SECTION 11

VEGETATION

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Section 11 Abbreviations

Abbreviation	Definition
CO	carbon monoxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DAR	Developer's Assessment Report
Dominion Diamond	Dominion Diamond Ekati Corporation
e.g.	for example
Ekati Mine	Ekati Diamond Mine
ELC	Ecological Landscape Classification
ESA	effects study area
et al.	and more than one additional author
GIS	Geographic Information System
i.e.	that is
ICRP	Interim Closure and Reclamation Plan
KIA	Kitikmeot Inuit Association
LKDFN	Łutselk'e Dene First Nation
MDNN	mean distance to nearest neighbour
MVRB	Mackenzie Valley Review Board.
n/a	not applicable
NOx	nitrogen oxides
NSMA	North Slave Métis Alliance
NWT	Northwest Territories
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 microns (μm) or smaller
Project	Jay Project
RFD	Reasonably Foreseeable Development
SARA	*Species at Risk Act*
SO_2	sulphur dioxide
SO_x	sulphur oxides
SON	Subject of Note
spp.	multiple species
TG	Tłįchǫ Government
TOR	Terms of Reference
TSP	total suspended particulate
VC	valued component
WPKMP	Wastewater and Processed Kimberlite Management Plan
WROMP	Waste Rock and Ore Storage Management Plan
WRSA	waste rock storage area
YKDFN	Yellowknives Dene First Nation
PAG	potentially acid generating
H^+	hydrogen
OH	hydroxide
CO_2	carbon dioxide

Abbreviation	Definition
NMHC	non-methane hydrocarbons

Section 11 Units of Measure

Unit	Definition
%	percent
<	less than
>	greater than
cm	centimetre
$g/m^2/d$	grams per square metre per day
ha	hectare
keq/ha/yr	kiloequivalents per hectare per year
km	kilometre
km^2	square kilometres
m	metre
$\mu g/m^3$	micrograms per cubic metre

11 VEGETATION

11.1 Introduction

11.1.1 Background

The existing Dominion Diamond Ekati Corporation (Dominion Diamond) Ekati Diamond Mine (Ekati Mine) and its surrounding claim block are located approximately 300 kilometres (km) northeast of Yellowknife in the Northwest Territories (NWT) (Map 11.1-1). Dominion Diamond proposes to develop the Jay Project (Project), which includes associated mining and transportation infrastructure, to add 10 or more years of operating life to the existing Ekati Mine. The majority of the facilities required to support and process the kimberlite currently exist at the Ekati Mine, including:

- Misery Pit mining infrastructure (e.g., fuel facility, explosives magazines);
- primary roads and transportation infrastructure (e.g., Ekati Mine airstrip, Misery Haul Road);
- Ekati Mine main camp and supporting infrastructure;
- Ekati Mine processing plant; and,
- fine processed kimberlite management facilities.

The Jay kimberlite pipe (Jay pipe) is located beneath Lac du Sauvage in the southeastern portion of the Ekati Mine property approximately 25 km from the main facilities and approximately 7 km to the northeast of the Misery Pit. A horseshoe shaped dike will be constructed to isolate the portion of Lac du Sauvage overlying the Jay kimberlite pipe. The isolated portion will be dewatered to allow for open-pit mining of the kimberlite pipe. The Project will also require an access road, pipelines, and power lines to the Jay Pit from the Misery Pit.

11.1.2 Purpose and Scope

This section of the Developer's Assessment Report (DAR) for the Project addresses the Subject of Note (SON): Impacts to Vegetation from Project Components identified in the Terms of Reference (TOR) issued by the Mackenzie Valley Review Board (MVRB) in July 2014. The entire TOR document is included in Appendix 1A, and the complete Table of Concordance for the DAR is in Appendix 1D.

The purpose of this section is to meet the TOR issued by the MVRB (Appendix 1A), and specifically, to assess the effects the Project may have on vegetation, soils, and eskers as identified in the TOR. Eskers are important habitat for some species of wildlife; therefore, effects on eskers are also forwarded to Sections 12 and 13. Project effects on soils, which influence vegetation, are assessed in Appendix 11A; relevant soils information from the appendix is summarized in this section.

LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY

150 0 150

SCALE 1:6,000,000 KILOMETRES

REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATION OF THE JAY PROJECT

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_001_GIS	
DESIGN	JF	21/08/14	SCALE AS SHOWN	REV. 0
GIS	LMR	07/10/14		
CHECK	JF	07/10/14		
REVIEW	CD	07/10/14		

MAP 11.1-1

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\13-1328-0041 Jay & Lynx EA\Vegetation\DAR\DAR_Veg_001_GIS.mxd

11.1.3 Valued Components, Assessment Endpoints, and Measurement Indicators

The TOR identified vegetation, soils, and eskers as valued components (VCs) that should be included in the assessment of effects on the terrestrial environment. In this SON, vegetation VCs are plant populations and communities, listed plant species and habitat, and traditional use plants (Table 11.1-1). Valued components represent physical, biological, cultural, social, and economic properties of the environment that are considered to be important by society. The inter-relationships between components of the biophysical and socio-economic (human) environments provide the structure of a social-ecological system (Walker et al. 2004; Folke 2006). Identification of VCs and assessment endpoints was determined partially from the outcome of the community scoping sessions, including local and traditional knowledge, public, and regulatory engagement process (Section 4). The vegetation, soils, and eskers VCs were selected based on the following criteria:

- represent important ecosystem processes;
- likely sensitive to Project-related effects;
- can be measured or described with one or more practical indicators;
- changes to soils and eskers influence plant populations and communities;
- eskers are known to be important traditional use, cultural, and caribou movement sites;
- plant populations and communities provide food and habitat for wildlife;
- protection of listed (rare) plant species designated by Government of the Northwest Territories, *Species at Risk Act* [SARA] (SARA 2013), and Committee on the Status of Endangered Wildlife in Canada [COSEWIC] 2014; and,
- several plant species are considered to be important for traditional and economic purposes, including berries (blueberry [*Vaccinium uliginosum*; dzìewà, jìewà], lingonberry [*Vaccinium vitis-idaea*], black crowberry [*Empetrum nigrum*; tsǫht'è], red bearberry [*Arctostaphylos rubra*; k'àowocho, k'àowotso], cloudberry [*Rubus chamaemorus*; nǫdlàa]), willow (*Salix* spp.; k'àa, k'òò), dwarf birch (*Betula glandulosa*; k'i), mosses (kw'ah), and lichen (adzį̀į, ajį̀į, ajìì) (Traditional Land Use and Traditional Knowledge Baseline Report, Annex XVII).

The vegetation assessment focuses on measurement indicators and assessment endpoints derived from ecology and conservation science. Community and regulatory engagement, and local and traditional knowledge were a key consideration for selecting VCs, but assessment endpoints for vegetation VCs do not explicitly consider societal values, such as continued opportunities for traditional and non-traditional use of plants. Societal values concerning changes in plant populations or communities are important and must also be considered to understand the full suite of potential effects of the Project (i.e., both human and ecological dimensions). Consequently, measurement indicators from the vegetation section were carried forward so that effects on societal values could be appropriately captured in the sections dealing specifically with those values (Section 15).

Assessment endpoints are qualitative expressions used to assess the significance of effects on a VC and represent the key properties of the VC that should be protected for use by future human generations (i.e., incorporate sustainability). Assessment endpoints are general statements about what is to be protected. Measurement indicators are quantitative and/or qualitative expressions of changes to the assessment endpoints. Self-sustaining and ecologically effective plant populations and communities is the assessment endpoint for vegetation VCs. Measurement indicators are provided in Table 11.1-1.

Long-term population viability is frequently applied as an ecologically relevant target by conservation biologists and resource managers (Ruggiero et al. 1994; With and Crist 1995; Fahrig 2001; Nicholson et al. 2006). Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating stochastic demographic processes (Reed et al. 2003). Maintaining ecologically effective populations and communities goes beyond what may be required only to achieve a self-sustaining population and also requires that healthy ecological relationships are maintained among species to prevent unexpected biodiversity loss due to changes in properties of highly interactive species (Soulé et al. 2003, 2005).

The vegetation VCs have both measurement indicators and assessment endpoints (Table 11.1-1). Soils and eskers have no explicit assessment endpoints; therefore, they are not assessed for environmental significance (Section 6.2.2). Soils support vegetation, and changes to soils are important for determining effects on vegetation. Eskers are characterized by a complex of different plant communities, and changes to eskers are also important for determining effects on vegetation. Changes to soil and esker measurement indicators are used for determining the significance of related effects on self-sustaining and ecologically effective plant populations and communities (Table 11.1-1).

Table 11.1-1 Summary of the Valued Components, Assessment Endpoints, and Measurement Indicators

Valued Component	Assessment Endpoint	Measurement Indicators
Plant populations and communities Listed plant species and listed plant habitat potential Traditional use plants and traditional use plant habitat potential	self-sustaining and ecologically effective plant populations and communities	• quantity, arrangement and connectivity (fragmentation) of plant communities; • plant community health and diversity; • abundance and distribution of habitat for listed and traditional use plants; and, • presence of invasive species.
Soils and eskers[a]	no assessment endpoint	• soil quality, quantity, and distribution; and, • abundance and distribution of eskers.

a) No assessment endpoint because the VC represents measurement indicators and pathways to other VCs with assessment endpoints.

DOMINION DIAMOND

11.1.4 Spatial Boundaries

11.1.4.1 *Vegetation Baseline and Effects Study Areas*

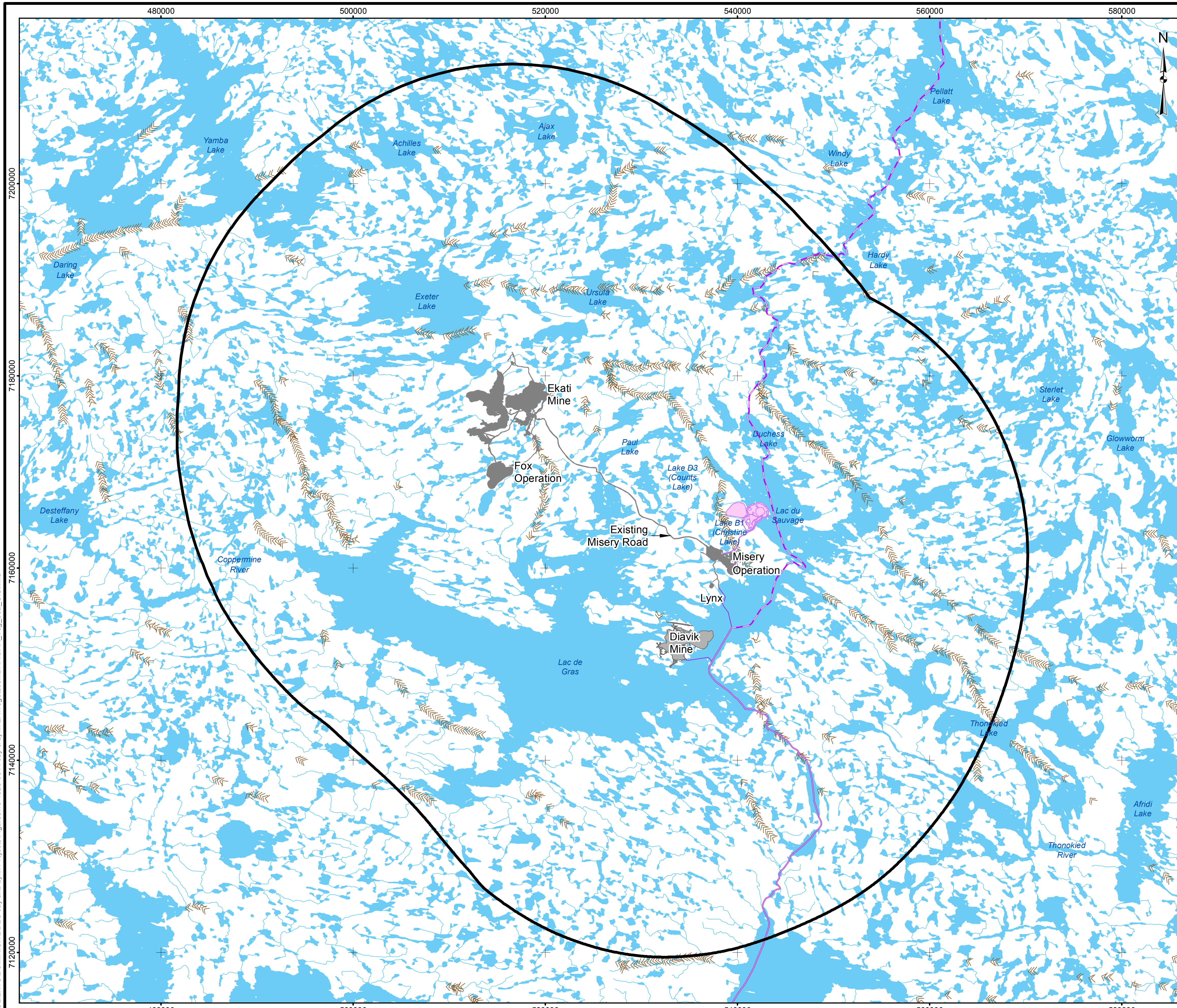
The vegetation baseline study area was designed to measure and characterize existing environmental conditions on a continuum of scales from the anticipated Project footprint to broader, regional levels. The vegetation effects study area (ESA) is the same as the baseline study area and is approximately 5,933 square kilometres (km^2) (593,274 hectares [ha]), and includes both unaffected (i.e., reference) areas, as well as areas influenced by the Project (Map 11.1-2). The size of the ESA is expected to be large enough to contain most or all of the populations of plant species and communities that may be influenced by the Project. A population is a group of individuals of the same species that is primarily affected by natural and human-related factors that change survival and reproduction of individuals (Berryman 2002). Developments outside the ESA are expected to have little to no influence on plant populations and communities occupying the ESA. The ESA is also expected to be large enough to provide an ecologically relevant and confident assessment of the direct and indirect effects on vegetation from the Project, and the potential cumulative effects from the Project and other, previous, existing and reasonably foreseeable developments.

