10.3 ELC AND BIODIVERSITY

10.3.1 Baseline

10.3.1.1 Introduction

This baseline provides a summary of baseline ecological land classification units and biodiversity

This baseline provides a summary of the ecological land classification (ELC) units found within the regional study area (RSA) and local study area (LSA) of the De Beers Canada Inc. (De Beers) Snap Lake Diamond Project. In addition, the setting describes the baseline biodiversity, which uses ELC mapping to measure and quantify landscape, ecosystem, and species level biodiversity indices in both the RSA and LSA. Biodiversity is the variety of life at all levels of organization from gene to landscapes, and the ecological and biological processes through which these levels are connected. Detailed information on the cumulative effects assessment (CEA) is found within the cumulative effects section (Section 12).

Ecological land classification units are integrated units that describe terrain, soils, and vegetation

In the Snap Lake Diamond Project area, the types and distribution of vegetation communities are strongly influenced by geological and terrain features. Geological, terrain, and vegetation attributes were integrated into discrete ecological units. For example, the bedrock ELC unit consists of exposed bedrock that supports less than 20% vegetative cover including a limited number of vascular plant species and crustose lichens. The ELC units developed for the Snap Lake Diamond Project were based on consultation with the Department of Resources, Wildlife and Economic Development (RWED) and detailed field inventories undertaken in the study areas. The final ELC units selected are consistent with other mapping programs undertaken in the Northwest Territories (NWT) by RWED.

Landscape and ecosystem level biodiversity measures and describes the configuration and composition of the ecological land classification units

ELC units were used to measure and describe baseline biodiversity in the Snap Lake Diamond Project areas. Biodiversity encompasses the variety of life at all levels of organization from gene to landscapes, and the ecological and biological processes through which these levels are connected. For this assessment, biodiversity is described at the landscape and ecosystem level. Landscape level indices were selected to measure the broad configuration of patterns across the landscape, consisting of the number, size, and closeness of patches of different ELC units. These patches can be seen in Figures 10.3-1 and 10.3-2 (*e.g.*, widely dispersed, small patches of heath bedrock can be seen within large areas of heath boulder located south of the LSA in Figure 10.3-2). Ecosystem biodiversity focuses on the species and

Figure 10.3-1 Regional Study Area for ELC and Biodiversity

Figure 10.3-2 Local Study Area for ELC and Biodiversity

individuals within an ELC unit, which is a much finer focus. Ecosystem biodiversity measures the community richness, species richness (number of different species) and species evenness (which compares the number of individuals of each species) within an ELC unit. A ranking system was developed to describe biodiversity at the ecosystem level. A description of the indices selected to measure and describe biodiversity is provided in Section 10.3.1.4.

10.3.1.2 Study Areas

Regional study area and local study area were selected

Regional and local study areas were selected to describe baseline ELC units and biodiversity for the Snap Lake Diamond Project. The following provides a description of the study areas and a rationale for their selection.

The regional study area, located with a 31 km radius was selected to assess impacts beyond the local study area

The RSA is defined as the area within a 31 km radius of the centre of the active mine site (Figure 10.3-1). The outside southern boundary is situated approximately 180 km northeast of Yellowknife. The RSA was selected to assess and quantify impact areas that are situated outside the LSA but may be affected by the Snap Lake Diamond Project. For example, potential impacts on ELC units from the winter access road, which will be constructed annually from the Tibbitt-Contwoyto winter road to the project area, will be assessed within the RSA. In addition, an assessment of the potential effects on ELC units from air emissions (*i.e.*, road dust) will be quantified within the RSA. The ELC units within the RSA will be used to assess potential impacts on wildlife habitat since the home ranges of some species (*e.g.*, grizzly bears) extend beyond the LSA boundary (Section 10.4.1.4). Further details on the rationale for the selection of the RSA boundary is provided in the Wildlife Section (Section 10.4.1.3).

The regional study area is 301,889 ha in size and is dominated by heath/boulder and water

The RSA is 301,889 ha in size and the dominant ELC unit is heath/boulder, which occupies 46% of the RSA. The water ELC unit, which includes lakes, rivers, and streams, comprises 36% of the RSA. The remaining ELC units comprise 19% of the RSA.

The local study area consists of the project footprint with a 500 m buffer

The Snap Lake Diamond Project LSA is defined as the mine footprint with a 500 m buffer (Figure 10.3-2). A 500 m buffer around the mine footprint provides suitable area to assess all direct impacts from mine related activities. For example, all direct impacts from mine clearing and landform alteration on ELC units will be confined to the mine footprint, which is situated within the LSA. In addition, road dust immediately around the mine footprint, excluding the winter access roads, may affect ELC units that are situated within the 500 m buffer. ELC units within this 500 m buffer were described to assist in the assessment of potential impacts on wildlife habitat. Further details on LSA selection are provided in the wildlife assessment (Section 10.4.1.3).

The local study area is 1,435 ha and is dominated by heath/boulder and water

The LSA occupies an area of 1,435 ha. Similar to the RSA, the majority of the LSA is dominated by heath/boulder (55%), while heath tundra accounts for only 0.1% of the LSA. Water comprises 31% of the LSA.

10.3.1.3 General Setting

Climate, geology, terrain, and soils typical of this region restrict the number and types of plants that occur

The RSA is situated within the Taiga Shield Ecozone in the High Subarctic Ecoclimatic Region. Throughout the taiga, cool air temperatures, a short growing season, geology, and recent glaciation have resulted in lower biological productivity and diversity than in the more southerly parts of Canada (Environment Canada 2001a). The few plant species that thrive have adapted to the harsh climate and poor soils. Because of the cold conditions, vegetation does not decompose rapidly into the soil but rather is preserved in the form of peat, which covers most low-lying areas (Environment Canada 2001a).

Vegetation typical of this region consists of stunted conifers, dwarf shrubs, and tundra grasses

The taiga forms the transition between forested lands to the south and forest tundra to the north. The predominant vegetation of the taiga consists of open, very stunted stands of black spruce and tamarack with secondary quantities of white spruce and a ground cover of dwarf birch, willow, ericaceous shrubs, cottongrass, lichen, and moss. Poorly drained sites usually support tussocks of sedge, cottongrass, and sphagnum moss. Low shrub tundra, consisting of dwarf birch and willow, are also common (Environment Canada 2001b). The peak flowering period for most plants in this ecozone ranges from July 1 to July 31 (Environment Canada 2001a).

The climate consists of short, cool summers and very cold winters

The climate is characterized by short, cool summers and very cold winters. The average annual temperature is approximately -7.5°C. The mean summer temperature is 9°C and the mean winter temperature is -24.5°C. The mean annual precipitation ranges from 200 to 300 mm (Environment Canada 2001b).

Dystric brunisols and cryosols are the dominant soil types in the regional study area

The strongly glaciated rock outcrops are common, and dystric brunisols are the dominant soil type. Turbic cryosols occur on permanently frozen sites and organic cryosols, which occur in poorly drained, peat-filled depressions, are also present in small pockets throughout the RSA. These permafrost areas are discontinuous with low ice content and sparse ice wedges present in soil profiles (Environment Canada 2001b).

10.3.1.4 Methods

The methods used for fieldwork, mapping, and analysis are provided below

The following section provides a summary of the field and mapping methods used to describe and define ELC units. The methods used to measure and describe baseline biodiversity are also provided below. The methods used to assess impacts on ELC units and biodiversity are described in Sections 10.1.5 and 10.3.2.3.

10.3.1.4.1 Field Investigations

A total of 120 field plots were surveyed to provide ecological land classification, rare plant, and traditional plant data

Field investigations were conducted from July 8 to July 15, 1999 to classify, describe, and inventory terrain, soil, and vegetation within each ELC unit. A total of 120 field plots were surveyed within the RSA. Since the LSA is within the RSA, it is encompassed by the RSA sites. A helicopter was used to access survey locations and to undertake aerial mapping. These survey locations were used as ground truthing for the final satellite mapping (*i.e.*, to determine that the ELC identified from the satellite is the ELC observed at that location). The field surveys were focused on sampling large homogeneous units as well as complexes of ELC units to ensure that the satellite imagery could be accurately classified into distinct ELC units. A stratified sampling approach was undertaken, with more common ELC units being sampled more frequently. Some ELC units such as deep water were only identified from an aerial survey, which did not allow for a plant inventory.

Field data collected included site description and plant inventory including rare and traditional plants

At each survey location, UTM coordinates and site conditions such as moisture regime, slope, aspect, microtopography, soil, and percent covers were recorded. The ELC unit was identified and all plants, including rare and traditional plants, were also recorded on data sheets. The field investigation coincided with the peak flowering period for plants in the area, which allowed for a thorough inventory of plants present within ELC units.

Field data were entered into a database for further analysis

All information collected was entered into an ELC database. A data analysis was undertaken to describe ELC units as well as provide information on ecosystem level biodiversity.

10.3.1.4.2 Mapping

Mapping accuracy was assessed to be 85%

The RSA and LSA mapping methods are described in the following sections. An overall accuracy assessment was undertaken following final classification by using field data that were not used as training data. The overall accuracy for the imagery was 85%. The following provides details on specific mapping procedures undertaken in both the RSA and LSA.

Enhanced satellite imagery was used to classify ecological land classification units

Satellite imagery was used for mapping ELC units in the RSA and LSA. Landsat Thematic Mapper imagery was acquired from August 1994 and enhanced with false colour infra-red wavelengths to increase the contrast associated with various ELC unit patterns.

Satellite imagery was classified into ecological land classification units based on field observations

ELC patterns were classified by applying an automated classification process to the imagery. This process involved delineating ELC unit sample or training areas. Training areas were defined through helicopter-based field investigations to ensure that the spectral signatures for each ELC unit were well understood. Each ELC unit has a unique spectral signature that is used to differentiate among varying ELC units. A maximum likelihood classifier was applied to the satellite image to match spectral patterns with the sample areas. Once the satellite image were classified into discrete ELC units, some additional edits were applied.

Manual edits corrected details on eskers and north-facing slopes

Some ELC units were either identified or improved through manual delineation techniques. In particular, esker complexes, which were identified as important wildlife habitat, are highly variable with a diverse range in vegetation types and densities. As such, eskers were difficult to detect on the satellite imagery. Therefore, they were identified based on existing mapping within the RSA (*i.e.*, 1:250,000 national topographic system maps) as well as aerial surveys. Manual edits were also required to correct misclassified pixels. For example, north-facing slopes produced a low sun angle that resulted in shadows. These shadows were incorrectly classified as heath units when these areas were spruce forest units. In these cases, topographical information was used the manually edit and correct the classification.

A recent decrease of 0.2 ha in disturbance area is not shown since the original ELC units were more conservative

Impact areas in the RSA for the ELC and biodiversity sections are based on the disturbance footprint from September 2001. Subsequent (October/November 2001) changes to the location and size of the esker quarry located south of the main development area are not reflected in the calculations. The disturbance area reported in the EA for the RSA is 643.2 ha. The total disturbance area based on the updated footprint is 643.0 ha, a decrease of 0.2 ha. The RSA-related figures in the terrestrial section delineate the most recent development footprint; however, a recalculation of the impact area based on the updated footprint was deemed to be unnecessary since the total disturbance area has decreased. Therefore, the assessments in the following sections have been completed based on a slightly more conservative estimate of the total disturbance area.

Local study area also uses mapping and aerial photographs

The LSA mapping is based upon satellite imagery and interpretation of 1:9,000 scale, colour, aerial photographs. Polygons were classified and delineated into the same ELC units that were used for the RSA.

10.3.1.4.3 Biodiversity

Biodiversity is measured and described at the landscape and ecosystem level

The baseline biodiversity assessment measures and describes ELC units at a landscape and ecosystem level. Due to the complexity of the study areas and software limitations, the 17 ELC units that were identified in the RSA and LSA were grouped into broader, more general, classes that resulted in the ten ELC types that were used for this biodiversity assessment. Table 10.3-1 shows how ELC units were grouped into the final ten classes.

Table 10.3-1 Ecological Land Classification Units for Biodiversity Assessment

ELC Units	Grouped ELC Units
Bedrock	bedrock/boulder/heath
Boulder	bedrock/boulder/heath
Heath/bedrock	bedrock/boulder/heath
Heath/boulder	bedrock/boulder/heath
Heath tundra	heath tundra
Esker complex	esker complex
Open spruce forest	spruce forest
Closed spruce forest	spruce forest
Mixedwood deciduous forest	mixedwood deciduous
Birch seep	birch seep/riparian areas
Riparian tall shrub	birch seep/riparian areas
Tussock-hummock	tussock-hummock/sedge wetland
Sedge wetland	tussock-hummock/sedge wetland
Deep water	water
Shallow water	water
Burn	burn
Disturbed	disturbed

At the landscape level, a coarse filter approach was used

At the landscape level, a coarse filter approach was applied to determine baseline configuration and composition of ELC units in the RSA and LSA. Across a landscape, numerous small patches of vegetation are interspersed among larger patches of boulder fields, bedrock outcrops, and eskers. Collectively these patches of vegetated and terrain features comprise the landscape. The patterns that they form on the landscape are referred to as the landscape's configuration.

Configuration indices were used to measure landscape patterns

Configuration indices were used to measure patterns in the landscape. For example, class area was used to determine the total area of each patch type. For the purposes of this assessment, patch type is the ELC unit (*e.g.*, spruce forest is a patch type; heath tundra is a different patch type). In addition to class area, the total amount of human disturbance area and undisturbed area was also measured. This provides an estimate of current disturbance across a landscape. Number of patches for each ELC unit was also measured. For example, the total number of sedge wetlands in a landscape could be 100 whereas the total number of bedrock outcrops could be 20. This information coupled with mean patch size, or the average size of a patch type, for example would allow for additional interpretations. For example, if the mean patch size of the 100 sedge wetlands was 1 ha and the mean patch size of the bedrock outcrops was 1,000 ha, then it could interpreted that small isolated patches of sedge wetlands are interspersed among large patches of bedrock. The average distance between patches, referred to as mean nearest neighbour, provides information on how widespread these patches are in the landscape. For example, if the mean nearest neighbour for the sedge wetland was 10 m, then it can be assumed that those sedge wetlands are clustered together in one area and not widespread across the landscape.

Evenness measures the distribution of units across the landscape

The last index, evenness, collectively measures the distribution or proportions of ELC units across a landscape, which is referred to as the composition of a landscape. A low evenness value would indicate that only a few ELC units are dominant in the landscape and that the remaining ELC units represent only a small proportion of the landscape. A high evenness value would indicate that all ELC units are evenly distributed across the landscape and are not dominated by one or two ELC units. Collectively, these indices describe the configuration and composition of ELC units across a landscape. Table 10.3-2 provides a list of the five indices used to describe landscape level biodiversity.

Table 10.3-2 Landscape Level Biodiversity Indices

Landscape Measurements	Description/Definition	Type of Analysis	Study Area	Units	Patch Types Used in Analysis
Class area (CA)	area of each patch type	configuration	RSA/ LSA	hectares	natural vs. disturbed areas; ELC units
Disturbance area (DA)	area of disturbance	configuration	RSA/ LSA	hectares	natural vs. disturbed areas; ELC units
Total number of patches (NP)	number of patches in a landscape	configuration	RSA/ LSA	number	natural vs. disturbed areas; ELC units
Mean patch size (MPS)	average area of each patch type in a landscape	configuration	RSA/ LSA	hectares	natural vs. disturbed areas; ELC units
Mean nearest neighbour (MNN)	mean of the shortest distance between each patch and each adjacent patch of the same type	configuration	LSA	metres	ELC units
Patch richness (PR)	number of patches in each ELC unit	composition	RSA/ LSA	none	ELC units
Shannon's evenness (SHEI)	distribution of patch types	composition	RSA/ LSA	none	ELC units

Note: Modified from McGarigal and Marks (1995) and Franklin and Dickson (1999).

