Air Quality Criteria ($\mu g/m^3$)	120	60	400	200	100	450	150	30

NOTES:

TSP and SO_2 criteria based on Nunavut Department of Sustainable Development Environmental Guideline for Air Quality - Sulphur Dioxide & Suspended Particulates, 2002.

NO_2 criteria adopted from the NWT Department of Environment and Natural Resources Guideline for Ambient Air Quality Standards in the Northwest Territories, January 2011.

9.3.6 Determination of Significance for Change in Vegetation Quality

Change in vegetation quality due to air emissions and dust deposition during Project construction and operation activities is predicted to be not significant. This is based on the fact that:

- There will be little change from measured baseline concentrations in browse, forage and berries within the LAAs.
- Only 0.2% the Mine LAA outside of the Project footprint will potentially be exposed to PAI values in exceedance of the threshold level.
- NO2 and SO2 concentrations are predicted to be below threshold values.
- Most dust deposition will occur within the confines of the Project footprint.
- Only 0.08% of the ELC map units located adjacent to the Project footprint are expected to be exposed to the dust threshold level of 25 g/m^2/year.

Overall, confidence in this prediction is considered moderate. While the effects of air emissions on most vegetation types is relatively well understood, and the effectiveness of mitigation measures is well documented, no established thresholds exist for determining the effects of dust deposition on vegetation quality.

Prediction confidence will be improved through specific monitoring programs that will occur throughout the Project (dust and air emissions, vegetation sampling for analyte concentrations from permanent sampling plots).

9.3.7 Compliance and Environmental Monitoring for Change in Vegetation Quality

Compliance and environmental monitoring for change in vegetation quality will include the following:

- Permanent sampling plots will be established adjacent to the Project Footprint, and vegetation samples will be collected and analyzed to determine changes in analyte concentrations (Tier 3, Technical Appendix 6D).
- Air quality monitoring stations will be established within the Mine LAA and will be routinely surveyed to measure potential changes in NO2, SO2, and analytes (Tier 3, Technical Appendix 4C). Results from these stations will be compared to analyte concentrations in vegetation from the permanent sampling plots.
- Dust deposition stations will be established adjacent to the mine footprint, as well as the access roads. Monitoring of these stations will commence prior to construction activities and will continue throughout the duration of the Project (Tier 3, Technical Appendix 4C). Results from these stations will be compared to analyte concentrations in vegetation from the permanent sampling plots.

9.4 Cumulative Effects Analysis for Vegetation

9.4.1 Screening for Cumulative Environmental Effects

Of the projects and activities identified in the Project Inclusion List (Tier 1, Volume 1), only the Meadowbank dock site facility has the potential to interact with the Project. The Meadowbank dock facility is located approximately 1 km from the preferred dock site (Option #1). Both construction and operation activities at the Project dock facility could overlap temporally with operation of the Meadowbank dock and potentially cause cumulative effects on vegetation quality as a result of increased air emissions.

An air quality assessment was completed as part of the Atmospheric Environment Assessment (Tier 2, Volume 4) to determine potential cumulative effects from the combined operations of the Meadowbank and Kiggavik dock and storage facilities. Result of the modelling predicted exceedances of the 1-hour and 24-hour threshold values for ambient NO_2 concentrations during periods when both facilities are operating simultaneously. The exceedances are predicted to occur approximately 1% of the time annually and are expected to be localized. While this NO_2 deposition could result in a decrease in vegetation quality, this would represent only a fraction of the ambient NO_2 concentrations which are unlikely to cause a detectable change in vegetation quality.

No other projects were identified within the RAA. However, exploration activities are currently occurring near the proposed Project (Tanqueray option, Ukaliq, Schultz Lake, St. Tropez Claims, Judge Sissons, and Kiggavik S. exploration sites). As such, these activities are considered as part of the Base Case, and have been addressed in the context of current baseline conditions for soils.

None of the exploration sites located within the RAA are involved in the regulatory process, or have made a public announcement to seek regulatory approval. The effects of these exploration activities on vegetation are likely to be localized to the exploration site, and are not anticipated to overlap with the residual effects from the Kiggavik Project. As well, no other projects or developments are known to occur and no future projects are anticipated within the LAA and RAA boundary. As the Project effects are not expected to extend beyond the LAA or overlap with any other projects, no cumulative effects on vegetation are anticipated. As a result, the cumulative effect of changes in vegetation abundance, quality and community diversity is not considered further in this assessment.

9.5 Summary of Project Residual Environmental Effects on Vegetation

Project residual effects on vegetation abundance and community diversity, and vegetation quality are predicted to be not significant (Table 9.5-1). During construction, Project activities associated with site clearing and burial of vegetation will be restricted within the confines of a pre-surveyed Project footprint area. Depending on the Project development option, the total disturbed area will range between 1.2% and 1.5% of the combined LAAs. Approximately 168 ha to 175 ha (i.e., 0.5% to 0.4%, respectively) of the wetland area within the LAA boundaries that supports vegetation is expected to be lost. Heath tundra will be most affected, with a decrease in abundance representing between 1.9% and 2.8% of the total area, depending on the Project development option combination selected.

Air emissions generated by the Project components will change the analyte concentrations in vegetation; however, the majority of the predicted changes are within the threshold values, except for zinc, cobalt, and copper where baseline levels were found to naturally occur at the upper critical level for phytoxicity concentrations. Changes in these analyte concentrations are not anticipated to exceed upper thresholds; therefore, no adverse effects on vegetation quality are expected to occur. PAI levels greater than the critical load threshold value are predicted to occur over 81 ha adjacent to the Kiggavik mine site, affecting approximately 0.2% of the Mine LAA and resulting in a negligible residual effects on vegetation. No residual effects from NO_2 and SO_2 concentrations on vegetation are anticipated to occur, as generated emissions are predicted to be below threshold values.

Effects of dust deposition on vegetation are anticipated to be local, representing only about 36 ha adjacent to the Kiggavik and Sissons mine sites. Dust deposition along the proposed access roads is anticipated to be negligible, with a predicted annual deposition of 0.1 g/m^2.

The residual effects for vegetation were based on looking at Project-related effects on an individual basis (e.g., PAI alone, changes in COPC concentrations alone). While these residual effects may be low in magnitude and vary in duration, the combination of the Project-related effects and how they influence the residual effects could have additional changes to vegetation. These combined interactions and potential changes are complex and difficult to understand, and no clear interaction mechanism has been found in the literature. Based on professional judgment, the combination of Project-related effects and the subsequent residual effects for vegetation are anticipated to be no greater that the residual effects on an individual basis, as these effects were assessed on a conservative basis. Therefore, the combined Project-related effects on vegetation are predicted to be not significant.

9.5.1 Effects of Climate Change on Project Effects on Vegetation

Climate change could influence the effect of the Project on vegetation. An earlier snow-melt that extends the growing season due to temperature increases, as predicted by modelling discussed in Technical Appendix 5K, can accelerate any potential changes in vegetation abundance and community diversity caused by the Project. While changes in vegetation composition from a tundra sedge community to either a graminoid or shrub community in areas adjacent to human development have been documented, climate change has the potential to facilitate and accelerate this change. Hollister (2003) found a general increase in graminoid and shrub cover, with a decrease in cover of mosses and lichens. This change in cover was postulated to be caused by climate change. Modelling studies completed by Hinzman et al. (2002) postulated that changes in vegetation communities in the Arctic have the potential to influence climate, and the magnitude and extent of the effect will depend on the temporal and spatial patterns of land cover change.

Climate change may also provide more favourable growing conditions for non-indigenous species, especially in areas disturbed by the Project. To prevent the introduction of non-indigenous and/or potentially invasive vegetation to the Project area, all equipment and machinery will be cleaned of foreign particles (e.g., soil, thatch) prior to initial transport to the Project (i.e., prior to loading onto the barge, or shipping by air). All equipment and machinery will be further inspected for foreign particles upon arriving at either the dock facility or while being off-loaded at the airstrip. Any foreign particles found on equipment and machinery will be removed, collected, and incinerated to prevent propagule establishment and proliferation.

While non-native species that are inadvertently introduced by the Project may not establish and proliferate due to the adverse conditions that currently occur, climate change may facilitate changes in conditions that promote their growth. The introduction of non-indigenous species could potentially out-compete native species for limited resources, creating a change to the vegetation community and potentially increasing species richness (Johnson 2008; Walther et al. 2002). Although climate change has the potential to alter the ranges of species, a new species moving into an area due to a range extension would not necessarily be considered an invasive species (GN DoE 2014).

Table 9.5-1 Summary of Project Residual Environmental Effects: Vegetation

Project Phase	Mitigation/ Compensation Measures	Residual Environmental Effect (Y/N)	Direction	Residual Environmental Effects Characteristics: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Environmental Context	Significance	Likelihood	Prediction Confidence	Recommended Follow-up and Monitoring
Change in vegetation abundance and community diversity: Site clearing and vegetation burial during construction will affect vegetation abundance and community diversity													
Construction	Activities confined within the work area boundaries.	Y	A	L	S	LT	O	R	ND	N	N/A	H	Environmental monitoring during construction.
Change in vegetation quality: Dust created by Project activities will affect vegetation quality													
Construction	Dust suppression by spraying water or other approved substance on mine site travel areas.	Y	A	L	L	LT	C	R	ND	N	N/A	M	Monitoring of vegetation permanent sampling plots located around the mine sites and access roads for changes in vegetation abundance and community diversity.
Operation	Avoid blasting on days when winds are excessive.	Y	A	M	L	LT	C	R	ND				
Final Closure	Reduced speed limits in dust-prone areas.	Y	A	L	L	LT	C	R	ND				Dust deposition monitoring around the mine sites as well as the access roads.
Change in vegetation quality: Air emissions from Project components will affect vegetation quality													
Construction	All industrial machinery and equipment (including the diesel-powered generators) will meet federal air emission standards.	Y	A	L	R	LT	C	R	ND	N	N/A	M	Monitoring of vegetation at locations around the mine sites and access roads for changes in vegetation quality.
Operation	Use of low sulphur diesel fuel.												
Final Closure	Scrubbers installed on mill stacks to remove particulates and contaminants before discharge into the atmosphere.												Monitoring of air emissions from static emissions sources associated with the Project (e.g., acid plant).
Post Closure													

KEY

Direction:
- P Positive
- N Neutral
- A Adverse

Magnitude:
- N Negligible: no measureable change in vegetation abundance and community diversity, or vegetation quality.
- L Low: effect is detectable but within the range of natural variation or baseline values.
- M Moderate: effect is detectable and outside the range of natural variation or baseline values, but is unlikely to change vegetation abundance and community diversity, or vegetation quality
- H High: effect is detectable and outside the range of natural variation or baseline values leading to a change in vegetation abundance and community diversity, or vegetation quality.

Geographic Extent:
- S Site-specific: (i.e., Project Footprint)
- L Local (i.e., within the LAA)
- R Regional (i.e., extends beyond the LAA but within the RAA)

Duration:
- ST Short term: change no longer detectable at the end of construction
- MT Medium term: change no longer detectable at the end of final closure
- LT Long term: change extends beyond the life of the Project

Frequency:
- O Once.
- S Sporadically: occurs more than once, but at unpredictable intervals
- R Regularly: occurs repeatedly at regular intervals
- C Continuous: occurs continuously throughout the Project

Reversibility:
- R Reversible
- I Irreversible

Environmental Context:
- D Disturbed: area has been substantially disturbed previously by human development, or human development is still present.
- N Not Disturbed: area has not been disturbed by human activity.
- N/A Not Applicable

Significance:
- S Significant
- N Not Significant

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

Likelihood:
Of a significant effect occurring
- N/A Not applicable
- L Low probability of occurrence
- M Medium probability of occurrence
- H High probability of occurrence

Cumulative Effects
- Y Potential for effect to interact with other past, present or foreseeable projects or activities
- N Effect will not or is not likely to interact with other past, present or foreseeable projects or activities

9.6 Summary of Mitigation Measures for Vegetation

Mitigation measures that will be implemented to reduce the Project effects on vegetation are described below. Many of the mitigation measures associated with vegetation quantity and quality incorporate IQ guiding principles (GN 2009), including Qanuqtuurnunnarniq (being resourceful to solve problems), Avatimik Kamattiarniq (environmental stewardship), and Pilimmaksarniq (skills and knowledge acquisition).