The ESA occurs entirely within the Tundra Shield Low Arctic (south) Level III Ecoregion (ECG 2012) and is characterized by long, cold winters and very short, cold summers. Characteristic landscape features in the region include extensive till and outwash deposits, as well as granitic and sedimentary rocklands bisected by numerous eskers. Dwarf-shrub tundra and low-shrub tundra represent the most dominant vegetation types on upland areas, while sedge fens are predominant in wet areas (ECG 2012). The ESA is located in a transitional area between the boundaries of the Level IV Point Upland Ecoregion and the Contwoyto Upland Ecoregion, with a small portion to the south occurring within the Level IV Mackay Upland Ecoregion (ECG 2012).

The western portion of the ESA occurs within the Point Upland Ecoregion; it is characterized by a rugged landscape dominated by exposed bedrock with extensive boulder tills and patches of dwarf-shrub and rock lichen communities. The predominant vegetation types are erect dwarf-shrub tundra and low-shrub tundra, which occur with nearly continuous cover on fine-textured veneers throughout much of the ecoregion. The vegetation type distribution becomes patchy in the northwestern third of the ESA where rocklands and bouldery tills dominate the landscape (ECG 2012). In low-lying areas or seepage zones, wetlands dominated by sedges, mosses, and low and dwarf shrubs occur, while tall willow stands are common along stream drainages and lakeshores (ECG 2012).

The Contwoyto Upland Ecoregion encompasses the eastern portion of the ESA. This ecoregion includes deposits of fine-textured, level to hummocky bouldery till plains, with nearly continuous tundra cover (ECG 2012). Small eskers and kame deposits are scattered throughout the region, and permafrost is continuous. The most common vegetation type is the erect dwarf-shrub tundra, but low-shrub tundra is locally extensive, particularly in the eastern portion of this ecoregion. In low-lying areas, or seepage zones, wetlands dominated by sedges, mosses, and low and dwarf shrubs occur, while tall willow stands are common along stream drainages and lakeshores (ECG 2012).

The Mackay Upland Ecoregion occurs in the southern portion of the ESA and is characterized by level terrain to hummocky terrain with deep till blankets, bouldery till, and minor areas of exposed bedrock (ECG 2012). Dry upland tundra is the dominant vegetation type and is composed of erect dwarf-shrub tundra and low-shrub tundra, which often occur as complexes in networks of non-sorted circles (ECG 2012). Localized wetlands dominated by sedges, mosses, and low and dwarf shrubs occur in low-lying areas or seepage zones, while tall willow stands are common along stream drainages and lakeshores (ECG 2012).



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ESKER
- WATERCOURSE
- WATERBODY
- EFFECTS STUDY AREA

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

10 0 10
SCALE 1:400,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATION OF THE VEGETATION EFFECTS STUDY AREA

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_002_GIS	
DESIGN	JF	24/02/14	SCALE AS SHOWN	REV 0
GIS	LMR	07/10/14	MAP 11.1-2	
CHECK	JF	07/10/14		
REVIEW	CD	07/10/14		

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11.2 Existing Environment

The purpose of this section is to describe the existing composition and distribution of plant communities within the ESA (Base Case, Section 11.4.1.2) as a basis to assess the potential Project-specific effects on vegetation. The detailed methods and results for the baseline surveys are located in the Vegetation Baseline Report (Annex VI).

11.2.1 Methods

11.2.1.1 *Data Collection*

Baseline vegetation surveys were carried out from July 24 to 31, 2013 and July 4 to 8, 2014. The objectives of the field surveys were to:

- collect baseline vegetation data at representative locations within each Ecological Landscape Classification (ELC) map unit to provide site-specific, descriptive information on the nature and characteristics of plant communities that might be affected by the Project; and,
- search for listed plant species.

Field survey information was used to characterize and verify the mapped vegetation types (ELC map units; habitats), compile a vegetation inventory of observed species, and document any listed and traditional use species found in the study areas. In total, 49 plots were established in 2013, including 8 detailed plots, 16 reconnaissance plots and 25 listed plant survey sites (Map 11.2-1). A total of 27 listed plant survey sites were completed in 2014, and were focused in the Project footprint. Detailed and reconnaissance plots were established in representative locations of selected ELC units, and at least one detailed plot was established in each mapped ELC unit. The Vegetation Baseline Report (Annex VI, Appendix A) and Table 11B1-1, Appendix 11B provides a list of plant species observed during the 2013 and 2014 vegetation field surveys.

11.2.1.2 *Ecological Landscape Classification*

An ELC was used to provide information about the abundance and distribution of vegetation types (ELC map units; habitats) within the ESA. The ELC provides a broad-level inventory of habitats in the ESA. Generally, ELC mapping is often completed as a part of an environmental impact assessment, as it provides a means of relating vegetation conditions with other critical resources, such as soils and wildlife, and biodiversity (Treweek 1999). Results from an ELC can also facilitate the process of evaluating the effects of proposed mining developments on selected VCs (IUCN and ICMM 2003). The ELC for the ESA was obtained from an existing classification developed for the Diavik Mine environmental assessment (DDMI 1997; Golder 1997) and is described in detail in Annex VI, Section 2.1.

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- 2013 - DETAILED AND RECONNAISSANCE VEGETATION SURVEY LOCATION
- 2013 - LISTED PLANT SURVEY LOCATION
- 2014 - LISTED PLANT SURVEY LOCATION

REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

4 0 4

SCALE 1:175,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

VEGETATION AND LISTED PLANT SURVEY LOCATIONS

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_Veg_006_GIS
DESIGN	JF	21/07/14	SCALE AS SHOWN REV 0
GIS	LMR	07/10/14	
CHECK	JF	07/10/14	MAP 11.2-1
REVIEW	CD	07/10/14	

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11.2.1.3 *Listed Plants*

Territorial and federal agencies maintain lists of plant species of conservation concern, which include rare species as well as other species that may not necessarily be rare, but are of conservation concern due to declining populations or other sensitivities. The definition of a rare plant species is any native plant that, because of biological characteristics or for some other reason, exists in low numbers or in very restricted areas (Drury 1974; Rabinowitz 1981). In the strict sense of the definition, rare plants have restricted spatial, ecological, and/or temporal distributions in variable or diverse environments (Harper 1981). In this regard, the term "listed plant" is used rather than rare plant, as it better reflects the broader nature of species of conservation concern.

For the purposes of the DAR, listed plant species are:

- any plant species listed as "At Risk," "May be at Risk," or "Sensitive" in the NWT according to the Northwest Territories General Status Ranking Program and listed on the Northwest Territories Species Monitoring Infobase (NWT Infobase 2012) that may be recommended to be protected under the *Species at Risk (NWT) Act*;
- any plant species listed in the *Species at Risk (NWT) Act* (2010);
- any plant species recommended COSEWIC (2014) to be protected under SARA; and,
- any plant species listed in SARA (2013).

Plant species rankings included on these lists are dynamic, and change as new information becomes available or as the status of a given plant species population changes. For example, a species may be delisted due to increased survey intensity and detection that indicate that the species occurs more frequently than initially thought.

11.2.1.3.1 *Listed Plant Species Occurrences*

A reference list of all potential vascular and non-vascular listed plant species occurring in the region was compiled before completing listed plants surveys (Annex VI, Appendix B). Survey methods followed Alberta Native Plant Council guidelines for listed plant surveys (ANPC 2012). A wide range of plant communities was surveyed, with the greatest effort focused towards those habitats with the highest potential to support listed plant species (e.g., riparian areas, seepage areas, habitat edges [ecotones]). Surveyors searched for listed plant species using a random meandering technique, focusing the search effort on habitats and microhabitats (e.g., small areas with unique habitat features) identified to have a greater potential to support listed plant species. However, listed species surveys were not limited to areas with highest habitat potential, as suitable microhabitats exist across all vegetation types. The length of each meander varied according to the complexity and number of microhabitats present at each location.

11.2.1.3.2 *Listed Plant Habitat Potential*

To support the assessment of effects on listed plants, the ELC map units within the ESA were ranked according to their ability to support listed plant species based on the habitat requirements for each listed plant species (Annex VI, Section 2.3.2). Riparian Tall Shrub and Shallow Water map units were considered to have a high potential to support listed plants species. Esker Complex and Sedge Wetland were considered moderate. Deep Water, Existing Disturbance, and Unclassified map units were not ranked. The remainder of the ELC map units were considered to have a low potential to support listed plant species. Within all map units, where specific microhabitats occurred, these microhabitats were considered to have higher potential for listed plant species occurrence.

11.2.1.4 *Traditional Use Plants*

An evaluation of traditional use plants that may occur within specific ELC map units was completed through analysis of Annex XVII and summarized in this section.

11.2.1.4.1 *Traditional Use Plant Habitat Potential*

To support the assessment of effects on traditional use plants, the ELC map units within the ESA were ranked according to the habitat's probability to contain traditional use species, using available data on the number of traditional plant species that occur in each ELC type and professional judgement (Table 11.2-1).

Table 11.2-1 Potential of Ecological Landscape Classification Map Units in the Effects Study Area to Support Traditional Use Plants

Ecological Landscape Classification (ELC) Map Units	Traditional Use Plant Habitat Potential
Upland ELC Map Units	
Esker Complex	Moderate
Bedrock Complex (>80% rock)	Low
Boulder Complex (>80% rock)	Low
Heath Tundra 30% to 80% Bedrock	High
Heath Tundra 30% to 80% Boulder	High
Heath Tundra	High
Wetland ELC Map Units	
Riparian Tall Shrub	Moderate
Birch Seep and Riparian Shoreline Shrub	High
Tussock/Hummock	Moderate
Sedge Wetland	Moderate
Non-Vegetated ELC Map Units	
Shallow Water	Low
Deep Water	Very Low
Existing Disturbance ELC Map Unit	
Existing Disturbance	Very Low
Unclassified ELC Map Unit	
Unclassified	Not Ranked

> = greater than; % = percent.

11.2.1.5 *Non-native Invasive Plant Species*

Non-native invasive plant species are defined as invasive alien plant species in the NWT (GNWT-ENR 2014). These are plant species that have been introduced into the NWT through various means, including use as food crops, revegetation tools, and landscaping varieties, or simply unintentionally (GNWT-ENR 2014). So far, there are no known alien plant species with a high level of invasiveness in the NWT (GNWT-ENR 2014). Many of the non-native invasive plant species occurring in NWT will not cause economic or environmental damage because they need constant human assistance to survive (Oldham 2007; GNWT-ENR 2014). A review of the territorial invasive species lists was completed and cross-checked with 2013 and 2014 field survey data. A review of the documented observation locations was also completed to determine whether any invasive plant observations have been recorded in the ESA.

11.2.2 Results

11.2.2.1 *Ecological Landscape Classification*

A total of 14 ELC map units are mapped within the ESA, including six upland, four wetland, two non-vegetated, one existing disturbance, and one unclassified map unit (Table 11.2-2; Map 11.2-2). Upland ELC map units comprise 54 percent (%) of the ESA. Of the upland ELC map units, Heath Tundra is the dominant map unit, occupying 37% of the ESA. Wetland ELC map units account for 12% of the ESA, of which the majority is classified as the Tussock/Hummock (9% of the ESA). Non-vegetated ELC map units account for 33% of the ESA and are predominantly Deep Water (29%). The Existing Disturbance ELC map unit accounts for 1% of the ESA and is associated with existing man-made disturbances, which include the current Ekati and Diavik mine's footprints, the Lynx Project footprint, mineral exploration locations, portages associated with winter roads, and all-season roads. Less than 1% of the ESA is unclassified due to cloud or shadows in the satellite image. Descriptions of each mapped ELC map unit within the ESA are provided in Annex VI, Section 3.1.2.

Table 11.2-2 Total Area and Percent Cover of Ecological Landscape Classification Map Units in the Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Area (ha)	Proportion of ESA (%)
Upland ELC Map Units		
Esker Complex	5,322	1
Bedrock Complex (>80% rock)	1,302	<1
Boulder Complex (>80% rock)	2,103	<1
Heath Tundra 30% to 80% Bedrock	14,825	2
Heath Tundra 30% to 80% Boulder	75,211	13
Heath Tundra	221,577	37
Upland ELC map units subtotal	*320,341*	*54*
Wetland ELC Map Units		
Riparian Tall Shrub	449	<1
Birch Seep and Riparian Shoreline Shrub	6,389	1
Tussock/Hummock	50,553	9
Sedge Wetland	16,305	3
Wetland ELC map units subtotal	*73,695*	*12*

Table 11.2-2 Total Area and Percent Cover of Ecological Landscape Classification Map Units in the Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Area (ha)	Proportion of ESA (%)
Non-Vegetated ELC Map Units		
Shallow Water	23,995	4
Deep Water	170,173	29
Non-vegetated ELC map units subtotal	*194,167*	*33*
Existing Disturbance ELC Map Unit		
Existing Disturbance	4,916	1
Existing Disturbance ELC map units subtotal	*4,916*	*1*
Unclassified ELC Map Unit		
Unclassified	154	<1
Unclassified subtotal	*154*	*<1*
Total	**593,274**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

ha = hectares; % = percent; ESA = effects study area; < = less than; > = greater than.