ELC = land classification.

Fragmentation examines the changes in landscape patterns as a result of natural or human disturbances

Fragmentation is another method of describing biodiversity and understanding the effects of natural or human disturbances. For example, under baseline conditions, the indices described above provide a description of how patches occur or are distributed across a landscape. If a development such as a road or mine were to be constructed on that landscape then the same indices can be used to determine how that landscape has changed. For example, a road that dissects a landscape could result in a few patches of sedge wetlands, for example, being increased into several smaller patches. In addition, a road may create a barrier between two patches of sedge wetlands, which could result in an increased distance between sedge wetlands (mean nearest neighbour). Fragmentation is a useful measure to understand how developments may fragment wildlife habitat. For example, if esker complexes are used as wildlife corridors, then a road that dissects that corridor could potentially disrupt wildlife movement until the disturbance is removed or wildlife begin to tolerate the disturbance. For the purposes of this assessment, only human disturbances are assessed.

Units are ranked as having a high, moderate, and low biodiversity potential

At the ecosystem level, a fine filter approach was applied whereby each ELC unit was ranked as having a high, moderate, or low potential to support biodiversity. Table 10.3-3 provides a summary of the information collected to rank each ELC unit into biodiversity potentials.

Table 10.3-3 Ecosystem Level Ranking for Biodiversity Potential

Ecological Land Class	Mean Cover (%)	Mean Number of Communities (%)	Mean Plant Richness	Mean Plant Diversity	Biodiversity Rank [a]
Bedrock	16	2	10	2.1	L
Boulder	5	2	4	3.2	L
Heath/bedrock	56	3	15	4.5	M
Heath/boulder	26	2	15	5.3	M
Heath tundra	70	4	20	5.8	H
Esker complex	10-64	5	25	6.7	H
Open spruce forest	41	2	12	6.2	M
Closed spruce forest	65	4	17	5.9	M
Mixedwood deciduous forest	63	6	28	6.8	H
Birch seep	40	3	13	4.8	M
Riparian tall shrub	75	5	26	6.8	H
Tussock-hummock	85	2	22	5.1	H
Sedge wetland	80	2	23	6.9	H
Deep water	1	1	1	N/A [b]	L
Shallow water	5	1	1	4.2	L
Burn	85		6	3.2	M
Disturbed	N/A	N/A	N/A	N/A	L
Unclassified	N/A	N/A	N/A	N/A	L

[a] H = high; M = moderate; L = low.

[b] N/A = no information was collected in these units but it is assumed that the values are low. Winter and summer scenarios.

Characteristics selected to rank biodiversity potential

At the ecosystem level, ELC units were ranked as having a high, moderate, and low biodiversity potential based on the following characteristics:

- vegetation percent cover;
- mean number of plant communities (as a percentage) within each ELC unit;
- mean plant species richness; and,
- mean plant species diversity.

Percent cover was estimated from the amount of vegetation cover in each unit

Vegetation percent cover was estimated based on the amount of the surface area that is covered by vegetation in each ELC unit. Sedge wetlands, for example, had a mean vegetation cover of 80%.

The total number of plant communities is the total number of communities present in each unit

The total number of plant communities is the total number of communities present in each ELC unit and was estimated based on field observation. For example, the heath tundra unit supports a mean of four different community types that include tall shrub, low shrub, forbs, and sedge/graminoid communities, whereas the bedrock unit only supports low shrub and forb communities.

Species richness is the total number of plant species

Plant species richness is expressed as the total number of plant species recorded in each ELC unit based on data collected from field surveys.

Plant species diversity is a measure of the distribution of plants

Plant species diversity or evenness is a measure of the distribution of plants within an ELC unit. Shannon evenness index was used to calculate diversity or evenness. A high value indicates that plant percent covers are in similar proportions whereas as a low value indicates that plant percent covers are disproportionately represented in the ELC unit.

A 1,000 m footprint was assumed for all access roads

The baseline description of biodiversity must identify all disturbance features including access roads. An area of 500 m on either side of access roads or 1,000 metres in total width was considered to be the disturbance footprint.

The biodiversity assessment includes both a winter and summer scenario

The winter access road and the esker access road will only result in an effect on biodiversity (*i.e.*, fragmentation) during the winter months. The roads are not accessible during the summer months since the majority of the roads occur over frozen water (*i.e.*, lakes). Therefore, during the summer months these roads do not contribute to the fragmentation of the landscape. Impacts from the Snap Lake Diamond Project on baseline landscape and ecosystem biodiversity were assessed for both the winter and summer months. The winter scenario includes the access roads while the summer scenario does not.

10.3.1.5 Ecological Land Classification

Eighteen ecological land classification units were identified in the regional study area

Eighteen distinct ELC units were identified from the Landsat™ imagery of the RSA. Table 10.3-4 provides a summary of the areas for each ELC within the RSA, as well as the percentage of the total area occupied by each ELC unit.

Table 10.3-4 Ecological Land Classification Units within the Study Areas

ELC Units	RSA		LSA	
	ha	%	ha	%
Bedrock	99.3	<0.1	0	0
Boulder	1,991.9	0.7	0	0
Heath/bedrock	716.6	0.2	0	0
Heath/boulder	137,530.4	45.6	784.5	54.7
Heath tundra	8,743.4	2.9	2.0	0.1
Esker complex	552.0	0.2	0	0
Open spruce forest	18,169.8	6.0	69.3	4.8
Closed spruce forest	1,520.2	0.5	0	0
Mixedwood deciduous forest	0.4	<0.1	0	0
Birch seep	2,661.6	0.9	6.2	0.4
Riparian tall shrub	0.2	<0.1	0	0
Tussock-hummock	15,011.8	5.0	108.3	7.5
Sedge wetland	7,240.0	2.4	21.2	1.5
Deep water	107,229.7	35.5	443.5	30.9
Shallow water	201.9	0.1	0	0
Burn	47.6	<0.1	0	0
Disturbed	172.1	0.1	0	0
Unclassified	0.2	<0.1	0	0
Total	***301,889.1***	***100.0***	***1,435.3***	***100.0***

Seven units were identified in the local study area

The ELC units used for the LSA correspond to those identified in the RSA. Only seven of the ELC units identified in the RSA were identified in the LSA. Table 10.3-4 also includes the ELC units found in the LSA. The following provides a brief description of each ELC unit found in the RSA or in the RSA and LSA, based on the field investigation.

Bedrock ecological land classification unit is comprised of less than 20% vegetation cover

The bedrock ELC unit consists of exposed bedrock that supports less than 20% vegetative cover. These areas are generally wind swept and moisture free due to excessive run-off. The vascular plants that do occur colonize cracks and crevices where there is some soil and moisture accumulation. The dominant vascular plants include bog billberry, bearberry, lingonberry, crowberry, and scattered occurrences of saxifrage. Early non-vascular colonizers such as crustose lichens are common, but coverage is highly variable and favours protected areas such as crevices and depressions where growth can be initiated. The bedrock ELC unit represents <0.1% (99 ha) of the RSA. The bedrock ELC unit is restricted to the northeast section of the RSA (Figure 10.3-1). In the LSA, bedrock >80% was not observed (Table 10.3-4 and Figure 10.3-2).

Boulder fields are comprised of 80% boulders often with lichens but very few vascular plants

Boulder fields exist in the study area. They occur as boulder outcrops, and boulder streams and drainages, as well as glacial erratics. This ELC unit supports very little vascular plant growth (*i.e.,* <20%). Boulders, however, support a variety of rock lichens that include crustose lichens such as rocktripe, orange rock lichen, green map lichen, and green starburst lichen. This ELC unit represents 0.7% (1,991.9 ha) of the RSA, but it is not present in the LSA.

Heath/bedrock consists of 30% to 80% bedrock interspersed with scattered vegetation cover

Heath/bedrock occurs where heath tundra thins and bedrock outcrops are exposed. Vegetation is discontinuous and is best described as isolated patches of open mats of heath tundra interspersed with bedrock. Moisture ranges from mesic (moderate) to xeric (dry). Tall shrub species include bog birch and green alder that occur in prominent depressions where there is sufficient amount of soil for rooting. Low shrubs are composed of bog billberry, bearberry, lingonberry, dwarf labrador tea, and crowberry. Lichen consists of rock tripe and map lichen with reindeer lichens being less prevalent. The heath/bedrock ELC represents 0.2% (716.6 ha) of the RSA. In the RSA, this ELC unit is scattered in small isolated patches. The heath/bedrock ELC unit does not occur in the LSA (Table 10.3-6).

Health/boulder consists of 30% to 80% boulder interspersed with scattered vegetation cover

Heath with boulder fields is also an open mat plant community that transitions between boulder fields. Differences in lichen composition and cover on boulders and bedrock outcrops also contribute to the identification of these separate classes. The vegetation cover is composed of complexes of shrubs, forbs, grasses, and lichens. Tall shrubs observed include willows, green alder, dwarf birch, and swamp birch. Low shrubs consist of a combination of bog billberry, net-veined willow, bearberry, lingonberry, bog rosemary, and dwarf Labrador tea. Forb species are not pervasive within this class; however, some of the species observed include false asphodel, saxifrage, and Arctic harebell. In the low-lying areas within this class, there is enough moisture and soil accumulation to support small sedge wetlands that are composed of sedges and cotton grasses. More information on large sedge wetlands is provided below. The heath/boulder ELC unit represents 45.6% (137,530.4 ha) of the RSA and 54.7% (784.5 ha) of the LSA.

Heath tundra is a closed mat that is comprised of low shrub, cottongrasses, and sedges with less than 30% rock

The ELC unit of heath tundra is a closed mat plant community that grows on moderate to well drained soils, covering most of the upland areas. Plants generally belong to the heath or Ericacea family of plants. The vegetation layer forms a mat of low shrubs dominated by dwarf birch and Labrador tea. Other common plant species include lingonberry, blueberry, crowberry, alpine milkvetch, and alpine azalea. Herb and moss layers are not well developed. Typical lichens include several species of *Cetraria*, *Cladina*, *Cladonia*, and others. As a closed mat community, vegetation covers at least 70% of the surface area. The heath tundra ELC represents 2.9% (8,743.4 ha) of the RSA and 0.1% (2.0 ha) of the LSA.

The crests of eskers support sparse vegetation cover due to increased wind exposure

The crests of eskers are wind-swept and therefore accumulate very little snow during the winter. Vegetation is sparse, composed of plants such as three-toothed saxifrage, moss campion, sandwort, blueberry, crowberry, lingonberry, bearberry, and alpine azalea. Vegetation generally grows in low mats to prevent wind abrasion. Sand and gravel is generally loose, and ground moisture is low.

Esker slopes support several different plant communities

Esker slopes support several different plant communities depending on their exposure to wind and snow. Leeward slopes support bands of dwarf birch that may reach heights of 1 m. Willow is also present with an understory of ericaceous shrubs including blueberry, Labrador tea, lingonberry, and crowberry. Grasses, fireweed, and other species are also common. Snowbed communities, which tend to occur on south-facing slopes, support plants such as bog laurel, mountain heather, and least willow, where soil moisture is available for much of the growing season. Esker slopes exposed to the prevailing winds develop low heath communities with some dwarf birch.

Eskers occupy 552 ha in the regional study area

The esker complex ELC unit represents 0.2% (552.0 ha) of the RSA. The esker complex ELC is not present in the LSA.

Open spruce forest is comprised of stunted black spruce and jack pine with a canopy closure of <30%

Open black spruce stands have a canopy closure of <30%. Shrub lichens occupy the forest floor with exposed bedrock. Soils accumulate in the cracks and crevasses of the bedrock, which serve as a root zone for shrub species such as Labrador tea. The open spruce forest ELC represents 6.0% (18,169.8 ha) of the RSA and 4.8% (69.3 ha) of the LSA.

Closed spruce forest with a canopy closure >30% have a higher accumulation of organic soils

Closed black spruce stands are associated with a higher accumulation of organic soils. The increased soil depths allows for a more moisture-rich habitat, which allows for a denser cover of spruce. The canopy cover is generally >30%. Sphagnum mosses occur on the forest floor. The understory consists of grass and forbs such as cloudberry with scattered patches of Labrador tea. The closed spruce forest ELC unit represents 0.5% (1,520.2 ha) of the RSA, and is not present in the LSA.

Mixedwood deciduous forest is comprised of birch and spruce with a shrub understory

The mixedwood deciduous forest was observed in a small isolated area adjacent to a lake in the eastern portion of the RSA. The mixedwood forest is comprised of 8-10 m tall birch trees. The understory is comprised of Labrador tea, black current, and gooseberry. The forbs consist of common wintergreen, violet, and saxifrage. Fragrant shield fern (*Dryopteris fragrans*), a rare plant, was also observed. The mixedwood deciduous forest ELC unit represents <0.1% (0.4 ha) of the RSA.

Birch seep occurs where there is water seepage

The birch seep ELC unit occurs in areas of active water seepage through boulder fields and boulder streams. Bog birch is the dominant vegetation, which commonly reaches a height of 1 m. Diamond-leafed willow is also present in smaller amounts. Bluejoint and water sedge are common plant species occurring in the understory along with crowberry, Labrador tea, and mosses. The birch seep ELC unit represents 0.9% (2,661.6 ha) of the RSA and 0.4% (6.2 ha) of the LSA.

Riparian tall shrub comprised of willows and alders is associated with drainage systems

The riparian tall shrub unit occurs adjacent to active stream courses, usually with a boulder substrate. Riparian tall shrub appears as linear plant associations of birch, willow, and alder. Tall shrubs such as diamond-leafed willow and green alder can reach heights up to 4 m. Black spruce may also be associated with this community, particularly in some southern parts of the study area. Understory plant species include dwarf raspberry, dwarf marsh violet, cloudberry, grasses, sedges, club mosses, and common horsetail. The riparian tall shrub ELC unit represents <0.1% (0.2 ha) of the RSA.

Tussock-hummocks occur on water saturated soils that overlie permafrost

The tussock-hummock unit occurs on water saturated soils that overlie permafrost. These sites, however, are drier and less frequently flooded than sedge wetlands. Tussocks produce mounds or hummocks of 0.4 m to 1 m in diameter that form on older mounds. Troughs form between hummocks. Hummocks are invaded by bog rosemary, cloud berry, Labrador tea, blueberry, and lingonberry. Dwarf birch often establishes on the older hummocks. Sphagnum, sedges, and cotton grasses typically occur in the troughs between hummocks. The tussock-hummock ELC unit represents 5.0% (15,011.8 ha) of the RSA and 7.5% (108.3 ha) of the LSA.

Sedge wetlands occur in association with open water

Wetland complexes that consist of open water, sedge meadow, and other sedge associations have been classified as sedge wetlands, which represent this non-tussock unit. Sedge species (*e.g.*, *Carex aquatilis*, and *C. bigelowii*) and cotton grass (*e.g.*, *Eriophorum angustifolium*) are the dominant vegetation types. Plant species occupy wet sites where standing water is present throughout much of the growing season. The substrate is usually organic or silty soils. The sedge wetland ELC unit represents 2.4% (7,240.0 ha) of the RSA and 1.5% (21.2 ha) of the LSA.

Shallow water is defined as a water body that does not exceed 2 m in depth

Shallow water is defined as a water body that does not exceed 2 m in depth. This ELC unit supports submergent and emergent plant species. This is caused by light reflecting off the bottom of the water body. Turbid water also has the same effect. The shallow water ELC unit represents 0.1% (201.9 ha) of the RSA, and does not occur in the LSA.

Deep water includes all lakes and rivers that exceed 2 m in depth

Deep, clear lakes and major river systems characterize the deep water unit of a water body. In general, these water bodies have water depths greater than 2 m. The deep water ELC represents 35.5% (107,229.7 ha) of the RSA and 30.9% (443.5 ha) of the LSA.