9.6.1 Vegetation Quantity

Pre-construction surveys will be completed of the surveyed Project footprint boundaries for listed species to confirm their absence from the area to be disturbed. If any listed species are observed, a number of mitigation measures may be employed. For any listed species observed along the proposed access roads, efforts will be made to re-route the access to avoid disturbing the listed species. If listed species are observed within the proposed mine sites or dock facility, AREVA will consult with the GN regarding transplanting the listed species to another suitable location.

Best management practices will occur during construction of the Project. Construction activities will likely be postponed during large precipitation events to prevent excessive disturbance to vegetation and soils due to wet working conditions.

Site clearing and vegetation burial will occur within the confines of the Project footprint to reduce the potential for additional vegetation loss and prevent unnecessary disturbance to vegetation adjacent to the Project development area. The work area boundaries will be clearly identified by markers placed along the perimeter of the work area during construction to reduce vegetation damage and disturbance.

During topsoil stripping and stockpiling, the vegetation seedbank will also be preserved. Preservation of this seedbank will provide seeds and propagules during soil replacement, facilitating natural regeneration of native vegetation to reclaimed areas.

The proposed routing of the winter roads makes use of waterbodies (e.g., lakes) and watercourses (e.g., streams) as much as possible. Rig matting may also be used in areas where the use of granular material is not practical to prevent damage to the underlying vegetation along the Winter Road.

To prevent the introduction of invasive and non-native vegetation to the Project area, all equipment and machinery will be cleaned of foreign particles (e.g., soil, thatch) prior to initial transport to the Project (i.e., prior to loading onto the barge, or shipping by air). All equipment and machinery will be further inspected for foreign particles upon arriving at either the dock facility or while being off-loaded at the airstrip. Any foreign particles found on equipment and machinery will be removed, collected, and incinerated to prevent propagule establishment and proliferation.

Progressive reclamation will occur throughout the Project on decommissioned areas to return disturbed areas to a natural state. Adaptive management strategies based on the most recent research and literature pertaining to reclamation of disturbed areas in arctic environments will be implemented and monitored for succession and to assess whether further reclamation efforts are necessary.

9.6.2 Vegetation Quality

Air emissions that could adversely affect vegetation quality will occur throughout the duration of the Project. To reduce the effects of air emissions on vegetation, all industrial machinery and equipment and diesel-powered generators will meet the federal air emission standards. Low sulphur diesel fuel will be used to reduce SO_2 fumigation. The acid plant will be the largest producing unit of SO_2 associated with the Project. As such, a scrubber will be installed on the exhaust stack to remove particulates, acid mist and excess SO_2.

Dust will be created throughout the duration of the Project due to Project activities such as blasting, hauling of ore and waste rock materials from the mine pits, as well as vehicular traffic along the access roads, During the detailed design of the roads, efforts will be made to use non-calcareous materials from quarry sites to minimize dust-prone aggregate from being used during road construction. During open pit mining, blasting patterns will be used to control the dispersion of materials as well as dust. Where possible, blasting may also be avoided on days where dust dispersion outside of the Project footprint is anticipated to be excessive due to the prevailing winds speeds. Dust suppression (EN-BL OH Nov 2013 [158]) will involve spraying water from a tanker truck affixed with either a spray nozzle or spray bar onto dust-prone mine site areas. If water spraying is not effective in preventing dust occurrence, an adaptive management strategy focussing on addition dust suppression techniques will be investigated, such as using a dust suppressant identified in the GN (2002) guidelines. Speed limits around the mine site and along all Project roads will be strictly adhered to, to reduce airborne dust from vehicular and other equipment traffic.

The Air Quality Monitoring and Mitigation Plan (Tier 3, Technical Appendix 4C) outlines mitigation by design and mitigation by management for changes in air quality; these mitigation measures will reduce effects of air emissions on vegetation quality.

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[158] EN-BL OH Nov 2013: *Dust from road. What will AREVA do to suppress dust?*

9.7 Summary of Compliance and Environmental Monitoring for Vegetation

A summary of compliance and environmental monitoring for vegetation that will occur during the Project are described below. Compliance and environmental monitoring plans associated with vegetation quality and quantity incorporate IQ guiding principles (GN 2009), including Qanuqtuurnunnarniq (being resourceful to solve problems), Avatimik Kamattiarniq (environmental stewardship), Pilimmaksarniq (skills and knowledge acquisition) and Piliriqatigiingniq (collaborative relationships or working together for a common purpose). The importance of environmental monitoring was highlighted through IQ interviews and engagement feedback (e.g. EN-BL OH Nov 2013[159]).

9.7.1 Vegetation Quantity

An environmental monitor will be on-site during all phases of the Project to work with AREVA personnel and contractors to meet and comply with environmental regulations associated with vegetation.

Measurements of dust deposition from snow survey stations and dust gauges placed around the Project Footprint and along the proposed access roads will be taken prior to construction activities (Tier 3, Technical Appendix 4C).

Permanent sampling plots to monitor vegetation abundance and community diversity will be established around the Project Footprint and adjacent to the proposed access roads prior to their construction. These permanent sampling plots will be routinely surveyed and assessed to measure potential changes in vegetation abundance and community diversity (Tier 3, Technical Appendix 4C). Any non-indigenous and/or invasive species identified in the permanent sampling plots will be documented and reported to Government of Nunavut Department of Environment (GN DoE 2014).If invasive species are identified as noxious weeds, or other vegetation species that are suspected of competing with native vegetation, efforts will be made to remove these occurrences to prevent a spread or proliferation of these invasive species.

Results from dust deposition monitoring and the vegetation community monitoring will inform on the effectiveness of mitigation, and whether further actions are required.

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[159] EN-BL OH Nov 2013: *What about the environment? How do you know what is in the air and water and lichen that caribou eat?*

9.7.2 Vegetation Quality

Vegetation quality monitoring will occur throughout the duration of the Project, along with air emissions and dust deposition to evaluate their effects on vegetation quality (Tier 3, Technical Appendix 4C). Vegetation quality monitoring will involve collection of vegetation samples from locations within the predicted exposure areas as determined by the isopleths for PAI and TSP within mine LAA (i.e., exposure plots), as well as reference plots located within the Project RAA. Chemical analyses of the vegetation samples will be completed and comparisons will be made between the reference and exposure site values, as well as to the baseline values and CCME guidelines. The importance of monitoring vegetation quality was noted in IQ and engagement comments (e.g. EN-BL OH Oct 2012[160]). Dust monitoring (Tier 3, Technical Appendix 4C) will be undertaken to determine the amount of dust generated by the Project and its dispersal. The monitoring will help determine if any effects are occurring on vegetation and to inform adaptive management strategies.

[160] EN-BL OH Oct 2012: *Will the berries and animals be protected if your mine goes ahead?*

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11 Scope of the Terrestrial Wildlife and Habitat Assessment

11.1 Issues and Concerns Identified During Inuit Qaujimajatuqangit Interviews and Inuit, Government and Stakeholder Engagement

In addition to issues and concerns about possible Project effects on terrestrial wildlife and habitat identified in the NIRB Project Guidelines (Nunavut Impact Review Board 2011), AREVA engaged Inuit, Government and Stakeholders in a variety of forums to ensure that issues are considered and addressed in the Project effects assessment. This included meetings to discuss terrestrial wildlife and habitat effects with individuals (informal meetings and formalized interviews), the Baker Lake Hunter and Trapper Organization (BLHTO), the Beverly and Qamanirjuaq Caribou Management Board (BQCMB), the Government of Nunavut Department of Environment (GN-DoE), Environment Canada (EC) and other relevant organizations. Issues and concerns were also submitted as part of the NIRB review process during the DEIS information request and technical comment stages, and summarized in the Preliminary Hearing Report (Nunavut Impact Review Board 2013).

The Project's environmental assessment guidelines prepared by the Nunavut Impact Review Board identify issues to be addressed in the Project's environmental impact statement (Nunavut Impact Review Board 2011). The NIRB developed those guidelines based in part on their public scoping process that included sessions in Baker Lake, Repulse Bay, Coral Harbour, Chesterfield Inlet, Arviat, Whale Cove and Rankin Inlet. One of the objectives of those meetings was to solicit the public's advice on valued ecosystem components (VECs) that should be addressed in the EIS.

As part of AREVA's efforts to gather input and feedback from Kivalliq community members on the Project, a number of public engagement events (Tier 2, Volume 3, Part 1 Public Engagement) and Inuit Qaujimajatuqangit (IQ) interviews (Tier 2, Volume 3, Part 2 Inuit Qaujimajatuqangit) were conducted. AREVA efforts to engage various groups (e.g. Elders, youth, hunters, women) within communities demonstrates the commitment to IQ guiding principles (GN 2009) of Tunnganarniq (fostering good spirit by being open, welcoming, and inclusive), Aajiiqatigiingniq (consensus decision-making) and Inuuqatigiitsiarniq (respecting others, relationships, and caring for people) and as all groups are recognized as valued contributors. The term Inuit Qaujimajatuqangit is used to describe Inuit epistemology or the Indigenous knowledge of the Inuit (Tagalik 2012). Inuit Qaujimajatuqangit translates into English as "that which Inuit have always known to be true." Throughout the assessment, Inuit Qaujimajatuqangit and engagement comments are differentiated by a prefix of either 'IQ' for Inuit Qaujimajatuqangit or 'EN' for engagement.

Many of the issues and concerns raised about the potential effects of the Project on the terrestrial environment highlight the understanding that *the health of Inuit, of wildlife and of the environment are* *interconnected* (IQ-Nunavut Tunngavik Inc. 2005) and the IQ guiding principle of Avatimik Kamattiarniq, the concept of environmental stewardship (GN 2009).

Most of the issues and concerns regarding wildlife at the stakeholder engagement and IQ sessions focused on the Project's potential interaction with caribou (*Rangifer tarandus*). Throughout the Inuit and stakeholder engagement sessions, numerous comments were received regarding caribou, showing the species' cultural, societal, and ecological importance to people residing in the Kivalliq region. From the comments received, the majority of concerns about Project-related effects on caribou were associated with caribou migration (EN-BL NIRB April 2010[161], EN-AR NIRB May 2010[162]), hunting and caribou mortality (IQ-BLH 2009[163]), caribou health (IQ-ARHT 2009[164], EN-CI KIA Apr 2007[165]), and habitat (EN-RB NIRB April 2010[166], IQ-BLE 2009[167]). These concerns formulated the basis of the environmental effects assessment for caribou (Section 13).

Caribou were consistently mentioned as an important wildlife species due to their cultural, dietary, and economic importance to the local people. Representative comments made during the stakeholder engagement sessions regarding wildlife include:

- *People want to be assured that the Project will not disturb caribou on which people are still greatly dependent. They believe that if the migration routes are affected, the caribou may move too far away for people to hunt* (IQ-ARE 2009).

