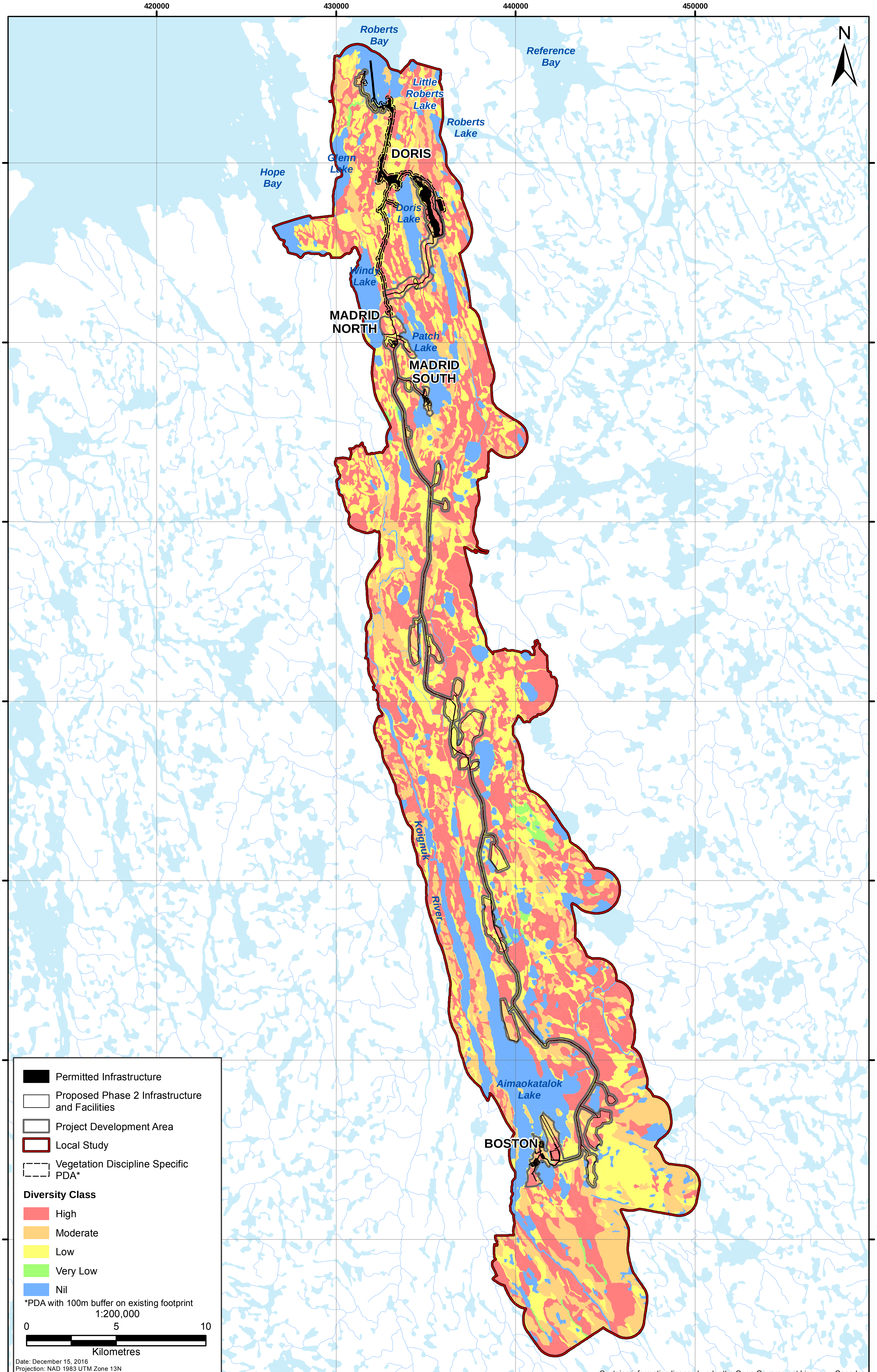
Figure 8.5-3
Project Effects to Vegetation Species Diversity Classes within Footprints and Project Development Areas



Hope Bay Project – Loss of Vegetation Species Diversity

Loss of vegetation species diversity for the Hope Bay Project will occur during Construction/Operation of Phase 2 and for previously permitted activities and infrastructure for the Hope Bay Project, which precedes Phase 2. Loss assessed as part of the Hope Bay Project is due to clearing and grubbing associated with construction of Phase 2 and previously permitted activities and infrastructure. During Operation, there will be very limited localized losses that are assessed within the PDA for the Hope Bay Project.

Losses of species diversity class were similar in the high (1,578 ha, 2.8%), moderate (1,280 ha, 2.3%) and low (1,552 ha, 2.8%) species diversity classes (Table 8.5-8; Figure 8.5-3). Effects in the high class are mostly attributable to loss of Eriophorum Tussock Meadow, the most abundant ecosystem in the LSA.

Table 8.5-8. Hope Bay Project Potential Loss of Vegetation Species Diversity by Diversity Classes within Footprints and Project Development Area

	LSA	Hope Bay Project Footprint Loss		Hope Bay Project PDA Loss	
Species Diversity Class	**ha**	**ha**	**%**	**ha**	**%**
High	16,372	412.2	0.7%	1,577.8	2.8%
Moderate	13,212	437.0	0.8%	1,280.5	2.3%
Low	16,151	413.3	0.7%	1,552.2	2.8%
Very Low	851	4.9	0.0%	42.3	0.1%
Nil (Non-vegetated and Water)	9,753	73.9	0.1%	116.4	0.2%
Total	**56,340**	**1,341.3**	**2.4%**	**4,569.2**	**8.1%**

Based on the assessment, residual effects due to the Hope Bay Project are predicted for vegetation species diversity due to loss. Residual effects are carried forward to the next section for characterizations according to the defined criteria and significance determination.

Loss of Vegetation Productivity

Vegetation productivity is a measure of the annual net primary productivity (ANPP). It is the expression of plant species growth rates that is influenced by ecosystem properties and climatic conditions. The least productive communities are cryptogram communities such as blockfields and rock outcrops. The highest ANPP values are found in ecosystems such as riparian willow communities. As ANPP increases so does above ground biomass, which can indicate greater forage availability and increased habitat values.

To assess potential effects to primary productivity, published ANPP values for land cover types were assigned by corresponding the ecosystem types with the ecosystems and ANPP values reported in the literature (Bliss and Mateyeva 1992; Gould et al. 2003; Walker 1999). Five classes were used to group productivity ranges for the ecosystem types including: Very Low for generally barren or largely unvegetated types such as Dry Carex-Lichen; Low for sparsely vegetated types or those with very low prostrate vegetation cover such as Dryas Herb Mat; Moderate for hemi-prostrate shrub or sedge dominated meadows such as Wet Meadows; High for erect dwarf shrub complexes such as the Dwarf Shrub-Heath; and Very High for low shrub dominated ecosystems such as Riparian Willow ecosystems (Table 8.5-9).