Burn unit occurs as an isolated patch within a primarily tussock-hummock unit

A prevalent burn area was identified in the field and on the satellite imagery. The burn area occurs within a primarily tussock-hummock area. Plant species regenerating in this area include cottongrasses, sedges, cloudberry, and rosemary. Dwarf birch and other woody shrubs are conspicuously absent within the burn area. This burn ELC unit represents <0.1% (47.6 ha) of the RSA, and does not extend into the LSA.

The disturbed units include all human development

The disturbed units include all human development. In the RSA, existing developments include one fishing lodge, and a winter access road. Disturbed units comprise 172.1 ha or 0.1% of the RSA. Disturbances associated with the Snap Lake Diamond Project in the LSA are considered to be impact areas and are assessed in the impact sections of the EA.

Unclassified units include pixels that could not be assigned

Pixels that could not be successfully assigned to one of the above ELC units are considered to be unclassified. The unclassified unit comprises 0.2 ha or <1% in the RSA. There were no unclassified units in the LSA.

10.3.1.6 Rare and Traditional Plant Potentials

One rare plant was observed in the study area

During the field surveys conducted for the Snap Lake Diamond Project, one rare plant was reported. A single observance of fragrant shield fern was observed in a mixedwood deciduous forest in the east central portion of the RSA beyond predicted development (*i.e.*, away from winter access roads).

Rare and traditional plant potential were selected as valued ecosystem components

The VECs selected for the ELC and Biodiversity component are representative of public, traditional, and scientific values. The VECs selected include rare plant potential and traditional plant potential, which rank ELC units as having a high, moderate or low potential to support rare or traditional plants. A potential was assigned to each ELC unit since it was not possible to search and locate rare and traditional plants throughout the entire LSA and RSA.

A rare plant potential was assigned to each ecological land classification unit within the local and regional study areas based on field observations and literature review

A rare plant potential was assigned to each ELC unit within the LSA and RSA based on field observations and literature review. Those ELC units in which rare plants were observed were given higher ratings than those without. In addition, those ELC units that are characteristic rare plant habitat, but were not inhabited by rare plants were assigned higher ratings than those units that are not typical rare plant habitat. Consequently, all habitat types identified were assigned rare habitat potentials ranging from "low potential" to "high potential". Table 10.3-5 provides the rare plant potentials for the ELC units in the LSA and RSA.

Table 10.3-5 Rare and Traditional Plant Potential Rating for the Study Areas

Ecological Land Classification Unit	Rare Plant Potential	Traditional Plant Potential
Bedrock	low	low
Boulder	low	low
Heath/bedrock	moderate	moderate
Heath/boulder	moderate	moderate
Heath tundra	moderate	moderate
Esker complex	moderate	high
Open spruce forest	high	high
Closed spruce forest	high	high
Mixedwood deciduous forest	high	high
Birch seep	high	high
Riparian tall shrub	high	high
Tussock-hummock	high	low
Sedge wetland	high	low
Deep water	low	low
Shallow water	low	moderate
Burn	high	low
Unclassified	low	low

Traditional plants identified by Lutsel K'e elders

A preliminary study on the traditional ecological knowledge at Gahcho Kué was conducted in 1999 (Lutsel K'e Dene First Nation 1999). In this study, Lutsel K'e Dene elders identified key plant species that were of traditional importance. Table 10.3-6 outlines these species and their respective uses, where available.

Table 10.3-6 Traditional Plants in the Study Areas

Common Name	Species Name	Traditional Use
Black berries	***	food
Cranberries	*Viburnum spp*	food
Bearberries	*Arctostaphylos uva-ursi*	food
Blueberries	*Vaccinium*	food
Cloudberries	*Rubus chamaemorus*	food
Whiskey jack eye	***	food
Blistered rock tripe	*Umbilicaria hyperborea*	food
Labrador tea	*Ledum spp*	medicinal
Red pixie cup	*Cladonia borealis*	medicinal
Juniper berries	*Juniperus spp*	medicinal
Crowberries	*Empetrum nigrum*	medicinal
Spiny wood fern	*Dryopteris expansa*	medicinal
Lingonberry	*Vaccinium vitus-idea*	medicinal
Sphagnum	*Sphagnum spp*	diapers, smoking meat
Old black spruce	*Picea mariana*	firewood
Spruce tree roots	*Picea spp*	thread
Bog birch	*Betula glandulosa*	firewood
Beaked willow	*Salix bebbiana*	firewood
Green alder	*Alnus crispa*	cooking
Turf moss	***	n/a
Northern bog laurel	*Kalmia polifolia*	n/a
Spray paint lichen	*Icmadophila ericetorum*	n/a
Leather leaf	*Chamaedaphne calyculata*	n/a

Source: Lutsel K'e Dene First Nation 1999.

Review of vegetation data collected assigned rare plant potentials

A review of vegetation plot data indicated that these species occurred in specific ELC units. ELC units that had more that five of these plant species recorded were assigned a high traditional plant potential; ELC units with two to five species recorded were assigned a moderate potential; and, if only one species was recorded, then a low potential was assigned (Table 10.3-5).

10.3.1.7 Biodiversity

Biodiversity is assessed at the landscape and ecosystem levels

Biodiversity is assessed at two different levels or scales of resolution. At the landscape level, a coarse filter approach was undertaken to describe patterns of ELC unit patches across the landscape. At the ecosystem level, a fine filter approach was used to understand impacts to ELC units that were assigned a high, moderate, and low biodiversity potential. This biodiversity potential is a measure of how unique the ELC units are in terms of community richness, species richness, and species evenness.

10.3.1.7.1 Landscape Level Biodiversity

Landscape level biodiversity differs between winter and summer due to access roads in the winter

Landscape level biodiversity differs between the winter and summer due to the use of access roads in the winter. As such, the description of baseline biodiversity includes both a winter and a summer scenario. Although the differences between scenarios have been calculated for all ELC units, they do not necessarily represent functional changes in biodiversity due to the surficial nature of winter roads. For example, a winter road located on the ice does not alter the biodiversity of the aquatic plants located in deep water under the ice. Table 10.3-7 provides a summary of the landscape configuration indices for the winter and summer scenarios.

Table 10.3-7 Landscape Level Biodiversity in the Regional Study Area

ELC Units	Winter			Summer		
	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)
Heath/bedrock/ boulder	459	305	125	456	308	125
Heath tundra	497	18	490	497	18	490
Esker complex	38	14	2,501	38	14	2,484
Open/closed spruce forest	762	26	357	759	26	356
Mixedwood deciduous forest	1	<1	0	1	<1	0
Birch seep/tall riparian shrub	170	16	698	170	16	698
Tussock-hummock/ sedge wetland	5,460	4	146	5,443	4	146
Deep/shallow water	1,014	102	211	994	108	210
Burn	1	<1	0	1	<1	0
Disturbed	1	<1	0	1	<1	0

Heath/bedrock/ boulder patches indicate that they are large and widespread throughout the regional study area

The heath/bedrock/boulder unit type is comprised of 459 patches across the landscape in the winter scenario and 456 patches in the summer. Again the increase in patch number in the winter is attributed to the winter access road. The average size (*i.e.*, mean patch size) of the heath/bedrock/boulder unit is much larger than the tussock-hummock/sedge wetland unit, which indicates that there are larger rock patches across the landscape (RSA). Patch size is slightly smaller in winter than in summer, which is attributed to the winter access road. The distance between these large patches of heath/bedrock/ boulder is 305 m in winter and 125 m in summer. The number, size and distances between the number of patches for heath/bedrock/boulder indicate that they are large and widespread throughout the RSA.

Esker complexes occur in small patches that are relatively far apart

The esker complex has 38 patches in both winter and summer. The average patch size (*i.e.*, mean patch size) is 14 ha and the average distance between eskers range from 2,501 m in the winter and 2,484 m in the summer. These landscape measures indicate that esker complexes occur in small patches that are relatively far apart. This is consistent with esker complexes, given that they are sinuous ridges formed as glacial rivers.

Heath tundra class is relatively widespread in small isolated patches in the regional study area

In both winter and summer, the heath tundra unit consists of 497 patches in the RSA. The mean patch size range is 18 ha and the average distance between patches is 490 m. In the RSA, it can be assumed that the heath tundra class is relatively widespread in small isolated patches in the RSA.

Spruce forests are widespread throughout the regional study area and occur in relatively small patches

The forested ELC unit, which includes open and closed spruce forest ELC units, has 762 patches in winter and 759 patches in summer. The mean patch size is relatively small (26 ha) and the average distance between patches is 357 ha in winter and 356 ha in summer. This indicates that the spruce forests are relatively widespread throughout the RSA and occur in relatively small patches.

The mixedwood forest, burn and disturbed units consist of only one patch in the regional study area

The mixedwood forest, burn and disturbed units consist of only one patch in the RSA. It should be noted that the winter access roads were considered in the disturbance unit for this assessment, but the one fishing lodge (MacKay Lake Lodge) in the RSA was not considered for this assessment.

Birch seep/ riparian tall shrub occur in small scattered patches across the regional study area

The birch seep/riparian tall shrub wetland unit type is comprised of 170 patches in both winter and summer. The average size is 16 ha and the distance between patches is 698 m in winter and summer. According to the landscape indices, birch seep/riparian tall shrub units occur in small, scattered patches across the RSA, which is consistent with the fact that these units are associated with drainage features.

Tussock-hummock/sedge wetland patches are clustered together in one small area and are not widespread throughout the regional study area

The tussock-hummock/sedge wetland unit type has the largest number of patches (5,443 and 5,460) for both the summer and winter scenarios, respectively. An increase in the number of tussock-hummock/sedge wetland patches occurs in the winter as a result of the winter road, which fragments the summer patches into more patches in the winter. The mean patch size of the tussock-hummock/sedge wetland is 4 ha and that does not change between the summer and winter scenarios. The mean nearest neighbour, which is a measure of the average distance between patches, is 146 m for both the summer and winter scenarios. This relatively small distance between patches suggests that the patches are clustered together in one small area and are not widespread throughout the landscape (*i.e.*, the RSA).

The deep/shallow water unit has relatively large patches that are scattered throughout the regional study area

Deep/shallow water unit is comprised of 1,014 patches in the winter and 994 patches in the summer, which is attributed to the winter road that travels over frozen lakes. The mean patch size ranges from 102 ha in winter and 108 ha in summer. The mean or average patch distance is 211 m in winter and 210 m in summer. As mentioned earlier, these changes may not represent functional differences to the shallow and deep water communities located under the ice. The deep/shallow water unit consists of relatively large patches that are scattered throughout the RSA.

Some ecological land classification units dominate the regional study area disproportionately

Landscape level composition indices indicate that the total number of ELC units in the RSA is ten and that evenness, which is an expression of the relative proportion of units in the RSA, is 0.65 (winter) and 0.63 (summer). The evenness suggests that some ELC units such as tussock-hummock/sedge wetlands are dominant in the RSA whereas other ELC units such as mixedwood forest are limited to one patch in the RSA.

Six ecological land classification units occur in the local study area

Table 10.3-8 provides a summary of landscape level indices for each ELC unit in the LSA. Only the summer scenario was assessed in the LSA. There are six ELC units that occur in the LSA.

Table 10.3-8 Landscape Level Biodiversity in the Local Study Area

ELC Units	Summer		
	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)
Heath/bedrock/boulder	9	87	122
Heath tundra	1	2	0
Open/closed spruce forest	5	14	120
Birch seep/tall riparian shrub	1	6	0
Tussock-hummock/sedge wetland	38	3	168
Deep/shallow water	5	89	256

Landscape indices are described for ecological land classification units that occur in the local study area

The heath/bedrock/boulder unit consists of nine patches with a mean patch size of 87 ha and an average distance of 122 m between patches. There is one patch each of heath tundra unit and birch seep/tall riparian shrub unit in the LSA. The forest unit consists of five patches that average 14 ha in size with a mean distance between patches of 120 m, which indicates that the unit occurs as small, isolated patches that are scattered throughout the LSA. The tussock-hummock/sedge wetland unit consists of 38 patches that are an average size of 3 ha with an average distance between patches of 168 m, indicating that this unit exists as small patches that are quite distant from one another in the LSA. The deep/shallow water unit consists of five patches that average 89 ha in size with a mean distance between patches of 256 m.

10.3.1.7.2 Ecosystem Level Biodiversity

Biodiversity potential is based on community richness, species richness, and species evenness

Table 10.3-9 provides a summary of ecosystem level biodiversity. A summary of the information collected to rank each ELC unit into biodiversity potential was provided earlier (Table 10.3-3). The potentials are assigned based on community richness, species richness, and species evenness, which were based on data that were collected in the field. ELC units assigned a high potential to support biodiversity support a relatively high community and species richness; species recorded in ELC units assigned a high potential were evenly distributed. It is assumed that ELC units that are ranked as having a high potential to support biodiversity are capable of supporting a relatively large number of species and could be considered more sensitive than other ELC units that are ranked as supporting low biodiversity.

Table 10.3-9 Ecosystem Level Biodiversity in the Study Areas

Biodiversity Potential[a]	Regional Study Area		Local Study Area	
	(ha)	%	(ha)	%
High	31,547.8	10	129.5	9
Moderate	160,646.2	53	862.3	60
Low	109,695.1	37	443.5	31
Total	**301,889.1**	**100**	**1435.3**	**100**

[a] Table 10.3-3 lists the biodiversity potential assigned to each ELC unit.

In the regional study area, 10%, 53%, and 37% of units support high, moderate, and low biodiversity, respectively

In the RSA, units classified as having a high potential to support biodiversity comprise 9% (31,547.8 ha). ELC units classified as having moderate potential to support biodiversity comprise 53% (160,646.2 ha) and ELC units ranked as supporting low biodiversity comprise 37% (109,695.1 ha) of the RSA.

In the local study area, 9%, 60%, and 31% of units support high, moderate, and low biodiversity, respectively

In the LSA, units classified as having a high potential to support biodiversity comprise 9% (129.5 ha). ELC units classified as having moderate potential to support biodiversity comprise 60% (862 ha) of the LSA and ELC units ranked as supporting low biodiversity comprise 31% (443.5 ha) of the LSA.

10.3.2 Impact Assessment

10.3.2.1 Introduction

Terms of Reference identify issues that must be addressed in this impact assessment

According to the Terms of Reference issued for the Snap Lake Diamond Project, the environmental assessment report must analyze potential project effects on the following:

- local plant communities (*i.e.*, classified as vegetation cover types);
- rare or highly valued species;
- long-term, direct and indirect, habitat loss or alteration;
- vegetation productivity;
- effects of air quality changes and climate on biological receptors such as vegetation and wildlife; and,
- effects of treated sewage flows to associated wetlands and downstream waters.

Loss of productivity included

Loss of vegetation productivity will be addressed as direct loss of ELC units and indirect losses through effects on plant health. Effects of air quality on vegetation will also be addressed in this section; wildlife concerns are addressed in Section 10.4.

10.3.2.1.1 Key Questions

Four key questions were developed based upon issues identified through the Terms of Reference, public consultation, traditional knowledge, and project description

Four key questions were developed to address issues identified in the Terms of Reference for the Snap Lake Diamond Project as well as information gathered through public consultation, traditional knowledge, and the project description. The four key questions developed for this assessment are the following:

Key Question ELC-1: What direct impacts will the Snap Lake Diamond Project have on ecological land classification units?

Key Question ELC-2: What direct impacts will the Snap Lake Diamond Project have on biodiversity?

Key Question ELC-3: What indirect impacts will air emissions from the Snap Lake Diamond Project have on vegetation (ELC unit) health?

Key Question ELC-4: What indirect impacts will water releases from the Snap Lake Diamond Project have on vegetation (ELC unit) health?