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161 EN-BL NIRB April 2010: *Caribou migration routes are very important in the region.*

162 EN-AR NIRB May 2010: *Concerns over potential effects of noise on migrating animals and the need to put in place mitigation measures.*

163 IQ-BLH 2009: *Hunters emphasized that most people in Baker Lake still depend on caribou for food.*

164 IQ-ARHT 2009: *Hunters and Elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

165 EN-CI KIA Apr 2007: *Caribou eat off the ground and then we eat the caribou. If they get sick, we get sick. We'll get diseases.*

166 EN-RB NIRB April 2010: *Concerned with wildlife habitat and potential impacts to the flora and fauna that the wildlife will live off.*

167 IQ-BLE 2009: *Elders are concerned that mining will take away land from the hunting grounds.*

Numerous comments focused on the proposed access road and potential for the road to affect migration, negatively or positively affect hunting, dust created and settling on near-by vegetation that would be consumed by wildlife and the management of the road:

- One Elder suggested that *if a road is built from Baker Lake to the Kiggavik mine site, it may cause the caribou to go to Chesterfield Inlet* (IQ-CI03 2009). Another Elder pointed out that *there is a calving area around Josephine Lake, and the Sure [Shear] Minerals camp does not affect the caribou* (IQ-CI01 2009).
- Participants in the young adults' focus group were concerned that *Project-related roads may affect caribou migration, which in turn may require Elders to travel farther for food* (IQ-RIYA 2009).
- *If AREVA builds a road, it may cause changes to the caribou migration and limit hunter access* (IQ-BLHT 2011).
- *If AREVA builds a road, there will be dust from the road in the summer time. This dust will collect on the grass on which the caribou feed, and may affect caribou health. This should be minimized* (IQ-BLHT 2011).
- *A road could potentially provide better access to the caribou, but there would need to be more wildlife monitors in place (3-4). These monitors are most useful between June and December* (IQ-BLHT 2011).

Concerns about potential contamination of wildlife and wildlife habitat was raised in a number of meetings:

- *Young adults have heard about damage to the environment caused by mines and believe the effect assessment should consider the potential effects of the Project during all seasons. They also believe priority should be given to considering potential effects of the Project on caribou migration routes* (IQ-RIYA 2009).
- *HTO members are concerned about caribou that may get too close to the mine causing potential contamination to the caribou* (IQ-RBHT 2009).
- *Community members emphasized that AREVA will need to keep the caribou out of danger and to educate people about the potential dangers from a uranium mine* (IQ-WCE 2009).
- Whale Cove Elders *are aware there have been problems at other mines and cited instances of caribou eating harmful things at mine sites* (IQ-WCE 2009).
- Women said *they were concerned about the potential effects of the Project on water, wildlife, caribou, and on the air in particular* (IQ-RIW 2009).
- *Hunters and elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou* (IQ-ARHT 2009).
- *Would wildlife get contaminated eating onsite?* (EN-RI OH Nov 2013)

Although the focus of many issues and concerns was on caribou, a wide range of other terrestrial wildlife species, such as birds and small mammals, were discussed:

- *Everyone is concerned about birds that migrate past Baker Lake* (IQ-RBE 2009).
- *I am pretty sure there will be dust that will spread everywhere. You'll need wildlife monitors all the time. There will be lots of dust and animals like rabbits and wolves will be affected* (EN-BL EL Oct 2012).
- *Concerns over small animals (ptarmigan, rabbits) and wildlife and potential impacts if they get too close to the mine site. Will they be impacted by the concentrated uranium?* (EN-AR NIRB May 2010)

There were specific concerns raised about animals drinking contaminated water and making sure that water is safe for wildlife:

- *I am concerned about the environmental assessment and how it is going to be completed, especially with the water testing. The animals drink the water, and it would be best to have all things safe for the animals.* (EN-BL EL Mar 2009)

A consistent theme raised was the importance of wildlife protection:

- *I am worried about the wildlife, will you protect it, make sure you don't harm it?* (EN-CH OH Nov 2010)
- *If this mine goes ahead it will employ people, but need to protect and mitigate impacts to land, wildlife, environment and workers.* (EN-BL NIRB April 2010)
- *Concerns regarding water quality, terrestrial wildlife and their habitat, marine mammals and their habitat, birds and their habitat, fish and their habitat, heritage resources in the area, Inuit harvesting activities, local development in the area, tourism in the area, and human health*. (EN-BL NIRB Apr 2010).

The Baker Lake Hunters and Trappers Organization (BLHTO) met with AREVA a number of times since the inception of the Project. Recent key meetings include a Road Management Workshop in November 2011, their written submission and attendance at the Preliminary Hearing Conference in June 2013, and follow-up meetings in April 2014 to further discuss the technical meeting comments. Their issues and concerns generally include use of IQ in the baseline and assessment, road access and management, potential project effects on harvest, and cumulative effects of possible future uranium projects in the region. At the technical meetings during review of the DEIS, the BLHTO reiterated several of their concerns that were summarized in the Preliminary Hearing Conference Decision report (Nunavut Impact Review Board 2013). Most of the comments were related to caribou with little discussion about other wildlife. The BLHTO requested that AREVA assess the Project's potential to cause animals to avoid important Inuit hunting areas, but it was also noted several times that it is difficult to identify where hunting occurs because it may occur everywhere. There were requests to consider the potential cumulative effects of possible additional uranium projects and exploration activities in the area. They also identified the importance of incorporating IQ in the Project effects assessment, and that the science and information gained from collared animals does not reflect the entire caribou population. There were concerns about road dust and changes to caribou movement based on BLHTO members' experience with the Meadowbank road and mine operation.

The BLHTO commissioned a report on Inuit Qaujimajatuqangit regarding Project road options (JT Consulting 2011) that was made available to AREVA for use in the effects assessment. The research included interview and meetings with BLHTO board members, other hunters and elders. The report summarized concerns about the Project's road options on wildlife and Inuit harvesting practices. While the report was based on information provided by experts on the Kiggavik area and representatives elected by local hunters, it was not intended to represent the full concerns nor indicate support or opposition by the community as a whole. The concerns reflected in the report were noted as being based on the personal experiences with the all-weather road to the Meadowbank gold mine. Positive and negative effects of that road were reflected in the report. The benefits of the road included increased harvester access, while the negatives included the limitations it places on snow machine travel (e.g., limited crossing points) and restrictions placed on road users. There was mixed opinion about the road's effects on wildlife, and that the road may or may not be influencing caribou distribution. There were general concerns about the effects of road dust on vegetation and fish populations in nearby lakes and rivers. Hunters were concerned about harvest restrictions that may be placed on new roads and the negative effects that may have on their current harvest practices. The report noted that attempts at mapping areas used by harvesters was difficult because many hunters claimed to "hunt all over" and change land use regularly. Regardless of that challenge, it was noted that hunters continue to use the area where AREVA will develop a mine and road.

The Beverly and Qamanirjuaq Caribou Management Board (BQCMB) identified a number of issues and concerns related to the Project's effects assessment on caribou through meetings with AREVA and during the Information Request and Technical Meeting review of the DEIS. The BQCMB consistently raised concerns about ensuring that IQ be integrated into the assessment and monitoring plans, that robust methods of habitat classification be used, possible cumulative effects of development within the ranges of the Beverly and Qamanirjuaq caribou, that habitat, movement, mortality and health be properly addressed, identify mitigation to reduce the zone of influence, and that cumulative effects address effects of all disturbances within the combined ranges of the Beverly and Qamanirjuaq caribou.

The Government of Nunavut Department of Environment (GN-DoE) documented their issues formally during the Information Request stage of the NIRB review process, and those issues were summarized in the Preliminary Hearing Conference Decision report (Nunavut Impact Review Board 2013). The GN raised concerns about species other than caribou including potential effects on grizzly bear, wolverine, wolves and shorebirds. The GN identified concerns about the effects of an all season road, harvesting effects and cumulative effects. Environment Canada (EC) submitted

Information Requests and provided technical comments during the NIRB review process of the DEIS. Assessing and mitigating potential project effects on species at risk and aircraft overflight effects on congregations of migratory birds were key concerns for that organization.

11.2 Influence of Inuit Qaujimajatuqangit and Inuit and Stakeholder Engagement on the Terrestrial Wildlife Assessment

Through IQ interviews and engagement activities, AREVA learned about the importance of terrestrial wildlife to Kivalliq community members. Terrestrial wildlife are integral to the Inuit way of life (IQ-BLH 2009[168]) and the maintenance of traditional culture is a very important component of people's wellbeing (EN-RI KWB Oct 2009[169]). AREVA's understanding of the importance of terrestrial wildlife is demonstrated in the scope and approach taken in the terrestrial assessment. Issues and concerns (Section 11.1) identified during the stakeholder engagement sessions and IQ interviews were incorporated into the terrestrial assessment (e.g. list of Project-environment interactions, scope of assessment) and informed the associated mitigation and monitoring plans. Engagement data and IQ was also integrated throughout the terrestrial baseline report. Based on multiple engagement meetings, interviews with IQ knowledge holders, and some IQ provided by the BLHTO (specifically in their commissioned report by JT Consulting 2011), AREVA incorporated available IQ in the baseline reports, effects assessment, and the wildlife mitigation and monitoring framework.

AREVA endeavoured to engage local community members who are recognized as being Qaujimanilik, which means a person who is recognized by the community as having in-depth knowledge of a subject (Nunavut 2008). As such, AREVA has initiated and participated in on-going meetings with HTOs (35 meetings in 7 communities since 2006), the Kivalliq Wildlife Board (5 meetings) and the Beverly and Qamanirjuaq Caribou Management Board (10 meetings). AREVA will continue to work with the BLHTO on wildlife issues and will continue to meet with the other Kivalliq HTOs (Tier 3, Technical Appendix 3C). This demonstrates AREVA's commitment to the IQ principles of:

- Avatimik Kamattiarniq (people are stewards of the environment and must treat all of nature holistically and with respect, because humans, wildlife and habitat are inter-connected and each person's actions and intentions towards everything else have consequences, for good or ill),
- Piliriqatigiingniq (people must work together in harmony to achieve a common purpose),

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168 IQ-BLH 2009: *Hunters emphasized that most people in Baker Lake still depend on caribou for food.*

169 EN-RI KWB Oct 2009: *We rely on country foods and these have to be protected.*

- Papattiniq (the obligation of guardianship or stewardship that a person may owe in relation to something that does not belong to the person), and
- Ikpigusuttiarniq Nirjutilimaanik (all wildlife should be treated respectfully).

The Baker Lake HTO and the Beverly and Qamanirjuaq Caribou Management Board requested that AREVA clearly demonstrate in the FEIS how IQ was integrated in the effects assessment and adaptive mitigation and monitoring plans for the Project (Nunavut Impact Review Board 2013). The issues and concerns related to IQ and IQ relevant to wildlife mitigation and monitoring are included in the remainder of this document and highlighted by citation to engagement meeting notes and IQ-based comments. Engagement data and IQ is incorporated throughout the environmental assessment, as described in the following sections.

Baseline

Prior to baseline field studies, available IQ was collected to determine current and historical presence of wildlife species in and around the Kiggavik Project and to identify areas of special concern in the Project area. The information sources included informal discussions with the BLHTO, community leaders, regulatory agencies (e.g., Kivalliq Inuit Association, Nunavut Planning Commission), non-governmental organizations (e.g., Beverley and Qamanirjuaq Caribou Management Board, Kivalliq Wildlife Board), local area residents and hunters. The IQ was useful in identifying VECs (Section 11.5) of greatest importance to hunters and residents, prioritizing field programs and the scope of the programs, and defining the final boundaries of the Regional Study Area to encompass known caribou use areas (Section 11.6.1).

IQ from 2008 and 2009 interviews and focus group discussions in Baker Lake and nearby communities was reviewed and incorporated into the Terrestrial Wildlife Baseline Report (Tier 3, Technical Appendix 6C). The IQ provided information on wildlife presence, behaviour, and habitat use to supplement and inform historical and regional data, as well as current data from the 2007 to 2010 field surveys. In particular, information on important caribou use areas (i.e., water crossings, calving and post-calving areas, and areas of migration), and historical and current presence and use of caribou, other mammals and birds provided valuable insight to the terrestrial wildlife dataset. IQ information specific to the Kiggavik project included knowledge about the site being adjacent to the Beverly caribou post-calving ground, and that the Qamanirjuaq herd is calving close to the site. A number of baseline maps were created which included scientific and IQ data for specific species or activities such as migration, denning areas and calving areas. Refer to Tier 3, Technical Appendix 6C and Section 12 below for examples of these datasets. For instance, Figures 12.6-1 to 12.6-5 in Section 12 provide insights into how data from a number of sources were compiled to create valuable baseline data on a topic, such as caribou migration, muskox herd ranges, and grizzly bear observations.