Phase 2 – Loss of Vegetation Productivity

Most Phase 2 effects occurred in ecosystems associated with low vegetation productivity (2,018 ha, 3.6%), followed by effects to ecosystems with very low productivity (1,169 ha, 2.1%). There are 750 ha that occur in moderate, high, and very high classes which comprise 1.4% of the LSA (Table 8.5-10 and Figure 8.5-4).

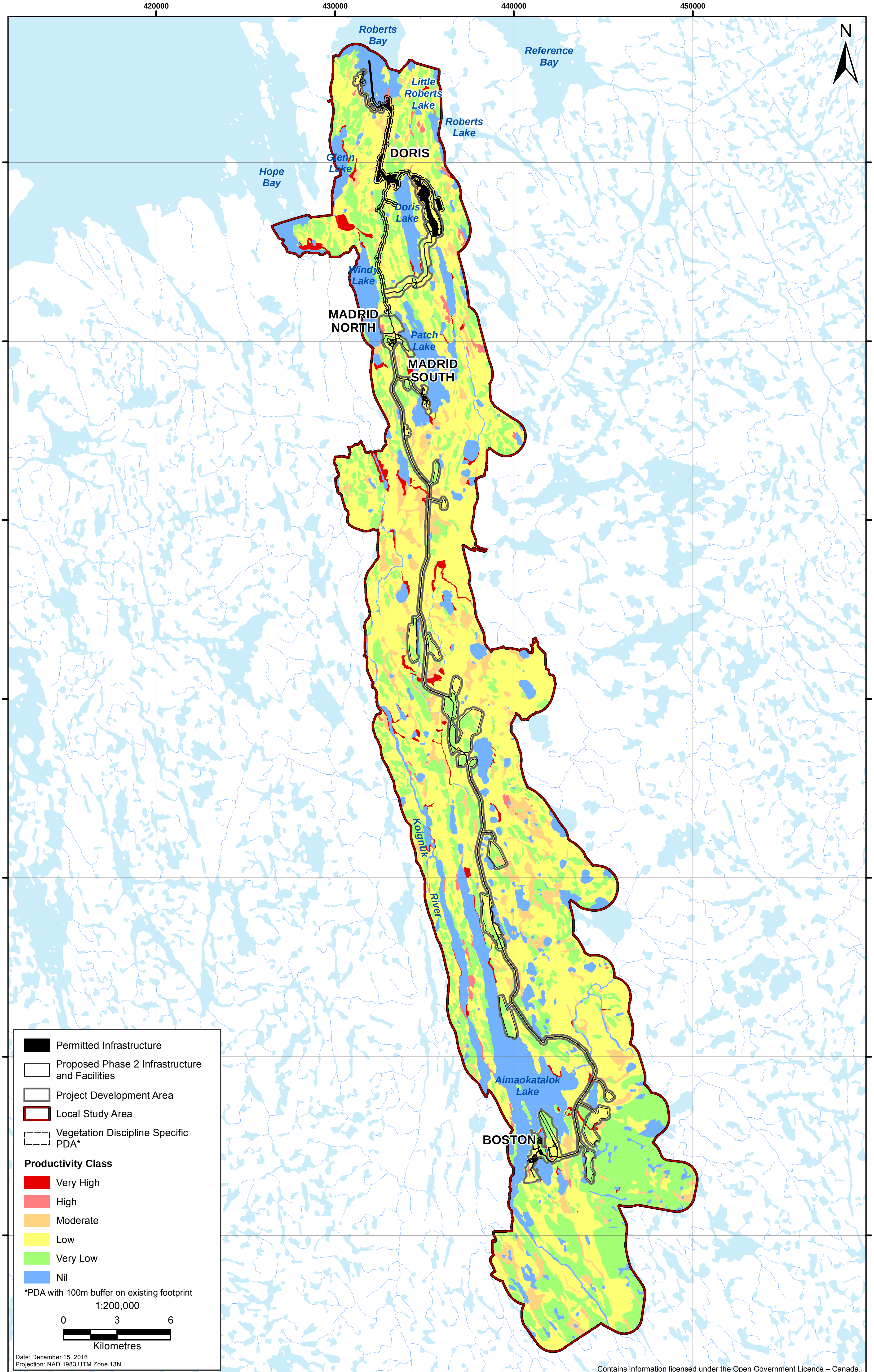
Table 8.5-9. Vegetation Productivity Classes and Annual Productivity Estimates within the Local Study Area

Map Code	Description	Productivity Class Range	Productivity Class	Total LSA (ha)	Percent of LSA
BA	Barren	< 20	Very Low	5.8	< 0.1%
BE	Beach	< 20	Very Low	20.9	< 0.1%
BI	Blockfield	< 20	Very Low	979.1	1.7%
BL	Betula-Ledum-Lichen	< 20	Very Low	7,075.8	12.6%
BM	Betula-Moss	< 20	Very Low	1,708.4	3.0%
CL	Dry Carex-Lichen	< 20	Very Low	527.1	0.9%
DH	Dryas Herb Mat	20 - 50	Low	4,344.8	7.7%
DW	Dry Willow	20 - 50	Low	1,243.8	2.2%
EM	Emergent Marsh	50 - 150	Moderate	751.1	1.3%
ES	Exposed Soil	< 20	Very Low	77.5	0.1%
FP	Low Bench Floodplain	20 - 50	Low	122.8	0.2%
LA & PD	Lakes and Ponds			8,214.6	14.6%
MB	Marine Backshore	< 20	Very Low	17.7	< 0.1%
MI	Marine Intertidal	20 - 50	Low	3.3	< 0.1%
MS	Mine Spoils	< 20	Very Low	16.9	< 0.1%
OW	Shallow Open Water	< 20	Very Low	10.6	< 0.1%
PG	Polygonal Ground	20 - 50	Low	2,569.3	4.6%
RI	River			797.6	1.42%
RO	Rock Outcrop	< 20	Very Low	3,280.4	5.8%
RU	Rubble (Talus)	< 20	Very Low	19.6	< 0.1%
RW	Riparian Willow	250 – 1,000	Very High	1,229.5	2.2%
SH	Dwarf Shrub-Heath	150 - 250	High	741.8	1.3%
LA & PD	Salt Water			741.1	1.3%
TM	Eriophorum Tussock Meadow	20 - 50	Low	15,630.1	27.7%
WM	Wet Meadow	50 - 150	Moderate	6,210.4	11.0%
Total				**56,340.0**	**100.0%**