Direct impacts from construction and operation activities will result in the loss or alteration of units

Direct impacts associated with construction and operation of the Snap Lake Diamond Project will result in direct losses or alteration to ELC units in the LSA and RSA, which will be quantified in the impact assessment. Specifically, this key question will analyze the impact on local plant communities (*i.e.*, ELC units), and rare and highly valued species (*i.e*., rare and traditional plant potential).

Long-term (far future) direct habitat loss or alteration will be quantified

The impact assessment will also provide predictions on ELC units that will be reclaimed following closure. These predictions are referred to as the far future scenario. The impact assessment will describe the long-term direct habitat loss or alteration by quantifying the change in ELC units between baseline and the predicted far future scenario.

Potential impacts on landscape and ecosystem level biodiversity, including fragmentation are assessed

Biodiversity is closely related to the resilience of a community; therefore, it is included in the impact assessment, although biodiversity is not specified in the Terms of Reference for the Snap Lake Diamond Project. Direct impacts on ELC units may result in the alteration of biodiversity, including fragmentation, in the LSA and RSA. The impact assessment will quantify and describe the change in biodiversity between baseline and the predicted far future scenario (*i.e.*, post-closure).

Project related air emissions might result in indirect changes to the quality or health of ecological land classification units

Changes in air quality and climate associated with the Snap Lake Diamond Project may result in indirect impacts on vegetation, expressed as ELC units. The quality or health of ELC units includes changes in plant species composition, richness, plant vigor, plant productivity and/or plant tissue health. Potential impacts from air emissions are on a regional scale (*i.e.*, RSA) due to the predicted aerial extent of air emissions. Specifically, potential impacts from potential acid input (PAI) and road dust will be assessed.

Potential acid input was modelled to assess potential effects on ecological land classification units

The PAI was modelled for the Snap Lake Diamond Project and the results are presented in the Air Quality component (Section 7.3). The application case assesses the PAI contribution of the Snap Lake Diamond Project when the project is operating at maximum capacity. ELC units are ecological receptors that may be indirectly altered or lost due to PAI. The predicted PAI isopleth is superimposed onto ELC units to quantify and describe impacts.

Dust was identified as an issue through traditional knowledge

All Aboriginal communities identified a concern regarding the possible effects of dust related to underground and surface mining activities on vegetation.

> *They should try to keep that mine dust underground. All that dust that comes out of the mine holes, it can kill plants. The caribou and foxes eat that stuff and they get sick (PC 11 07 01)* (Lutsel K'e Dene First Nation 2001).

> *Grizzly bears, wolves, foxes and ravens depend on the caribou as much as people for survival; they too are likely to be negatively affected by loss of vegetation from dust or other contamination from mining* (Weledeh Yellowknives Dene 1997).

> *Well, it can't be good for them I'm sure, but I don't know how they react to it (dust). If it did something to the …. (caribou), but they would seek out better forage, they're highly specialized in picking out what is good feed, if they loose an area, then it could be important to them in terms of their survival and migration. If they came to a spot that was dusty, what would they do? I don't know, would they still eat it or would they keep on moving to try to find a better spot? It can't be good for them* (Adrian D'hont, North Slave Métis Alliance, N.D.).

The aerial extent of dust was modelled to determine potential impacts on ecological land classification units

Dust from activities on the active mine site and hauling on the winter access roads is addressed. Roads, which will be constructed as part of the mine development, will result in adjacent ELC units being exposed to road dust. The effects of road dust on plant communities and plant health have been documented in other regions. Specifically, dust has been documented (as described later) to affect plant health, in terms of species composition, plant vigor, plant productivity, and plant tissue quality. The predicted aerial extent of road dust has been modelled and impacts to ELC units will be quantified and described.

Water releases might result in indirect changes

The impacts from potential water releases or changes in natural surface water flow (*e.g.*, runoff) associated with the Snap Lake Diamond Project may result in indirect impacts on vegetation, expressed as ELC units.

Treated sewage will not be discharged to wetlands in response to concerns identified by Elders

The EA Terms of Reference for this project requires an assessment of the potential impacts associated with treated sewage flows to associated wetlands and downstream waters. Initially, treated sewage was going to be directed to a nearby wetland as an additional level of treatment (see also Section 2.7). Based on concerns for the wetland identified by the Lutsel K'e Elders (Lutsel K'e Dene First Nation 2001), effluent from the sewage treatment plant will be combined with effluent from the water treatment plant and discharged to Snap Lake, as described in the Project Description (Section 3.6). Since sewage flows will not affect wetlands, this point in the Terms of Reference will not be addressed further. Treated sewage impacts to Snap lake will be addressed in the water quality impact assessment (Section 9.4.2).

10.3.2.1.2 Linkage Diagram

Linkage diagrams show pathways considered for assessing ecological land classification and biodiversity and linkages to other related resources

The linkage diagram (Figure 10.3-3) shows the four linkages (*i.e.*, site clearing and surface disturbance, reclamation activities, change to hydrology and water quality, and changes to air quality) that are necessary to address the four key questions. In addition, the linkage diagram shows the other five related resources (*i.e.*, resource use, wildlife habitat, conservation and reclamation plan, human and wildlife health, and geology and terrain) that will use information from the ELC and biodiversity assessment to undertake those respective assessments.

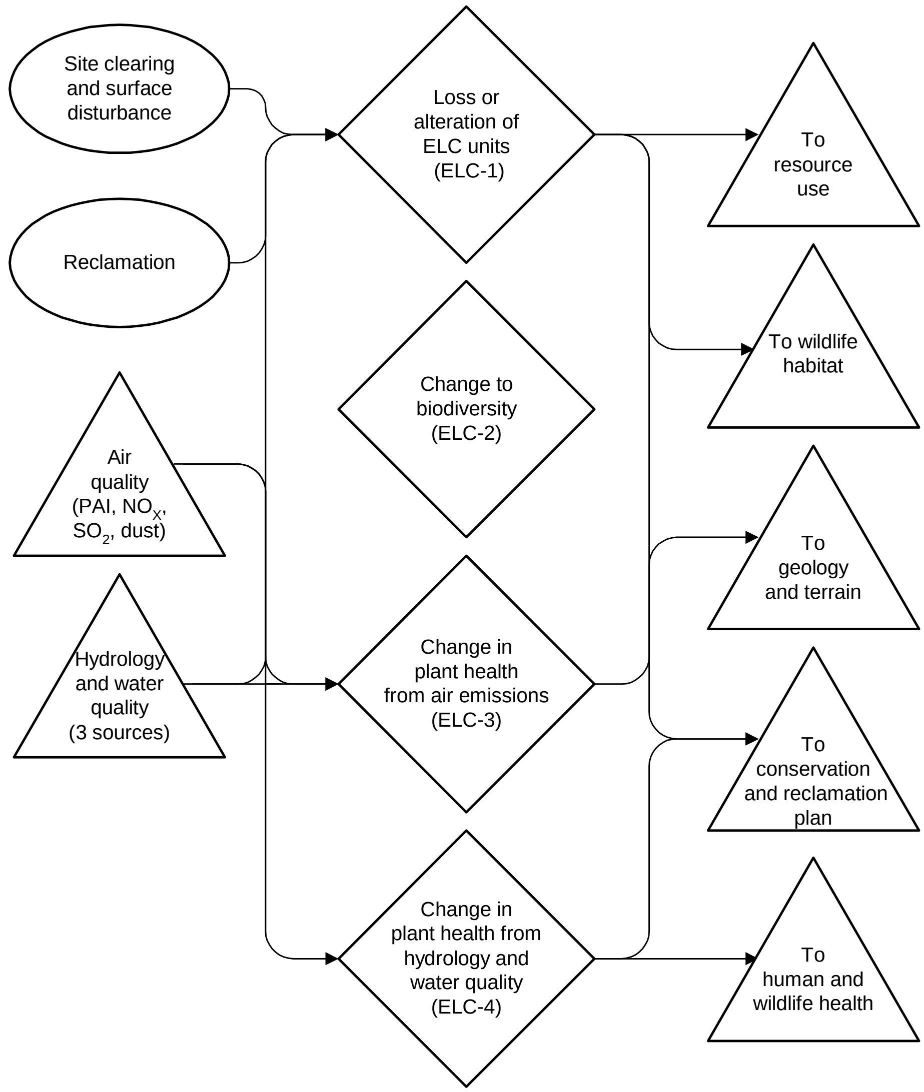
10.3.2.1.3 Assessment Method

Assessment method involves six steps that lead to the assessment, classification, and monitoring of impacts

The assessment method undertaken included the following steps:

- define regional and local study areas;
- select valued ecosystem components (VECs);
- collect baseline information relevant to the key questions and linkage diagrams;
- map and quantify ELC units and biodiversity in the LSA and RSA under baseline conditions;
- map and quantify ELC units and biodiversity affected through both direct (*e.g.*, site clearing and site disturbance) and indirect (*e.g.*, changes in air emissions and water releases) impacts associated with the Snap Lake Diamond Project;
- determine and describe appropriate activities that will mitigate impacts;
- classify all residual impacts; and,
- provide recommendations on monitoring programs to assess potential long-term effects from the project.

Figure 10.3-3 Ecological Land Classification Linkage Diagram



Local and regional study areas provide a geographical boundary

Local and regional study areas have been developed to establish a geographical boundary to assess impacts. As discussed in Section 10.3.1.2, local and regional study areas were selected and defined to assess impacts of this project on ELC units and biodiversity.

Valued ecosystem components were selected to focus the assessment

VECs selected are representative of public, traditional, and scientific values. The VECs selected comprise rare plant potential and traditional plant potential, which rank ELC units as having a high, moderate, or low potential to support rare or traditional plants. The potential impacts of the Snap Lake Diamond Project are assessed on changes to these two VECs and ELC units.

Baseline data were collected in the field to describe current conditions in the study areas

To effectively address each of the key questions and VECs, it was necessary to acquire baseline information that describes the current conditions in the LSA and RSA. Data collected in the field to map and describe baseline ELC units and biodiversity in the LSA and RSA are provided in Section 10.3.1.4 of the baseline.

Baseline ecological land classification units and biodiversity are mapped, quantified and assessed

A geographical information system (GIS) was used to calculate the relative abundance of ELC units and biodiversity indices within the LSA and RSA. The methods used to define baseline ELC units is provided in Section 10.3.1.4 of this report.

The impact assessment compares baseline conditions to conditions that are expected to result from the Snap Lake Diamond Project

By superimposing the Snap Lake Diamond Project mine footprint over the existing ELC polygons, the area of each ELC unit affected, either directly or indirectly, was quantified, described, and assessed. In addition, predicted ELC units at closure have been superimposed on the baseline map to predict ELC units that will re-establish following closure. The impact assessment is completed by comparing baseline conditions in the LSA and RSA with conditions that are expected to result following closure of the Snap Lake Diamond Project, which is referred to as the far future.

Mitigation measures were developed and described for each key question

Mitigation measures were developed to reduce impacts; these measures are described for each key question. For example, losses to ELC units and biodiversity will be mitigated with appropriate reclamation practices, which will result in the re-establishment of some ELC units within the study areas. The impacts remaining following mitigation are referred to as residual impacts.

Impact classification system is used to rank and describe impacts on residual effects

Residual impacts are described and ranked by an impact classification system that incorporates the direction, magnitude, geographic extent, duration, reversibility, and frequency of the impact. Definitions of these impact classification terms are provided in Section 10.1.5.1. Ecological resilience is not assessed as part of the ELC and biodiversity assessment since there is considerable, ongoing debate on the subject with respect to vegetation communities, ELC units, and biodiversity. This is further discussed in Section 10.1.5.1.

Monitoring programs are described, where deemed appropriate, to reduce potential long-term impacts

Monitoring programs are described, where deemed appropriate, to reduce potential long-term impacts. Moreover, monitoring programs are established to ensure that appropriate mitigation is undertaken to reduce any further impacts. It is expected that information gathered through monitoring programs that begin during the operation phase will provide information on which mitigation measures are successful. Monitoring will also determine if mitigation measures need to be altered to achieve reclamation goals.

10.3.2.2 Key Question ELC-1: What Direct Impacts Will the Snap Lake Diamond Project Have on Ecological Land Classification Units?

10.3.2.2.1 Linkage Analysis

Most direct impacts are due to site clearing and disturbance

Project related developments occur within a mine footprint that is situated within the LSA (Figure 10.3-2). The majority (*i.e.*, 559.5 ha or 39%) of direct impacts on ELC units in the LSA will result from site clearing and site disturbances, which are necessary to construct and provide operational facilities for the Snap Lake Diamond Project. The Project Description (Section 3), contains an overall site plan (Figure 3.1-4) and a facilities site plan (Figure 3.3-1) showing all infrastructure within the footprint.

Site clearing and disturbance in the regional study area is due to access roads

In the RSA, there will be an additional 83.7 ha of disturbance although 53.1 ha (63%) of this disturbance is over deep water. This area will be used for an access road into the mine from the Tibbitt-Contwoyto winter road and an access road to the esker used as a source of granular material.

Loss of the mine footprint area is assumed for determining losses to ecological land classification units

The mine footprint encompasses all mine-related development areas (Figure 10.3-2). Although the mine footprint is larger than the combined development areas defined for this project, the total area of ELC units in this footprint was assumed to be lost or altered. This is a conservative estimate, which assumes a maximum area of direct impacts on ELC units. Detailed information on the specific areas calculated for individual mine-related developments is provided in the Decommissioning and Reclamation Plan (Appendix III.11).

Site clearing and disturbance is the only linkage considered for this key question

The only linkage (Figure 10.3-3) that will result in direct impacts (*i.e.*, loss or alteration) to ELC units is site clearing and site disturbances. This linkage is valid and will be assessed. All other linkages are considered indirect disturbances and will be assessed as part of other key questions.

10.3.2.2.2 Mitigation

Mitigation measures will be adopted to ensure the re-establishment of some ecological land classification units

Mitigation measures will be undertaken to allow ELC resources to re-establish to pre-development capability. A detailed discussion of closure planning mitigation options is provided in the Decommissioning and Reclamation Plan (Appendix III.11). The following specific mitigation measures are proposed to reduce and/or eliminate disturbances to ELC resources from site clearing in the Snap Lake Diamond Project area:

- avoiding, or reducing, impacts to ELC units during project planning by re-using previously disturbed areas, where possible;
- avoiding, or reducing, impacts to rare species;
- re-contouring closure landforms and placing reclamation materials to ensure that the final topography and site conditions are similar to other ELC units of the same type in the region;
- establishing suitable habitat for plant species to invade and re-establish; and,
- using adaptive management approaches to ensure that advances in reclamation research are included in final closure planning efforts.

Applying appropriate mitigation will allow ecological land classification resources to return to pre-development capability

The objective of reclamation is to return the developed area to a condition of "equivalent capability". Applying appropriate mitigation methods and allowing for adaptive reclamation management will allow those ELC resources to return to pre-development capability.

10.3.2.2.3 Impact Analysis

Impact analysis assessed is from direct removal or alteration of ecological land classification units during construction and operation

Losses or alteration of ELC units and VECs are primarily due to site clearing and site disturbance during the construction and operation phases of the Snap Lake Diamond Project. The majority of mine related disturbances are restricted to the LSA; however, there will be 83.7 ha of additional site disturbance in the RSA related to winter access roads. Therefore, the following provides an impact analysis of direct impacts on ELC units and VECs in both the LSA and RSA.

Direct Losses/Alterations from Site Clearing

Approximately 560 ha of land disturbance will result in the loss or alteration of ecological land classification units in the local study area

Table 10.3-10 shows the areas of each ELC unit that will be lost or altered in the LSA during the construction and operation phases of the project. A total of 559.5 or 39.0% of ELC units are predicted to be lost or altered in the LSA. There are seven ELC units that occur in the LSA. There will be permanent or temporary losses of six of the ELC units. Specifically, there will be permanent or temporary alterations to 414.6 ha heath/boulder, 44.5 ha of open spruce forest, 5.1 ha of the birch seep, 53.9 ha of tussock-hummock, 8.9 ha of sedge wetland and 32.5 ha of deep water. The heath tundra unit, although present in the LSA, is not predicted to be disturbed by project activities.