Baseline data collection was enhanced and informed by local Inuit staff hired to assist with fieldwork (identified in Tier 2, Volume 3, Part 1, Section 3.4.9). Their knowledge of the land and insight into historical and current land use patterns of local Inuit helped define the scope of the terrestrial baseline program and demonstrates the IQ principle of Qaujimanilik (a person who is recognized by the community as having in-depth knowledge of a subject; Nunavut 2008).

The Baker Laker Hunter Harvest Study (HHS) was initiated by Agnico-Eagle Mines Inc. in 2007 as a condition of the NIRB certificate for the Meadowbank Gold Project, and serves to monitor hunting patterns, before, during, and following construction for that project. In 2009, AREVA became a partner in that regional study, and the study area was expanded westward to include the Kiggavik RSA. The HHS tracks the spatial distribution, seasonal patterns, and harvest rates of hunter kills. The study is similar to the Nunavut Wildlife Harvest Study (Priest and Usher 2005) and the Inuvialuit Harvest Study conducted between 1988 and 1997 (The Joint Secretariat 2003); however, it is limited to one community (Baker Lake) and focuses on three VEC species (muskox, caribou, and wolverine) that are relevant to Inuit and northern culture. Data from the HHS were incorporated through the assessment and demonstrates AREVA's commitment to gathering and using data which is based on local knowledge and experience.

Engagement with the GN-DoE influenced AREVA's decision to discontinue aerial surveys as part of the baseline data collection.

Project Design

In terms of Project design, there was considerable interest in the all season road that would be built between Baker Lake and the Kiggavik site for transporting materials to the site. Roads are seen as ways to access land and wildlife. AREVA was respectful of suggestions to involve Elders, hunters, and consult with the community prior to making a final selection of a road option and organized a number of road options meetings from 2007 to 2009. Road options were discussed at meetings with the Baker Lake Community Liaison Committee, Kivalliq Wildlife Board, community leaders, high schools, HTOs, Elders and at AREVA's Open Houses and NIRB scoping sessions (Tier 2, Volume 3, Part 1, Community Engagement). IQ interviews included questions and comments about road options (e.g. IQ-BL02 2008[170]; IQ-BL17 2008[171]; IQ-BLHT 2011[172]). It was clear that public access to

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[170] IQ-BL02 2008: *I wish that the bridge and the road will go through the Thelon, not by Hagliq. I would be very pleased if there would be a bridge, but I have mixed feelings on a road going through Hagliq*

[171] IQ-BL17 2008: *Hagliq is a very important place, so people will be upset if road were built there. That area is used for camping every spring, to hunt, fish or just spend time with family. It's even used in winter. As for this area around the Thelon River, people travel up river by boat, but only in the summer, and they can travel by land too. I would prefer they build the road to cross the Thelon River, because it would be better that way*

roads is important to the people of Baker Lake as is wildlife protection. Based on feedback from road options meetings and IQ comments, the south all-season road and the associated dock site option on the south side of Baker Lake was removed from the assessment of site access and dock options, respectively. This was in part due to concerns about terrestrial wildlife (IQ-BL07 2008[173]; IQ-BL06 2008[174]). By incorporating community feedback and IQ related to terrestrial wildlife into project design, AREVA has committed to the following: the winter road is the primary option in the Project proposal; caribou mitigation plans will be prepared; the road will be designed to allow caribou crossing; and AREVA will continue to work with the Baker Lake HTO regarding access to the road by the public.

Consideration of engagement data and the biological environment including terrestrial wildlife was included throughout the alternatives assessment (Tier 3, Technical Appendix 2A) to determine the Project assessment basis (Tier 2, Volume 2, Section 20). In ranking alternatives, public opinion and the environment were key factors. An example from the alternatives assessment was the Pointer Lake airstrip was determined to have a smaller influence on terrestrial wildlife habitat (smaller footprint) and wildlife movement (smaller zone of impact) than the Drumlin Lake airstrip alternative; Pointer Lake was selected as the preferred location of the airstrip and included in the environmental assessment.

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[172] IQ-BLHT 2011: *Road construction for the Kiggavik site was a concern for the HTO members. They explained that although roads do provide easier access to caribou for hunters, they can also have negative impacts. The participants expressed concern that If AREVA were to succeed at building a road through the Baker Lake area, then their access to traditional hunting grounds would be restricted.*

[173] IQ-BL07 2008: *if the road were to go through Hagliq, a lot of people are not going to be happy because most people go to that area to go camping, fishing, and hunting. In the spring people go out there to hunt*

[174] IQ-BL06 2008: *But through Hagliq, the road would block people from going fishing and stop people going to Qikiqqtaujaq to pick goose eggs. Although personally I never went there to pick goose eggs, I know that around Mihaluk there could be a lot of goose eggs because that's the nesting ground for geese. The caribou also usually walk through this area in the spring*.

Effects Assessment

Not all Project-environment interactions are equally important to community members. Efforts were made in the terrestrial wildlife assessments to focus on (assess) interactions with the greatest potential to result in ecosystemic affects while considering public feedback and IQ. Engagement data and IQ, particularly the analysis of issues and concerns, was used in the screening level assessments to help determine which Project-environment interactions may be of greatest public concern and interest and therefore warrant a higher screening rating and more detailed assessment.

Community engagement and IQ highlighted movement, animal health, and possible behavioural responses of caribou to roads and mining in the region. The IQ knowledge shared with the project team resulted in a focus of the wildlife assessment on caribou, and assessment of the potential effects on caribou populations, and estimates to localized effects on caribou distribution. Engagement feedback and IQ helped to focus the assessment for caribou and muskox on:

1. direct effects of increased mortality risk from potential vehicle collisions and indirect effects from increased harvester access from the all-season access road (EN-BL NIRB April 2010[175]);
2. reduced habitat availability from the Project footprint that results in a direct loss of foraging habitat, and sensory disturbances that result in an indirect loss of functional habitat (EN-RB NIRB April 2010[176], EN-AR NIRB May 2010[177]);
3. change to seasonal movements from physical structures (e.g., road embankment, open pits, buildings) and sensory disturbances that could directly affect seasonal movement (EN-CH NIRB May 2010[178], EN-BL NIRB April 2010[179]) (Note that only caribou are assessed for effects on movement because muskox do not make traditional seasonal migrations from wintering to calving areas (IQ-CI03 2009[180]); consequently, changes to muskox movement are covered in the assessment of habitat use); and,

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[175] EN-BL NIRB April 2010: *Concerned about wildlife and disruptions by environmental changes.*

[176] EN-RB NIRB April 2010: *Concerned with wildlife habitat.*

[177] EN-AR NIRB May 2010: *Concerns over potential effects of noise on migrating animals and the need to put in place mitigation measures.*

[178] EN-CH NIRB May 2010: *Have any studies been done in regards to the caribou migrating through the area and on the caribou calving grounds?*

[179] EN-BL NIRB April 2010: *Caribou migration routes are very important in the region.*

[180] IQ-CI03 2009: *Muskox do not migrate and travel very slowly. If old tracks are seen in an area, they will still be in the area. Muskox stay in an area where there is vegetation, and only move when it is gone*

4. change in health as a result of ingestion of contaminants (e.g., consumption of forage mixed with dust) (EN-CI KIA Apr 2007[181], IQ-ARHT 2009[182]; IQ-Nunavut Tunngavik Inc. 2005[183]).

In addition to focusing the assessment on areas of public concern, the assessment erred on the side of precaution in order for AREVA to predict or understand the maximum potential effects of the Project on the environment and adequately address public concerns. A key example of how a precautionary approach is taken in the assessment is the use of a 25-year Project life based on maximum tailings storage capacity, as opposed to 14 years based on current ore reserves and the expected production rate. An example of the conservative assessment approach in the terrestrial wildlife assessment is in the assessment of potential effects of constituents of potential concern (COPCs) on caribou health (Section 13; and details in Tier 3, Technical Appendix 8A). The intake of COPCs by wildlife can be estimated using the predicted concentrations and assumptions about how much food and water the animals consume. The amount of time that wildlife spend in the area is also an important factor. For caribou, a precautionary scenario was used in the assessment. It was assumed that some caribou may spend 1.1% of their time in the LAA while other caribou may spend 4.7% of their time in the RAA. These are cautious estimates on the amount of time a caribou would spend in an area.

Knowledge holders also stressed the importance to Inuit of year-round harvesting of caribou to provide food and clothing for the community (IQ-CHE 2009[184]; IQ-CHE 2009[185]). The socio-economic assessment (Tier 2, Volume 9, Part 1) includes the assessment of effects on traditional culture, including harvesting and food security. Project-related effects associated with COPCs in wildlife and their potential effects on humans who consume terrestrial biota is described in the Ecological and Human Health Risk Assessment report (Tier 3, Technical Appendix 8A). Caribou, ptarmigan, sik sik,

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[181] EN-CI KIA Apr 2007: *Caribou eat off the ground and then we eat the caribou. If they get sick, we get sick. We'll get diseases.*

[182] IQ-ARHT 2009: *Hunters and Elders expressed concerns about the potential for airborne contamination settling on vegetation and being consumed by caribou.*

[183] IQ-Nunavut Tunngavik Inc. 2005: *The contamination of wildlife is a concern in itself, not just because of the potential repercussions on country foods; the focus of contaminants research should therefore not focus exclusively on human health*.

[184] IQ-CHE 2009: *Since the north is so cold, we design and make our own clothes. The store-bought clothes are not warm enough. We depend on animals not just for food but for our clothing*.

[185] IQ-CHE 2009: *There are enough people still engaged in hunting. The Elders crave country food. "You need it to keep you warm."*

and fish were included in human receptor dietary characteristics for the Kiggavik Project (Tier 3, Technical Appendix 8A) based on community feedback through IQ and engagement activities.

The BQCMB input influenced the revisions to the analyses of potential effects on caribou in the FEIS. Based primarily on their comments summarized in the Preliminary Hearing Report (Nunavut Impact Review Board 2013) and a follow-up meeting with their technical expert in Saskatoon in April 2014, a number of revisions and some additions were made to the FEIS. The revisions included a stronger acknowledgement of uncertainty about regional caribou distribution and movement, clarification on approaches used for habitat classification, and the addition of encounter and residency rates in zones of influence and an energetics-based assessment of project and cumulative effects. Those revisions are reflected in numerous sections of the wildlife assessment of the FEIS from the Technical Boundaries section (were uncertainty is noted and incorporated into the effects assessment conclusions) through to the Wildlife Mitigation and Monitoring Plan (where monitoring programs are designed to address uncertainties).

The meetings with and input provided by the BLHTO influenced the incorporation of social context when considering the significance of effects on caribou and muskox populations, and the concomitant possible effects on harvest practices.

The Government of Nunavut, Department of Environment (GN-DoE) input and comments influenced AREVA's decision to include an assessment of wolf denning and shorebird habitat in the effects assessment, and to consider the accuracy of the Ecological Land Classification data in the summary of confidence of effects predictions. Earlier undocumented discussions with the GN-DoE personnel placed an early focus on assessing the potential effects of an all-season road on harvest effects, which are addressed in the cumulative effects assessment of the Project.

Environment Canada's comments on the DEIS about the airstrip zone of influence led to changes in calculations of available habitat (revised from the DEIS and included in this FEIS).