Table 8.5-10. Phase 2 Loss of Vegetation Productivity Classes within the PDA and Footprint

	LSA	Phase 2 Footprint Loss		Phase 2 PDA loss	
Productivity	**ha**	**ha**	**%**	**ha**	**%**
Very High	1,229.5	17.9	0.0%	110.3	0.2%
High	741.8	128.0	0.2%	46.6	0.1%
Moderate	6,961.5	548.7	1.0%	594.1	1.1%
Low	23,914.1	456.4	0.8%	2,017.8	3.6%
Very Low	13,739.7	-	0.0%	1,168.9	2.1%
Nil (Non-vegetated and Water)	9,753.3	73.5	0.1%	93.0	0.2%
Total	**56,340.0**	**1,224.5**	**2.2%**	**4,030.7**	**7.2%**

Figure 8.5-4
Project Effects to Vegetation Productivity Classes within Footprints and Project Development Areas



Based on the assessment, residual effects due to Phase 2 are predicted for vegetation productivity due to loss. Residual effects are carried forward to the next section for characterizations according to the defined criteria and significance determination.

Hope Bay Project – Loss of Vegetation Productivity

Loss of vegetation productivity for the Hope Bay Project will occur during Construction/Operation of Phase 2 and for previously permitted activities and infrastructure that support the Hope Bay Project, which precedes Phase 2. Loss of vegetation productivity assessed as part of the Hope Bay Project is due to clearing and grubbing associated with construction of Phase 2 and previously permitted activities and infrastructure. During Operation, there will be very limited localized losses that are assessed within the PDA for the Hope Bay Project.

Similar to Phase 2, most Hope Bay Project effects occurred in ecosystems associated with low vegetation productivity (2,291 ha, 4.1%), followed by effects to ecosystems with very low productivity (1,287 ha, 2.3%) and moderate productivity (697 ha, 1.2%). There are 874 ha that occur in moderate, high, and very high classes which comprise 1.5% of the LSA (Table 8.5-11 and Figure 8.5-4).

Table 8.5-11. Hope Bay Project Potential Loss of Vegetation Productivity Classes within the PDA and Footprint

	LSA	Hope Bay Project Footprint Loss		Hope Bay Project PDA Loss	
Productivity	**ha**	**ha**	**%**	**ha**	**%**
Very High	1,229.5	17.9	0.0%	111.1	0.2%
High	741.8	134.4	0.2%	66.2	0.1%
Moderate	6,961.5	571.9	1.0%	696.7	1.2%
Low	23,914.1	522.9	0.9%	2,291.2	4.1%
Very Low	13,739.7	20.2	0.0%	1,287.5	2.3%
Nil (Non-vegetated and Water)	9,753.3	73.9	0.1%	116.4	0.2%
Total	**56,340.0**	**1,341.3**	**2.4%**	**4,569.2**	**8.1%**

Based on the assessment, residual effects due to the Hope Bay Project are predicted for vegetation productivity due to loss. Residual effects are carried forward to the next section for characterizations according to the defined criteria and significance determination.

<u>Loss of Special Landscape Features</u>

Special Landscape Features were included in the assessment based on their rarity or their ability to support unique habitat types that provide materials for tools, hunting opportunities, travel corridors, habitat for rare plant species, habitat for animals including bird species, denning places, forage habitat, and security habitat for wildlife such as wolverine. The distribution of the landscape features in the LSA, PDA, and Project Footprint are show in Table 8.5-12. These were grouped into five classes: riparian ecosystems, Dwarf Shrub Heath (which was also includes eskers complexes), sensitive or rare wetlands, rock dominated ecosystems including cliffs, and beach and marine areas.

Phase 2 - Loss of Special Landscape Features

Loss of Special Landscape Features associated with Phase 2 activities and infrastructure is shown in Table 8.5-12 and Figure 8.5-5. In total, 1,388 ha are lost in the PDA. This represents 2.5% of total area in the LSA and 8.4% of the total area associated with Special Landscape Features in the LSA. The greatest loss occurs to Wet Meadows (560 ha; 3.4%).

Table 8.5-12. Phase 2 Loss of Special Landscape Features within the PDA and Footprint

Special Landscape Features	TEM Map Code	LSA	Phase 2 Footprint Loss		Phase 2 PDA Loss	
		ha	ha	%	ha	%
Riparian ecosystems and floodplains	RW	1,229.5	28.8	0.2%	110.3	0.7%
	FP	122.8	0.0	0.0%	3.1	0.0%
Total		1,352.3	28.8	0.2%	113.4	0.7%
Dwarf Shrub Heath (Can contain esker complexes)	SH	741.8	17.9	0.1%	46.6	0.3%
Total		741.8	17.9	0.1%	46.6	0.3%
Sensitive or rare wetlands	WM	6,210.4	124.0	0.8%	560.0	3.4%
	PG	2,569.3	22.5	0.1%	161.5	1.0%
	OW	11.0	0.5	0.0%	5.7	0.0%
	EM	751.1	4.1	0.0%	34.1	0.2%
Total		9,541.8	151.0	0.9%	761.3	4.6%
Bedrock cliff and Bedrock-lichen veneer ecosystems	RO	3,280.4	179.0	1.1%	346.2	2.1%
	CL	5,27.1	48.9	0.3%	86.7	0.5%
	BI	979.1	0.1	0.0%	30.1	0.2%
Total		4,786.6	228.1	1.4%	463.1	2.8%
Beaches, marine backshores and intertidal areas	BE					
	MB	17.7	0.2	0.0%	3.2	0.0%
	MI	3.3	0.0	0.0%	0.0	0.0%
Total		21.0	0.2	0.0%	3.2	0.0%
Grand Total		**16,443.4**	**426.0**	**2.6%**	**1,387.7**	**8.4%**

Based on the assessment, residual effects due to Phase 2 are predicted for Special Landscape Features due to loss. Residual effects are carried forward to the next section for characterizations according to the defined criteria and significance determination.

Hope Bay Project - Loss of Special Landscape Features

Loss of Special Landscape Features for the Hope Bay Project will occur during Construction/Operation of Phase 2 and for previously permitted activities and infrastructure the Hope Bay Project, which precedes Phase 2. Loss of Special Landscape Features assessed as part of the Hope Bay Project is due to clearing and grubbing associated with construction of Phase 2 and previously permitted activities and infrastructure. During Operation, there will be very limited localized losses that are assessed within the PDA for the Hope Bay Project.

Loss of Special Landscape Features associated with Hope Bay Project activities and infrastructure is shown in Table 8.5-13 and Figure 8.5-5. In total, 1,619 ha are lost in the Hope Bay Project PDA. This represents 2.9% of total area in the LSA and 9.8% of the total area associated with Special Landscape Features in the LSA. The greatest loss occurs to Wet Meadows (662 ha; 4.0%). Footprint losses are 2.9% (470 ha) of the 16,433 ha of Special Landscape Features in the LSA.