Table 10.3-10 Direct Losses or Alterations of Existing Ecological Land Classification Units in the Local Study Area

ELC	Baseline (ha)	Baseline %[a]	Loss/Alteration Due to Snap Lake Diamond Project (ha)	Loss/Alteration %[b]	Far Future (ha)	Change from Baseline ELC Unit (%)[c]
Heath/boulder	784.8	54.7	414.6	52.8	892.1	+13.8
Heath tundra	2.0	0.1	0.0	0.0	2.0	0
Open spruce forest	69.3	4.8	44.5	64.2	24.8	-64.2
Birch seep	6.2	0.4	5.1	82.8	6.2	0
Tussock-hummock	108.3	7.5	53.9	49.8	54.4	-49.8
Sedge wetland	21.2	1.5	8.9	42.1	12.3	-42.0
Deep water	443.5	30.9	32.5	7.3	442.5	-0.2
Total LSA	**1,435.3**	**100.0**	**559.5**	**39.0**	**1,435.3**	**0**

[a] % of total LSA baseline area.
[b] % of baseline area of ELC unit.
[c] % change from baseline area of the ELC unit in the far future.

The heath/boulder and birch seep units will be re-established following closure

Following closure, it is expected that the heath boulder unit will re-establish on the north pile landform. Moreover, portions of other ELC units, open spruce forest, sedge wetland, tussock-hummock, and open water that currently exist under the north pile will also be reclaimed to the heath boulder unit. This will result in a net increase in the heath/boulder unit of 7.7% in the far future. Birch seeps, which form on the sheltered slopes, are expected to re-establish around the north pile and therefore, there should be no net decrease in this unit in the far future.

Majority of the deep water unit will not be permanently altered

The majority (107,228.7 ha) of the deep water will not be permanently altered, with the exception of one small (IL1) lake that is situated under the north pile. As such, the change in open water is expected to decrease by 0.1% in the far future.

Adaptive management approach will examine the possibility of re-establishing sedge wetlands and open spruce forests

Sedge wetlands and open spruce forests, which occur in small isolated pockets or patches in the LSA, are not predicted to be re-established in the far future. These units may re-establish over time if suitable habitat conditions such as low-lying drainage areas or sheltered areas that have sufficient soils and moisture regimes are re-constructed. However, it is difficult to predict a time frame or locations where these units might re-establish.

Reclamation will be an ongoing process using monitoring results and successful approaches from other locations

The Snap Lake Diamond Project will initiate a reclamation monitoring program throughout the operation and decommissioning phases of the project to incorporate new mitigation that may provide more landform options. Moreover, De Beer's will develop an adaptive management approach to reclamation which will incorporate new research and reclamation approaches that have been developed as part of other mine operations in the region. As such, the reclamation of this project is considered to be an iterative and ongoing process.

There will be an additional increase of 83.7 ha of disturbance in the regional study area

Table 10.3-11 provides a summary of areas predicted to be lost or altered in the RSA. There are 172.1 ha of existing disturbance in the RSA that includes the existing Tibbitt-Contwoyto winter road. There will be an additional 83.7 ha of disturbance to ELC units. The total loss or alteration of 643.2 ha (Table 10.3-10) consists of 559.5 ha of the project footprint (in the LSA) plus 83.7 ha of direct disturbance in the RSA beyond the LSA. The Tibbitt-Contwoyto winter road located in the RSA will affect the same ELC units identified in the LSA, as well as the heath tundra and esker units.

Table 10.3-11 Direct Losses or Alterations of Existing Ecological Land Classification Units in the Regional Study Area

ELC	Baseline		Loss/Alteration Due to Snap Lake Diamond Project		Far Future	Change from Baseline ELC Unit (%)[c]
	(ha)	%[a]	(ha)	%[b]	(ha)	
Bedrock	99.3	<0.1	0.0	0.0	99.3	0
Boulder	1,991.9	0.7	0.0	0.0	1,991.9	0
Heath/bedrock	716.6	0.2	0.0	0.0	716.6	0
Heath/boulder	137,530.4	45.6	433.6	0.3	137,648	+0.1
Heath tundra	8,743.4	2.9	0.2	<0.1	8,743.4	0
Esker complex	552.0	0.2	0.5	0.1	551.5	-0.1
Open spruce forest	18,169.8	6.0	47.8	0.3	18,122.0	-0.3
Closed spruce forest	1,520.2	0.5	0.0	0.0	1,520.2	0
Mixedwood deciduous forest	0.4	<0.1	0.0	0.0	0.4	0
Birch seep	2,661.6	0.9	5.9	0.2	2,661.6	0
Riparian tall shrub	0.2	<0.1	0.0	0.0	0.2	0
Tussock-hummock	15,011.8	5.0	57.1	0.4	14,954.7	-0.4
Sedge wetland	7,240.0	2.4	12.4	0.2	7,227.6	-0.2
Deep water	107,229.7	35.5	85.6	0.1	107,229.7	0
Shallow water	201.9	0.1	0.0	0.0	201.9	0
Burn	47.6	<0.1	0.0	0.0	47.6	0
Disturbed	172.1	0.1	0.0	0.0	172.1	0
Unclassified	0.2	<0.1	0.0	0.0	0.2	0
Total RSA	**301,889.1**	**100.0**	**643.2**	**0.2**	**301,889.1**	**0**

[a] % of total RSA baseline area.
[b] % of baseline area of ELC unit.
[c] % change from baseline area of the ELC unit in the far future.

Temporary alteration of some ecological land classification units will result from construction and operation of the access road

Increases in disturbance to heath/boulder, open spruce forests, birch seeps, tussock-hummock, sedge wetlands, and deep water are predicted to be only a temporary alteration since the winter access roads will not permanently remove landforms. As such, it is predicted these ELC units will re-establish after road activity is halted.

Materials will be extracted from the esker, which will be recontoured at closure

In addition, there will be 0.5 ha of disturbance to an esker complex unit, which is situated outside the LSA but within the RSA. Materials will be extracted from the esker for project use. The predicted impacts on the esker unit will result in a net loss of 0.1 ha in the RSA in the far future. Eskers will be re-contoured following closure so it is predicted that vegetation will re-establish in the long-term. In addition, there will be approximately 0.2 ha of disturbance to the heath tundra unit. It is expected that the heath tundra unit will be restored once construction and alteration of the access road is completed.

Rare and traditional plant potentials are assessed

In addition to affects on the above ELC units, impacts to rare plant potential and traditional plant potential are also assessed. Table 10.3-12 and Table 10.3-13 outline the baseline and predicted disturbance areas for combined ELC units that are ranked as having a high, moderate, and low potential to support rare plants in the LSA and RSA, respectively. Those ELC units in which rare plants were observed were given higher ratings than those without. In addition, those ELC units that are characteristic rare plant habitat, but were not inhabited by rare plants were assigned higher ratings than those units that are not typical rare plant habitat. Consequently, all habitat types identified were assigned rare habitat potentials ranging from "low potential" to "high potential". Methods for assigning rare plant potential are provided in the baseline (Section 10.3.1). Table 10.3-5 lists the rare and traditional plant potential ratings of each ELC unit.

In the local study area, high rare plant potential will decrease and moderate rare plant potential will increase

In the LSA, the Snap Lake Diamond Project will alter 112.4 ha (54.9%) of the high rare plant potential, 414.6 ha (52.7%) of the moderate rare plant potential and 32.5 ha (7.3%) of the low rare plant potential areas during construction and operation (Table 10.3-12). Following closure, there will be an overall reduction of 52.3% in ELC units that are ranked as having a high rare plant potential in the LSA. ELC units ranked as having a moderate potential to support rare plants will result in a net increase of 13.6%, which is attributed the creation of the health/boulder unit following closure. ELC units ranked as having a low potential to support rare plants (*i.e.*, deep water) will remain the same.

High rare plant potential in the regional study area will increase and moderate rare plant potential will decrease

Table 10.3-13 outlines the loss of high, moderate, and low rare plant habitat within the RSA. Following closure, there will be a net decrease, expressed as a change of -0.3%, in ELC units ranked as having a high potential to support rare plants. ELC units ranked as having a moderate potential to support rare plants will increase by a factor of <0.1% and there will be no change in the low rare plant potential.

Table 10.3-12 Direct Losses or Alterations of Rare and Traditional Plant Potentials in the Local Study Area

	Baseline		Loss/Alteration Due to Snap Lake Diamond Project		Far Future (ha)	Change from Baseline ELC unit (%) [c]
	ha	% [a]	ha	% [b]		
Rare Plant Potential						
High	205.0	14.3	112.4	54.8	97.7	-52.3
Moderate	786.9	54.8	414.6	52.7	894.1	+13.6
Low	443.5	30.9	32.5	7.3	443.5	-<0.1
Total LSA	**1,435.3**	**100.0**	**559.5**	**39.0**	**1453.3**	**0**
Traditional Plant Potential						
High	75.5	5.3	49.6	65.7	31.0	-58.9
Moderate	786.8	54.8	414.6	52.7	895.1	+13.8
Low	573.0	39.9	95.3	16.6	509.2	-11.1
Total LSA	**1,435.3**	**100.0**	**559.5**	**39.0**	**1435.3**	**0**

[a] % of total LSA baseline area.
[b] % of baseline area of ELC unit.
[c] % change from baseline area of the ELC unit in the far future.

Table 10.3-13 Direct Losses or Alterations of Rare and Traditional Plant Potential in the Regional Study Area

	Baseline		Loss/Alteration Due to Snap Lake Diamond Project		Far Future (ha)	Change from Baseline ELC Unit (%) [c]
	ha	% [a]	ha	% [b]		
Rare Plant Potential						
High	44,651.6	14.8	123.3	0.3	44,534.3	-0.3
Moderate	147,542.5	48.9	434.3	0.3	147,659.5	<+0.1
Low	109,695.1	36.3	85.6	<0.1	109,695.3	0
Total RSA	**301,889.1**	**100.0**	**643.2**	**0.2**	**301,889.1**	**0**
Traditional Plant Potential						
High	22,904.2	7.6	54.2	0.2	22,855.9	-0.2
Moderate	147,192.3	48.8	433.9	0.3	147,310.1	+0.1
Low	131,792.6	43.6	155.1	0.1	131,723.1	-0.1
TOTAL RSA	**301,889.1**	**100.0**	**643.2**	**0.2**	**301,889.1**	**0**

[a] % of total RSA baseline area.
[b] % of baseline area of ELC unit.
[c] % change from baseline area of the ELC unit in the far future.

Traditional potential assessed in the local and regional study areas

Traditional plants are assessed based upon the traditional plant potential of an ELC unit. Each ELC unit present in the LSA and RSA has been assigned a traditional plant potential (Table 10.3-5). Tables 10.3-12 and 10.3-13 outline the impacts to the traditional plant potential within the LSA and RSA, respectively, as a result of the Snap Lake Diamond Project.

Moderate traditional plant potential will increase but high and low traditional plant potential will decrease

The Snap Lake Diamond Project will alter 49.6 ha of the high traditional plant potential and 414.6 ha of the moderate traditional plant potential in the LSA. The Snap Lake Diamond Project will alter 95.3 ha of low traditional plant potential. Following closure, there will be a decrease in ELC units assigned a high traditional plant potential, expressed as a change of -58.9%, and a decrease in ELC units assigned a low traditional plant potential, expressed as a change of -11.1% within the LSA. There will however, be an increase in ELC units assigned a moderate plant potential because reclamation will establish ELC units that have been assigned a moderate potential to support traditional plants.

Impacts to traditional plant potential will be less that 1% in the regional study area

In the RSA <0.1% (54.2 ha) of the high traditional plant potential and 0.1% (433.9 ha) of the moderate traditional plant potential will be altered. The Snap Lake Diamond Project will alter 155.1 ha (<0.1%) of low traditional plant potential. Following closure, ELC units assigned as having a high traditional plant potential will decrease by 0.2% whereas ELC units assigned as having a moderate traditional plant potential will increase by 0.1%. ELC units that were assigned as having a moderate potential to support traditional plants will not change.

10.3.2.2.4 Residual Impact Classification

Eight ecological land classification units will not be directly affected by the project

Eight ELC units will not be affected by the Snap Lake Diamond Project. These eight ELC units include bedrock, boulder, heath/bedrock, closed spruce forest, mixedwood deciduous forest, riparian shrub, burn, and shallow open water ELC units. As such, there are no environmental consequences from site clearing or surface disturbance on these ELC units.

Eight ecological land classification units will be directly affected by the project

Eight ELC units in the RSA and LSA will be directly affected by site clearing and surface disturbance. Table 10.3-14 provides a summary of the residual impact classification assigned to each ELC unit including VECs (*e.g.*, rare plant potential and traditional plant potential). The ELC units that will be directly affected by the project are heath/boulder, esker complex, heath tundra, open spruce forest, birch seep, tussock-hummock, sedge wetland, and deep water. Impact to these ELC units will cause a direct loss in vegetation productivity during the operation phase. The heath/boulder unit will increase in size at closure resulting in a positive impact after the operation phase. For all units, the direct impacts are predicted to be medium-term since the activities causing the effects will not continue beyond closure (*i.e.*, 26 years). The impacts are also considered to be low in frequency since project related clearing and disturbance is expected to occur only once.

Table 10.3-14 Classification of Residual Impacts on Ecological Land Classification Units and Valued Ecosystem Components in the Regional Study Area

Component Criteria	Impact Assessment Criteria						
	Direction	**Magnitude[a]**	**Geographic Extent**	**Duration**	**Reversibility**	**Frequency**	**Environmental Consequence**
Heath/boulder	positive	negligible	local	medium-term	reversible (long-term)	low	no negative consequence
Esker complex	negative	negligible	regional	medium-term	reversible (long-term)	low	low
Heath tundra	negative	negligible	regional	medium-term	reversible (long-term)	low	low
Open spruce forest	negative	negligible	local	medium-term	irreversible	low	low
Birch seep	neutral	negligible	local	medium-term	reversible (long-term)	low	low
Tussock-hummock	negative	negligible	local	medium-term	irreversible	low	low
Sedge wetland	negative	negligible	local	medium-term	irreversible	low	low
Deep water	negative	negligible	local	medium-term	irreversible	low	low
Rare plant potential	negative	negligible	regional	medium-term	irreversible	low	moderate
Traditional plant potential	negative	negligible	regional	medium-term	reversible (long-term)	low	low

n/a = not applicable.

[a] Magnitude is based on the application of definitions in Table 10.1-3 to the losses or alterations in Tables 10.3-11 and 10.3-13.

A low environmental consequence is assigned to the esker complex, heath tundra, open spruce forest, birch seep, tussock-hummock, sedge wetland, and deep water ELC units

The residual impact classification indicates that there will be a low environmental consequence assigned to the esker complex, heath tundra, open spruce forest, birch seep, tussock-hummock, sedge wetland, and deep water ELC units. Environmental consequence is not assigned to the heath/boulder unit since the direction is positive (*i.e.*, the area of this unit will increase).