Mitigation and Monitoring

The Wildlife Mitigation and Monitoring Plan (WMMP; Tier 3, Appendix 6D) describes mitigation and monitoring that AREVA will implement to reduce or eliminate disturbance effects on terrestrial wildlife and wildlife habitat. The WMMP provides guidance to protect and limit disturbances to birds and terrestrial wildlife from Project activities. The WMMP lists all of the mitigation actions that will be taken and provides an overview of the monitoring efforts proposed to assess Project effects on terrestrial wildlife and wildlife habitat. Engagement data and IQ were used to develop mitigation plans for terrestrial wildlife. Examples include: avoiding construction activities within 10 km of designated water crossings from 15 May to 1 September, in accordance with the DIAND Caribou Protection

Measures (EN-BL NIRB April 2010[186]) and implementing temporary road shutdowns if large numbers of caribou are observed migrating through the area (IQ-BLHT 2011[187], EN-BL HTO Mar 2009[188]). Information collected from hunters and Elders in the road options report commissioned by the BLHTO (JT Consulting 2011) identified some potential mitigation of road construction and operation. Not to be regarded as a comment supporting road development, but as a general comment, roads may be acceptable if traffic and construction activity stopped when caribou are migrating through the area, especially to allow the caribou leaders to cross, because disturbing the leaders can disrupt the migration of an entire herd.

The WMMP is a working document that is periodically reviewed and revised throughout the life of the Project to ensure it meets health, safety, and environmental performance standards. This process of adaptive management and continual improvement (Tier 2, Volume 2, Section 17) demonstrates the Inuit Qaujimajatuqangit (IQ) principles of Pilimmaksarniq *maintaining and improving skills through experience and practice;* and Qanuqtuurunnarniq *being resourceful and flexible to solve problems.* The action items in the WMMP will develop and evolve through the life of the Project with input from regulators and stakeholders that participate in the review of the results of monitoring activities. Revisions will keep the mitigation and monitoring actions focused on key potential effects to ensure that AREVA and stakeholder resources are effectively applied to managing Project effects on terrestrial wildlife and wildlife habitat.

IQ and engagement data that are made available to AREVA will continue to be incorporated in the mitigation and monitoring plan as that program develops post project approval. Results of the terrestrial assessment and Wildlife Monitoring and Mitigation Plan (Tier 3, Technical Appendix 6D) will be communicated to local stakeholders through implementation of the Community Involvement Plan (Tier 3, Technical Appendix 3C). AREVA's commitment to engagement and community involvement is throughout the life of the Project and continues throughout construction, operations, decommissioning and reclamation. A key part of the Community Involvement Plan is providing information on risk perception and assurance that country foods continue to be safe for consumption.

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[186] EN-BL NIRB April 2010: *Importance of water crossings, annual migration routes (summer as well as winter ranges) needs to be considered especially regarding the road option.*

[187] IQ-BLHT 2011: *According to traditional caribou hunting practices, the first group of themigrating herd must be allowed to pass through an area undisturbed. After a few days, the hunting can commence.*

[188] EN-BL HTO Mar 2009: W*hen there is a herd, the leader of the heard is followed quite closely by the rest of the heard, and nobody tries to disturb the heard to not disrupt the migratory route.*

People were concerned that terrestrial wildlife could become contaminated from Project activities. A number of design and management mitigation measures will be employed to reduce potential effects of air emissions (Tier 2, Volume 6, Section 9.6.2 and Tier 3, Technical Appendix 4C) and treated effluent discharge (Tier 2, Volume 5, Section 8.5 and Tier 3, Technical Appendix 2I) on terrestrial wildlife health.

Engagement with the GN-DoE influenced AREVA's decision to support the ongoing GN-DoE led caribou collaring. Environment Canada's comments about set-back distances from bird nests and flight altitude guidelines led to inclusion of specific mitigation options for birds and bird species at risk in the wildlife mitigation and monitoring plan.

11.3 Regulatory Setting

11.3.1 Nunavut Wildlife Act

The *Nunavut Wildlife Act* (Government of Nunavut 2005) is territorial legislation established for the management of wildlife and habitat in Nunavut, including the conservation, protection and recovery of species at risk. The Act applies to all terrestrial and aquatic wildlife and their habitat. The Department of Environment has a legislated mandate for the management of terrestrial species in Nunavut and is responsible for fulfilling GN responsibilities under federal legislation, and national and international agreements and conventions.

Harvest — Section 10(1) identifies the Inuit right to harvest subject to where harvesting does not exceed his or her basic needs level or where a total allowable harvest for a population is established. Section 10(2) further states that where a total allowable harvest for a population is not established, than an Inuk can harvest, without exceeding, their full economic, social and cultural needs. Section 10(4) states that non-quota limitations established on Inuit shall not unduly or unreasonably constrain their harvesting activities. Section 11 states that "…all Inuit have the free and unrestricted right of access for the purpose of harvesting wildlife to all lands within Nunavut." The right of access is excluded within a radius of 1.6 km of any building, structure or other facility on lands under a surface lease (11(2)(f)). The right of access may also be limited by the Nunavut Wildlife Management Board (NWMB) for the purposes of conservation (11(3)(b)). Section 11(4) states that "Pursuant to the Agreement, any term of an employment contract that attempts to limit an Inuk's rights of access to wildlife or harvesting of wildlife during the Inuk's leisure hours shall be null and void. Section 120 (1) identifies the NWMB as the authority in the Nunavut Settlement Area that establishes levels of total allowable harvest or harvesting. Section 121 states that the Minister may establish limits on the quantity of wildlife that may be harvested where necessary to implement a decision of the NWMB or where the Minister considers it necessary or advisable in respect to those matters within the jurisdiction of the Government of Nunavut.

11.3.2 Species at Risk Act

The SARA is federal legislation that "provides for the legal protection of wildlife species and the conservation of the biological diversity" (SARA website). The SARA is designed to prevent the extirpation and/or extinction of wildlife species through formal protection measures identified through a species recovery planning process. The plans are designed to identify actions that will lead to the recovery of species of conservation concern. Schedule 1 of the SARA lists the status of species of conservation concern under four risk categories: extirpated, endangered, threatened, and species of special concern. Once a species is listed on Schedule 1 of the SARA, individuals of these species are protected from "killing, harming, harassing, capturing, taking, possessing, collecting, buying, selling or trading" (SARA website). Recovery or management plans are required for listed species.

Under the SARA, persons/organizations who are "required by or under an Act of Parliament to ensure that an assessment of the environmental effects of a project is conducted" must inform the competent minister if a project "is likely to affect a listed wildlife species" (Subsection 79[1]). Further, those persons/organizations are required to "identify the adverse effects of the project on the listed wildlife species and its critical habitat and, if the Project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans" (Subsection 79[2]).

11.3.3 Migratory Birds Convention Act

The *Migratory Birds Convention Act* provides "for the protection [and conservation] of migratory birds through the Migratory Birds Regulations". The Act protects migratory populations, individuals and their nests (1994, c. 22, s. 4; 2005, c. 23, s. 3) through prohibition of:

- possession of a migratory bird or nest
- the purchase, sale or exchange of migratory birds or nests
- deposition of substances into waters that is harmful to migratory birds, or in a location where the substance can enter waters, without appropriate authorizations

11.3.4 Nunavut Land Claims Agreement

Under the NLCA, the government has the ultimate responsibility for wildlife. The GN Department of the Environment is the lead GN Agency in fulfilling Government obligations with respect to wildlife in Nunavut.

The Nunavut Wildlife Management Board (NWMB) is the main instrument of wildlife management and the main regulator of access to wildlife in Nunavut. Among the functions of the Board is the establishment, modification or removal of total allowable harvest (TAH) levels. The exercise of harvesting by Inuit is overseen by the Regional Wildlife Organizations (RWO) and the HTO. Powers and functions of the HTO include regulation of harvest technique, allocation and enforcement of community basic needs and management among members. Ultimately, Section 5.2.1 (i) of the NLCA states that Government retains the ultimate responsibility for wildlife management.

11.3.5 Keewatin Regional Land Use Plan

The Keewatin Regional Land Use Plan was approved in June 2000 (Nunavut Planning Commission 2000) and it is currently the land use plan in effect in the Project area. Objectives of the plan that address mmineral exploration in relation to wildlife state:

- The environment, wildlife and wildlife habitat should be protected and conserved for the use of future generations (Section 2).
- Non-renewable resource development should have no significant adverse effects on the environment, wildlife or wildlife habitat (Section 3).

Terms applicable to terrestrial wildlife state that:

- Development activities shall be prohibited on all public lands and water within all caribou calving areas during calving season and within caribou water crossings in the Keewatin, in accordance with the terms of the DIAND caribou protection measures (Subsection 2.6).
- Development activities shall be restricted near polar bear denning areas (Subsection 2.7).

11.3.6 Caribou Protection Measures

Caribou Protection Measures (DIAND 1978, Appendix H of Keewatin Land Use Plan) apply to the Kiggavik Project. The protection measures restrict:

- activities, without approval, between 15 May and 15 June within the caribou protection areas as depicted on the 1978 'Caribou Protection Map
- the location of any operation that will block or divert seasonal migrations
- activities that will interfere with seasonal migrations, and that those activities must cease until migrating caribou have passed
- activities within 10 km of designated caribou water crossings from 15 May and 1 September.

11.4 Project-Environment Interactions

Individual Project activities have the potential to interact with terrestrial wildlife during all Project phases. A list of individual Project activities and the likely degree of interaction with wildlife and habitat is provided in Table 11.4-1. The list is presented as a high-level scoping of key Project activities that could have effects on wildlife. Individual activities are not assessed individually because it is likely that they collectively have potential effects on wildlife habitat, movement, mortality risk and health.

Individual activities likely have differing magnitudes of effect on different wildlife. For instance, a single drilling platform may have limited effects on muskox habitat, but that same activity may have a substantial effect on caribou movement if the drill were to be operational near a caribou water crossing when caribou are attempting to cross. Therefore, the interaction ratings (described below) presented in Table 11.4-1 reflect a worst-case scenario for an individual activity, but for this assessment activities are assessed as collective disturbances.

If there is no interaction or no potential for substantive interaction between a Project activity and terrestrial wildlife, an assessment of that environmental effect is not required. These interactions are categorized as 0, and are not considered further in the EA. The environmental effects of those activities are, by definition, rated not significant.

If there is likely to be a potential interaction between an activity and terrestrial wildlife, but not likely to be substantive due to planned mitigation, the interaction is categorized as 1. Such interactions are well understood and are subject to prescribed mitigation or codified practices. These interactions are subject to a less detailed environmental effects assessment and are rated as not significant. Justification is provided and the proposed mitigation is described in the effects assessment and detailed in the Wildlife Mitigation and Monitoring Plan (Tier 3, Technical Appendix 6D). Such interactions can be mitigated with a high degree of certainty with proven technology and practices.

If a potential interaction between an activity and terrestrial wildlife could result in more substantive environmental effects despite the planned mitigation, if there is less certainty regarding the effectiveness of mitigation, or if there is high concern from regulatory agencies, Inuit or stakeholders, the interaction is categorized as 2. These potential interactions are subject to a more detailed analysis and consideration in the environmental assessment to predict, mitigate and evaluate the potential environmental effects.