Based on the assessment, residual effects due to the Hope Bay Project are predicted for Special Landscape Features due to loss. Residual effects are carried forward to the next section for characterizations according to the defined criteria and significance determination.

Figure 8.5-5
Project Effects to Special Landscape Feature within Footprints and Project Development Areas

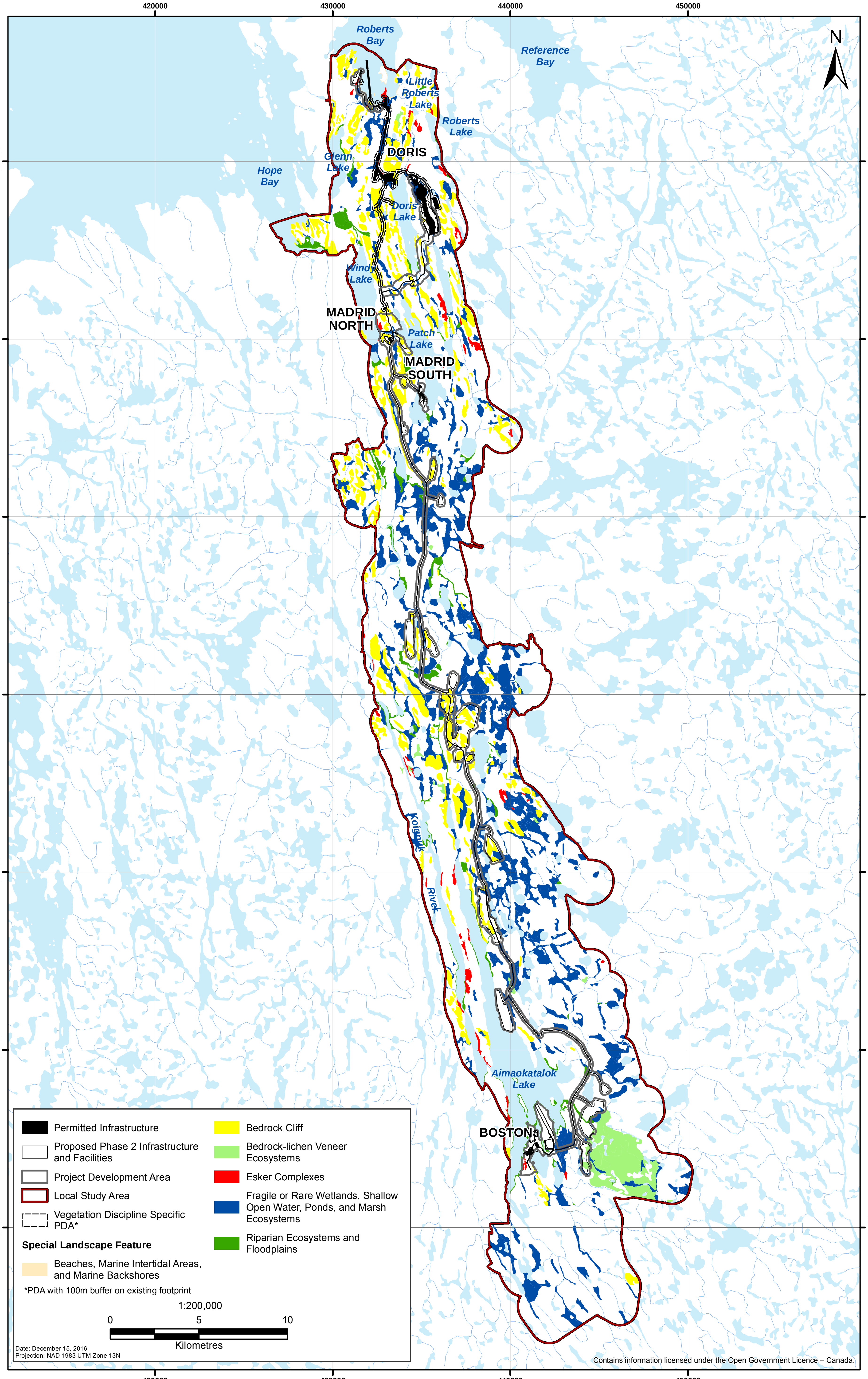


Table 8.5-13. Hope Bay Project Potential Loss of Special Landscape Features within the PDA and Footprint

Special Landscape Features	TEM Map Code	LSA	Hope Bay Project Footprint Loss		Hope Bay Project PDA Loss	
		ha	ha	%	ha	%
Riparian ecosystems and floodplains	RW	1229.5	28.8	0.2%	111.1	0.7%
	FP	122.8	0.0	0.0%	3.5	0.0%
Total		1352.3	28.8	0.2%	114.6	0.7%
Dwarf Shrub Heath (Can contain esker complexes)	SH	741.8	24.3	0.1%	66.2	0.4%
Total		741.8	24.3	0.1%	66.2	0.4%
Sensitive or rare wetlands	WM	6210.4	147.2	0.9%	662.0	4.0%
	PG	2569.3	23.8	0.1%	170.5	1.0%
	OW	11.0	0.8	0.0%	21.2	0.1%
	EM	751.1	4.1	0.0%	34.4	0.2%
Total		9541.8	175.9	1.1%	888.1	5.4%
Bedrock cliff and Bedrock-lichen veneer ecosystems	RO	3280.4	191.0	1.2%	423.7	2.6%
	CL	527.1	49.0	0.3%	89.5	0.5%
	BI	979.1	0.1	0.0%	30.1	0.2%
Total		4,786.6	240.1	1.5%	543.4	3.3%
Beaches, marine backshores and intertidal areas	BE					
	MB	17.7	0.6	0.0%	5.6	0.0%
	MI	3.3	0.1	0.0%	0.7	0.0%
Total		21.0	0.7	0.0%	6.3	0.0%
Grand Total		**16,443.4**	**469.8**	**2.9%**	**1618.6**	**9.8%**

8.5.4.2 Alteration of Vegetation and Special Landscape Features

Localized alteration of Vegetation and Special Landscape Features due to soil compaction or erosion, changes in permafrost or snow depth, or invasive plant species will be largely mitigated through the mitigation measures outlined in Section 8.5.3.3. Where effects remain after the application of mitigation measures, these are not expected to occur outside of the PDA. The exception to this are potential effects from fugitive dust which may affect areas outside the PDA.

To assess fugitive dust, an air quality model was developed for the Phase 2 Project for the Construction and Operation phases; this model incorporated mitigation measures intended to protect air quality (Volume 4, Section 2, Air Quality Effect Assessment) and *the Air Quality Management Plan* (Volume 8, Annex 19). Predictions for fugitive dust deposition to soil during construction and operation are included in Volume 6, Section 5 (Appendix V6-5H and V6-5I).