Heath tundra, heath/boulder, birch seep, and esker complex are expected to be reversible in the long-term

Impacts to heath/boulder, esker complex, heath tundra, and birch seep ELC units are expected to be reversible in the long-term since they will re-establish in the far future (100 years). There will be a permanent loss to one small lake (*i.e.*, >1 ha) in the LSA; as such, the impact to deep water is considered to be irreversible. The heath tundra unit will re-establish in the far future following road closure. When borrow materials are no longer needed, the esker will be re-contoured; vegetation communities are expected to re-establish in the far future. As such, the esker should re-establish as a viable ecosystem that will continue to function as suitable habitat for plant species as well as wildlife. From this perspective, the impact is reversible in the long-term; the loss of esker material (rather than the ELC unit) is included in Section 10.2.2.3. It is predicted that heath/boulder will re-establish on the reclaimed north pile, which will result in a net increase (*i.e.*, positive direction) of this ELC unit in the far future. Since the birch seep is predicted to re-establish along the bottom of the reclaimed north pile slopes to a similar area as baseline (Table 10.3-10), the direction is considered neutral. Directions for all other components besides heath/boulder and birch seep are negative.

The geographic extent for all ELC units except heath tundra and esker complex is local

The geographical extent of six ELC units (Table 10.3-14) is considered to be local since the majority of disturbances to these ELC units will occur in the LSA. Heath tundra will be affected by the access roads in the RSA only and not in the LSA; therefore, the geographical extent for this ELC unit is considered regional. The esker complex is also considered to be regional in geographical extent, since the disturbance extends beyond the LSA into the RSA.

Impacts to open spruce forests will have an environmental consequence of low, although the impact is considered irreversible

Impacts to open spruce forests are assigned an environmental consequence of low. Open spruce forests occur as scattered patches across the LSA and RSA. Since the majority of disturbance to open spruce forests will occur in the LSA, the geographical extent is considered to be local. The direction is negative and the magnitude is negligible since the change to open spruce forests is -0.3% in the RSA. The duration is considered to be medium-term since the activities causing impacts will not continue beyond closure. Currently, the closure plan does not specifically detail mitigation methods that will re-establish open spruce forests; however, through ongoing monitoring and reclamation initiatives that will be undertaken throughout the life of the project, spruce forests may re-establish in the far future. For the purposes of this assessment, the impacts are considered to be irreversible since there are currently no plans to re-establish open black spruce forests in the far future (Table 10.3-14).

Impacts to tussock-hummocks and sedge wetlands will have a low environmental consequence, but effects are irreversible

Tussock-hummocks and sedge wetlands are two types of wetlands that occur in the LSA and RSA. Impacts to both wetland types are classified as having a low environmental consequence. Similar to open black spruce, the closure plan does not specifically detail mitigation methods that will re-establish these wetlands in the far future. New reclamation initiatives and technologies may be developed that will allow these wetlands to re-establish. However, for the purposes of this assessment, the impacts are considered to be negative in direction, negligible in magnitude, medium-term in duration, and irreversible.

Environmental consequence of impacts to VECs is low to moderate

The two VECs identified include rare plant potential and traditional plant potential. The environmental consequence of impacts assigned to rare plant potential and traditional plant potential is classified as moderate and low, respectively.

Ecological land classification units assigned a rare plant potential of high will be lost or altered due to the project

There will be no known loss to rare plants since the rare plant identified during the field program is not located near any proposed activity. It is possible that other rare plants may be present in the LSA and RSA that were not identified. Rare plant potential examines the potential of ELC units to support rare plants. Disturbances to ELC units such as eskers, open spruce forests, tussock-hummock, and sedge wetland, which are ranked as having a high rare plant potential, represent a loss of high rare plant potential in the LSA and RSA. Thus, the loss to high rare plant potential is negative in direction and negligible in magnitude since the change is -0.3% in the RSA (Table 10.3-13). The impact extends into the RSA and is, therefore, regional in geographical extent. With ongoing reclamation initiatives it may be possible to re-establish ELC units assigned a high rare plant potential in the far future; however, for the purposes of this assessment, the impact is considered irreversible.

Ecological land classification units assigned a traditional plant potential of high will not be permanently altered by the project

Impacts to traditional plant potential is considered to have a low environmental consequence. The majority of ELC units having a high traditional plant potential will either not be disturbed or they will be reclaimed in the far future. The majority of the impacts will affect ELC units assigned as having a moderate potential to support traditional plants. Overall, the impacts are considered to be negative in direction and negligible in magnitude since the loss to ELC units assigned a high traditional plant potential is -0.2% in the RSA. The impacts will occur in both the RSA and LSA and therefore, the geographical extent is considered to be regional. Some of the ELC units ranked as having a high traditional plant potential are expected to re-establish in the far future therefore, the impact is considered to be reversible in the long term.

The probability of occurrence is high

The probability of occurrence is considered high since direct impacts on ELC units from site clearing and site disturbance are expected.

The level of confidence that ecological land classification units will re-establish in the far future is moderate

Since successful reclamation of landforms in the Snap Lake area has not been demonstrated, the level of confidence that ELC units will re-establish in the far future is moderate. It is expected that, if landforms are reclaimed with similar materials as pre-development, vegetation will re-establish.

Moreover, reclaimed landforms that have a similar slope, aspect, and moisture regime should allow for the invasion of surrounding native plant species into the far future (100 years).

Overall, the environmental consequences of direct impacts to ecological land classification units are low to moderate

The overall environmental consequences for direct impact on ELC units, including the VECs, from the Snap Lake Diamond Project are rated as low to moderate. The area planned for disturbance is small (approximately 643.2 ha over 26 years) and the progressive reclamation throughout the life of the Snap Lake Diamond Project is expected to return most ELC units to pre-development equivalent capability (Appendix III.11).

10.3.2.2.5 Monitoring

De Beers will use monitoring and adaptive management to enhance reclamation

The Snap Lake Diamond Project will initiate a decommissioning and reclamation monitoring program throughout the construction, operation, and decommissioning phases of the project. De Beer's will develop an adaptive management approach to reclamation that will incorporate the results of the monitoring program, as well as new research and reclamation approaches that have been developed as part of other mine operations in the region.

10.3.2.3 Key Question ELC-2: What Direct Impacts Will the Snap Lake Diamond Project Have on Biodiversity?

10.3.2.3.1 Linkage Analysis

Loss or alteration of ecological land classification units in the local study area and regional study area will result in changes to biodiversity

Project related developments will occur within a defined mine footprint, which is situated in the LSA. The development will result in the loss or alteration of 559.5 ha in the LSA. In addition, there will be 83.7 ha disturbed for access roads (*e.g.*, winter access road and esker access road) that are situated outside the LSA but within the RSA. Loss or disturbances to ELC units will result in changes to both local and regional biodiversity. Site clearing and disturbance, and the resulting loss or alteration to ELC units is a valid linkage; therefore, changes in biodiversity will be assessed.

10.3.2.3.2 Mitigation

Mitigation to minimize disturbance to biodiversity will be focused on re-establishing pre-development capability

Mitigation that will be undertaken to minimize disturbance to biodiversity will be focused on re-establishing ELC units to pre-development capability following closure. The same mitigation that will be undertaken to minimize impacts to ELC units will also mitigate the effects on biodiversity. Further details on mitigation measures are provided in the Decommissioning and Reclamation Plan (Appendix III.11).

10.3.2.3.3 Impact Analysis

Landscape Level Biodiversity

Biodiversity is assessed at the landscape and ecosystem scales, which are two different scales of resolution assessed in the local and regional study areas

Biodiversity is assessed at two different levels or scales of resolution. At the landscape level, a coarse filter approach is undertaken to describe patterns across the landscape. At the ecosystem level, a fine filter approach is used to understand impacts to ELC units that are assigned a high, moderate, and low biodiversity potential. This biodiversity potential is a measure of how unique the ELC units are in terms of community richness, species richness, and species evenness. Both landscape and ecosystem level biodiversity are assessed in the RSA and LSA.

Ecological land classification units were combined into 10 distinct units

For the purposes of the biodiversity assessment, ELC units were combined into 10 distinct units that are listed in Table 10.3-1. It was necessary to combine ELC units due to software constraints in undertaking the biodiversity analysis. These 10 units will be referred to as biodiversity ELC units. Further details on the rationale for combining ELC units is provided in the biodiversity methods section of the baseline (Section 10.3.1.4.3).

Number of patches, mean patch size, and mean nearest neighbour were selected to assess landscape level biodiversity

Number of patches, mean patch size, and mean nearest neighbour were selected to measure landscape level biodiversity. A patch is an individual clump of vegetation or ELC unit that is bordered by other individual ELC units. For example, lakes that are scattered across the LSA are considered patches of lakes (deep water/shallow water). A count of these patches, for example the number of lakes in the LSA, derives the number of patches. Mean patch size is the average size of all patches of a particular ELC unit. Mean nearest neighbour is the distance between patches, for example the average distance between lakes (deep water/shallow water).

Project related developments will result in changes to these landscape level biodiversity indices

Project related developments will result in changes to these landscape level biodiversity indices. For example, development of an access road may fragment larger ELC patches into smaller patches, which would result in an increase in the number of patches and perhaps a decrease in the mean patch size of an ELC unit. Moreover, an access road, for example, may also result in an increase or decrease in distance between some ELC units. Increasing the distances among ELC units may, in turn, affect wildlife habitat by increasing the distance between similar habitat units. Decreasing the distance among ELC units may result from fragmenting a large patch into many smaller patches, which would increase the proximity between patches. This could, in turn, result in a positive affect on wildlife habitat. However, a decrease in the size of patches (*i.e.*, habitat units) may result in a change in habitat use if habitat is no longer a suitable size to provide adequate shelter, food, or protection for a particular wildlife species. As such, understanding changes in landscape patterns and their potential implications to wildlife species is necessary to assess potential changes in landscape level biodiversity.

Baseline landscape level indices are compared to indices measured following the development of the project

Baseline landscape level indices were measured in both the LSA and RSA. These baseline indices will be compared to the same indices measured following the development of the Snap Lake Diamond Project. This process involves superimposing the Snap Lake Diamond Project area on the baseline ELC map and then computing the indices, which are referred to as impact indices.

Landscape level biodiversity differs between the winter and summer, due to the use of access roads in the winter

Landscape level biodiversity differs between the winter and summer months in the RSA due to the use of winter access roads. In the LSA, the access roads and other mine related disturbances would be present in both winter and summer. As such only one scenario is presented. In the RSA, however, the description of baseline and impact landscape biodiversity includes both a winter and summer scenario.

There are six biodiversity ecological land classification units that occur in the local study area

Table 10.3-15 provides a summary of baseline and impact landscape level indices for each of the six ELC units in the LSA. Table 10.3-16 provides a summary of the change, expressed as a percent change, in landscape level indices in the LSA. In general, the mean patch size in the LSA will decrease as a result of the project. The number of patches of heath/bedrock/boulder and open/closed spruce forest will increase, resulting in a decrease in the distance between patches (*i.e.*, mean nearest neighbour). The reverse will occur in tussock-hummock/sedge wetlands.

Landscape level biodiversity differs between the winter and summer, due to the use of access roads in the winter

Landscape level biodiversity differs between the winter and summer months in the RSA due to the use of winter access roads. Table 10.3-17 provides a summary of the landscape level indices in the RSA and Table 10.3-18 provides a summary of the change in landscape level indices in the RSA. This assessment includes both the mine footprint and the access roads. In general, the mean patch size in the RSA will decrease. The number of patches of heath tundra, open/closed spruce forest and deep/shallow water will increase in both the summer and winter, while the number of patches of birch seep/tall riparian shrub and tussock-hummock/sedge wetlands will decrease in both seasons. Heath/bedrock/boulder ELC units will show the greatest seasonal change.

Table 10.3-15 Landscape Level Biodiversity in the Local Study Area

ELC Units	Baseline			Impact		
	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)
Heath/bedrock/ boulder	9	87	122	20	18	98
Heath tundra	1	2	0	1	2	0
Open/closed spruce forest	5	14	120	9	3	62
Birch seep/tall riparian shrub	1	6	0	1	1	0
Tussock-hummock/sedge wetlands	38	3	168	28	2	249
Deep/shallow water	5	89	256	5	84	246
Disturbance	0	0	0	4	138	217

Table 10.3-16 Change in Landscape Level Biodiversity in the Local Study Area

ELC Units	Change		
	Number of Patches (%)	Mean Patch Size (%)	Mean Nearest Neighbour (%)
Heath/bedrock/boulder	+122.2	-79.3	-19.6
Heath tundra	0	0	0
Open/closed spruce forest	+80.0	-35.7	-48.3
Birch seep/tall riparian shrub	0	-83.36	0
Tussock-hummock/sedge wetlands	-26.3	-33.3	+48.2
Deep/shallow water	0	-5.6	-3.9

Table 10.3-17 Landscape Level Biodiversity in the Regional Study Area

ELC Units	Winter Baseline			Winter Impact			Summer Baseline			Summer Impact		
	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)	Number of Patches	Mean Patch Size (ha)	Mean Nearest Neighbour (m)
Heath/bedrock/ boulder	459	305	125	467	297	126	456	308	125	472	297	125
Heath tundra	497	18	490	499	17	488	497	18	490	499	17	488
Esker complex	38	14	2,501	38	14	2,623	38	14	2,484	38	14	2,623
Open/closed spruce forest	762	26	357	765	25	355	759	26	357	763	25	355
Mixedwood deciduous forest	1	<1	0	1	<1	0	1	<1	0		<1	0
Birch seep/tall riparian shrub	170	16	698	169	15	705	170	16	698	168	15	705
Tussock-hummock/ sedge wetlands	5,460	4	146	5,399	4	146	5,443	4	146	5,405	4	146
Deep/shallow water	1,014	102	210	1,046	97	211	994	108	210	1,042	97	211
Burn	1	<1	48	1	48	0	1	<1	0	1	48	0
Disturbed	1	<1	0	8			1	<1	0	9		

Table 10.3-18 Change in Landscape Level Biodiversity in the Regional Study Area

ELC Units	Change Winter				Change Summer		
	Number of Patches (% change)	Mean Patch Size (% change)	Mean Nearest Neighbour (% change)	Total Change (%)	Number of Patches (% change)	Mean Patch Size (% change)	Mean Nearest Neighbour (% change)
Heath/bedrock/ boulder	+1.7	-2.6	-0.8	-0.1	-3.5	-3.6	0
Heath tundra	+0.4	-5.6	-0.4	-5.6	+0.4	0	-0.4
Esker complex	0	0	+4.9	+4.9	0	0	+5.6
Open/closed spruce forest	+0.4	-3.8	-0.3	-4.0	+0.5	-3.8	-0.3
Mixedwood deciduous forest	0	0	0	0	0	0	0
Birch seep/tall riparian shrub	-0.6	-6.2	+1.0	-5.9	-1.1	-6.3	+1.0
Tussock-hummock/ sedge wetlands	-1.1	0	0	-1.1	-0.7	0	0
Deep/shallow water	+3.2	-4.9	+0.5	-1.7	+4.8	-10.2	+0.5
Burn	0	0	0	0	0	0	0

Ecosystem Level Biodiversity

Biodiversity potential is based on community and species richness, and species distribution

Table 10.3-19 provides a summary of ecosystem level biodiversity, which is expressed as high, moderate, and low biodiversity potential for the RSA and LSA. The potentials are assigned based on community richness, species richness, and species evenness, which were based on data that were collected in the field. ELC units assigned a high potential to support biodiversity support a relatively high community and species richness, and species recorded in the ELC unit were evenly distributed. Further details on methods to rank biodiversity potential are provided in Section 10.3.1.4.3. It is assumed that ELC units that are ranked as having a high potential to support biodiversity are capable of supporting a relatively large number of species and could be considered more sensitive than other ELC units that are ranked as supporting low biodiversity.

The ecological land classification units supporting low biodiversity will increase

In the LSA, units classified as having a high potential to support biodiversity will be reduced from 129.5 ha or 9% to 68.7 ha or 4.8%. ELC units classified as having moderate potential to support biodiversity will be reduced from 862.3 ha or 60% to 396.1 ha or 27.6%. ELC units ranked as supporting low biodiversity will increase from 443.5 ha or 31% to 970.5 or 67.6% of the LSA.