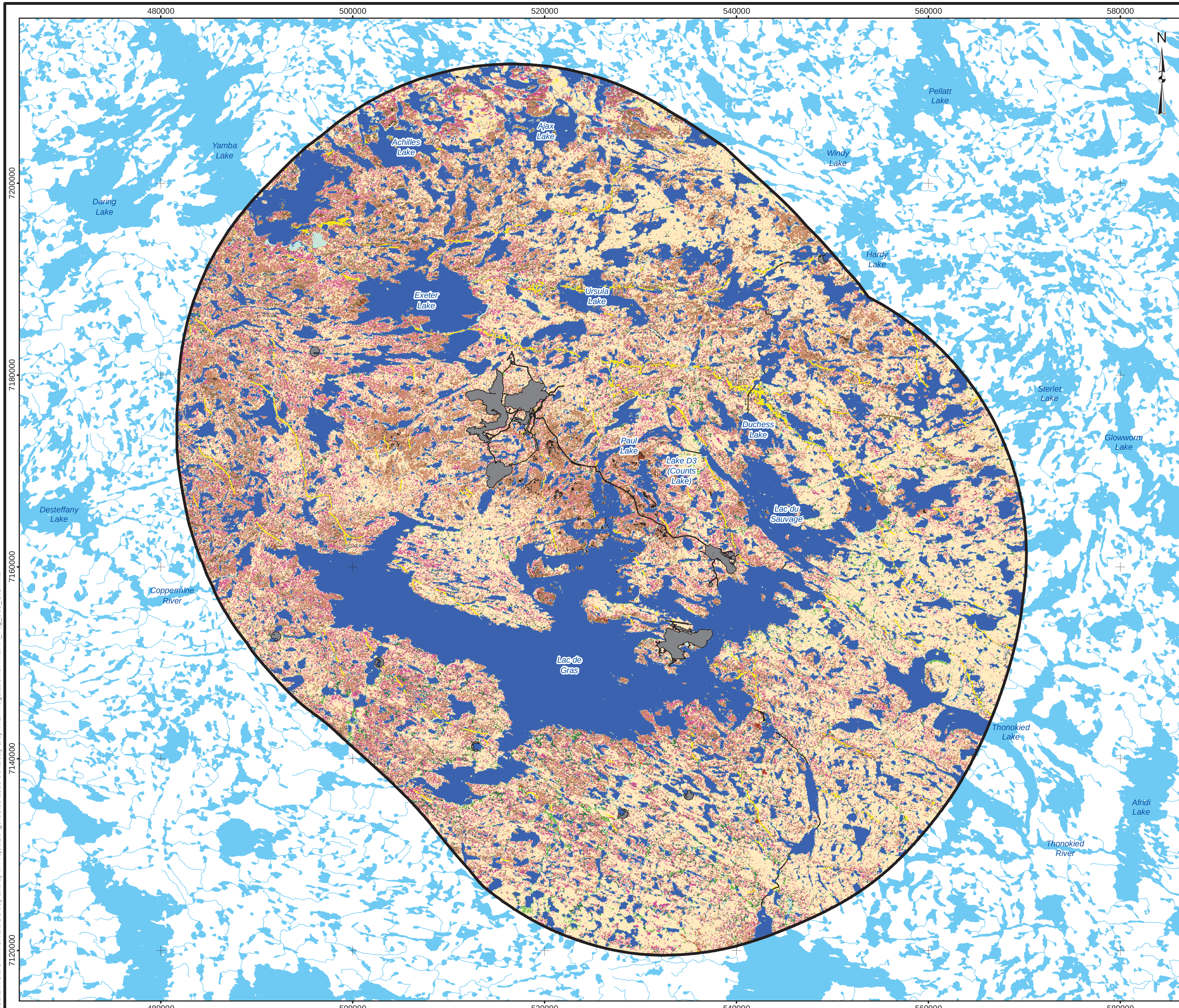
Ecological Landscape Classification map units of restricted distribution are defined as units that represent 1% or less of the landscape within the ESA (Table 11.2-2). Three upland and two wetland ELC map units meet this description. The Esker Complex is formed by remnant deposits of rivers that flowed within the continental ice sheets, and is characterized by complexes of plant communities (DDMI 1997; Golder 1997). Within the ESA, eskers tend to form long, sinuous, linear features on the landscape, and are relatively uncommon. The Bedrock Complex (greater [>] than 80% rock) and Boulder Complex (>80% rock) ELC map units tend to occur as small isolated patches along the north and western shoreline of Lac du Sauvage, as well as along the all-season road between the Ekati and Misery mine sites. In contrast, the Riparian Tall Shrub and Birch Seep and Riparian Shoreline Shrub are associated with riparian areas along inlets and outlets to lakes, and along lake shorelines.

11.2.2.2 *Listed Plants*

11.2.2.2.1 *Listed Plant Species Occurrences*

Two territorial listed vascular plant species and four non-vascular plant species were confirmed as occurring within the ESA during the 2014 field program (Table 11.2-3 and Map 11.2-3). For specific locations where these species were observed, Appendix 11B, Table 11B-2. No COSEWIC (2014) or SARA (2013) listed species were observed within the ESA during the 2013 and 2014 field surveys.

The number of listed species observations documented during field programs does not preclude the potential for other listed species to occur within the ESA. Listed plant occurrences at a site can be missed due to timing of plant surveys, as species presence can vary annually and locally. In addition, climatic fluctuations might not allow adequate time for plants to mature and produce flowers, making them more difficult to spot and identify. Available microhabitats within larger habitat types can also vary over time and space. Therefore, a listed plant survey cannot confirm the absence of listed plants; it can only confirm their presence.



LEGEND

- WATERCOURSE
- WATERBODY
- EFFECTS STUDY AREA

ECOLOGICAL LANDSCAPE CLASSIFICATION MAP UNITS

- ESKER COMPLEX
- BEDROCK COMPLEX (>80% ROCK)
- BOULDER COMPLEX (>80% ROCK)
- HEATH TUNDRA 30% TO 80% BEDROCK
- HEATH TUNDRA 30% TO 80% BOULDERS
- HEATH TUNDRA
- RIPARIAN TALL SHRUB
- BIRCH SEEP AND RIPARIAN SHORELINE SHRUB
- TUSSOCK/HUMMOCK
- SEDGE WETLAND
- SHALLOW WATER
- DEEP WATER
- EXISTING DISTURBANCE
- UNCLASSIFIED

REFERENCE

VEGETATION CLASSIFICATION DATA: DIAVIK LANDSAT CLASSIFICATION 1997; WEST KITIKMEOT CLASSIFICATION 2001; MODIFIED BY GOLDER ASSOCIATES 2014
NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

10 0 10

SCALE 1:400,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ECOLOGICAL LANDSCAPE CLASSIFICATION IN THE EFFECTS STUDY AREA

Golder Associates

PROJECT	13-1328-0041	FILE No. DAR_Veg_003_GIS	
DESIGN	JF	24/02/14	SCALE AS SHOWN REV 0
GIS	LMR	07/10/14	MAP 11.2-2
CHECK	JF	07/10/14	
REVIEW	CD	07/10/14	

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DOMINION DIAMOND

Table 11.2-3 Listed Plant Species Observed during the 2014 Field Program

Latin Name	Common Name	NWT General Status Rank[(a)]	Habitat Observed
Forbs			
Ranunculus pallasii	Pallas' buttercup	Sensitive	In Shallow Water depression associated with Hammer Lake
Graminoids			
Carex richardsonii	Richardson's sedge	Sensitive	Fringe of Sedge Wetland
Bryophytes			
Cynodontium tenellum	tiny fork-moss	Sensitive	Rocky crevices associated with a rock face adjacent to slumping channel into lake Bedrock crevice associated with Heath Tundra 30% to 80% Bedrock
Lichens			
Cetraria kamczatica	Kamchatka Icelandmoss lichen	Sensitive	In drier part of Heath Tundra, Tussock/Hummock ecotone (2 observations) Atypical Tussock/Hummock-Birch Seep complex
Hypogymnia vittata	umber monk's hood lichen	Sensitive	In drier part of Heath Tundra, Tussock/Hummock ecotone
Parmelia skultii	silver-rimmed crottle lichen	Sensitive	Birch Seep along small pond
Sphaerophorus fragilis	cushion coral lichen	Sensitive	Heath Tundra 30% to 80% Bedrock In drier part of Heath Tundra, Tussock/Hummock ecotone

a) Status ranks obtained from NWT Infobase 2012.

Note: None of these plant species are listed by COSEWIC (2014) or SARA (2013).

For observation locations, see Appendix 11B, Table 11B-2.

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY

LISTED PLANT SPECIES OBSERVATION

- PALLAS' BUTTERCUP
- RICHARDSON'S SEDGE
- TINY FORK-MOSS
- KAMCHATKA ICELANDMOSS LICHEN
- UMBER MONK'S HOOD LICHEN
- SILVER-RIMMED CROTTLE LICHEN
- CUSHION CORAL LICHEN

NOTES

1. FOR OBSERVATION LOCATIONS SEE APPENDIX 11B, TABLE 11B-2.

REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATIONS OF LISTED PLANT SPECIES OBSERVATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_009_GIS	
DESIGN	JF	21/08/14	SCALE AS SHOWN	REV 0
GIS	LMR	07/10/14	**MAP 11.2-3**	
CHECK	JF	07/10/14		
REVIEW	CD	07/10/14		

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11.2.2.2.2 *Listed Plant Habitat Potential*

A total of 8% of the ESA was determined to have high (4%) or moderate (4%) listed plant potential (Table 11.2-4). Map units with a high potential to support listed plants are the Shallow Water and Riparian Tall Shrub ELC map units. Map units with a moderate potential to support listed plant species are the Esker Complex and Sedge Wetland units. The majority of the ESA (63%) is composed of ELC map units with a low potential to support listed plants. Deep Water, Existing Disturbance and Unclassified map units (30%) were not ranked.

Table 11.2-4 Total Area and Percent Cover of Listed Plant Habitat Potential in the Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Area (ha)	Proportion of ESA (%)
High Potential ELC Map Units		
Riparian Tall Shrub	449	<1
Shallow Water	23,995	4
High Potential ELC Map Units subtotal	*24,444*	*4*
Moderate Potential ELC Map Units		
Esker Complex	5,322	1
Sedge Wetland	16,305	3
Moderate Potential ELC Map Units subtotal	*21,627*	*4*
Low Potential ELC Map Units		
Bedrock Complex (>80% rock)	1,302	<1
Boulder Complex (>80% rock)	2,103	<1
Heath Tundra 30%-80% Bedrock	14,825	2
Heath Tundra 30%-80% Boulders	75,211	13
Heath Tundra	221,577	37
Birch Seep and Riparian Shoreline Shrub	6,389	1
Tussock/Hummock	50,553	9
Low Potential ELC Map Units subtotal	*371,960*	*63*
Non-ranked ELC Map Units		
Deep Water	170,173	29
Unclassified	154	<1
Existing Disturbance	4,916	1
Non-ranked ELC map units subtotal	*175,243*	*30*
Total	**593,274**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

ha = hectare; % = percent; ESA = effects study area; < = less than; > = greater than.

11.2.2.3 *Traditional Use Plants*

Traditional plants used in the NWT include edible plants, medicinal plants, and plants used for construction or other purposes. A list of traditional plants applicable to the Project is provided in Table 11.2-5. This list is a summary of Annex XVII and the species included in Table 11.2-5 are those that occur in the vegetation ESA. This list also identifies the most probable ELC types where these plant species will occur with sufficient abundance for traditional use.

Table 11.2-5 Traditional Use Plants and Associated Ecological Landscape Classification Map Units

Common Name	Latin Name	Tłįchǫ Name	Most Probable Dominant ELC Map Unit(s)[b]	Traditional Use
Willow (various)	*Salix* spp.	k'àa, k'òò	Birch Seep and Riparian Shoreline Shrub, Riparian Tall Shrub	fuel, food, tools, shelter, medicine, tobacco, insect repellent, moth ball, fire starter[d]
Dwarf birch	*Betula glandulosa*	k'i	Birch Seep and Riparian Shoreline Shrub, Heath Tundra	fuel, food, tools, shelter, fire starter[d]
Blueberry	*Vaccinium uliginosum*	dzìewà, jìewà	Esker Complex, Heath Tundra, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food, medicine[d]
Lingonberry	*Vaccinium vitis-idaea*	--	Birch Seep, Riparian Tall Shrub, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food, medicine, dye[d]
Black crowberry	*Empetrum nigrum*	tsǫht'è	Esker Complex, Heath Tundra, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food, medicine[c]
Red bearberry	*Arctostaphylos rubra*	k'àowocho, k'àowotso	Esker Complex, Heath Tundra, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food[d]
Labrador tea	*Ledum palustre*	gots'agoò, lìgaezǫ̀ǫ̀, lìgaezǫ̀ą	Birch Seep; Heath Tundra; Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food, medicine[d]
Cloudberry	*Rubus chamaemorus*	nǫdlàa	Birch Seep and Riparian Shoreline Shrub, Riparian Tall Shrub, Sedge Wetland, Tussock/Hummock	food[d]
Acerbic bulrush	*Schoenoplectus acutus*[a]	--	Sedge Wetland; Shallow Water	food, medicine, baskets[c]
Peat moss	*Sphagnum* spp., wetlands species	kw'ah	Birch Seep and Riparian Shoreline Shrub Riparian Tall Shrub, Sedge Wetland, Tussock/Hummock	diapers, cleaner[d]
Lichen	*Cladina* spp., *Flavocetraria* spp., *Parmelia* spp., *Actinogyra* spp.	adzį̀į̀, ajį̀į̀, ajìì	Esker, Heath Tundra, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders	food, medicine[c]

a) Genus or species not found during Golder 2013 vegetation surveys.
b) Most probable dominant type based on survey data, habitat descriptions, and professional judgement.
c) Marles et al. 2000.
d) André and Fehr 2002.
ELC = Ecological Landscape Classification; spp. = multiple species; -- = No Tłįchǫ translation available;% = percent.

11.2.2.3.1 *Traditional Use Plant Habitat Potential*

A total of 54% of the ESA was determined to have high potential to contain traditional use plants (Table 11.2-6). A total of 35% of the ESA contains low (5%) and very low (30%) traditional use plant potential. Less than 1% of the map units were not ranked because these areas represent the Unclassified map unit and could not be assigned a potential.

Table 11.2-6 Distribution of Traditional Use Plant Species Habitat Potential within the Effects Study Areas

Ecological Landscape Classification (ELC) Map Units	Area (ha)	Proportion of ESA (%)
High Potential ELC Map Units		
Heath Tundra 30% to 80% Bedrock	14,825	2
Heath Tundra 30% to 80% Boulder	75,211	13
Heath Tundra	221,577	37
Birch Seep and Riparian Shoreline Shrub	6,389	1
High Potential ELC Map Units subtotal	*318,003*	*54*
Moderate Potential ELC Map Units		
Esker Complex	5,322	1
Riparian Tall Shrub	449	<1
Tussock/Hummock	50,553	9
Sedge Wetland	16,305	3
Moderate Potential ELC Map Units subtotal	*72,629*	*12*
Low Potential ELC Map Units		
Bedrock Complex (>80% rock)	1,302	<1
Boulder Complex (>80% rock)	2,103	<1
Shallow Water	23,995	4
Low Potential ELC Map Units subtotal	*27,400*	*5*
Very Low Potential ELC Map Units		
Deep Water	170,173	29
Existing Disturbance	4,916	1
Very Low Potential ELC Map Units subtotal	*175,088*	*30*
Non-ranked ELC Map Units		
Unclassified	154	<1
Non-ranked ELC map units subtotal	*154*	*<1*
Total	**593,274**	**100**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

ha = hectare; % = percent; ESA = effects study area; < = less than; > = greater than.