The quantitative air modelling results indicate that fugitive dust will not result in exceedances of Canadian Council of Ministers of the Environment (CCME 2016) agriculture guidelines for metal concentrations in soils (for Barium, the more conservative residential/parkland guidelines were used). Where baseline metal concentrations exceed CCME guidelines (chromium, copper, and nickel), Project effects will result in minor increases to soil concentrations of these metals which are not predicted to cause risks to human health (Volume 6, Section 5, Human Health and Environmental Risk Assessment).

Therefore, vegetation is not expected to be negatively altered by the Phase 2 Project due to fugitive dust, airborne emissions, or other media, and potential degradation is not discussed further.

As alteration effects on Vegetation indicators and Special Landscape Features are modelled and predicted to occur within the PDA boundary, no residual effects due to alteration are predicted. This is because total loss of all VECs within the PDA was assumed. This a precautionary approach as it is difficult to accurately spatially assess the potential effects on Vegetation and Special Landscape indicators related to dust, invasive species, and soil compaction. Potential effects related to water quality and quantity are assessed in Volume 5, Section 4 (Freshwater Water Quality) and Volume 5, Section 1 (Surface Hydrology).

The effects due to airborne fugitive dust fall, airborne contaminants from emission sources on vegetation quality are assessed in the Human Health and Environmental Risk Assessment (Volume 6, Section 5) and potential impacts related to air quality on soil eutrophication/acidification are identified in Landforms and Soils (Volume 4, Section 7).

The human health and ecological risk assessment (Volume 6, Section 5) evaluated potential changes in the quality of environmental media (e.g., soil, vegetation, and water) due to Hope Bay Project pre-construction activities, the combined Doris and Phase 2 Projects, and the potential for increased risk of adverse health effects in ecological receptors (e.g., caribou). The assessment determined that Hope Bay Project effects on environmental media quality were negligible; thus, there is no potential increase in risk of adverse health effects due to either the Phase 2 or Hope Bay Project activities. Therefore, the effects of environmental contaminants and bioaccumulation is not considered as a residual effect on Vegetation.

As no residual effects due to alteration of Vegetation and Special Landscape Features are predicted, alteration of Vegetation and Special Landscape Features is excluded from further assessment.

8.5.5 Characterization of Residual Effects

Project residual effects are the effects that are remaining after mitigation and management measures are taken into consideration. If the implementation of mitigation measures eliminates a potential effect and no residual effect is identified on that VEC, the effect is eliminated from further analyses. If the proposed implementation controls and mitigation measures are not sufficient to eliminate an effect, a residual effect is identified and carried forward for additional characterization and a significance determination. Residual effects of the Phase 2 Project and Hope Bay Project can occur directly or indirectly. Direct effects result from specific environment interactions with activities and components, and VECs. Indirect effects are the result of direct effects on the environment that lead to secondary or collateral effects on VECs.

8.5.5.1 Definitions for Characterization of Residual Effects

To determine the significance of residual effect, each potential negative residual effect is characterized by a number of attributes consistent with those defined in of the EIS Guidelines (Section 7.14, Significance Determination for the Hope Bay Project; NIRB). A definition for each attribute and the contribution that it has on significance determination is provided in Table 8.5-14.

The Effects Assessment Methodology (Volume 2, Section 4) describes the criteria used to evaluate potential residual effects. The criteria include direction of change, magnitude, duration, frequency, geographic extent, reversibility, probability of an effect, and confidence in the prediction.

Table 8.5-14. Attributes to Evaluate Significance of Potential Residual Effects

Attribute	Definition and Rationale	Impact on Significance Determination
Direction	The ultimate long-term trend of a potential residual effect - positive, neutral, or negative.	Positive, neutral, and negative potential effects on Vegetation and Special Landscape Features are assessed, but only negative residual effects are characterized and assessed for significance.
Magnitude	The degree of change in a measurable parameter or variable relative to existing conditions. This attribute may also consider complexity – the number of interactions (Project phases and activities) contributing to a specific effect.	The higher the magnitude, the higher the potential significance.
Duration	The length of time over which the residual effect occurs.	The longer the length of time of an interaction, the higher the potential significance.
Frequency	The number of times during the Project or a Project phase that an interaction or environmental/ socio-economic effect can be expected to occur.	Greater the number times of occurrence (higher the frequency), the higher the potential significance.
Geographic Extent	The geographic area over which the interaction will occur.	The larger the geographical area, the higher the potential significance.
Reversibility	The likelihood an effect will be reversed once the Project activity or component is ceased or has been removed. This includes active management for recovery or restoration.	The lower the likelihood a residual effect will be reversed, the higher the potential significance.

The significance determination represents the effects on the sustainability of Vegetation and Special Landscape Features and their capacity to meet the present and future needs. While the assessment of potential loss occurs at the indicator level, the final magnitude for significance determination is based upon the effects assessed for the VEC, not at the indicator level for specific ecosystems or landscape features.

Section 7.4 of the EIS Guidelines (NIRB) provided guidance, attributes, and criteria for the determination of significance for residual effects. Also, the Canadian Environmental Assessment Agency's *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects (*CEA Agency 1994*)* also guided the evaluation of significance for identified residual effects. The significance of residual effects is based on comparing the predicted state of the environment with and without the Project, including a judgment as to the importance of the changes identified.

Thresholds for assessing magnitude for Vegetation and Special Landscape Feature for loss and alteration do not presently exist for Arctic ecosystems. Research has indicated that as total habitat declines both population size and the number of wildlife species decline (not necessarily in a linear relationship) and that thresholds for wildlife often occur somewhere between 30 to 70% of habitat loss, depending on the ecosystem and wildlife species of interest (Mace et al. 1996; Mace and Waller 1997; Mace 2004; Schwartz et al. 2006; Interagency Conservation Strategy Team 2007; Price, Holt, and Kremsater 2007).

As effects to Vegetation and Special Landscape Features represent effects to wildlife, the selection of magnitude classes is consistent with the methodology for the wildlife habitat assessments. While loss of vegetation and habitat greater than 30% can be considered unacceptable (Price, Roburn, and MacKinnon 2009), a lower value was selected to align with the precautionary approach being taken by the Hope Bay

Project. The threshold value of 20% for high magnitude was selected based on the concept of maintaining ecosystem group representation. It has been suggested that poorly represented or rare ecosystems, such as wetlands, be offered greater protection (Bunnell et al. 2003; Wells et al. 2003).