Table 10.3-19 Ecosystem Level Biodiversity in the Regional and Local Study Areas

Biodiversity Potential	Baseline Regional Study Area		Impact Regional Study Area		Baseline Local Study Area		Impact Local Study Area	
	(ha)	%	(ha)	%	(ha)	%	(ha)	%
High	31,547.8	10	31,477.8	10	129.5	9	68.7	4.8
Moderate	160,646.2	53	160,695.2	54	862.3	60	396.1	27.6
Low	109,695.1	37	109,695.1	36	443.5	31	970.5	67.6
Total	**301,889.1**	**100**	**301,889.1**	**100**	**1435.3**	**100**	**1,435.3**	**100**

[a] Table 10.3-3 lists the biodiversity potential assigned to each ELC class.

In the regional study area, units classified as having a high, moderate, and low potential to support biodiversity comprise 10%, 53% and 37% of the total units

In the RSA, units classified as having a high potential to support biodiversity will decrease by 70 ha (0.003%) from 31,547.8 ha to 31,477.8 ha. ELC units classified as having moderate potential to support biodiversity will increase from 160,646.2 ha or 53% to 160,695.2 ha or 54%. ELC units ranked as supporting low biodiversity will not change from 109,695.1 ha or 37% of the RSA.

10.3.2.3.4 Residual Impact Classification

Residual impacts to biodiversity as a result of the Snap Lake Diamond Project will result in a low environmental consequence for biodiversity ecological land classification units

Residual impacts on both landscape and ecosystem biodiversity are classified in Table 10.3-20. There are a total of seven biodiversity ELC units in the RSA. The mixedwood deciduous and burn ELC units are located outside the Snap Lake Diamond Project development area. Therefore, there will not be any residual effects to these ELC units. There will be landscape level residual effects on the heath/bedrock/boulder, heath tundra, esker complex, open/closed spruce forests, birch seep/tall riparian shrub, tussock-hummock/sedge wetlands, and deep/shallow water biodiversity ELC units. The residual effects are considered to be negative in direction, and low to negligible in magnitude. Since the effects on the biodiversity ELC units occur in both the LSA and RSA, the geographical extent is considered regional. The duration is medium-term since the activities that cause the impacts will not extend beyond the life of the project (*i.e.*, 26 years). The effects are considered to be reversible in the long-term (100 years) with ongoing reclamation. The frequency is low since the alteration of landscape level biodiversity indices will only occur once.

The environmental consequences assigned to the biodiversity potentials are low

The environmental consequences assigned to the biodiversity potentials are considered low since the magnitude of change in the RSA is <10% and the duration of the impact is considered medium-term.

The probability of occurrence is high and the level of uncertainty is moderate

The probability of occurrence is high since site clearing and disturbance are necessary for the development of the Snap Lake Diamond Project. The level of confidence is considered moderate due to the uncertainty associated with reclamation technology and the limited research in northern environments. However, if landforms are reclaimed to similar design criteria as pre-development landforms, then plant species are expected to invade and re-establish on these reclaimed landforms in the far future. Moreover, it is expected that the plant species will establish in patches since the final topography of the reclaimed landforms is expected to be variable with respect to moisture regime, nutrient regime, slope, and aspect.

Table 10.3-20 Classification of Residual Impacts on Biodiversity

Component Criteria	Impact Assessment Criteria						
	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Heath/bedrock/ boulder	negative	low	regional	medium-term	reversible (long-term)	low	low
Heath tundra	negative	negligible	regional	medium-term	reversible (long-term)	low	low
Esker complex	negative	low	regional	medium-term	reversible (long-term)	low	low
Open/closed spruce forest	negative	low	regional	medium-term	reversible (long-term)	low	low
Birch seep/tall riparian shrub	negative	low	regional	medium-term	reversible (long-term)	low	low
Tussock-hummock/sedge wetlands	negative	low	regional	medium-term	reversible (long-term)	low	low
Deep/shallow water	negative	low	regional	medium-term	reversible (long-term)	low	low
High biodiversity potential	negative	low	regional	medium-term	reversible (long-term)	low	low
Moderate biodiversity potential	negative	low	regional	medium-term	reversible (long-term)	low	low
Low biodiversity potential	negative	low	regional	medium-term	reversible (long-term)	low	low

10.3.2.3.5 Monitoring

Decommissioning will be monitored during operation and closure

The Snap Lake Diamond Project will initiate a decommissioning and reclamation monitoring program throughout the operation and closure phases of the project. De Beers will develop an adaptive management approach to reclamation that will incorporate the results of the monitoring program as well as new research and reclamation approaches that have been developed as part of other mine operations in the region.

10.3.2.4 Key Question ELC-3: What Indirect Impacts Will Air Emissions from the Snap Lake Diamond Project Have on Vegetation (ELC Unit) Health?

10.3.2.4.1 Linkage Analysis

Short-term and long-term effects on vegetation can occur from airborne emissions

Airborne emissions from developments can have both short- and long-term effects on vegetation vigor, health, and productivity. Short-term exposure effects are usually restricted to a localized area and can result in plant tissue damage such as chlorosis or necrosis of plant tissues. Moreover, it can also result in a decrease in plant growth rates or eventually result in plant mortality. Long-term effects can occur over a much larger area and may result from the accumulation of contaminants in plant tissues, either by direct absorption into plant tissues from the air, or indirectly through deposition into the soil and into the roots. Once incorporated in the plant tissues, the chemicals can alter internal biochemical processes and consequently can reduce plant productivity, vigor, or health. Other sources of chemicals such as dust can be adsorbed onto the surface of plant tissues, reducing respiration and reception of radiation or photosynthesis. These processes may also reduce plant vigor and productivity.

The linkage analysis includes dust, sulphur dioxide, oxides of nitrogen and potential acid input

The air emissions that could potentially affect plants include dust, measured as total suspended particulate (TSP) matter, sulphur dioxide (SO_2), and oxides of nitrogen (NO_X). Both SO_2 and NO_X are potentially acid forming. The potential acid input (PAI) to vegetation and soils is also evaluated in the linkage analysis.

SO_2 concentrations from the project are compared to federal and GNWT guidelines

The air quality evaluation for the Snap Lake Diamond Project (Section 7.3) provided estimates of the maximum 1-hour, 24-hour, and annual ground level SO_2 concentrations. These values were then compared to regulatory guidelines established by the Federal Government and the GNWT (Table 10.3-21). The federal guidelines, established to protect sensitive components of the environment including vegetation, are divided into desirable, acceptable, and tolerable levels.

SO_2 concentrations are not predicted to exceed government guidelines therefore, it is not a valid linkage

The maximum SO_2 concentrations predicted to occur in the RSA (the RSA includes the project footprint) as a result of the Snap Lake Diamond Project are 11.6 micrograms per cubic metre (µg/m^3) (annual), 129.5 µg/m^3 (24-hour maximum) and 245.0 µg/m^3 (1-hour maximum) (see also Section 7.3.3.2). These values are all less than the federal desirable levels and NWT guidelines listed in Table 10.3-21. Indirect impacts from SO_2 concentrations are not predicted to affect plant health since the concentrations do not exceed guidelines that protect plants. Therefore, this is not a valid linkage and will not be assessed further.

Table 10.3-21 SO_2 Predictions and Regulatory Guidelines for Emissions

Period	Snap Lake Diamond Project (µg/m³)	Federal Government Guidelines			NWT Guidelines (µg/m³)
		Desirable (µg/m³)	Acceptable (µg/m³)	Tolerable (µg/m³)	
Annual	11.6	30	60	n/a	30
24 hour	129.5	150	300	800	150
1 hour	245.0	450	900	n/a	450

Predicted NO_2 concentrations are compared to guidelines

The air quality evaluation for the Snap Lake Diamond Project (Section 7.3.3.3) provided estimates of the maximum 1-hour, 24-hour and annual ground level NO_2 concentrations. These values were then compared to regulatory guidelines established by the Federal Government to protect sensitive components of the environment including plants (Table 10.3-22). The federal guidelines are divided into desirable, acceptable, and tolerable levels.

Table 10.3-22 NO_2 Predictions and Regulatory Guidelines for Emissions

Period	Snap Lake Diamond Project (µg/m³)	Federal Government Guidelines		
		Desirable (µg/m³)	Acceptable (µg/m³)	Tolerable (µg/m³)
Annual	88.8	60	100	n/a
24 hour	139.7	n/a	200	300
1 hour	236.5	n/a	400	1,000

n/a = no guideline established.

NO_2 concentrations are not predicted to exceed government guidelines; therefore, the linkage is not valid

The maximum NO_2 concentrations in the region due to the operation of the Snap Lake Diamond Project are 88.8 µg/m³ (annual), 139.7 µg/m³ (24-hour maximum), and 236.5 µg/m³ (1-hour maximum) (see Section 7.3.3.3). These values are all less than the federal criteria for acceptable levels listed in Table 10.3-22. Therefore, this linkage is not valid.

The Alberta guideline for critical loads of PAI has been used

The World Health Organization (1994) has proposed PAI critical loading factors for ecosystems of varying sensitivities. Critical load is defined as the highest load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecosystems (The Target Loading Subgroup 1996). There are currently no guidelines in the GNWT for critical loads. As such, the Alberta guideline developed by the Target Loading subgroup of the Clean Air Strategic Alliance (CASA 1996) is used as a basis for comparison. Alberta is the first jurisdiction in Canada to adopt the critical loading system based on PAI. The PAI used in Alberta is the most comprehensive measure of acid deposition since it includes wet and dry deposition of both nitrogen and sulphur. Therefore, it has been used in this assessment.

The critical loads are 0.25 , 0.5, and 1.0 keq/ha/yr for soils of varying sensitivity

The Target Loading subgroup of the Clean Air Strategic Alliance (CASA) have set out critical loads of 0.25 kiloequivalents per hectare per year (keq/ha/yr) for highly sensitive soils, 0.5 keq/ha/yr for moderately sensitive soils, and 1.0 keq/ha/yr for soils with low sensitivity (CASA 1999).

PAI isopleths do not extend beyond the mine site therefore, linkage is not valid

Figure 10.3-4 shows the aerial extent of the 0.25 keq/ha/yr and 0.5 keq/ha/yr PAI isopleths predicted for the Snap Lake Diamond Project. The PAI isopleths do not extend beyond the area that will be cleared or disturbed by mine related developments. Since the project footprint is a direct impact, the loss of all ELC units within this area was assumed and the impact of this loss was assessed in Key Question 1. Due to the direct effects, there will be no ELC units to be indirectly affected by PAI in this area. Since the PAI beyond the project footprint was below the critical loading factor for the protection of sensitive ecosystems, this linkage is not valid and will not require further analysis.

Dust can adversely effect plant health

Construction and operation of the Snap Lake Diamond Project will increase the level of dust within the LSA and RSA. In particular, dust levels will increase in the vicinity of the mine footprint and adjacent to the access roads. Increased dust levels have been documented to have varying effects on plants. Forbes (1995) documented effects from road dust on such species as Labrador tea, stiff club moss, and Arctic blueberry, which occur in ELC units located in the LSA and RSA. In northern areas, Walker and Werbe (1980) and Spatt and Miller (1981) also observed effects on other vascular plant species from high exposures of road dust. Moreover, Walker and Everett (1987) found that there were losses to such non-vascular plants as lichen and moss in areas exposed to high amounts of dust-fall. Auerbach *et al*. (1997) observed changes or shifts in plant species composition and above ground biomass in areas that were exposed to elevated levels of dust. However, even though the species composition can change and the aboveground biomass is lowered due to dust deposition, the ground cover is maintained (Auerbach *et al*. 1997). Some species such as cloudberry, willow, and cottongrass were observed to be more abundant as a result of dust deposition (Forbes 1995). This increase in selective species dominance is attributed to the fact that these species have a wider range of tolerance than other plant species for elevated levels of dust. As such, competition is reduced and species that are more tolerant to these conditions can thrive.

Figure 10.3-4 PAI Isopleth for Ecological Land Classification

Dust impact is generally confined to areas immediately adjacent to the source

The deleterious effects of dust are generally confined to the immediate area adjacent to the dust source (*i.e.*, roads) (Walker and Everett 1987; Everett 1980). Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50 m buffer on either side of a road. Moreover, Meininger and Spatt (1988) found that the majority of impacts occurred within 5 to 50 m of a road, with less obvious effects observed between 50 and 500 m from the road.

Both physical and chemical effects have been observed in plants situated adjacent to sources of dust

Elevated dust levels on plants can have a variety of physiological and chemical effects. These effects include reduced water content, increased conductivity, reduced chlorophyll content, and reduced carbon uptake (Spatt and Miller 1981). Meininger and Spatt (1988) documented an alteration of the quantity and chemical composition of interstitial water, moisture being wicked from plant tissues by a dust coating and evaporative water loss in dusty leaves. However, Walker and Everett (1987) and Auerbach *et al*. (1997) found that vegetation communities on non-acidic sites were less affected by calcareous road dust than acidic communities. In the Snap Lake Diamond Project areas, the majority of ELC units occur in more acidic environments. As such, there is a potential for calcareous dust to have a more obvious effect.

Snowmelt can also be effected by elevated dust levels which may indirectly affect ecological land classification units and the quality of wildlife habitat

Studies have also been conducted to analyze the effects of dust on snowpack and snowmelt areas in Alaska. Klinger *et al*. (1983) reported increased snow depths on the downwind side of a haul road but noted that these areas were often the first to melt. Woo (1984) also observed that increased dust levels accelerated melting of relatively clean snow. Dust-related acceleration of snowmelt also accelerated plant phenology (*i.e.*, plant flowering period) in tundra communities (Forbes 1995). Potential indirect effects of early snowmelt could decrease the dormancy of plant species and accelerate early plant growth before seasonal growth conditions, including temperature and sunlight, are optimal. As such, early plant growth may not be sustainable.

The Snap Lake Diamond Project activities would result in elevated dust levels

An increase in traffic will result in an increase in the amount of dust in the Snap Lake Diamond Project areas. In addition, the operation and use of the airstrip will also contribute to an increase in dust. Mine operations will also produce dust through mine ventilation. Therefore, the linkage from dust on ELC units is valid and will be assessed in the following sections.

10.3.2.4.2 Mitigation

Underground mining under wet conditions minimizes dust

The primary factor that reduces dust at the Snap Lake Diamond Project is the use of underground mining to recover the ore. The fact that the bulk of the operations occur underground in wet conditions will ensure that dust from the drilling, blasting, ore handling, and primary crushing activities will be minimal. In addition, conveyor belts will be used during full operations to transport ore from the primary underground crushers to the processing plant. Wet processing of the kimberlite ore will result in minimal dust emissions from the ore processing located above ground.

Site mitigation will include watering and ongoing reclamation

Mitigation measures that will be undertaken on the site to reduce potential effects of dust on ELC units include regular watering of roads and the airstrip during the plant growing period and reclamation of portions of the north pile during the operation phase.

Dustfall monitoring will measure mitigation effectiveness

In addition, dustfall monitoring programs have been established and will continue during the construction and operational phases of the Snap Lake Diamond Project to determine if any other site-specific mitigation is required.

10.3.2.4.3 Impact Analysis

A 50 m buffer around the development areas used to determine potential effects of dust on ecological land classification units

Potential impacts from dust were assessed within a 50 m buffer on either side of the road. This buffer distance is used based on data documented by Meininger and Spatt (1988), Walker and Everett (1987), and Everett (1980). A conservative approach was undertaken to assess potential impacts from dust on ELC units, which included quantifying all ELC units that occurred within a 50 m buffer around the winter access roads as well as all season roads and the active mine area.

Winter access roads are included in assessment to account for the potential sources of dust

Both winter and esker access roads were included in this assessment. Haul trucks travelling on the esker access road have the potential to generate dust from their loads during winter months, although the relative contribution of these loads to the overall dust accumulation in the area is considered to be small. The winter access road has been included in this assessment, but this likely results in an over-estimate of dust potential since the traffic on this road generally transports dust-free materials. To be conservative, the winter scenario, which represents the maximum geographical extent of this impact has been undertaken to assess potential effects.