11.2.2.4 *Non-Native Invasive Plant Species*

The ten most common non-native invasive plant species recorded along roadsides in the NWT in 2006 were white sweet-clover (*Melilotus albus*) field sowthistle (*Sonchus arvensis*), narrow-leaved hawk's-beard (*Crepis tectorum*), yellow sweet-clover (*Melilotus officinalis*), alsike clover (*Trifolium hybridum*), alfalfa (*Medicago sativa*), red clover (*Trifolium pratense*), pineapple weed (*Matricaria discoidea*), awnless brome (*Bromus inermis*), and prostrate knotweed (*Polygonum aviculare*) (Oldham 2007).

As of 2010, 116 non-native invasive plant species were known to occur in the NWT, and were mostly found in or near communities, near roads, and along disturbed areas, such as cut-lines, pipelines, and mine sites (GNWT-ENR 2014). Of these 116 species, few have demonstrated that they can successfully invade natural habitats because they do not tend to be highly competitive in non-disturbed areas (GNWT-ENR 2014). The majority of these invasive plant species do not cause damage to the natural ecosystem because these species need constant human assistance to survive (GNWT-ENR 2014). In addition, the harsh northern climate prevents many species from establishing populations in the NWT. Some introduced plant species have succeeded in spreading in some habitats; however, these are mostly associated with areas already disturbed by human activities (GNWT-ENR 2014).

The majority of the documented occurrences of non-native invasive plant species are located outside the ESA in the Taiga Plains (south) and Taiga Shield near the Mackenzie River, west of Yellowknife, and near the communities of Fort Simpson, Hay River, and Fort Providence (GNWT-ENR 2014). These species are mostly found in or near communities, along roads, and in disturbed areas, such as cut-lines, pipelines, and mine sites.

As of 2014, there are no known non-native invasive plant species with a high level of invasiveness in the NWT (GNWT-ENR 2014). A high level of invasiveness refers to species that invade man-made disturbed habitats and natural habitats quickly, are hard to eradicate, and have severe ecological impacts on physical processes, plant or animal communities, and vegetation structure (GNWT-ENR 2014). No non-native invasive plant species were observed during the 2013 and 2014 field surveys (Appendix 11B; WGGSNS 2011; GNWT-ENR 2014). However, European stickseed (*Lappula squarrosa* synonym *L. echinata*) was documented at the main camp and along the Long Lake Containment Facility perimeter road on July 4, 2013 (Martens 2014). This species is listed as alien in the NWT and the usual range of this species is not in the NWT (GNWT-ENR 2014). This plant is an annual or winter annual that reproduces by seed and is typically found in man-made and disturbed habitats in the western plains (Alberta Agriculture 1988; Whitson et al. 2009). It is a prolific seed producer and is easily spread on animal hair and clothing because of the hooked spines on the seed; however, it is easily controlled using mechanical weeding (e.g., hand weeding) (Alberta Agriculture 1988). Where present, plants were pulled by hand, placed in plastic bags and incinerated. Monitoring of observation locations and subsequent weeding may be necessary to control this plant.

11.2.3 Summary of Local and Traditional Knowledge

The information provided below is a summary of publicly available traditional knowledge and traditional land use information for five groups of Aboriginal peoples whose traditional lands overlap the Ekati Mine claim block. Details are provided in Annex XVII. The five groups are:

- Yellowknives Dene First Nation (YKDFN);
- Łutselk'e Dene First Nation (LKDFN);
- North Slave Métis Alliance (NSMA);
- Tłı̨chǫ Government (TG); and,
- Kitikmeot Inuit Association (KIA) (EAP 1996).

Sources of wood within the traditional lands were some of the most important plant resources for many Aboriginal peoples. Dwarf birch and various willow species were used as firewood and fire starting materials, and in the construction of sleds, tents, spears, arrows, caribou ropes, drying racks, baskets, storage and food containers, canoes and kayaks, paddles, and snowshoes. Dwarf birch also provides a strong root that has been used to repair canoes and make cord or lacing (babiche) (Annex XVII). Birch bark was harvested to make canoes, baskets, cups, plates, and small bowls. Birch and willow branches, cut and tied together, are also helpful when placed under bedding (caribou hides) to prevent dampness. Places where wood was available were named so that the information and significance of those places for survival were remembered.

Picking berries is a social event that is enjoyed by both men and women, but predominantly by women. In general, most edible berries were collected and used for food. Some of the most commonly harvested berries include blueberries, cranberries (lingonberries), cloudberries, and crowberries (blackberries). These berries are typically found throughout the traditional lands. Blackberries and blueberries were collected for food, juice, and tinder, while lingonberries and cloudberries were collected for food and made into jams (Annex XVII). Some used the berry plant leaves for tea (Banci et al. 2006). Many berries were dried and rolled into caribou fat and frozen as an easy meal to carry while travelling in the winter. Berries were also used to sweeten pound meat and for medicinal purposes. According to existing information, many think that blueberries harvested on the barrenlands taste better than those below the treeline (Łutselk'e Dene Elders and Land-Users et al. 2002).

Cottongrass seed heads were collected for use as wicks for oil lamps. Heather and blackberry bushes were sometimes used to smoke and cure meat. Heather would also be burned to change the scent (Banci et al. 2006). Peat moss has many traditional uses. Its soft, spongy, absorbent qualities make it an ideal material for infants and sick or incontinent adults; it was harvested all year round and dried before use. Moss was also used as fire-starter and burned to repel insects.

Lichen was sometimes used to flavor fish soup, as well as for creating highly nutritious porridge of lichen powder and water for young babies. Lichen is also identified as the primary food source for caribou; just like people like different types of food, caribou like to eat various types of lichen (Dominion Diamond 2013).

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Labrador tea, club lichen, juniper berries, crowberries, spiny wood fern, and cranberry have all been identified as important for medicinal purposes (LKDFN et al. 1999). Medicinal plants are harvested throughout the traditional lands and many people still travel into the barrenlands to collect medicine plants because they no longer trust many of the plants found around Dettah, N'Dilo, Yellowknife, and other parts of Great Slave Lake (Dominion Diamond 2013). Medicinal uses of plant species are numerous (Annex XVII). Some examples include:

- Cloudberries can be used to treat stomach aches.
- Crowberries can help treat constipation.
- Boiled blueberry bushes can be used to treat colds and a soaked cloth of boiled blueberry bush can help treat snow blindness.
- Roots of cranberry (lingonberry) bushes are useful for soothing coughs.
- Dwarf birch can be chewed and placed on insect bites to relieve irritation.
- Boiled black lichen can be used for soothing teas help digestion.
- Moss can help prevent diaper rash.
- Labrador tea can soothe a cold or headache.

Eskers in the traditional lands have been identified as important landscape features. For example, some groups have traditionally hunted wildlife, such as wolves and wolverine, on eskers. People have also identified the eskers as critical landscape features for caribou migration. Eskers were also often used for gravesites (Weledeh Yellowknives Dene 1997). Eskers are characterized by a complex of different plant communities, and changes to eskers are also important for determining effects on vegetation.

The Dene have expressed concern about how dust will have cumulative effects on the entire environment, including the lakes, plants, fish, and wildlife that depend on the local sources of water, vegetation, and other animals for their health and survival. The NSMA have expressed concerns about the impacts of dust on the caribou food in the area of the mines, such as moss, lichen, and muskeg. The YKDFN are concerned about the effects of dust on the vegetation in and around the Ekati Mine. They expect that plants and water east of the mining developments near Ekati Mine will experience high volumes of dust during the life of the mines. Concerns about the impacts from dust have also been expressed by the KIA.

Input on Project designs and mitigation have included advice to improve the health and diversity of plant life around the Mine. For example, participants in the 2013 vegetation workshop suggested that for closure, the Ekati Mine should make the tailings beaches wavy with little hills so that the plants can grow more easily (Annex XVII).

11.3 Pathway Analysis

11.3.1 Methods

Pathway analysis identifies and assesses the linkages between Project components or activities and the correspondent changes to the environment and potential residual effects (after mitigation) on vegetation. The first part of the analysis is to identify all potential effects pathways for the Project. Each pathway is initially considered to have a linkage to potential effects on the VC. Potential pathways through which the Project could affect vegetation were identified from the following sources:

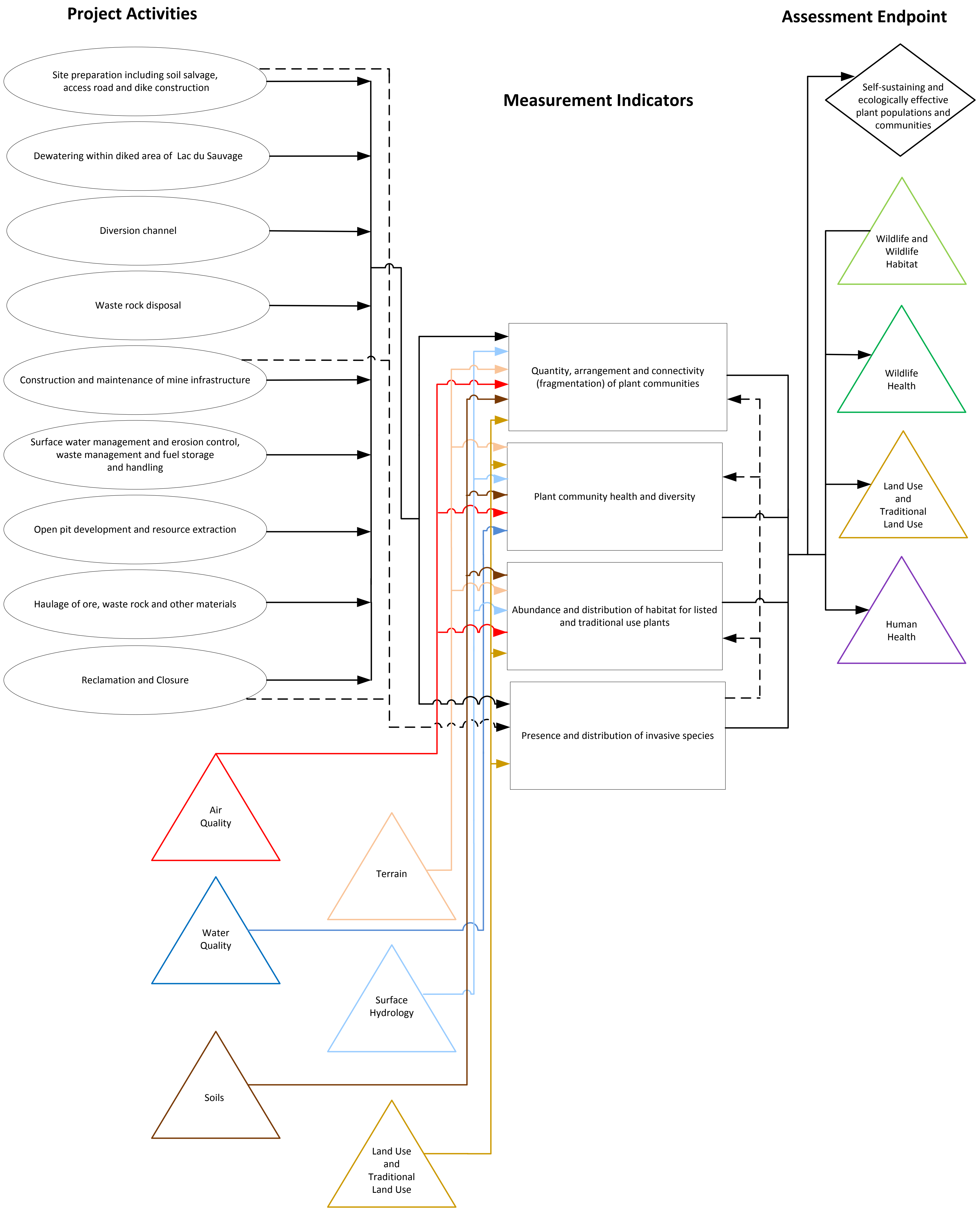
- a review of the Project description and scoping of potential effects by the environmental and engineering teams for the Project;
- information from past and ongoing consultations with Aboriginal communities that are part of the Ekati Mine Community Engagement Programs;
- local and traditional knowledge obtained from community scoping sessions in Behchokǫ̀, Yellowknife, and Łutsel K'e, and a technical scoping session in Yellowknife (Section 4);
- scientific knowledge and experience with other mines in the NWT; and,
- consideration of potential effects identified from the TOR (Appendix 1A).

For an effect to occur, there has to be a source (Project component or activity) that results in a measurable change to the environment (pathway or measurement indicator) and a correspondent effect on the VC.

Project Activity → **Change in Environment** → **Effect on Vegetation**

Project components and activities that are linked to changes in measurement indicators are illustrated by ovals in Figure 11.3-1. Effects from the Project on other disciplines that can influence measurement indicators for vegetation are shown as triangles on the left side of the figure (e.g., air quality, surface hydrology, water quality, and soils). Similarly, changes to plant populations and communities can affect other disciplines, such as land use, traditional land use, wildlife, and wildlife habitat (shown as triangles on the right side of Figure 11.3-1). Ultimately, changes in measurement indicators can have an effect on the assessment endpoint for vegetation VCs (represented by the diamond).

Figure 11.3-1: Linkage Diagram Identifying Potential Effects on Plant Populations and Communities



Note: Ovals represent Project activities; rectangles represent measurement indicators: triangles represent connections to and from other disciplines; and the diamond represents the assessment endpoint.

A key aspect of the pathway analysis is to identify environmental design features and mitigation that reduce or eliminate the potential effects on vegetation, including application of the precautionary principle (Section 6.1.2). Environmental design features include engineering design elements, environmental best practices, management policies and procedures, and spill response and emergency contingency plans. Environmental design features and mitigation were developed as an integral part of the Project's design, through an iterative process between the Project's engineering and environmental teams, to avoid or mitigate adverse effects identified by the pathways analysis.

After applying environmental design features and mitigation, a screening-level analysis is used to determine the existence and magnitude of linkages from the initial list of potential effects pathways for the Project. This screening step is largely a qualitative assessment; it is intended to focus the effects analysis on pathways that require a more comprehensive assessment of effects on vegetation. Pathways are determined to be primary, secondary (minor), or to have no linkage, using scientific, local and traditional knowledge, and experience with similar developments and environmental design features and mitigation. Each potential pathway is assessed and described as follows:

- **No linkage** – analysis of the potential pathway reveals that there is no linkage or the pathway is removed by environmental design features or mitigation such that the Project would not be expected to result in a measurable environmental change, and would therefore have no residual effect on vegetation relative to the Base Case values.
- **Secondary** – pathway could result in a measurable minor environmental change, but would have a negligible residual effect on vegetation relative to the Base Case values and is not expected to contribute to effects of other existing, approved, or reasonably foreseeable projects to cause a significant effect.
- **Primary** – pathway is likely to result in environmental change that could contribute to residual effects on vegetation relative to Base Case values.