A rank of 1 is applied to Project components where there is an obvious interaction, but based on evidence and standard mitigation techniques, will result in an effect that is not significant (e.g., infrequent blasting), or where there is an indirect effect (noise) from building construction. Generally, the site clearing and preparation of a site is considered the Project component that directly interacts with terrestrial wildlife. A rank of 1 is applied to further construction activities (e.g., construct building, install equipment) because there is no conceivable, measurable interaction of on-site activities once the primary disturbances have occurred. Sensory disturbances associated with these activities are temporary, and effects are expected to be not measurable. This applies to on-land construction, supporting activities, water and waste management, general services, transportation, on-going exploration, closure and post closure activities. Crushing and grinding are expected to create a continual sensory disturbance of noise and dust (and thus ranked 2), but other activities associated with milling, such as “transfer ore to mill” will have an undetected effect relative to the crushing and grinding. Activities such as freshwater withdrawal for In-water Construction is not expected to have a measurable effect on terrestrial wildlife or birds because standard operating procedures will be followed within water licence limits. Maintaining water levels during operational water management activities will interact with waterfowl habitat, but water level management in those waterbodies will have been addressed as a direct interaction from sensory disturbance of overall on-site Project activities. On-land decommissioning activities can readily be mitigated by conducting the activities outside of sensitive wildlife periods (e.g., managing activities when caribou are present as per Caribou Protection Measures).

The wildlife assessment focused on Project activities that could cause a change to the traditional movements of migrating animals, result in increased mortality, cause loss of important habitat (e.g., calving grounds) due to the Project footprint, or result in functional loss of habitat from sensory disturbance (e.g., visual and auditory stimuli). The bird assessment is focused on activities that could cause a reduction in productivity (i.e., recruitment) due to increased nest depredation or abandonment, a loss of important habitat (e.g., nesting or fledging sites) from the Project footprint, or a functional loss of habitat from sensory disturbance. The potential for collision of birds with aircraft can be mitigated through project design standards for airstrips (e.g., avoidance of areas where birds are known to congregate, eliminate attraction of birds, deterring bird congregations during airstrip operation, etc.). Based on baseline bird data and historical data, there are no known areas of bird concentration in the vicinity of the airstrip or approaches. Regardless, the disturbances around airstrips are addressed specifically as requested by Environment Canada during the DEIS technical meetings, and are thus rated as a “2” for migratory birds and habitat and species at risk for further assessment.

Project activities that could cause exposure of wildlife and birds to COPC are those that produce dust, discharge water or emissions containing COPCs. Most of the potential effects will occur near the mine site during operation. Other sources of potential effects are dust generation along the All-Season Road, if implemented, and emissions from the proposed Baker Lake dock site.

Table 11.4-1 Project-Environment Interactions: Terrestrial Wildlife

	Project Activities	Terrestrial Wildlife and Habitat	Raptors and Habitat	Migratory Birds and Habitat	Species at Risk
Construction					
Economic Activities	Construction workforce management; Contracts and taxes; Advance training of operations workforce	0	0	0	0
In-Water Construction	Construct freshwater diversions and site drainage containment systems (dykes, berms, collection ponds)	0	0	2	0
	Construct in-water/shoreline structures	0	0	2	0
	Water transfers and discharge	0	0	0	0
	Freshwater withdrawal	0	0	1	0
On-Land Construction	Site clearing and pad construction (blasting, earth moving, loading, hauling, dumping, crushing	2	2	2	2
	Construct foundations	1	0	1	1
	Construct buildings	1	0	1	1
	Install equipment	1	0	1	1
	Install and commission fuel tanks	0	0	0	0
	Mill dry commissioning (water only)	0	0	0	0
Supporting Activities	Transport fuel and construction materials	2	2	2	2
	Air transport of personnel and supplies	2	1	2	2
	Hazardous materials storage and use	0	0	0	0
	Explosives storage and use	2	0	0	2
	Waste incineration and disposal	0	0	0	0
	Industrial machinery operation	1	0	1	1
	Power generation	1	0	1	1
Operation					
Economic Activities	Workforce management; Employment; Contracts and taxes	0	0	0	0

Table 11.4-1 Project-Environment Interactions: Terrestrial Wildlife

	Project Activities	Terrestrial Wildlife and Habitat	Raptors and Habitat	Migratory Birds and Habitat	Species at Risk
Mining	Mining ore (blasting, loading, hauling)	2	2	2	2
	Ore stockpiling	1	0	1	1
	Mining special waste (blasting, loading, hauling)	2	0	1	1
	Special waste stockpiling	0	0	0	0
	Mining clean waste (blasting, loading, hauling)	2	0	1	1
	Clean rock stockpiling	0	0	0	0
	Mine dewatering	0	0	0	0
	Underground ventilation	0	0	0	0
	Backfill production and underground placement	0	0	0	0
Milling	Transfer ore to mill	1	0	1	1
	Crushing and grinding	2	0	2	2
	Leaching and U recovery	0	0	0	0
	U purification	0	0	0	0
	Yellowcake drying and packaging	0	0	0	0
	Tailings neutralization	0	0	0	0
	Reagents preparation and use	0	0	0	0
Tailings Management	Pumping and placement of tailings slurry	0	0	0	0
	Consolidation of tailings	0	0	0	0
	Pumping of Tailings Management Facility supernatant	0	0	0	0
Water Management	Create and maintain water levels	0	0	1	0
	Freshwater withdrawal	0	0	0	0
	Potable water treatment	0	0	0	0
	Collection of site and stockpile drainage	0	0	0	0
	Water and sewage treatment	0	0	1	0

Table 11.4-1 Project-Environment Interactions: Terrestrial Wildlife

	Project Activities	Terrestrial Wildlife and Habitat	Raptors and Habitat	Migratory Birds and Habitat	Species at Risk
Waste Management	Disposal of industrial waste	0	0	0	0
	Management of hazardous waste	0	0	0	0
	Management of radiologically contaminated waste	0	0	0	0
	Disposal of domestic waste	1	0	0	0
	Discharge of treated effluents (including greywater)	0	0	0	0
	Incineration and handling of burnables	1	0	0	0
	Disposal of sewage sludge	0	0	0	0
General Services	Generation of power	1	0	1	1
	Operate accommodations complex	0	0	0	0
	Recreational activities	0	0	0	0
	Maintain vehicles and equipment	0	0	0	0
	Maintain infrastructure	0	0	0	0
	Operate airstrip	0	0	0	0
	Hazardous materials storage and handling (reagents, fuel and hydrocarbons)	0	0	0	0
	Explosives storage and handling	0	0	0	0
Transportation	Marine transportation	0	0	0	0
	Truck transportation	2	1	1	1
	General traffic (Project-related)	1	1	1	1
	Controlled public traffic	2	1	1	0
	Air transportation of personnel, goods and supplies	2	1	1	1
	Air transportation of yellowcake	0	0	0	0
	General air transportation support	0	0	0	0
Ongoing Exploration	Aerial surveys	2	2	1	1
	Ground surveys	2	1	1	1
	Drilling	1	0	1	0

Table 11.4-1 Project-Environment Interactions: Terrestrial Wildlife

	Project Activities	Terrestrial Wildlife and Habitat	Raptors and Habitat	Migratory Birds and Habitat	Species at Risk
Final Closure					
Economic Activities	Decommissioning Workforce management; Employment; Contracts and taxes	0	0	0	0
General	Hazardous materials storage	0	0	0	0
	Industrial machinery operation	1	0	1	1
	Ongoing withdrawal, treatment and release of water, including domestic wastewater	0	0	1	0
In-water Decommissioning	Remove freshwater diversions; re-establish natural drainage	0	0	0	0
	Remove surface drainage containment	0	0	0	0
	Remove in-water/shoreline structures	0	0	2	0
	Water transfers and discharge	0	0	0	0
	Construct fish habitat as per FHCP	0	0	0	0
On-land Decommissioning	Remove site pads (blasting, earth moving, loading, hauling, dumping)	1	0	1	1
	Backfilling	0	0	0	0
	Contouring	0	0	0	0
	Covering	0	0	0	0
	Revegetation	2	0	2	2
	Remove foundations	0	0	0	0
	Remove buildings	0	0	0	0
	Remove equipment	0	0	0	0
	Remove fuel tanks	0	0	0	0
Post Closure					
	Management of restored site	0	0	0	0

11.5 Valued Environmental Components, Indicators and Measurable Parameters

11.5.1 Valued Environmental Components

Valued Environmental Components (VECs) are used to focus the assessment on components of the biophysical environment that if negatively affected by the Project would be a concern to stakeholders. In addition to the scoping obtained from AREVA public meetings and consultation with regulators, the NIRB guidelines identified four terrestrial wildlife and bird VECs in the Project's EIS guidelines (Nunavut Impact Review Board 2011, Sec. 7.2.1) that are representative of primary species groups and their habitats. The wildlife VECs identified in the guidelines included the following:

- terrestrial wildlife and their habitat
- raptors and their habitat
- migratory birds and their habitat
- species at risk and their habitat
- seabirds and habitat (addressed in Tier 2, Volume 7 — Marine Environment)

To better understand the importance and value of VECs to people in the Kivalliq, AREVA undertook specific engagement activities. During AREVA's 2009 Kivalliq open house tour (described in Tier 2, Volume 3, Part 1 Public Engagement), an interactive display was set up for participants to identify broad ecological and socio-economic areas they valued highly and/or had concerns about in relation to the Kiggavik Project. Each participant was given four stickers that they used to select areas of concern. All four stickers could be used to select a particular area or they could be spread to four separate areas. The eight broad VEC categories and the percent of responses were as follows:

- Wildlife: 25%
- Birds: 10%
- Air quality and noise: 7%
- Fresh water: 31%
- Freshwater fish and fish habitat: 17%
- Marine environment: 5%
- Permafrost and groundwater: 2%
- Soils, landforms and vegetation: 3%

These results provide an example of the importance and knowledge of terrestrial wildlife and bird VECs to Kivalliq community members.

The following year, in 2010, AREVA endeavoured to validate VEC selection by using interactive posters at the open house tour to learn more about *why* VECs, including the terrestrial VECs, are important to Kivalliq community members (Tier 2, Volume 3, Part 1 Public Engagement). Interactive posters included a list of 28 VECs and open house attendees were invited to place an unlimited number of stickers with descriptive words (i.e., Beautiful, Comfort, Peaceful, Happy, Money, Food, Clothing, Health, Respect, Spiritual, Tradition, Culture, IQ, Survival, Pride, Fun, Future, Safe /Secure) beside any and all VECs. The most frequently used values associated with terrestrial components were:

- *Food* and *Clothing* for caribou;
- *Food* and *Peaceful/Happy/Clothing/Respect/Survival/Safe or Secure* for muskox
- *Fun/Money/Peaceful* for lemmings
- *Comfort* and *Fun* for sik sik
- *Beautiful* and *Peaceful* for tundra swan
- *Food* and *Comfort/Peaceful/Happy/Tradition/Survival* for ptarmigan
- *Fun* and *Beautiful* for falcon
- *Peaceful* and *Pride* for sandpiper
- *Money* and *Spiritual* for merganser
- *Money* and *Clothing* for wolverine
- *Clothing* and *Money/Food/health/Survival/Pride* for grizzly bear
- *Money* and *Clothing* for wolf
- *Money* and *Beautiful/Peaceful/Survival* for Arctic fox

As evidenced by these engagement results, the selected of terrestrial VECs are valued for a wide range of reasons, from culture to well-being to basic needs such as clothing and food. Selection of terrestrial VECs and indicators (Section 11.6.2) was further validated by considering feedback received (importance, concern, issues, influence) through public engagement events and IQ interviews as described in Sections 11.1, 11.2 and 11.3 above. Overall, the issues and concerns raised by Kivalliq community members supported the selection of terrestrial VECs. The assessment of effects on these VECs is the basis of the Kiggavik Project wildlife assessment.

11.5.2 Indicators

Indicators represent key aspects of the VEC for the purpose of the effects assessment. The NIRB guidelines (Sec. 7.2.1) state that caribou, muskox (*Ovibos moschatus*), wolverine (*Gulo gulo*), grizzly bear (*Ursus arctos*) and wolf (*Canis lupus*) be considered indicators for assessing Project effects on wildlife. Species at risk indicators include those observed or expected to occur within the Project area, including grizzly bear, wolverine, and short-eared owl (*Asio flammeus*). Species at risk are addressed in Section 17.