Magnitude classes include negligible magnitude, where there is assumed to be no detectable change to baseline distributions, low magnitude (1% to 10% loss), medium magnitude (10.1% to 20% loss), and high magnitude, where loss is assumed to result in a long-lasting effect on the distribution or availability of vegetation communities in the LSA. Loss greater than 20.1% of Vegetation or Special Landscape Features relative to their LSA availability was considered a high magnitude effect. The magnitude classes in Table 8.5-15 were identified using threshold values from literature for loss and disturbance of wildlife habitat.

Table 8.5-15. Definitions of Magnitude Criteria for Vegetation and Special Landscape Features Residual Effects

Magnitude Class	Description
Negligible	Loss less than 1% of VEC availability in the LSA
Low	Loss between 1% to 10% of VEC availability in the LSA
Moderate	Loss between 10.1% to 20% of VEC availability in the LSA
High	Loss greater than > 20.1% VEC availability in the LSA

For the determination of significance, each attribute is characterized. The characterizations and criteria for the characterizations are provided in Table 8.5-16. Each of the criteria contributes to the determination of significance.

Table 8.5-16. Criteria for Residual Effects for Environmental Attributes

Attribute	Characterization	Criteria
Direction	Positive	Beneficial
	Variable	Both beneficial and undesirable
	Negative	Undesirable
Magnitude	Negligible	Loss less than 1% of VEC availability in the LSA
	Low	Differing from the average value for the existing Loss from 1% to 10% of VEC availability in the LSA
	Moderate	Loss between 10.1% to 20% of VEC availability in the LSA
	High	Loss greater than > 20.1% VEC availability in the LSA
Duration	Short	Up to 4 years (Construction phase)
	Medium	Greater than 4 years and up to 17 years (4 years Construction phase, 10 years Operation phase, 3 years Reclamation and Closure phase)
	Long	Beyond the life of the Project
Frequency	Infrequent	Occurring only occasionally
	Intermittent	Occurring during specific points or under specific conditions during the Project
	Continuous	Continuously occurring throughout the Project life
Geographic Extent	Project Development Area (PDA)	Confined to the PDA
	Local Study Area (LSA)	Beyond the PDA and within the LSA
	Regional Study Area (RSA)	Beyond the LSA and within the RSA
	Beyond Regional	Beyond the RSA

Attribute	Characterization	Criteria
Reversibility	Reversible	Effect reverses within an acceptable time frame with no intervention (0 to 25 years)
	Reversible with effort	Active intervention (effort) is required to bring the effect to an acceptable level (25 to 100 years)
	Irreversible	Effect will not be reversed (> 100 years)

Probability of Occurrence or Certainty

Prior to the determination of the significance for negative residual effects, the probability of the occurrence or certainty of the effect is evaluated. For each negative residual effect, the probability of occurrence is categorized as unlikely, moderate, or likely. Table 8.5-17 presents the definitions applied to these categories.

Table 8.5-17. Definition of Probability of Occurrence and Confidence for Assessment of Residual Effects

Attribute	Characterization	Criteria
Probability of occurrence or certainty	Unlikely	Some potential exists for the effect to occur; however, current conditions and knowledge of environmental trends indicate the effect is unlikely to occur.
	Moderate	Current conditions and environmental trends indicate there is a moderate probability for the effect to occur.
	Likely	Current conditions and environmental trends indicate the effect is likely to occur.
Confidence	High	Baseline data are comprehensive; predictions are based on quantitative terrestrial ecosystem mapping; effect relationship is well understood.
	Medium	Baseline data are comprehensive; predictions are based on quantitative terrestrial ecosystem mapping; effect relationship is generally understood, however, there are assumptions based on other similar systems to fill knowledge gaps.
	Low	Baseline data are limited; predictions are based on qualitative data; effect relationship is poorly understood.

Determination of Significance

The evaluation of significance was determined based on the residual effects characterization. The criteria used in assessing significance for Vegetation and Special Landscape Features include:

Not significant: The direction of effects can be positive to negative. The magnitude of effects can be negligible to moderate, and the duration of effects can be short to long. Frequency of effects can be infrequent to continuous, and the geographic extent must be limited to the LSA. Potential effects can be reversible within 25 years to irreversible (greater than 100 years required).

Significant: The direction of effects is negative. The magnitude of effects is high and the duration of is long. Frequency of effects can be infrequent to continuous. Geographic extent must extend beyond the LSA and may be within the RSA or beyond the RSA and has regional geographic extent, and effects can be reversible with effort (25 to 100 years) or irreversible (greater than 100 years required).

Confidence

The knowledge or analysis that supports the prediction of a potential residual effect—in particular with respect to limitations in overall understanding of the environment and/or the ability to foresee future events or conditions—determines the confidence in the determination of significance. In general, the lower the confidence, the more conservative the approach to prediction of significance must be. The level of confidence in the prediction of a significant or non-significant potential residual effect qualifies the determination, based on the quality of the data and analysis and their extrapolation to the predicted residual effects. "Low" is assigned where there is a low degree of confidence in the inputs, "medium" when there is moderate confidence and "high" when there is a high degree of confidence in the inputs. Where rigorous baseline data were collected and scientific analysis performed, the degree of confidence will generally be high. Table 8.5-17 provides descriptions of the confidence criteria.

Residual effects identified in the Phase 2 Project-related effects assessment are carried forward to assess the potential for cumulative interactions with the residual effects of other projects or human activities and to assess the potential for transboundary impacts should the effects linked directly to the activities of the Phase 2 Project inside the Nunavut Settlement Area (NSA), which occurs across provincial, territorial, international boundaries or may occur outside of the NSA.

8.5.5.2 Characterization of Residual Effect for Vegetation

This section characterizes the residual effects using the residual effects descriptors from the preceding section and provides a significance determination for each of the residual effects. For each residual effect, the rating for each criterion and a brief description is provided to justify the rating. Determination of significance is based on the combination of criteria described in the preceding section.

<u>Loss of Vegetation</u>

Phase 2 Residual Effects

Loss associated primarily with clearing and grubbing during construction for Phase 2 will result in the loss of 4,030 ha or 7.2% of the area of Vegetation VEC. Magnitude is low as loss of Vegetation is between 1 to 10% of the availability of Vegetation indicators in the LSA (Table 8.5-18).

The duration of effects is long, as the recovery time of arctic ecosystems after even light trampling or disturbance can be up to 25 years. Disturbances due to clearing and grubbing activities for Phase 2 Project infrastructure are severe and return to baseline conditions within 100 years is not predicted. Disturbance due to clearing and grubbing are infrequent as most clearing will be completed during the Construction phase. The geographic extent of loss to Vegetation will be contained within the PDA. Actual loss of Vegetation in the PDA will be closer to total Footprint size (1,224 ha), but residual effects have been characterized using the PDA as the loss boundary to provide a conservative estimate of Phase 2 Project effects and allow for flexibility in final infrastructure siting. The loss of Vegetation is considered irreversible (> 100 years) due to the extremely slow recovery processes for arctic vegetation.