Pathways with no linkage to vegetation are not assessed further because environmental design features or mitigation will remove the pathway. Pathways that are assessed to be secondary, and demonstrated to have a negligible residual effect on vegetation through a simple qualitative or semi-quantitative evaluation of the pathway are also not advanced for further assessment. Pathways determined to have no linkage to vegetation, or those that are considered secondary, are not expected to result in environmentally significant effects on self-sustaining and ecologically effective plant populations and communities. Primary pathways require further evaluation through more detailed quantitative and qualitative effects analysis (Section 11.4).

11.3.2 Results

11.3.2.1 *Review of Mitigation Effectiveness*

A monitoring plan is in place at the Ekati Mine, and is used for observing and tracking natural colonization of vegetation at the mine (Interim Closure and Reclamation Plan [ICRP] v.2.4, BHP Billiton 2011). Results of monitoring of the areas no longer used for operations are used to modify on-going and future potential reclamation activities, as required. Research and monitoring results indicate when natural colonization has been successful, and where there is a need for further reclamation work.

Research includes successful re-vegetation on processed kimberlite and other surficial materials, and research will continue through the Jay Project.. Research has also indicated that recontouring disturbed sites and surface roughening (e.g., deep ripping, placement of large rocks) creates microsites that are favourable for seed germination and natural colonization of adjacent tundra plant species. Stockpiling of soil materials to be spread out over sand and gravel and then the incorporation of soil material has shown to improve plant establishment in areas (BHP Billiton 2012).

Native plant seeds collected from the area have been successfully grown in a nursery, and seedlings have been planted in reclamation sites in the Long Lake Containment Facility. Species growing in adjacent areas are already adapted to the soil conditions present at the site, and are therefore good candidates for re-seeding these areas.

Willow and dwarf birch have been observed to successfully naturally colonize disturbed sites at the Ekati Mine (Martens 2013). Following willow and dwarf birch establishment, these two shrub species enhance site conditions for other species by trapping snow, intercepting rainfall, and providing additional microsites. Both shrubs can spread by root and by seed, are prolific seed producers, and both are well adapted to the climatic and soil conditions characteristic of the environment at the Mine site.

11.3.2.2 *Pathway Screening*

Project components and activities, effects pathways, and environmental design features and mitigation are summarized in Table 11.3-1. Classification of effects pathways (no linkage, secondary, and primary) on vegetation is also summarized in Table 11.3-1, and detailed descriptions are provided in the subsequent sections.

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Table 11.3-1 Potential Pathways for Effects to Plant Populations and Communities

Jay Project Component/Activity	Effects Pathway	Environmental Design Features and Mitigation Practices	Pathway Classification
• Physical Disturbance from Project Footprint • Construction or development of site access roads, Jay Pit, waste rock storage areas (WRSA), quarries, support buildings	• Changes to permafrost conditions from the Project footprint can cause changes to soils and affect vegetation.	• Design of the Jay Project minimizes the construction of new buildings, roads, pads, or excavations that might alter permafrost by using existing infrastructure. • Soil disturbance will be limited to only those areas required for construction and operation of the Project. • Footprints of the WRSAs and other structures will be optimized to limit surface disturbance to the extent practical. • Access roads will be as narrow as feasible, while maintaining safe construction and operation practices. • Buildings will be insulated to minimize heat loss, and will be dismantled as part of reclamation activities. • Manage drainage around infrastructure to reduce pooling of water at the surface. • Insulate thaw-sensitive slopes where necessary. • Use quarried granite for basal road construction to minimize frost effects.	Secondary
	• Direct loss, alteration, and fragmentation of vegetation from the Project footprint (pit, dams/dikes and WRSAs, access roads).	• The Project maximizes the use of the existing infrastructure to reduce the environmental footprint to the extent practical. • The new access roads will be as narrow as feasible, while maintaining safe construction and operation practices. • Footprints of the WRSAs and other structures will be optimized to limit surface disturbance to the extent practical. • A pipe bench will be constructed to accommodate the pipelines, which will follow existing and proposed road alignments to the extent practical to minimize the Project footprint. • Soil disturbance will be limited to only those areas required for construction and operation of the Project. • Siting and construction of the Project will be planned to avoid environmentally sensitive areas (e.g., listed plants and wetlands) to the extent practical. • The existing Misery and Lynx Pits will be used for dewatering and minewater management, limiting the requirement for additional areas to be disturbed for minewater management. • Environmental monitoring programs already in place at the Ekati Mine will be extended to incorporate construction and operation of the Jay Project. • Upper soil material, lake bed sediments, and glacial till overburden may be salvaged, to the extent practical, for possible future use in reclamation. • Management practices already in place at the Ekati Mine will be implemented to control erosion and sediment. • The existing Ekati Mine ICRP will be amended to include the Project. • Progressive reclamation of the Project will be completed to the extent practical. • Conditions will continue to be monitored over time to evaluate the success of the ICRP and, using adaptive management and newer proven methods as available, adjust the ICRP, if necessary.	Primary
• General Construction and Operation Activities. • Mining of the kimberlite pipes (pit development). • Operation of surface infrastructure and support facilities. • Vehicle traffic along the access road.	• Use of explosives can cause changes to soil quality and affect vegetation.	• Established Ekati Mine blasting practices will be used in the dewatered portion of Lac du Sauvage and for blasting of quarry rock, including on-going enhancements that may be developed prior to the start of the Project.	No Linkage
	• Air and dust emissions and subsequent deposition can cause chemical changes to the environment, which can alter soil quality and affect vegetation.	• Regular maintenance of equipment will continue at the Ekati Mine. • Dust suppression will be applied as appropriate to roads, airstrip, and laydown areas. • Speed limits will continue to be applied to limit fugitive dust. • Salvaged soil materials stockpiles or exposed soils will be seeded, where necessary, to reduce wind erosion.	Secondary
	• Dust deposition may cover vegetation and lead to physical damage.		Secondary
	• Introduction of non-native invasive plant species can affect plant community composition.	• The surficial materials may be salvaged, where practical, for possible future use in reclamation, per established practice at the Ekati Mine. • Local seed collection will continue per established practice for reclamation through direct seeding of nursery propagation. • Certified seed will be used for reclamation activities, per the existing Ekati Mine ICRP. • Reclamation objectives reflect the local native vegetation communities. • New equipment brought to the Ekati Mine for the Jay Project, will be cleaned to reduce the potential for introduction or spread of non-native species, according to established practices at Ekati Mine. • If non-native invasive species are identified, a response plan will be established as per current practice at the Ekati Mine.	Secondary

Table 11.3-1 Potential Pathways for Effects to Plant Populations and Communities

Jay Project Component/Activity	Effects Pathway	Environmental Design Features and Mitigation Practices	Pathway Classification
• Mine Rock Management.	• Seepage and surface runoff from WRSAs and kimberlite stockpiles can cause changes in groundwater, surface water and soil quality, and affect vegetation.	• Metasediment rock mined from the Jay open pit will be encapsulated within a thermally protective cover layer of granite such that metasediment is frozen into permafrost; this continues the approach successfully established at the Ekati Mine. • The existing Ekati Mine WROMP, including seepage monitoring, will be expanded to include the Jay WRSA. • Thermistors will be installed within the waste rock piles to monitor the progression of permafrost development. • Mine rock used to construct the dikes will be non-potentially acid generating (non-PAG). • The WRSA will include a basal layer of non-PAG granite that enhances permafrost aggradation and physically separates potentially reactive materials to prevent drainage with low pH.	No Linkage
• Site Water Management. • Dewatering of diked area of Lac du Sauvage. • Diversions.	• Dewatering of diked area of Lac du Sauvage may result in newly established vegetation on the exposed lakebed sediments.	• None possible, these changes will be temporary (during mine operations only).	Secondary
	• Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels from the dewatering of the diked area of Lac du Sauvage may change soils and affect vegetation.	• Where practical, natural drainage patterns will be unaltered to reduce the use of ditches or diversion berms. • The diversion channel that will be constructed at the Christine Lake outflow (Sub-Basin B Diversion Channel) will be reclaimed at closure so that water flows through the natural drainage pattern to Lac du Sauvage. • Culverts will be installed along site access roads, as necessary, to maintain drainage. • The road route alignment will minimize stream crossings and limit disturbance to sensitive habitat as feasible. • The Sub-Basin B Diversion Channel will be designed to manage flows and minimize potential for erosion and bank instability. • Dewatering and operational discharges will be monitored for downstream erosion and actions will be taken to prevent erosion in downstream lakes and channels.	Secondary
	• Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels may change water quality (e.g., suspended sediments, metals, and nutrients) and may cause changes to soils and vegetation.	• The Sub-Basin B Diversion Channel will be designed to manage flows and minimize potential for suspended sediment generation from bed and bank erosion. • Construction and monitoring of settling/sediment ponds and/or water treatment areas will be part of dewatering and minewater management • Water quality monitoring for total suspended solids will be completed during the dewatering period. • Standard erosion and sediment control measures (e.g., silt curtains, runoff management) will be used during construction, where appropriate	No Linkage
• General Closure and Decommissioning Activities. • Removal of project infrastructure. • Removal of dikes and diversions. • Back-flooding of Jay Pit.	• Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels from the back-flooding of the diked area of Lac du Sauvage may change soils and affect riparian vegetation.	• The existing Ekati Mine ICRP will be expanded to include the Jay Project. • Dike breaching and re-flooding of the dewatered area will be done in a controlled manner so water levels will be equalized on both sides of the dike and back-flooding will be managed to avoid adverse effects in source waterbodies and downstream. • Water quality monitoring for total suspended solids will be completed during the back-flooding period. • During excavation of dike breaches, silt curtains and other sediment and turbidity mitigation will be used as appropriate. • Reclamation of shoreline and shallow areas within the diked area will include localized repair of erosion and revegetation with aquatic and riparian plants, as necessary.	Secondary
	• Long-term seepage from WRSAs may cause local changes to soil quality and affect vegetation.	• Following established Ekati Mine WRSA practices, potentially acid generating metasediment rock will be encapsulated within a thermally protective cover layer of granite to facilitate permafrost development. • The existing Ekati Mine WROMP, including seepage monitoring, will be expanded to include the Jay WRSA. • Thermistors will be installed within the WRSA to monitor permafrost.	No Linkage
• Accidents and Malfunctions	• Chemical spills (i.e., fuels, petroleum products, reagents, pipeline leaks) on site can cause changes to soil quality and affect vegetation.	• The existing Spill Contingency Plan in place for the Ekati Mine will be expanded to include the Jay Project. • Regular equipment maintenance (e.g., regular checks for leaks) will continue. • Drip trays and/or absorbent pads are used during servicing and refuelling. • All hazardous substances are stored and handled on site in accordance with applicable regulations. • Fuel is stored at a central bulk fuel farm at the Ekati Mine main camp and at satellite fuel farms located at Misery, Fox, and Koala North. Fuel tanks are housed within bermed areas. • The Project will follow Ekati Mine's standard policies in the event of a spill; spill response training is provided and updated. • Soil and snow affected by hydrocarbon spills will continue to be handled in accordance with the existing Hydrocarbon-impacted Materials Management Plan and will be remediated in the landfarm or shipped off-site. • Minewater and fine processed kimberlite slurry pipelines will be monitored and inspected throughout construction (i.e., dewatering of diked area), operations, and closure. • Any leaks or spills identified along the pipelines will be addressed immediately and clean-up, if required, will be implemented following the existing Spill Contingency Plan.	No Linkage

WRSA = waste rock storage area; ICRP = Interim Closure and Reclamation Plan; WROMP = Waste Rock and Ore Storage Management Plan; PAG = potentially acid generating.

11.3.2.2.1 *Pathways with No Linkage*

A pathway may have no linkage to effects if the activity does not occur, or if the pathway is removed by mitigation and environmental design features so that the Project results in no measurable change in measurement indicators. Subsequently, no residual effect is expected. The pathways in the following bullets are anticipated to have no linkage to effects on vegetation and are not carried through to the effects analysis (Section 11.4).

- Use of explosives can cause changes to soil quality and affect vegetation.

Use of explosives during the Project has potential to change soil quality and affect vegetation. Ammonium nitrate fuel oil explosives may be used to remove the glacial till and waste rock from the Jay Pit (Section 3.5.3). This type of explosive has the potential to leave nitrogen residual substances (e.g., ammonia and nitrate) on the blasted material. Blasting activities and the removal of waste rock could also increase dust deposition.

Blasting activities will be managed using current practices applied at Ekati Mine. These practices have evolved in site-specific efficiency throughout the 15 plus years of operations at the Ekati Mine to provide good blast performance. Current blasting practices reduce the potential for enhanced nitrogen loading of soils. Seepage and surface water runoff from the waste rock storage area (WRSA) will be monitored for nitrogen residual substances according to the existing Ekati Mine Waste Rock and Ore Storage Management Plan (WROMP). Based on site-specific experience, the amount of residue in the waste rock is anticipated to diminish over time and is not expected to result in measurable changes to soil quality. Consequently, changes to soil quality from the use of ammonium nitrate fuel oil explosives were determined to have no linkage to effects on vegetation VCs.

- Seepage and surface runoff from WRSAs and kimberlite stockpiles can cause changes in groundwater, surface water, and soil quality, and can affect vegetation.
- Long-term seepage from the WRSAs may cause local changes to soil quality and affect vegetation.

Surface runoff, seepage, and long-term seepage from waste rock can change groundwater, surface water, and soil quality. Changes to groundwater, surface water, and soil quality can affect vegetation health. Acid rock drainage and metal leaching can result from chemical weathering of minerals present in rock exposed during construction and mining. When potentially acid-generating rock is exposed to the atmosphere, oxidation of sulphide minerals can produce acidic compounds, sulphate, and metals. Metasedimentary and diabase rock are considered potentially acid-generating because they contain trace amounts of sulphide minerals. Approximately 25% of waste rock from the Jay Pit will be metasedimentary, with minor amounts of diabase (Section 3.3.2). The remaining 75% of waste rock from the Jay Pit will be granite, which is non-acid-generating and non-metal-leaching.