Caribou and muskox are key wildlife species in the Kivalliq region; therefore, they are the primary indicators of Project effects on terrestrial wildlife and habitat. During community meetings and gathering of IQ, caribou were consistently identified as being important to Inuit (IQ-BLH 2009[189], IQ-CIHT 2009[190]; IQ-ARE 2009[191]; IQ- BL02 2008[192]). Caribou are a key food source for Baker Lake residents and are harvested for subsistence purposes, with a relatively small amount harvested for sport. The understanding of caribou ecology continues to grow, owing to current long-term research on caribou in the Kivalliq region, and a wealth of IQ from local residents.

Muskox were traditionally harvested by Inuit. In the mid-1900s, with concerns about declining populations, the territorial government banned all muskox harvest. Muskox harvest is currently controlled through a quota system as determined by the GN and the NWMB. To this day, Elders and hunters in Baker Lake talk about these restrictions and how the restrictions affect their current hunting patterns for muskox (IQ-BL10 2008[193], IQ-CI03 2009[194]). Elders said that *for many years, they were not aware that they could eat muskox and others said they didn't harvest them because they are protected* (IQ-BL10 2008; IQ-BL02 2008). The range of muskox has recently returned to the near-historic levels observed in the early 1900s (IQ-CI03 2009[195]; IQ-CI06 2009[3]; EN-BL CLC Nov 2008[196]).

Wolf numbers and distribution are likely dependent on the seasonal abundance of caribou in the region; therefore, Project effects on wolves can be indirectly assessed through effects on caribou distribution and abundance. Regardless, the GNDoE requested that wolves be included as a key indicator species to assess potential effects to denning habitat.

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[189] IQ-BLH 2009: *Hunters emphasized that most people in Baker Lake still depend on caribou for food.*

[190] IQ-CIHT 2009: *The people of Chesterfield continue to primarily depend on caribou, fish and seal. Consuming country food is not considered 'ritual food' but the daily way of life.*

[191] IQ-ARE 2009: *People also want to be assured that the Project will not disturb the caribou that people still greatly depend on.*

[192] IQ- BL02 2008: *Our main food sources were caribou and fish.*

[193] IQ-BL10 2008: *Elders did not identify muskox as an important food source*

[194] IQ-CI03 2009: *Inuit generally do not harvest muskox because the skin is not as good as caribou skin, the hair is of no use and they do not eat it*

[195] IQ-CI03 2009 and IQ-CI06 2009: *muskox numbers increasing and spreading eastward and along the south shore of Baker Lake*

[196] EN-BL CLC Nov 2008: *Around Judge Sisson Lake we saw about thirty Muskox*

Migratory birds are represented by the indicator species lapland longspur (*Calcarius lapponicus*) and long-tailed duck (*Clangula hyemalis*). Lapland Longspur was selected as an indicator because of its known abundance in many upland habitats in the study areas. Lapland longspurs are found within the Project footprint and in portions of the RAA. Long-tailed duck is representative of migratory bird use of waterbodies in the study area. This species is commonly observed throughout the study areas foraging in wetlands, and nesting in areas adjacent to wetlands. Both species are readily recognized by local land users, and there is some traditional knowledge of habitats and potential effects of human disturbance. The GNDoE requested that shorebirds be included as a key indicator for a habitat effects assessment.

Peregrine falcon (*Falco peregrinus*) was selected as the indicator for raptors in the study area. They were chosen as a suitable key indicator due to common nesting observations throughout the study area, their high nest site fidelity and the pre-existing knowledge of the species. Peregrine falcon is a COSEWIC Special Concern species due to previous population declines in the southern range of the species associated with the pesticide DDT. The species is readily recognized by land users and there is some traditional knowledge of habitats and potential impacts.

Species at risk that are either known or suspected to occur in the RAA include wolverine, grizzly bear, short-eared owl and peregrine falcon. For wolverine and grizzly bear, few observations of these species were recorded during baseline surveys, and most issues specific to wolverine and grizzly bear are readily addressed through common mitigation practices (e.g., Project personnel awareness training, camp and facility cleanliness to avoid attracting wolverine to a site). With so few observations of each species, it is difficult to separate potential Project-related effects on these species from the natural variation in abundance and distribution. The most common adverse effect of human activities on wolverine and grizzly bears is increased mortality. Mitigations aimed at reducing bear and wolverine mortality will reduce the potential to adversely affect wolverines and grizzly bears. Furthermore, mitigations that reduce effects on prey species, such as caribou and muskox, will benefit wolverine and grizzly bear. There were few short-eared owl observations in the RAA, but existing literature provides enough information to determine Project effects on potential nesting habitat.

Based on available information, NIRB guidelines, stakeholder engagement, IQ and experience of the Project assessment team specialists, the following species were selected as indicators to assess Project environmental effects on wildlife and birds:

- caribou
- muskox
- wolf
- lapland longspur
- long-tailed duck
- shorebirds

- peregrine falcon
- short-eared owl
- grizzly bear
- wolverine

11.5.3 Measurable Parameters

Measurable parameters are used to quantify the potential environmental effects on indicator species. Where habitat classification is possible, the area of suitable habitat can be extrapolated across all indicator species. Terrestrial habitat was quantified all indicator species except for wolverine and grizzly bear (Table 11.5-1). NIRB guidelines request that habitat, migration and behaviour be included in the assessment of caribou. Predicted behavioural responses to disturbances are used to assess the habitat area potentially affected by mine infrastructure and activities. This assessment also considers mortality risk on caribou, which was quantified by assessing potential increases in direct mortality risk and cumulative increases in herd harvest. Measureable parameters are discussed in detail below in the effects assessment.

Table 11.5-1 Measurable Parameters for Terrestrial Wildlife

Wildlife and Bird VEC	Indicator	Environmental Effect	Measurable Parameters	Rationale
Terrestrial Wildlife and Habitat	Caribou	*Habitat:* direct loss from footprint, reduced suitability within a Zone of Influence (indirect)	Area (km^2) of habitat by suitability class changed from baseline conditions	High quality suitable habitat may be limited and sensitive to change
		Mortality Risk: Increased from direct (infrastructure and activities) and indirect (increased harvester access) Project effects	Human-caused mortality Risk	Increased human presence and potential harvest effects on overall herd
		Movement: changes to movement patterns, filtering of baseline movement through Project infrastructure.	Qualitative discussion based on use of water crossings, known migration corridors, and localized movements	Migration to and from calving areas is an important part of caribou life, localized movements important for foraging and energetic effects
		Change in health	Radionuclide and metal content in tissues and modelling to predict increased from baseline	Dust deposition on vegetation could expose herbivores to increased metals
		Change in energetics	Population projections through to 2040	Encompasses the potential combined project effects on caribou energetics and productivity.

Table 11.5-1 Measurable Parameters for Terrestrial Wildlife

Wildlife and Bird VEC	Indicator	Environmental Effect	Measurable Parameters	Rationale
	Muskox	*Habitat:* direct loss within the PDA, reduced effectiveness within a Zone of Influence (indirect)	Area (km^2) of habitat by suitability class	High quality suitable habitat may be limited and sensitive to change
		Mortality Risk: Increased from direct (infrastructure and activities) and indirect (increased harvester access) Project effects	Human-caused Mortality Risk by herd	Increased human presence and potential harvest effects on population
		Change in health	Radionuclide and metal content in tissues	Dust deposition on vegetation could expose herbivores to increased metals
	Wolf	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km^2) of potential den habitat by suitability class changed from baseline conditions	There may be limited denning habitat potential in the Regional Assessment Area
		Change in health	Radionuclide and metal content in tissues	Transfer through the food chain
Raptors and Habitat	Peregrine Falcon*	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km^2) of potential nest habitat changed from baseline conditions	There may be limited cliff nesting habitat potential in the Regional Assessment Area
		Reduced chick survival	Nest Site Productivity	Sensory disturbance near nest sites may affect nesting success.
		Change in health	Radionuclide and metal content in tissues	Transfer through the food chain
Migratory Birds and Habitat	Lapland Longspur	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km^2) of habitat by suitability class changed from baseline conditions	Direct and indirect loss of breeding habitat from footprint and sensory disturbance.
		Change in health	Metal content in tissues	Uptake of contaminants resulting from emissions from the Kiggavik site

Table 11.5-1 Measurable Parameters for Terrestrial Wildlife

Wildlife and Bird VEC	Indicator	Environmental Effect	Measurable Parameters	Rationale
	Long-tailed Duck	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km²) of habitat by suitability class changed from baseline conditions	Direct and indirect loss of breeding habitat from footprint and sensory disturbance
		Change in health	Radionuclide and metal content in tissues	Emissions from the water treatment plant and subsequent bioaccumulation in the aquatic food chain
	Shorebirds	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km²) of habitat by suitability class changed from baseline conditions	Direct and indirect loss of breeding habitat from footprint and sensory disturbance
		Change in health	Radionuclide and metal content in tissues	Emissions from the water treatment plant and subsequent bioaccumulation in the aquatic food chain
Species at Risk	Short-eared Owl	*Habitat:* direct loss in footprint, reduced suitability within a Zone of Influence (indirect)	Area (km²) of habitat by suitability class changed from baseline conditions	Direct and indirect loss of breeding habitat from footprint and sensory disturbance.
		Change in health	Radionuclide and metal content in tissues	Transfer through the food chain
	Wolverine	Change in health	Radionuclide and metal content in tissues	Transfer through the food chain
	Grizzly Bear	Change in health	Radionuclide and metal content in tissues	Transfer through the food chain