In the local study area, 116.5 ha of ecological land classification units will be exposed to dust from the Snap Lake Diamond Project

The LSA consists of the project footprint plus a 500 m buffer included specifically to allow for dust effects adjacent to the site roads, quarry and other sources. The assessment in Key Question 1 assumed that the ELC units in the project footprint would be lost due to disturbance during construction and operation and assessed this loss. Therefore this dust assessment is considering dust impacts within the remaining 500 m buffer. Within the remainder of the LSA, the total dust exposure area associated with the Snap Lake Diamond Project is 116.5 ha (Table 10.3-23). Deep water will experience the largest area of dust exposure, which accounts for 61.6 ha (52.8%). However, since this will primarily occur during the winter months when the deep water or lakes are frozen and the only potential dust source is local traffic, the impacts on this ELC unit are expected to be minimal. Other ELC units such as health boulder, open spruce forests, birch seep, tussock-hummock, and sedge wetlands will be exposed to dust (Table 10.3-23). Impacts that may result include decrease in plant growth, shift in species composition, and metal absorption by plant species in these ELC units.

Table 10.3-23 ELC Units Exposed to Dust within the 50 m Buffer of the Local Study Area

Ecological Land Class	Area and Percent in LSA	
	ha	%
Heath/boulder	36.6	31.4
Open spruce forest	11.5	9.8
Birch seep	0.9	0.8
Tussock-hummock	5.8	5.0
Sedge wetland	0.2	0.2
Deep water	61.6	52.8
Total	***116.5***	***100.0***

Approximately 431 ha of ecological land classification units are currently exposed to dust from the Tibbitt-Contwoyto winter road

There is currently some exposure to dust on ELC units in the RSA, but outside the LSA, from the Tibbitt-Contwoyto winter road, which is defined as the baseline condition. Under these baseline conditions there are 431.4 ha of ELC units that have been exposed to dust (Table 10.3-24) in the RSA. The deep water ELC unit accounts for 91.5% (394.7 ha) of this area. However, as stated in the preceding section, impacts are expected to be minimal on this ELC unit. Other ELC units are exposed to dust under the baseline condition include heath boulder, tussock-hummock, and sedge wetlands. During the field investigation, there were no obvious signs of stress on plant species; however, the field investigation was not specifically designed to thoroughly investigate this impact. A study initiated in July 2001, was undertaken to measure the level of metal accumulation in plant tissues under baseline conditions. The results of this study are presented in Environmental Health (Section 11.3.1).

Table 10.3-24 ELC Units Exposed to Dust during Baseline in the Regional Study Area

Ecological Land Class	RSA	
	ha	%
Heath/boulder	18.1	4.2
Tussock-hummock	11.1	2.6
Sedge wetland	7.5	1.7
Deep water	394.7	91.5
Total	***431.4***	***100.0***

Approximately 956 ha of ecological land classification units will have the potential to be exposed to dust as a result of the project

Table 10.3-25 outlines the ELC units that will have a potential to be exposed to dust resulting from the Snap Lake Diamond Project. Under this impact case, a total of 956.0 ha of ELC units will be affected by increased dust associated with the project. This represents an increase of 121.6% from baseline. Again, dust exposure has the largest extent on the deep water ELC unit, which will total 715.1 ha. This impact is expected to be minimal. The largest terrestrial impact will be to the heath/boulder ELC unit with a predicted exposure area of 142.5 ha. The other ELC units in the RSA that will be exposed to dust include esker complex, heath tundra, open spruce forest, birch seep, tussock-hummock, and sedge wetlands. The other ELC (*e.g.*, riparian tall shrub) units that occur in the RSA are situated outside the predicted exposure area. Although dust levels will increase in the RSA, the areas of ELC units are relatively small.

Table 10.3-25 ELC Units in the Regional Study Area Exposed to Dust from the Project

Ecological Land Class	RSA			
	ha	%	Baseline (ha)	% Increase
Boulder	0.5	0.1	0.0	n/a
Heath/boulder	142.5	14.9	18.1	686.5
Esker complex	4.8	0.5	0.0	n/a
Heath tundra	1.1	0.1	0.0	n/a
Open spruce forest	27.8	2.9	0.0	n/a
Birch seep	5.2	0.5	0.0	n/a
Tussock-hummock	34.9	3.7	11.1	215.0
Sedge wetland	24.1	2.5	7.5	220.9
Deep water	715.1	74.8	394.7	81.2
Total	***956.0***	***100.0***	***431.4***	***121.6***

Rare and traditional plant potential, VECs, will result have similar effects as ecological land classification units

Effects on rare and traditional plants potential will be similar to effects on ELC units in the LSA and RSA since the potentials are assigned to ELC units. Rare plants generally have a lower range of tolerance to changes in habitats that may result from elevated dust levels. Traditional plants occur in varying abundance in ELC units. The ranges in tolerance of these plants are more variable than rare plants. As such, with appropriate mitigation measures implemented to reduce the amount, frequency, and duration of exposure, the effects on traditional plant potential are expected to be minimal.

10.3.2.4.4 Residual Impact Classification

Overall, the environmental consequence on ecological land classification units from dust exposure is expected to be low

Table 10.3-26 provides a summary of the potential residual effects from dust exposure on the four ELC units and two VECs that will be potentially affected by road dust. Overall, the environmental consequence assigned to the heath boulder, tussock-hummock, sedge wetlands, deep water, rare plant potential, and traditional plant potential is low. This environmental consequence classification is attributed to the minimal aerial extent of dust exposure and mitigation measures (*e.g.*, road watering) that will be undertaken by the Snap Lake Diamond Project to ensure the effects from dust on ELC units are minimal. There is, however, a potential for a decline in plant health in some of the species that comprise these ELC units. As a result, the direction is classified as negative. The magnitude varies according to the ELC unit that will be intermittently exposed to road dust.

Table 10.3-26 Classification of Residual Impacts of Air Emissions on Vegetation Health

Component Criteria	Impact Assessment Criteria						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Reversibility**	**Frequency**	**Environmental Consequence**
Heath/boulder	negative	moderate	regional	medium-term	reversible (short-term)	medium	low
Tussock-hummock	negative	moderate	regional	medium-term	reversible (short-term)	medium	low
Sedge wetland	negative	moderate	regional	medium-term	reversible (short-term)	medium	low
Deep water	negative	low	regional	medium-term	reversible (short-term)	medium	low
Rare plant potential	negative	moderate	regional	medium-term	reversible (short-term)	medium	low
Traditional plant potential	negative	moderate	regional	medium-term	reversible (short-term)	medium	low

The impact magnitude assigned to deep water is low and the magnitude assigned to tussock-hummock, sedge wetlands, and heath boulder is moderate

The deep water unit, for example, does not support as many plants (*i.e.*, macrophytes) as shallow open water and, therefore, road dust exposure to deep water is considered to be low in magnitude. Tussock-hummock and sedge wetlands do support a number of plant species and, therefore, the magnitude of potential effects is considered to be moderate. In addition, the heath boulder unit supports scattered plant communities that occur where there is sufficient soil and moisture within a boulder field. As such, the magnitude is also classified as moderate, which is a conservative estimate.

A moderate environmental consequence is assigned to rare and traditional plant potential impacts

The residual impacts to rare and traditional plant potential VECs will be similar to the effects on the ELC units previously described since the potentials are assigned to ELC units. Rare plants generally have a lower range of tolerance to changes in habitats. As such, elevated dust levels may result in the decline of rare plant growth. Traditional plants occur in varying abundance in ELC units. Traditional plants will vary in their tolerance to elevated dust levels. As a result, the effects on these plants are considered to be more variable than rare plants. With appropriate mitigation implemented to reduce the amount, frequency, and duration of exposure, the effects on traditional plant potential are expected to be minimal. The environmental consequence is considered low.

The geographic extent is considered to be regional, frequency is considered medium, and effects are reversible

The geographic extent is considered to be regional for all the ELC units and VECs since the impacts extend beyond the LSA into the RSA. Road dust exposure is expected to occur intermittently during operation and closure phases (*i.e.*, 26 years) of the Snap Lake Diamond Project and, therefore, the frequency is considered medium. The potential effects on plant health is expected not to continue once the Snap Lake Diamond Project area is reclaimed and, therefore, the effects are considered reversible in the short-term.

The probability of occurrence is considered high and the level of confidence is considered low

The probability of occurrence is considered high since road dust will result from the Snap Lake Diamond Project's operation of roads and mining infrastructure. However, the level of confidence is considered low since the extent and nature of the effects of dust on Arctic plant health are continuing to be researched. In a location where plant primary productivity is already limited by a relatively short growing season, low temperatures, and low precipitation rates, predicting the recovery of plants that have been affected by dust has a high level of uncertainty. The Snap Lake Diamond Project will continue to monitor the level of road dust and potential effects on plant health to better quantify and describe all site-specific effects.

10.3.2.4.5 Monitoring

Dustfall monitoring is ongoing

De Beers has implemented a dust fall monitoring program, which began in July 2001. More information on this program is provided in the Air Section (Section 7.2).

10.3.2.5 Key Question ELC-4: What Indirect Impacts Will Water Releases from the Snap Lake Diamond Project Have on Vegetation (ELC Unit) Health?

10.3.2.5.1 Linkage Analysis

Changes in water quality or quantity can affect vegetation

Water-borne chemicals can adversely effect vegetation productivity, vigor, and health. Chemicals, once released into water systems and soils, can affect plant health and vigor once they are adsorbed onto the plant tissues. Also, changes in drainage patterns can cause fluctuations in water levels and can alter soil moisture content from baseline conditions.

Since water will be collected, contained, and treated on site, impacts to vegetation will be limited

Water will be managed on site though a network of ditches, sumps, and sedimentation ponds that will direct water to the water treatment plant. Due to the high level of water management and treatment on site, changes that could effect plant health will be limited to the following:

- minor amounts of seepage from the south berm of the water management pond and from the north pile through the active zone; and,
- disruption of natural flow patterns over portions of the northwest peninsula as a result of construction and operation activities.

Since the ecological land classification units that could potentially be affected by the small quantities of seepage can tolerate fluctuating water levels, this linkage is not valid

Seepage from the north pile will be diverted to perimeter ditches that will surround the north pile. It is possible, however, that there will be potential run-off to the low-lying ELC units (*e.g.*, birch seeps, sedge wetlands and tussock-hummocks) that surround the north pile particularly following closure. These ELC units, in particular, can tolerate fluctuating water levels and increased sediment since they naturally attenuate flooding in the watershed throughout the growing season. As such, these ELC units are not sensitive to changes in water levels. Because of the very small volumes of seepage flow and lack of sensitive ELC units at the seepage sites, no impacts of seepage are expected. Also, no impacts due to seepage from the south berm of the water management pond are expected. Since seepage from these structures is not considered to have a measurable effect on plant health and therefore, these linkages are not valid.

Disruption of natural flows is a valid linkage

Disruption of natural flow patterns over portions of the northwest peninsula as a result of construction and mining activities as well as potential run-off from the road and air strip may affect surrounding ELC units. Therefore, this linkage is considered valid.

10.3.2.5.2 Mitigation

Mitigation is described elsewhere

Mitigation measures related to water quantity and quality are described in Sections 9.3, 9.4, and 3.6.

The installation and maintenance of drainage structures (e.g., culverts) will minimize changes

Outside the containment areas, roads and the airstrip will disrupt the natural drainage patterns and intercept overland flows. However, roads will have ditches and cross drainage structures located in low-lying areas to maintain flows in the current drainages. Therefore, roads should not impact runoff volumes. Culverts will provide cross drainage and will be sized to accommodate the 1 in 100-year flood. This, along with regular inspections for accumulated debris, will ensure that ponding does not occur in ELC units that are adjacent to the road and airstrip.

On closure, drainage will be reclaimed to baseline conditions

The Decommissioning and Reclamation Plan (Appendix III.11) indicates that the closure drainage pattern will be reclaimed to pre-development condition. The mine development area will be engineered and the surface of closure landforms (*e.g.*, north pile) will be re-contoured to ensure that the closure drainage will be sustainable and provide sufficient flows to maintain surrounding low-lying ELC units.

10.3.2.5.3 Impact Analysis

Ecological land classification units that might be affected by changes in flow patterns occur primarily in low-lying areas around the mine footprint

Disruption of natural flow patterns over portions of the northwest peninsula as a result of construction activities and run-off from the roads and air strip may potentially affect surrounding ELC units. In total, runoff over an area approximately 1.27 km^2 will be directed to the water treatment plant. Runoff from the remaining 98% of the Snap Lake watershed will be unaffected.

The ecological land classification units that may be affected by runoff tolerate water level fluctuations

In the event that runoff to ELC units surrounding roads and the airstrip does occur, the ELC units potentially affected include open spruce forest, tussock-hummock, sedge wetlands, and deep water (*e.g.*, lakes), which occur in these low-lying areas. These ELC units can tolerate fluctuations in water levels since they naturally attenuate flooding events in the watershed. Plants associated with these ELC units in the LSA are generally very well adapted to changes in water levels and increased sediments.

Rare and traditional plant potential will be affected in the same way as ecological land classification units

Rare and traditional plants will respond in the same way as the ELC units since the potentials are assigned to ELC units. Rare plants generally have a lower range of tolerance to changes in habitats that may result from increased water volumes and water quality. However, appropriate mitigation will reduce ongoing exposure or permanent impacts to rare plant habitat. Traditional plants occur in varying abundance within ELC units. The ranges in tolerance of these plants are more variable than rare plants. As such, with appropriate mitigation, including a reduction in the frequency and duration of exposure, the effects on traditional plant potential will be minimal.

10.3.2.5.4 Residual Impact Classification

Overall, the environmental consequence on ecological land classification units potentially affected by water releases is considered negligible

Table 10.3-27 provides a summary of the potential residual impacts from water releases on ELC units. Overall, the environmental consequence of water releases on plant health (*i.e.*, ELC units), that include open spruce forest, birch seep, tussock-hummock, sedge wetland and deep water, is considered negligible. The direction is considered negative and the magnitude negligible since the amount of runoff and disruption of natural drainage patterns are expected to be minimal. Moreover, closure planning will ensure that pre-development drainage patterns will be reclaimed. A frequency of medium has been assigned since there may be intermittent runoff to these ELC units during the construction, operation, and closure stages of the project. The duration is classified as medium-term since potential water releases will be restricted to mine operation or the early stages of closure. Geographic extent is classified as local since the effect will be restricted to the LSA and not extend into the region. Impacts are considered reversible in the short-term since reclamation measures will be undertaken to ensure that the drainage patterns will be reclaimed to pre-development patterns.

The probability of occurrence is high

The probability of occurrence is considered high since development of the Snap Lake Diamond Project will result in changes to existing drainage patterns. Due to the mitigation and closure initiatives planned, there is a high level of confidence that residual effects on ELC units and VECs will be negligible as predicted.

Table 10.3-27 Classification of Residual Impacts of Water Releases on Plant (ELC Unit) Health

Component Criteria	Impact Assessment Criteria						
	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Environmental Consequence
Open spruce forest	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Birch seep	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Tussock-hummock	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Sedge wetland	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Deep water	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Rare plant potential	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible
Traditional plant potential	negative	negligible	local	medium-term	reversible (short-term)	medium	negligible

10.3.2.5.5 Monitoring

The Snap Lake Diamond Project will establish an ongoing monitoring and response plan

Details on monitoring programs are provided in the Hydrology and Water Quality Sections (Sections 9.3 and 9.4). Moreover, De Beers has developed an emergency response plan and a spill contingency plan that outline specific response and mitigation procedures in the event of a spill to the surrounding environment.