The probability of loss due to clearing is likely as Phase 2 Project effects due to clearing are predictable and well understood. Residual effects to the Vegetation VEC are **not significant** as the magnitude is low and the geographic extent of the effects are limited to the PDA (Table 8.5-18). As 93% of the LSA is not affected, sufficient representation of vegetation types and functions exists within the LSA to continue to support existing uses. The confidence in the declaration of not significant is high. Ecosystem mapping is a well-established method for documenting vegetation communities and assessing potential effects to them.

Hope Bay Project Residual Effects

Loss associated primarily with the Hope Bay Project, which includes Phase 2, will affect 4,569 ha of the area of mapped ecosystem communities in the LSA. Total loss is 8.1% of the Vegetation in the LSA. Magnitude is low but bordering on moderate as loss effects are between 1 to 10% of the availability of Vegetation indicators in the LSA (Table 8.5-19).

Table 8.5-18. Summary of Residual Effects and Overall Significance Rating for Vegetation and Special Landscape Features - Phase 2

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Vegetation									
Loss	Negative	Low	Long	Infrequent	PDA	Irreversible	Likely	Not Significant	High
Special Landscape Features									
Loss	Negative	Low	Long	Infrequent	PDA	Irreversible	Likely	Not Significant	Moderate

Table 8.5-19. Summary of Residual Effects and Overall Significance Rating for Vegetation and Special Landscape Features - Hope Bay Project

Residual Effect	Attribute Characteristic						Overall Significance Rating		
	Direction (*positive, variable, negative*)	**Magnitude** (negligible, *low, moderate, high*)	**Duration** (*short, medium, long*)	**Frequency** (*infrequent, intermittent, continuous*)	**Geographic Extent** (PDA, *LSA, RSA, beyond regional*)	**Reversibility** (*reversible, reversible with effort, irreversible*)	**Probability** (*unlikely, moderate, likely*)	**Significance** *(not significant, significant)*	**Confidence** (*low, medium, high*)
Vegetation									
Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	High
Special Landscape Features									
Loss	Negative	Low	Long	Intermittent	PDA	Irreversible	Likely	Not Significant	Moderate

The duration of effects is long, as the recovery time of arctic ecosystems occurs over decades or centuries. Disturbances due to permitted activities and infrastructure will be severe and return to baseline conditions within 100 years is not predicted. Disturbance was assessed as intermittent as clearing will take place for previously permitted activities and infrastructure prior to disturbances associated with Phase 2 Construction Phase. The geographic extent of loss to Vegetation will be contained within the PDA. Actual loss of Vegetation in the PDA will be closer to total Footprint size (1,341 ha, 2.4% of the LSA), but residual effects have been characterized using the PDA as the loss boundary. The loss of Vegetation is considered irreversible (> 100 years) due to the extremely slow recovery processes for arctic vegetation.

The probability of loss due to clearing is likely as Hope Bay Project effects due to clearing are predictable and well understood. Residual effects to the Vegetation VEC are **not significant** as the magnitude is low and the geographic extent of the effects are limited to the PDA (Table 8.5-19). The confidence in the declaration of not significant is high. Ecosystem mapping is a well-established method for documenting vegetation communities and assessing potential effects to them.

8.5.5.3 Characterization of Residual Effect for Special Landscape Features

<u>Loss of Special Landscape Features</u>

Phase 2 Residual Effects

Loss associated primarily with clearing and grubbing during construction for Phase 2 will affect 1,388 ha or 8.4 % of the area occupied by Special Landscape Features due to Phase 2 Effects. To assess magnitude, total loss of Special Landscape Features was compared to the total area of Special Landscape Features in the LSA. Based on this, magnitude is low as loss effects are between 1 to 10% of the availability of Special Landscape Features indicators in the LSA (Table 8.5-18). The duration of effects is long due to slow recovery rates in the arctic. Disturbance due to clearing and grubbing activities for Phase 2 Project infrastructure are severe and return to baseline conditions within 100 years is not predicted. Disturbance due to clearing and grubbing are infrequent as most clearing will be completed during the Construction phase. The geographic extent of loss to Special Landscape Features will be contained within the PDA. Actual loss of Special Landscape Features in Footprints in the PDA will be closer to 426 ha, but residual effects have been characterized using the PDA. The loss of Special Landscape Features is considered irreversible (> 100 years) due to the extremely slow recovery processes for arctic vegetation.

The probability of loss due to clearing is likely as Phase 2 Project effects due to clearing are predictable and well understood. Residual effects to the Special Landscape Features VEC are **not significant** as the magnitude is low and the geographic extent of the effects are limited to the PDA (Table 8.5-18). The confidence in the declaration of not significant is high. Ecosystem mapping is a well-established method for documenting rare and unique ecosystems and assessing potential effects to them; however, ecosystem types that are less than 2 ha may not be mapped at a 1:20,000 mapping scale, so confidence in the assessment is moderate.

Hope Bay Project Residual Effects

Loss associated primarily with Hope Bay Project will affect 1,619 ha or 9.8% of the Special Landscape Features in the LSA. As described previously, this is relative to the total abundance of Special Landscape Features in the LSA not the total area of the LSA to ensure effects are assessed relative to availability. Magnitude is low but very close to moderate as loss effects almost 10% of the availability of Special Landscape Features indicators in the LSA (Table 8.5-19). Actual Footprint losses are anticipated to be closer to 3%, which is part of the rationale for not assessing magnitude as moderate magnitude. The duration of effects is long, as the recovery time of arctic ecosystems after even light trampling or disturbance can be up to 25 years. Disturbances due to permitted activities and infrastructure will be severe and return to baseline conditions within 100 years is not predicted. Disturbance was assessed as intermittent as clearing will take place for previously permitted activities and infrastructure prior to disturbances associated with Phase 2 Construction Phase. The geographic extent of loss to Special Landscape Features will be contained within the PDA. The loss of Special Landscape Features is considered irreversible (> 100 years) due to the extremely slow recovery processes for arctic vegetation.

The probability of loss to Special Landscape Features due clearing is predictable and well understood. Residual effects to the Special Landscape Features VEC are **not significant** as the magnitude is low and the geographic extent of the effects are limited to the PDA. Ecosystem mapping is a well-established method for documenting rare and unique ecosystems and assessing potential effects to them; however, ecosystem types that are less than 2 ha may not be mapped at a 1:20,000 mapping scale, so confidence in the assessment is moderate.