Waste rock from the Jay Pit will be stored in the new Jay WRSA. The existing Ekati Mine WROMP will be expanded to incorporate the Jay WRSA. Seepage quality will be monitored and reported to the Wek'èezhìi Land and Water Board as part of the requirements set out in the Water Licence.
The Jay WRSA will be constructed following existing Ekati Mine WRSA practices to facilitate permafrost development. Any potentially acid-generating waste rock removed from the Jay Pit will be encapsulated for closure within a thermally-protective cover of non-acid-generating material (in this case 5 metres [m] of granite rock). The WRSA will be monitored for long-term thermal performance as part of existing monitoring programs under the WROMP and ICRP.

Processing of the Jay kimberlite is expected to generate processed kimberlite. The Panda and Koala open pits are the primary deposition locations for processed kimberlite resulting from the Project (Section 3.5.6; Project Description). The use of mined-out open pits for processed kimberlite deposition has generally been acknowledged as a preferred approach as outlined in the original Environmental Assessment in 1995 (Section 3.5.6).

The Jay WRSA will be stabilized according to the methods described in the Ekati Mine ICRP and will focus on providing a thermally protective surface cover over potentially acid-generating materials and providing a relatively flat upper surface that discourages snow accumulation.

Changes to groundwater, surface water, and soil quality from surface runoff and seepage, and from long-term seepage from leaching of potentially acid-generating mine rock in the WRSA and from the kimberlite storage facilities, is expected to be limited through the use of mitigation and environmental design features. No change to soil quality is predicted. Consequently, this pathway was determined to have no linkage to effects on vegetation VCs.

- Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels may change water quality (e.g., suspended sediments, metals, and nutrients) and may cause changes to soils and affect vegetation.

Construction and operation of the Project may change surface flows and lake levels, which can change the water quality directly through altered chemistry or indirectly through change in biogeochemical processes. Water quality changes from changes in surface flows and lake levels may lead to the deposition and accumulation of sediments, metals, and nutrients onto soils adjacent to receiving waterbodies, thereby changing soil quality. Changes in soil quality can influence soil nutrient cycling, microbial communities, and the bioavailability of nutrients and metals for plant uptake (Ewing and Singer 2012; Pan 2012; Violante et al. 2012).

Runoff and surface flows will be managed as part of dewatering and minewater management in the Mine Water Management Plan to limit introduction of sediment into receiving waterbodies. Where practical, natural drainage courses will be used to reduce the need for constructed ditches and diversion berms. Existing erosion and sediment control practices (e.g., silt curtains) already in place at the Ekati Mine will be implemented to limit the generation of sediments, metals, and nutrients from changes in surface water. To reduce the potential for erosion in channels or backwatering due to higher than normal water flows and levels, natural drainage courses will be surveyed to evaluate capacity, and then modified, if required.

Water quality monitoring will occur during the Project and water will not be released to the surrounding environment unless it meets discharge criteria. Areas of exposed soils may require localized repair of erosion and re-vegetation to stabilize and prevent erosion (BHP Billiton 2011). This work will be based on experience gained through operations and closure of other areas of the Ekati Mine and is summarized in the ICRP.

It is anticipated that implementing environmental design features and mitigation will result in minor changes to water quality and would cause minor and local changes to soil quality. The minor changes to water and soil quality are not anticipated to cause measurable changes to vegetation VCs. Therefore, this pathway was considered to have no linkage to residual effects on vegetation VCs.

- Chemical spills (i.e., fuels, petroleum products, reagents, pipeline leaks) on site may cause changes to soil quality and affect vegetation.

Spills during construction, operations, or decommissioning and reclamation activities have the potential to change soil quality and affect vegetation. Spills that occur in high enough concentrations could contaminate soils and water and cause direct toxicity to vegetation. Spills are generally local in nature.

Mitigation identified in the existing Ekati Mine Spill Contingency Plan and environmental design features will be in place to limit the frequency and extent of spills that have potential to occur during Project activities. Hazardous materials and fuel will be stored, transported, and handled according to regulatory requirements to protect the environment and workers. Bulk fuel storage for the Project is within bermed containment areas. Emergency spill kits will be provided wherever hazardous materials or fuel are stored and transferred.

Hydrocarbon-impacted soil with average particle size less than 4 centimetres (cm) will be contained in the existing landfarm. Hydrocarbon-impacted soil that is unsuitable for on-site treatment will be temporarily stored in the landfarm until it is shipped off site for proper disposal (Section 3.4.1.8.5). Hydrocarbon-impacted snow and ice will be contained in the contaminated snow containment facility (Section 3.4.1.8.6). Individuals working on site and handling hazardous materials will be trained in spill response as per the Spill Contingency Plan.

Failure of minewater and fine-processed kimberlite slurry pipelines could result in the release of non-compliant water to the surrounding environment. During operations, minewater that may be non-compliant with the Water Licence will be pumped from the Jay pit and surface minewater sumps to the Misery pit. Additionally, fine-processed kimberlite slurry will be pumped from the processing plant to the mined-out Panda and Koala open pits. The fine-processed kimberlite slurry pipelines will lie within the catchments of the Ekati Mine camp and open pit collection systems such that spills would be contained in these areas.

Mitigations and management identified in Ekati Mine's existing Wastewater and Processed Kimberlite Management Plan (WPKMP) and environmental design features will be in place to limit the potential for pipeline failure. The integrity and performance of the pumping and pipeline systems will be monitored throughout the Project construction and operations phases to prevent the unintentional release of minewater to the environment. In the event of any leaks and spills from the pipeline, clean-up will follow existing procedures in place at Ekati Mine.

The implementation of the Ekati Mine Spill Contingency Plan and existing mitigation and environmental design features are anticipated to reduce the likelihood and extent of the release of spills and hazardous materials on-site, and mitigate the unintentional release of minewater from pipelines to the environment. Thus, spills occurring from Project construction and operations are not expected to change soil quality. Therefore, this pathway was considered to have no linkage to effects on vegetation VCs.

11.3.2.2.2 *Secondary Pathways*

In some cases, both a source and an interaction exist, but the Project is anticipated to result in a minor environmental change, and would have a negligible residual effect on vegetation relative to Base Case values. The pathways described in the following bullets are expected to be secondary and are not carried through the residual effects analysis (Section 11.4).

- Changes to permafrost conditions from the Project footprint can cause changes to soils and affect vegetation.

Loss and alteration of permafrost from the Project footprint have the potential to affect surface hydrology, soil moisture, nutrient availability and, thereby, vegetation. Freeze-induced displacement of soil (i.e., frost jacking) and thaw-induced displacement (i.e., subsidence) of soil are the main issues related to permafrost degradation. Changes to thaw penetration and thickness of the active layer can influence surface stability, through thaw settlement, frost heave, and bearing capacity, as well as slope stability (Tarnocai et al. 2004). Changes to the permafrost active layer can also affect vegetation by altering local hydrology, soil moisture, and nutrient availability conditions.

Numerous factors determine the magnitude of changes to permafrost areas and influence recovery of an area following disturbance, including type of construction activities, site infrastructure, vegetation, soil type, soil texture, density, water content, and snow depth (Lawson 1986; Nolte et al. 1998; Jorgenson et al. 2010). Thaw settlement caused by disturbance and subsequent melting of permafrost can initially lead to water impoundment, decreased albedo, and an increase in heat flux, which in turn cause more thaw settlement (Jorgenson et al. 2010). This can result in a change in surface hydrology that shifts recovery patterns towards new plant communities, further influencing permafrost. The depth of the active layer may continue to increase as a result of disturbance (Burgess and Harry 1990; Burn and Smith 1993; Hayhoe and Tarnocai 1993).

The ESA is within the continuous permafrost zone, where permafrost may occupy approximately 90% to 100% of the area (Natural Resources Canada 1995). The permafrost in this area is characterized by having a low ice content, which indicates the ground ice content in the upper 10 to 20 m of the ground has less than 10% ice content by volume of visible ice (Natural Resources Canada 1995). Soil present in the ESA ranged from having Low potential for permafrost (rapidly drained Brunisolic and Regosolic soils) to High (rapidly drained Cryosolic soils and imperfect to poorly drained Cryosolic and Organic soils; Appendix 11A, Section 11A1.2.2.2). Within the ESA, permafrost, when present, would likely have low ground ice content.

The amount of ground ice present in permafrost is important for assessing the response of permafrost to clearing, construction, and subsequent recovery of ice conditions following disturbance (Jorgenson et al. 2010). Areas with high ground ice content (i.e., terrain with abundant ice wedges) should be avoided where feasible. These areas are more sensitive to thaw-settlement and can result in longer-term changes in terrain, soils, surface hydrology, and vegetation (Jorgenson et al. 2010). Conversely, areas with small volumes of ground ice are not as sensitive to thaw settlement (Lawson 1986). Soil present in the ESA ranged from having Low potential for permafrost (rapidly drained Brunisolic and Regosolic soils) to High (rapidly drained Cryosolic soils and imperfect to poorly drained Cryosolic and Organic soils). Within the ESA, permafrost, when present, would likely have low ground ice content (Section 11A1.2.2.2).

The 1995 Environmental Impact Statement predicted that local disturbance of the permafrost layer would occur due to mine activities such as the digging of open pits, storage of waste rock, and construction of roads and the Long Lake Containment Facility. The disturbances were predicted to be local in nature and restricted to the mine footprint (BHP and Dia Met 1995). These predictions have been verified by results of permafrost monitoring undertaken to support Ekati Mine's original approval (BHP Billiton 2009, 2012). The low relief of the claim block and the implementation of appropriate engineering design and construction practices specific to Arctic areas typically mitigate most of the mine effects on permafrost. Permafrost will also form within the WRSAs as they cool.

Key mitigation and environmental design features to reduce the potential for permafrost melting are:

- Design of the Project minimizes the construction of new buildings, roads, pads, or excavations that might have an effect on permafrost.
- Footprints of the WRSAs and other structures will be optimized to limit surface disturbance to the extent practical.
- Disturbance will be limited to only those areas required for construction and operation of the Project.
- Buildings will be insulated to minimize heat loss, and will be dismantled as part of reclamation activities.

By implementing mitigation practices and based on site-specific experience, minor local changes to permafrost, soils, and plant community abundance and distribution relative to Base Case conditions within the Project footprint are anticipated. Consequently, this pathway was determined to have a negligible residual effect on vegetation VCs.

- Air and dust emissions and subsequent deposition can cause chemical changes to the environment, which can change soil quality and affect vegetation.

Construction and operation of the Project will generate air emissions such as carbon monoxide (CO), oxides of sulphur (SO_x includes sulphur dioxide [SO_2]), oxides of nitrogen (NO_x), particulate matter ($PM_{2.5}$), and total suspended particulates (TSP). Air emissions such as SO_x and NO_x can result from the use of fossil fuels in generators, vehicles, machinery, and the use of explosives used during the Project. Transportation routes used to access the Project and the dewatered diked area in Lac du Sauvage are the main source of dust ($PM_{2.5}$ and TSP) due to the re-suspension of soil and sediment particles (Farmer 1993; Harrison et al. 2003; Peachey et al. 2009; Liu et al. 2011).

The deposition of air and dust emissions can lead to changes in soil quality by altering soil pH and nutrient content, and soil fauna composition (Rusek and Marshall 2000; Jung et al. 2011). The related changes to soil from atmospheric inputs is determined by complex geochemical factors, which include nutrient uptake by plants, decomposition of vegetation, cation and anion exchange in soil, soil sensitivity to acidification, and duration and quantity of atmospheric inputs (Turchenek et al. 1998; Jung et al. 2011). Changes in soil fauna and soil quality can lead to effects on vegetation, as there could be alterations in rates of organic matter decomposition and nutrient cycling (Rusek and Marshall 2000). Deposition of SO_x and NO_x can also lead to acidification of wetlands, which can cause changes in plant communities (Bobbink et al. 1998). Deposition of SO_x and NO_x to vegetation can also have direct effects on plant communities.

Changes to soil and vegetation from atmospheric inputs of SO_x and NO_x and potential for acidification depend on the buffering capacity of the soil and the vegetation cover present in the receiving environment (Bobbink et al. 1998; Barton et al. 2002; Jung et al. 2011; Jung et al. 2013). Brunisolic and Regosolic soils in the ESA were rated as having a High sensitivity to acidification (Appendix 11A, Section 11A1.2.2.3.2). Cryosolic soils were rated as having a Medium sensitivity. Organic, Gleysolic, and peaty phase wetland soils, and the associated wetlands have a Low to Medium sensitivity (i.e., soil in Sedge Wetland is rated as Low and Tussock/Hummock is rated as Medium).

In addition to changes from the deposition of SO_x and NO_x chemical changes can occur from the deposition of dust. Rates of dust deposition and accumulation are dependent on the rate of supply from the source, wind speed, precipitation events, topography, and vegetation cover (Rusek and Marshall 2000; Liu et al. 2011). The indirect responses of vegetation to changes in soil quality depend on the chemical compositions of dust and its source (e.g., dried lake bed sediments) (Grantz et al. 2003). Total metal concentration were generally below sediment quality guidelines, with the exception of arsenic, chromium, and copper (Water and Sediment Quality Baseline Report Annex XI, Section 5.1). Dust deposition can also cause chemical loading in soils and plants if dust emissions include elevated concentrations of metal particles. Metal particle deposition can result in increased metal concentrations in plant leaves (Grantz et al. 2003; Peachey et al. 2009). Metal particle deposition can also affect soil biota composition (Grantz et al. 2003), which could indirectly affect vegetation. Although additions of metals through dust deposition can change vegetation chemistry, Peachy et al. (2009) found that vegetation that received metals from dust deposition did not cause direct toxicity to plants.

In addition to metals, dust can contain other cations and anions. The presence of cations such as calcium in dust emissions can reduce the acid generating potential of the SO_2 and NO_x because they tend to react with bases (e.g., carbonates) found in dust (McNaughton et al. 2009). When cations (e.g., ammonium) are deposited into an ecosystem, the vegetation present can take up the cation; however, hydrogen [H^+] can be released into the environment and decrease soil pH (Turchenek et al. 1998). When anions (e.g., chloride) are deposited into an ecosystem, anions such as hydroxide [OH^-] can be released. Although OH^- increases pH, cation and anion uptake has generally been shown to result in a net production of acidity. The net effect is acidification because the cations are generally retained in the plant biomass and are therefore not mineralized. Ultimately, the concentration and duration of air and dust emissions and the sensitivity of the ecosystems determine the overall influence that emission deposition will have on vegetation (Bobbink et al. 1998).