11.6 Assessment Boundaries

11.6.1 Spatial Boundaries

11.6.1.1 Local Assessment Area

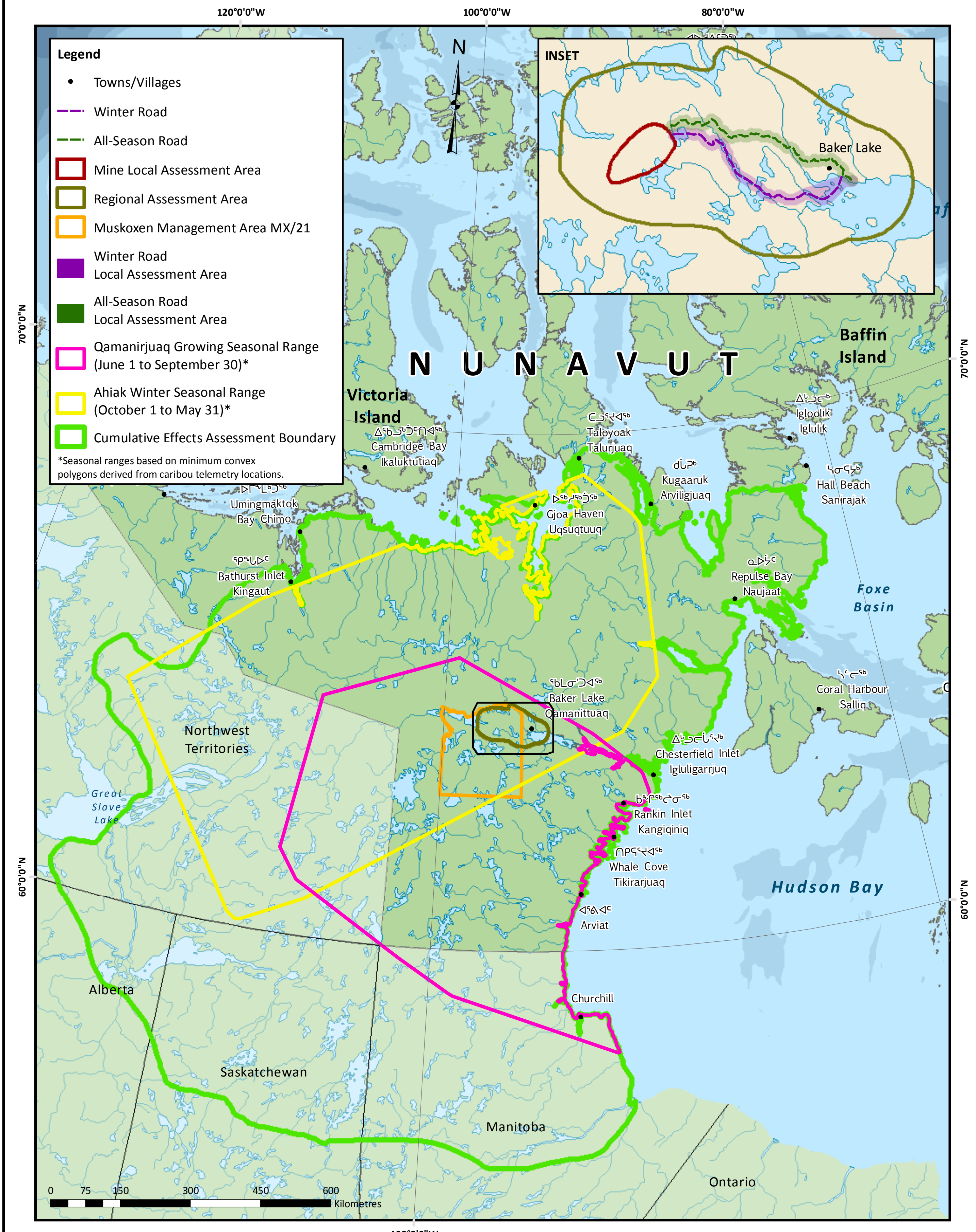
The Local Assessment Area (LAA) characterizes an area of potential direct effects within the vicinity of the proposed Project activities. The LAA includes a 5-km buffer surrounding the Kiggavik and Sissons deposits and all proposed Project facilities in that area, including the proposed airstrip and site haul roads. Dimensions of the Mine LAA are approximately 29 km x 20 km (450 km²; Figure 11.6-1). The access road portions of the LAA include a 5 km-wide buffer centered on the all-season access road alignment and winter road alignment. The All-Season Road has a total LAA of 520 km². The Winter Road has a total LAA of 561 km². Other potential facilities included within the road alignments include a dock facility at Baker Lake and potential quarry sites.

11.6.1.2 Regional Assessment Areas

Regional Assessment Areas (RAAs) are used to characterize Project effects and effect significance at a biologically relevant spatial scale that varies depending on the wildlife indicator and measurable parameter being assessed. Relevancy is in part determined by expected seasonal distribution, defined management units, or representative landscape and habitat information that would be relevant to the species of interest. The various RAAs encompass all Project features and associated zones of influence, known caribou water crossing locations (DIAND 1992), and many areas identified by IQ studies such as water crossings and areas of wildlife presence.

Mortality Risk RAA — The effects assessment for mortality risk was based on the probability of increased mortality risk for wildlife encountering Project facilities. Wildlife encountering the Project, particularly caribou, could be from a number of populations (herds) through the life of the project, and therefore the mortality risk effects assessment is not spatially constrained.

Movement RAA — The effects assessment on movement is based on possible wildlife encounters with Project facilities, the possible effects on natural movement patterns, and/or effects on energy resulting from changes to movement patterns. Therfore, the project effects assessment for movement was not necessarily spatially constrained, rather it was based on caribou encounters with the Project's Zone of Influence.



Projection: NAD 1983 UTM Zone 14N
Creator: Caslys Consulting Ltd.
Date: 09/18/2014 Scale: 1:11,000,000
File: 11.7-1_Wildlife_LAAs_RAA_CEA.mxd
Data Sources: Natural Resources Canada, GeoBase®, National Topographic Database, Geological Survey of Canada, Gov't of Nunavut, and Gov't of NWT.

FIGURE 11.6-1

LOCATION OF THE WIDLIFE LOCAL, REGIONAL, AND CUMULATIVE EFFECTS ASSESSMENT AREAS FOR THE KIGGAVIK PROJECT

KIGGAVIK PROJECT - EIS

Gebauer & Associates ENVIRONMENTAL CONSULTANTS

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AREVA

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Habitat Effects RAAs for wolf, peregrine falcon, lapland longspur, long-tailed duck, shorebirds, and short-eared owl — The RAA used to assess habitat effects on wolf, peregrine falcon, lapland longspur, long-tailed duck, shorebirds and short-eared owl was equivalent to the Wildlife Baseline Study's Regional Study Area (RSA; Tier 3, Volume 6, Technical Appendix 6C). This area was used because there was available detailed ecological land classification data that could be used to assess habitat at a reasonable scale in a geographic area that may represent a local population's use of the area within and surrounding the project. That area is generally a 25 km buffer from the edge of all proposed facilities, including the Sissons and Kiggavik mine zones, proposed access road options, and facilities near Baker Lake. A wider buffer was established along the northern edge of the Project area to encompass the Thelon River, including portions of Aberdeen, Qamaniq, and Schultz lakes, and several identified caribou crossing areas along the Thelon River. The area also includes all of Judge Sissons Lake and southern portions of Aberdeen and Schultz lakes. Water crossings on the east and west sides of Shultz Lake are included in the RAA. The resulting general RAA is 150 km long and 70 km wide, for a total area of 9,828 km^2 (Figure 11.6-1).

Caribou habitat effects RAAs — The RAAs used to assess habitat effects on caribou were the growing season range for the Qamanirjuaq caribou (394,930 km^2) and the winter range for the Ahiak caribou (600,686 km^2; Figure 11.6-1).

Muskox habitat effects RAA — The RAA used to assess habitat effects on muskox was muskox management unit MX/21. That management encompasses the Kiggavik Project activities. The roughly rectangular area extends from the northern shores of Schultz, Qamaniq and Aberdeen lakes, south along the western shore of Mallery Lake to northwest of Tulemalu Lake, north of Yathkyed Lake, and west of Baker Lake (Figure 11.6-1). This management unit (~ 31,872 km^2) is used by the Government of Nunavut to bound a muskox population and to summarize population estimates and establish harvest quotas (Government of Nunavut Department of Environment 2007). This is deemed a reasonable and practical spatial scale upon which to base the significance of Project-level effects.

11.6.1.3 Cumulative Effects Assessment Area

For a number of reasons described further in this volume, the cumulative effects assessment focused on caribou habitat and movement. For the most part, the seasonal ranges used to predict Project-level effects were also used to characterize cumulative effects to habitat and movement. The broadest spatial bounds used to develop a Project Inclusion List include the traditional ranges of the Beverly and Qamanirjuaq caribou (provided to AREVA by the Beverly and Qamanirjuaq Caribou Management Board), and the known ranges of the Ahiak, Lorillard and Wager Bay herds (Figure 11.6-1). The spatial bounds and the Project Inclusion List are further described in Appendix 1E — Cumulative and Transboundary Effects. Details of how those areas were used to describe cumulative effects on caribou are described further in Section 13.

11.6.2 Administrative Boundaries

The Project's environmental assessment is subject to administrative limitations. Administrative limitations occur when AREVA has no authority to make adjustments or management decisions because a feature is managed by a government or other organization (e.g., KIA). Examples of administrative boundaries include:

- Mortality of a wildlife species through harvest may be an potential cumulative effect, but AREVA does not have authority to manage wildlife harvest.
- Habitat loss across the range of migratory species outside of the Project area cannot be managed or mitigated by AREVA.

11.6.3 Technical Boundaries

Technical and/or scientific limitations occur when there is limited, conflicting, or no information on a topic that would inform effect predictions or mitigations. The project area and the greater Kivalliq region are relatively rich with information regarding wildlife. Both scientific and IQ information is available for many species; however, these data do not definitively capture the complete picture of wildlife in the region, considering the dynamic nature of wildlife and ecosystems. Data gaps exist for many aspects of wildlife ecology and behaviour.

Throughout the assessment process, a number of technical boundaries were encountered. These boundaries do not detract from the determination of potential effects to wildlife; however, to adequately address the uncertainty they introduce, these limitations are described. In general, the limitations can increase uncertainty regarding the magnitude of effects, and can ultimately reduce the confidence in effects predictions. Technical limitations that may have influenced effects predictions are described in detail in Sections 13 (Caribou and Muskox), 14 (Wolves), 15 (Raptors), 16 (Migratory) and 17 (Species at Risk).

Multiple information sources generally provided a breadth of data on wildlife in the region, but it also presented some technical limitations. Broadly described, general technical boundaries encountered for all KI species included:

- A lack of standards or definitive thresholds for determining the significance of Project effects on wildlife;
- Information gaps in species ecology and effects of disturbance;
- Multiple data sources providing similar, but sometimes conflicting information on species ecology, and
- Limitations on data availability or permissions to conduct certain analyses.

For most key indicator species, the following types of information were used to determine potential Project and/or cumulative effects:

- Inuit Qaujimajatuqangit (IQ)
  - Gathered from both historical studies in the region and AREVA-led interviews
- Engagement
  - Gathered from AREVA-led interviews and meetings in the region
- Baseline wildlife studies conducted by AREVA from 2007 to 2010
- Governmental reports, surveys, and data (Government of Nunavut and Government of Northwest Territories)
- Published scientific literature
- Documents, data, information, and feedback provided by stakeholder groups (e.g., BQCMB, BLHTO)
- Information from other projects including wildlife baseline reports, environmental assessment reports, and mitigation and monitoring plans and reports.

11.7 Residual Environmental Effects Criteria for Terrestrial Wildlife

Residual effects criteria for wildlife are defined separately by effects within each VEC group. In general, residual environmental effects on the terrestrial wildlife and habitat were described according to the criteria below.

- ***Direction:*** the trend of the environmental effect (i.e., positive = enhancement of population; neutral = maintains population; or adverse = detrimental effect to population)
- ***Magnitude:*** the degree of change in a variable relative to baseline (i.e., negligible, low, moderate, high). In general, magnitude is quantified for all indicators as either the percent of habitat by suitability class within the RAA, or proportional loss of breeding territories with the RAA. Definitions of magnitude are provided for each VEC in their respective sections.
- ***Geographical Extent:*** the geographic area within which an environmental effect of a defined magnitude occurs (i.e., site-specific, local, regional, territorial, national, international). It is considered to be limited to the Project Footprint, LAA or ZOI, RAA, or outside of the RAA.
- ***Frequency:*** the number of times during the Project that an environmental effect may occur (i.e., once, sporadically, regular, continuous)
- ***Duration:*** the period of time that is required until the VEC returns to its baseline condition or the environmental effect can no longer be measured or otherwise perceived (i.e., short term, medium term, long term, permanent). The duration of a potential effect is considered within the combined construction, operation and closure, or beyond closure.

- ***Reversibility:*** the likelihood that a measurable parameter for the VEC will recover from an environmental effect (i.e., reversible = the VEC is able to recover from the effect to a state similar to that existing before the VEC was affected. Depending on the effect considered, reversibility may be assessed on both an individual (immediate) and population (long-term) level; irreversible = the VEC is unable to recover from the effect).
- ***Ecological Context:*** the general characteristics of the area in which the Project is located (i.e., undisturbed, disturbed).

11.8 Standards or Thresholds for Determining Significance

Standards and thresholds for determining significance are specific to each indicator and are described in the assessment sections. In general, standards or thresholds for determining significance do not exist for most species and potential effects. This is identified as a technical limitation in Section 11.6.3. Thresholds used in each assessment are typically derived from one or more of the following sources:

- Inferences made from literature (e.g. Boulanger et al. 2012);
- Values used or lessons learned in other northern mining assessments;
- Government-determined sustainable harvest levels;
- Regional social and ecological context derived from IQ and engagement, and/or
- Opinion and experience based the author’s experience on similar projects and reviews of results from other arctic mining projects.