8.6 CUMULATIVE EFFECTS ASSESSMENT

As residual effects due to loss of Vegetation and Special Landscape Features are predicted for both the Phase 2 and Hope Bay Projects and there is potential for interactions with residual effects from other projects, cumulative effects are assessed.

8.6.1 Methodology Overview

8.6.1.1 Approach to Cumulative Effects Assessment

The general methodology for cumulative effects assessment (CEA) is described in Volume 2, Section 4, and focuses on the following activities:

1. Identify the potential for Project-related (Phase 2 and the complete Hope Bay Project) residual effects to interact with residual effects from other human activities and projects within specified assessment boundaries. Key potential residual effects associated with past, existing, and reasonably foreseeable future projects were identified using publicly available information or, where data was unavailable, professional judgment was used (based on previous experience in similar geographical locations) to approximate expected environmental conditions.
2. Identify and predict potential cumulative effects that may occur and implement additional mitigation measures to minimize the potential for cumulative effects.
3. Identify cumulative residual effects after the implementation of mitigation measures.
4. Determine the significance of any cumulative residual effects.

8.6.1.2 Assessment Boundaries

The CEA considers the spatial and temporal extent of Project-related residual effects on VECs combined with the anticipated residual effects from other projects and activities to assist with analyzing the potential for a cumulative effect to occur.

<u>Spatial Boundaries</u>

The RSA was selected as a suitable boundary for the cumulative effects assessment, as the RSA encompasses the maximum area where the Phase 2 Project effects to Vegetation and Special Landscape Features could interact spatially with residual effects from other past, present, or reasonably foreseeable future projects and activities (Figure 8.2-1). It encompasses the regional setting for the Phase 2 Project and implicitly considers ecological factors.

Temporal Boundaries

The temporal boundaries for the CEA go beyond the phases of the Phase 2 Project, beginning before major industrial resource development actions were undertaken in the region, and extending into the future. It is not possible to precisely predict which other human actions will occur after the end of Post-Closure; however, an extrapolation of a likely future development scenario for the next several decades—based on information available today—is provided.

8.6.2 Potential Interactions of Residual Effects with Other Projects

With respect to Phase 2 Project residual effects, loss of Vegetation and Special Landscape Features were identified as negative residual effects of Phase 2 and the complete Hope Bay Project that could interact cumulatively with other past, present, or future projects or activities.

Only one past project was identified in the RSA that could interact with Phase 2 or Hope Bay Project residual effects: Roberts / IDA Bay. No present or reasonably foreseeable future projects were identified in the RSA that have the potential to act cumulatively.

Roberts/IDA Bay were silver mines operated by the Roberts Mining Company between 1973 to 1975. Remediation of the sites was completed in 2008 by Quantum Murray LP under contract to Indian and Northern Affairs Canada. The total area disturbed was less than 4 ha for both sites, which have been restored to conform to natural landforms in the area.

As Roberts/IDA Bay has been reclaimed and the disturbance area was small, less than 2 ha for each mine site, no cumulative interactions are predicted with either Phase 2 or Hope Bay Project residual effects. Therefore, no cumulative effects are predicted.

8.7 TRANSBOUNDARY EFFECTS

The EIS Guidelines (NIRB) define transboundary effects as those effects linked directly to the activities of the Phase 2 Project inside the NSA, which occur across provincial, territorial, international boundaries or may occur outside of the NSA (NIRB 2012a). Transboundary effects of the Phase 2 Project have the potential to act cumulatively with other projects and activities outside the NSA.

The Phase 2 and Hope Bay Project effects assessed in Section 8.5.1 for Vegetation and Special Landscape Features are predicted to remain in the PDA and LSA, and no cumulative residual effects are predicted (Section 8.6). These effects are all contained within the boundaries which are within Nunavut. Transboundary effects are not predicted and are not further addressed.

8.8 IMPACT STATEMENT

The assessment of potential effects on plant communities, ecosystems, and unique or sensitive landforms for Phase 2 and the complete Hope Bay Project was assessed using two VECs: Vegetation, and Special Landscape Features. The potential effects assessed included loss due to clearing and grubbing and alteration associated with potential changes in permafrost, water quality or quantity, soil conditions, snow deposition, potential contaminants, and dust.

Direct loss and alteration of Vegetation and Special Landscape Features are predicted to occur primarily during the Construction phase for Phase 2, adding to losses occurring during the construction of the existing and approved components of the Hope Bay Project. To assess loss and alteration to Vegetation and Special Landscape Features, indicators were identified.

Vegetation indicators included ecosystem types, species diversity, and productivity; and Special Landscape indicators included riparian ecosystems, rare or sensitive wetlands, ecosystems that can contain esker complexes, cliffs, bedrock lichen and outcrop ecosystems, and beaches and marine intertidal areas.

Mitigation measures were developed to reduce potential effects to Vegetation and Special Landscape Features including avoidance, minimization of effects, and restoration on-site environmental values. As effects due to alteration were not identified outside the PDA boundaries after mitigation, alteration was excluded from further assessment.

The loss of Vegetation within the PDA will result in effects to ecosystem abundance, species diversity, and vegetation productivity. Total loss of ecosystems and Vegetation in the PDA will result in 4,030 ha and a 7.2% reduction of availability in the LSA for Phase 2 and a 4,569 ha (8.1%) reduction associated with the Hope Bay Project. The greatest change in baseline ecosystem distribution due to Phase 2 and the Hope Bay Project results in the loss of 1,348 ha and 1,512 ha of Eriophorum Tussock Meadow (TM) respectively.

Loss of Special Landscape Features in the PDA will result in a total loss of 1,388 ha and an 8.4% reduction in availability in the LSA for Phase 2 and 1,619 ha and a 9.8% reduction of availability associated with the Hope Bay Project. The greatest changes to Special Landscape Features were observed in Wetland Meadows, which provide 662 ha of wetland habitat. Losses for individual features are all below 10% of their respective baseline distributions.

Loss of Vegetation and Special Landscape Features was restricted to the PDA and magnitude for for Phase 2 and the Hope Bay Project was assessed as low for both VECs.

Residual effects due to loss of Vegetation for Phase 2 and the Hope Bay Project are assumed to be irreversible but **Not Significant** as ecosystems and Vegetation lost in the PDA are common within the LSA boundary and the RSA (Table 8.5-18 and 8.5-19).

Residual effects due to loss of Special Landscape Features are assumed to be irreversible but **Not Significant** as effects are limited to the PDA. The features occur throughout the LSA and the RSA and will continue to support traditional uses and wildlife habitat (Table 8.5-18 and 8.5-19).

The two project residual effects were included in a cumulative effects assessment, the boundary of which was the Vegetation and Special Landscape Features RSA. However, as no spatial overlap with past, present, or foreseeable future projects was identified, no cumulative interactions were identified and no transboundary effects will occur.

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