Air quality modelling was completed to predict the spatial extent of air and dust emissions and deposition from the Project (Section 7.4). Air quality modelling was completed for the Base Case and Application Case. The Base Case includes emissions from the existing Ekati Mine and the Diavik Mine (Section 7.4.1). The Application Case includes the Base Case plus emissions during the worst case operations year and provides the maximum potential effects from the Project. Assumptions were incorporated into the model to contribute to conservative estimates of emission concentrations and deposition rates.

Results of the air quality modelling indicate that the maximum ground-level concentrations of CO and SO_x, are below the Northwest Territories Ambient Air Quality Standards (GNWT-ENR 2014; Section 7.4.2.2). The maximum 1-hour and annual NO_2 concentrations are above the NWT standard in both the Base Case and Application Case. The maximum 24-hour NO_2 concentrations in the Base Case are below the NWT standard but above the standard in the Application Case. All predictions exceeding the NWT standards are confined to small areas within a few hundred metres from the edge of the Diavik Mine or Jay Pit. These higher predictions are primarily a result of mine fleet exhaust along the haul roads at the perimeters of the mine sites. The predicted concentrations decrease with distance from the edge of the mine sites.

Modelling results indicate that the maximum annual potential acidic inputs is 1.46 kiloequivalents per hectare per year (keq/ha/yr), and is associated with the boundary of the Jay Pit. The Project's maximum annual potential acidic input outside of the Project footprint is predicted to be between 0.17 keq/ha/yr to 0.5 keq/ha/yr, with values dropping below 0.17 keq/ha/yr within 1 km of the Project.

The maximum annual $PM_{2.5}$ emissions resulting from the Project is 39.4 micrograms per cubic metre ($\mu g/m^3$), which is above the NWT air quality standard of 10 $\mu g/m^3$. The maximum annual TSP emissions resulting from the Project is 607 $\mu g/m^3$, which is above the annual NWT air quality standard of 60 $\mu g/m^3$. The maximum annual totals are predicted to be confined to the boundaries of the existing Ekati Mine, the Jay Pit and the Diavik Mine. The area with $PM_{2.5}$ and TSP above the annual NWT air quality standards extends no further than approximately 1 km beyond the sources. In addition, because of the conservatism used for the air quality modelling, it is expected that the actual $PM_{2.5}$ and TSP concentrations at the Project will be lower than predicted, closer to the concentrations currently measured at the Ekati Mine.

Overall, air and dust emissions and subsequent deposition are expected to result in minor and local changes soil quality and the abundance and distribution of plant communities relative to Base Case conditions. Therefore, this pathway was determined to have a negligible residual effect on vegetation VCs.

- Dust deposition may cover vegetation and lead to physical damage.

Accumulation of dust (i.e., particulate matter and total suspended particulate deposition) produced from the Project may result in a local direct change on the quantity, distribution, and quality of vegetation within the ESA. During Dominion Diamond's engagement and the MVRB's scoping and technical sessions for the Project, Elders and communities expressed concerns about the effects of dust on the vegetation in and around Ekati Mine.

Deposition of dust onto vegetation can result in a variety of physiological effects, including reduced water content, chlorophyll content, respiration, reception of radiation or photosynthesis, carbon uptake, and increased conductivity (Spatt and Miller 1981). Larger dust particles can cause visible injuries and abrasions (Farmer 1993; Grantz et al. 2003), while smaller dust particles landing on leaves can affect photosynthesis by blocking sunlight and reduce respiration and transpiration by clogging stomata (Farmer 1993; Grantz et al. 2003). Dust on vegetation can also result in a reduction of plant growth and biomass, and can alter species composition (Grantz et al. 2003). Walker and Everett (1987) and Everett (1980) reported that few vascular plant species showed physiological effects from dust, except where vegetation was subject to very high dust loading.

Sources of dust deposition modelled in the Application Case include blasting activities, the processing plant, activities at the open pit and other ancillary facilities, the exposed lake bed sediments, the air strip, and vehicle traffic along the mine roads (Section 7.4). The results of the air quality modelling predicted that the estimated deposition rate outside of the Project footprint is approximately 4,722 kilograms per hectare per year. The maximum deposition that occurs would be mostly associated with the Jay Pit and haul roads. This conservative estimate is equivalent to 1.29 grams per square metre per day ($g/m^2/d$). Lichens and mosses that derive some of their moisture and nutrient requirements from the atmosphere can be sensitive to the effects of dust (Farmer 1993).

Some lichens can trap dust particles and others have been found to incorporate the dust into their tissue; however, this is dependent on the growth form of the lichen (Farmer 1993). Direct effects on lichen are likely more important in ground-dwelling lichen species that normally receive all of their nutrients directly from the atmosphere. Dust can shade the lichen or interfere with the lichen-wall exchange sites and affect nutrient uptake (Farmer 1993). Mosses such as *Sphagnum* are sensitive to dust deposition. *Sphagnum* along a gravel road in the Alaskan tundra have been observed to have decreased photosynthetic rates and a decline in cover when dust deposition was 1.0 to 2.5 $g/m^2/d$ (Farmer 1993). Although there was a decline in *Sphagnum* cover, it was replaced by more tolerant mosses such as haircap moss (*Polytrichum* spp.) and Bryum moss (*Bryum* spp.) (Farmer 1993). Auerbach et al. (1997) found that, although plant species composition may change and aboveground biomass may be reduced by dust deposition, ground cover is still maintained. Species such as cottongrass (*Eriophorum* spp.) are more tolerant of dust and were found to be more abundant next to a road, and some shrub species such as willow (*Salix* spp.) increase in cover with dust deposition (Auerbach et al. 1997). Long-term monitoring at the Diavik mine indicates that dust deposition adjacent to the mine has resulted in statistically lower lichen cover and higher vascular plant species richness relative to reference plots (Golder 2014).

The area receiving dust deposition extends no further than approximately 1 km beyond the Project footprint. This is to be expected, as in general the majority of dust tends to settle out within 1 km of ground-level sources, which are the primary sources of TSP at the Project (Everett 1980; Walker and Everett 1987; Watson et al. 1996; Meininger and Spatt 1988; Grantz et al. 2003).

Environmental design features and mitigation have been incorporated into the Project to reduce potential effects from dust deposition (Table 11.3.1). For example, dust suppression will be applied as appropriate to roads, airstrip, and laydown areas and speed limits are established on all roads to reduce the production of dust. These environmental design features and mitigation, which should reduce dust deposition, have not been incorporated into the modelling; thus, the modelling results provide conservative estimates of deposition rates (Section 7.4). Because of the conservatism used for the air quality modelling, it is expected that the actual dust deposition from the Project will be lower than predicted, closer to the concentrations measured currently at the Ekati Mine. In addition, because the result represents the emissions during worst case operations year (i.e., during initial blasting of the Jay Pit), once mining activities advance, it is expected that dust will no longer be emitted outside of the Jay Pit. The amount of dust deposition will decrease substantially.

Dust deposition is expected to result in minor and local changes to vegetation quantity (i.e., a change in species composition) and health relative to Base Case conditions. Therefore, this pathway was determined to have a negligible residual effect on vegetation VCs.

- Introduction of non-native invasive plant species can affect plant community composition.

The construction, operation, and reclamation of the Project have potential to introduce non-native invasive plant species into new areas, especially when entering areas with known populations of non-native invasive plant species. Construction equipment and personnel have the potential to introduce non-native invasive plant species into new areas by transporting seed or plant parts on equipment or clothing. Preventing invasive species from entering an area is often more efficient and cost effective than dealing with their removal once established (Clark 2003; Polster 2005; Carlson and Shepard 2007).

The introduction of these species can disrupt plant communities and decrease habitat quality by affecting plant community structure and species diversity directly through competition, and indirectly through alterations to soil microorganisms, nutrients, and soil moisture (Mack et al. 2000; Carlson and Shepherd 2007; Truscott et al. 2008).

The majority of non-native invasive plant species introductions arise from human transport (Mack et al. 2000; Reichard and White 2001). Roads also act as dispersal routes and habitat for non-native invasive plant species establishment (Parendes and Jones 2000). Transportation corridors to and from construction areas provide a means of ingress for non-native invasive plant species through direct dispersion of plant propagules (seeds and/or vegetative parts) from vehicles and machinery, and indirectly through the formation of suitable sites for non-native invasive plant species in the form of disturbed areas. Many non-native invasive plant species are able to spread more easily in landscapes that have been fragmented, and often become established along edge habitats, such as disturbed road edges associated with transportation corridors (Lafortezza et al. 2010).

As of 2014, there are no known alien plant species with a high level of invasiveness in the NWT (GNWT-ENR 2014). A high level of invasiveness refers to species that invade man-made disturbed habitats and natural habitats quickly, are hard to eradicate, and have severe ecological impacts on physical processes, plant or animal communities, and vegetation structure (GNWT-ENR 2014). The majority of the documented occurrences of these species are located outside the ESA in the Taiga Plains (south) and Taiga Shield near the Mackenzie River, west of Yellowknife, and near the communities of Fort Simpson, Hay River, and Fort Providence (GNWT-ENR 2014). These species are mostly found in or near communities, along roads, and in disturbed areas such as cut-lines, pipelines, and mine sites.

No historical records of the species on the non-native invasive plant species list (GNWT-ENR 2014) occurred in the ESA, and none were recorded during the 2013 and 2014 vegetation surveys (Section 11.2.2.4). European stickseed (*Lappula squarrosa* syn. *L. echinata*) was documented at the main camp and along the Long Lake Containment Facility perimeter road on July 4, 2013 (Martens 2014). This species is listed as alien in the NWT and the usual range of this species is not in the NWT (GNWT-ENR 2014). This plant is an annual or winter annual that reproduces by seed and is typically found in man-made and disturbed habitats in the western plains (Alberta Agriculture 1988; Whitson et al. 2009). It is a prolific seed producer and is easily spread on animal hair and clothing because of the hooked spines on the seed.

Routine monitoring will be completed to evaluate the presence of non-native invasive plant species including European stickseed. If non-native invasive species are identified, a response plan will be established as per current practice at the Ekati Mine. In the event new equipment is brought to the Ekati Mine for the Jay Project, all equipment will be cleaned to reduce the potential for introduction or spread of non-native invasive species, according to established practices at Ekati Mine.

Local seed collection will continue per established practice for reclamation through direct seeding of nursery propagation. Certified seed will be used for reclamation activities, as per the existing Ekati Mine ICRP. Some plant species have both native and alien invasive subspecies and varieties. Species used in seed mixes will be checked with the invasive species list so that alien invasive subspecies and varieties are not used in seed mixes during reclamation. If non-native invasive species are identified, a response plan will be established as per current practice at the Ekati Mine.

The implementation of mitigation will reduce the potential for introduction or spread of non-native invasive species. The localized introduction or spread of non-native invasive plant species could result in minor and local changes to abundance and distribution of plant communities relative to Base Case conditions. As such, this pathway was determined to have a negligible residual effect on vegetation VCs.

- Dewatering of the diked area of Lac du Sauvage may result in newly established vegetation on the exposed lakebed sediments.

It is expected that vegetation will colonize the dried dewatered areas within the dike area, which may reduce potential for soil erosion, and result in an increase in plant communities and vegetation cover in this area. Odland and del Moral (2002) found that vegetation, primarily annuals, rapidly established in areas of drawdown and they found that this rapid establishment was a result of the persistent seed bank present in the soil. The primary influence of plant colonization on a lake bed is the condition of the surface (e.g., moisture status, resistance to wind erosion) and proximity to the former shoreline (Ovenden 1986). Species commonly observed to colonize disturbed and drawdown areas often include the genera *Carex*, *Puccinellia*, *Arctagrostis*, *Calamagrostis*, *Epilobium*, and *Polytrichum* (Ovenden 1986; Kershaw and Kershaw 1987; Odland and del Moral 2002; Hugron et al. 2011).

Establishment of vegetation in these areas has the potential to increase vegetation cover during operations. During closure, filling of the open pit and breaching of the dike would remove vegetation established during operations. Overall, the establishment of vegetation in the diked area during the operation of the Project is predicted to result in a local and minor change in the abundance and distribution of plant communities relative to Base Case conditions, and a negligible residual effect on vegetation VCs.

- Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels from the dewatering of the diked area of Lac du Sauvage may change soils and affect vegetation.
- Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and changes in water levels from the back-flooding of the diked area of Lac du Sauvage may change soils and affect vegetation.

Dewatering of the diked area of Lac du Sauvage and diversion of headwater flows from tributaries that flow into this area are required for the Project. The location of the proposed Jay Pit currently receives runoff from sub-basin B and a small portion of the Lac du Sauvage main watershed. To divert water away from the proposed Jay Pit, the Sub-Basin B Diversion Channel will be constructed to divert water to Lac du Sauvage outside the dewatered area. Changes in water levels in Lac du Sauvage beyond the natural range of variation could lead to a loss of soils through erosion and change the quantity and quality of vegetation. In addition to changes in lake water levels, inflows and outflows (e.g., altered drainage patterns, flow velocities) could affect vegetation downstream.

Wetland and riparian vegetation distribution is a result of water regime and a plant species tolerance to flooding and saturation (Casanova and Brock 2000; Odland and del Moral 2002). Natural water fluctuations result in cyclic vegetation changes. Alternating wet and dry patterns determine plant establishment and composition by stimulating or inhibiting germination of seeds in the soil seed bank (Casanova and Brock 2000) and water depth is the primary influence on seed bank composition (Lu et al. 2010). Prolonged flooding or drying eliminates some plant species while favouring others because of changes in soil oxygen levels, nutrients, and species tolerance to saturated or dry soil conditions (Casanova and Brock 2000).

A change in lake levels would alter the distribution of wetlands, riparian, and upland areas in relation to the changes in soil moisture (Nilsson and Svedmark 2002; Odland and del Moral 2002; Shafroth et al. 2002; Leyer 2005). As soil moisture levels change because of changes in surface flows and water levels, plant species that thrive in drier soil moisture regimes can out-compete riparian species that rely on fluctuations in soil moisture (Shafroth et al. 2002; Leyer 2005).

Dewatering of the diked area to Lac du Sauvage is expected to temporarily increase the lake water level and outflow. During construction, the largest changes to Lac du Sauvage would result from dewatering discharge. The dewatering phase modelling predicts an increase of up to 0.05 m in the water level in Lac du Sauvage compared to median baseline conditions, and an increase in the 2-year daily peak flood discharge of approximately 10% compared to baseline conditions (Section 8.5.3.2). Discharge flow rates will be managed to reduce the potential for soil loss through erosion and changes to riparian vegetation.

At closure, the back-flooding of the Jay Pit is predicted to result in a decrease in Lac du Sauvage water levels of up to 0.06 m (Section 8.5.3.2). Back-flooding will be managed to minimize adverse effects in source waterbodies and downstream. Following back-flooding of the Jay Pit, baseline water levels in Lac du Sauvage are anticipated to be re-established. The riparian (shoreline) and littoral (shallow) areas around the perimeter of Lac du Sauvage at the re-established water elevation will be reclaimed where necessary to enable natural regrowth of riparian and aquatic vegetation. The reclamation work is expected to include localized repair of erosion, and re-vegetation of select areas with aquatic and riparian plants as necessary. This work will be based on experience gained through reclamation research of riparian areas and operations and closure of other areas of the Ekati Mine.

The cumulative effects from overlapping activities for the Ekati and Diavik mines are within the Lac de Gras watershed downstream of the Lac du Sauvage sub-basin. Negligible effects to surface hydrology from Ekati Mine closure and Diavik Mine operational and closure activities are expected for Lac du Sauvage. Based on modelling results, the maximum annual change to the average Lac du Sauvage mean discharge is predicted to be less than 0.02% and the maximum annual change to the Lac du Sauvage mean water levels are predicted to be less than 0.001 m for the period of 2016 to 2037 (Section 8.5.3.3).

The largest cumulative increase in Lac de Gras outlet flows predicted is during Project dewatering and the back-flooding of the Fox Pit, and Diavik operational activities during 2019. Modelling results predicted a less than 1% cumulative increase in the mean annual discharge and a 0.001 m cumulative increase in the mean annual water levels as compared to baseline conditions (Section 8.5.3.3). The largest cumulative decrease in Lac de Gras outlet flows is predicted to occur during the back-flooding of the diked area in Lac du Sauvage in 2032. Modelling results predicted a 5% cumulative reduction in the mean annual discharge and a 0.04 m cumulative reduction in the mean annual water levels as compared to baseline conditions (Section 8.5.3.3). Cumulative effects to Lac de Gras outlet flows and water levels in an average climate year are within the range of natural variability.

Environmental design features and mitigation have been included to limit loss of soils through erosion and to reduce changes in the quantity and quality of wetland and riparian plant communities from dewatering and back-flooding the diked area in Lac du Sauvage. Lac du Sauvage water levels and outflow discharges will be monitored, and pit back-flooding rates may be adjusted during low water years. Cumulative changes in Lac du Sauvage and Lac de Gras are predicted to be temporary and within the range of natural variability. Minor and local changes in the abundance and distribution of soils and plant communities are predicted relative to Base Case conditions. Therefore, these pathways were determined to have a negligible residual effect on vegetation VCs.

11.3.2.2.3 *Primary Pathways*

The following primary pathway is assessed in detail in the residual effects analysis.

- Direct loss, alteration, and fragmentation of vegetation from the Project footprint.

11.4 Residual Effects Analysis

11.4.1 General Approach

11.4.1.1 *Project Phases*

The analysis is completed for the vegetation VCs:

- plant populations and communities;
- listed plant species and listed plant habitat potential; and,
- traditional use plants and traditional use plant habitat potential.

The Project phases are construction, operation, and closure. Final relinquishment of the Project will occur after the completion of reclamation. Many effects of the Project will end when operations cease or at closure, but effects on vegetation communities will continue after Project closure until vegetation is re-established.

The effects analysis encompasses the Project phases as follows:

- construction (2016 to 2019);
- operations (2019 to 2029); and,
- closure (2030 to 2033).

The above timeframes are intended to be sufficiently flexible to capture the effects of the Project on vegetation. Effects to vegetation VCs begin during the construction phase with the removal and alteration of vegetation, and continue through the operation phase and for a period of time during the completion of reclamation activities (unless determined to be permanent). Therefore, effects on vegetation were analyzed and assessed for significance from Project construction through closure and considers the time it takes for vegetation recovery. This approach generates the maximum potential spatial and temporal extent of effects on the abundance and distribution of plant communities, which provides confident and ecologically relevant effects predictions.

11.4.1.2 *Assessment Cases*

The residual effects analysis consists of three cases: Base Case, Application Case (the maximum point of development of the Project [includes construction, operation, and closure]), and the Reasonably Foreseeable Development (RFD) Case (if applicable; Table 11.4-1). Cumulative effects could occur in all three cases because of past, existing, and future mining and reclamation activities. The objective of the DAR is to assess cumulative effects for VCs where Project effects could contribute to a cumulative effect. Therefore, incremental and cumulative effects from the Project and other developments are analyzed and assessed together in this section of the DAR.

Table 11.4-1 Contents of Each Assessment Case

Base Case		Application Case	Reasonably Foreseeable Development Case
Reference Condition	**2014 Baseline Condition**		
No human development	Conditions from all previous, existing, and planned and approved developments.	Base Case plus the Project	Application Case plus reasonably foreseeable developments

Base Case represents a range of conditions over time within the ESA before application of the Project. Environmental conditions on the landscape prior to human development, which represent reference conditions, were considered independently within the Base Case. The Base Case describes the existing environment prior to the application of the Project, to provide an understanding of the current conditions that may be influenced by the Project. Existing (2014 baseline) conditions include the cumulative effects from all previous and existing developments and activities that are planned and approved (e.g., Lynx Project). The crusher/laydown area near Misery haul road and Misery WRSA is included in the 2014 baseline condition because it is anticipated to be in use prior to commencement of Jay Project construction. Current effects from ongoing projects that are approved (e.g., mining and reclamation at Ekati and Diavik mines) are included in the baseline condition. Previous and existing exploration activities and portages associated with winter roads are also included in the Base Case.

Application Case represents predictions of the cumulative effects of the developments in the Base Case combined with the effects from the Project. Physical disturbance to vegetation is expected to occur at the beginning of construction and the effects from the Project are expected to be strongest during construction and the initial period of mining operation. The main components of the Project footprint are the proposed infrastructure (Jay Pit, Jay WRSA, Ore Stockpile and Transfer Pad, Sub-Basin B Diversion Channel, and dike alignment) and Jay access roads, pipeline and power line. The physical changes to the terrestrial environment from the footprint and the effects on vegetation are considered permanent because the time required to reverse the effect is uncertain. The Application Case is also used to identify the incremental effects from the Project that are predicted to occur between the Base and Application cases.

Reasonably Foreseeable Development (RFD) Case represents the Application Case and reasonably foreseeable developments. The RFD Case includes the predicted duration of residual effects from the Project, plus other previous, existing, and future projects and activities. The RFDs are defined as projects that:

- are currently under regulatory review or have officially entered a regulatory application process;
- have a reasonable likelihood of being initiated during the life of the Project, or may be induced by the Project; and,
- have the potential to change the Project or the effects predictions.

None of the reasonably foreseeable developments identified in Section 6.5.2.4 are located within the vegetation ESA. The closest reasonably foreseeable development is the Courageous Lake project, which is located approximately 73 km to the southwest of the Project, outside of the ESA. Therefore, the RFD Case is not included in this section of the DAR.

11.4.1.2.1 *Previous and Existing Developments*

The Aboriginal Affairs and Northern Development Canada Cumulative Impact Monitoring Program provided the development database through the Inventory of Landscape Change initiative. The dataset included all disturbances for which information was publicly and digitally available, including developments requiring a land use permit, contaminated sites, transmission lines, winter and all-season roads, communities, and mines up to the end of 2013. The database also included recent land use permit applications from the Mackenzie Valley Land and Water Board and the Nunavut Impact Review Board up to the end of 2013. The number and type of previous and existing developments in the ESA are listed in Table 11.4-2 and illustrated in Map 11.4-1.

Table 11.4-2 Previous and Existing Developments in the Vegetation Effects Study Area for the 2014 Baseline Condition

Type of Development	Footprint Area (ha)	Number of Active Sites	Number of Inactive Sites	Linear Feature Length (km)
Lodge (outfitters, tourism)	0.2	1	0	n/a
Mine[(a)]	4,403	2	0	n/a
Mineral exploration	382	5	3	n/a
Staging area (equipment or material storage)	0.2	1	0	n/a
Winter road portages	60	n/a	n/a	24
All-season road segments	348	n/a	n/a	70
Total	**5,193**	**9**	**3**	**94**

a) The current Ekati and Diavik mine's footprints and the Lynx Project footprint.

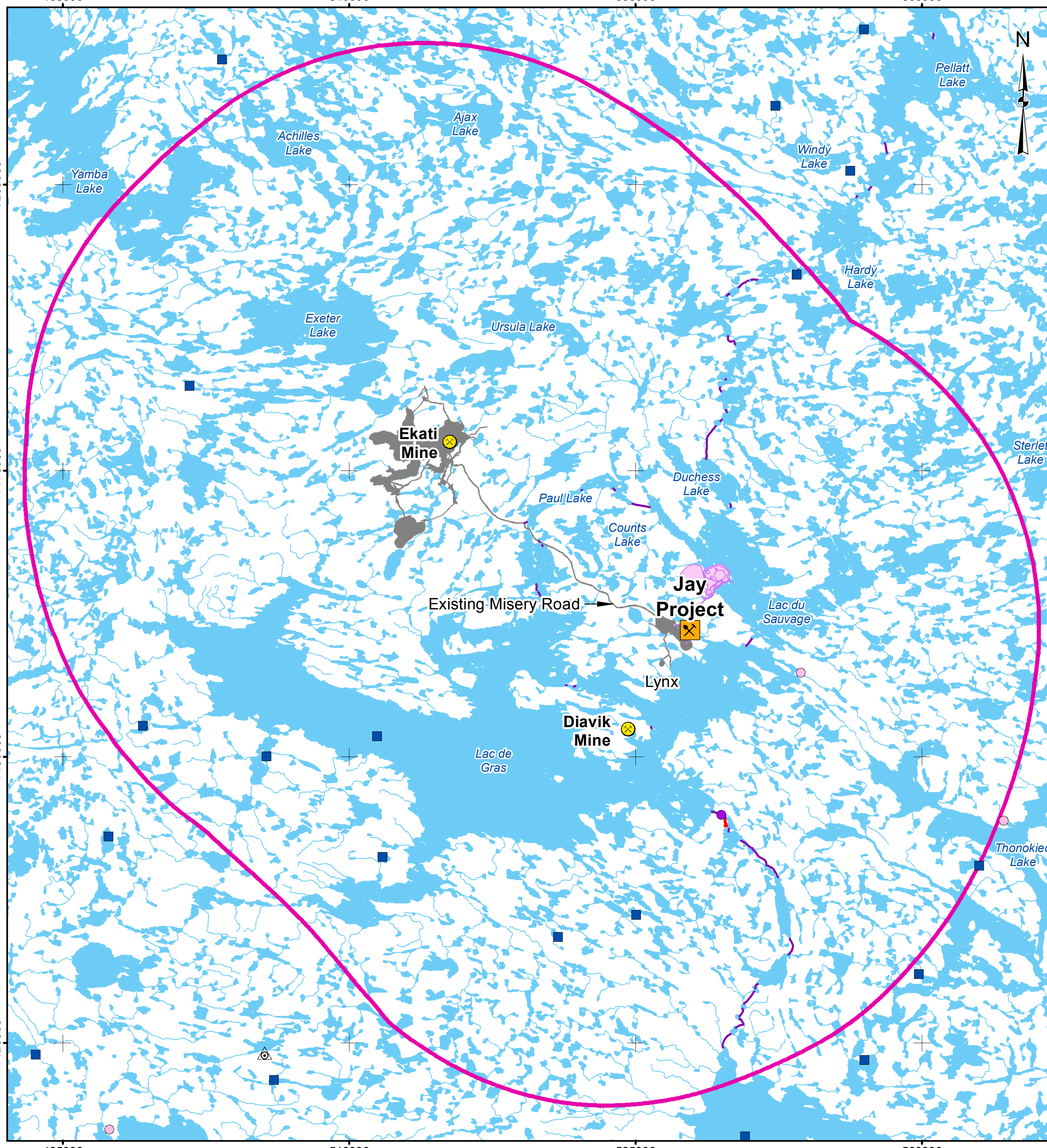
Note: The overlapping areas of 277 ha were considered together for the analysis so the area was not counted twice.

Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

ha = hectare; km = kilometre; n/a = not applicable.

Point disturbances in the Inventory of Landscape Change originated from spreadsheet databases of land use permits (except for mines), so locations are not precise. The Geographic Information System (GIS) spatial data were examined for overlap of information. In cases where two or more pieces of location information were present for the same activity (such as a land use permit for an exploration camp and a second land use permit to expand the fuel cache), the information was considered together so that the spatial data contained the largest spatial extent and only one point per development for the 2014 baseline condition.

As the Inventory of Landscape Change database does not describe the footprint of developments, the physical area of the footprint was estimated. Actual footprints were used for mines. Vegetation types that occurred within the 500 m buffer around exploration activity point features were removed; open water was not removed by exploration activities. For all developments, the physical footprint was carried through the entire effects analysis as it was assumed that direct disturbance to the landscape had not yet been reversed. Footprints with overlapping areas on the landscape were not counted twice.



LEGEND

- JAY PROJECT
- EKATI MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- ALL-SEASON ROAD
- PORTAGE
- WATERCOURSE
- WATERBODY
- EFFECTS STUDY AREA
- COMMUNICATIONS
- MINE
- MINERAL EXPLORATION
- STAGING AREA
- TOURISM

10 0 10

SCALE 1:500,000 KILOMETRES

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

PREVIOUS AND EXISTING DEVELOPMENTS IN THE VEGETATION EFFECTS STUDY AREA FOR THE 2014 BASELINE CONDITION

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_010_GIS
DESIGN	LD	15/07/14	SCALE AS SHOWN REV. 0
GIS	DW	07/10/14	MAP 11.4-1
CHECK	JF	07/10/14	
REVIEW	CD	07/10/14	

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11.4.2 Effects on Plant Populations and Communities

The residual effects analysis is focused on thoroughly evaluating the primary pathway associated with the Project and other developments on vegetation VCs. The residual effects assessment is completed by calculating and estimating changes to measurement indicators of plant populations and communities. These measurement indicators are:

- distribution of the Esker Complex ELC unit;
- quantity, arrangement, and connectivity (fragmentation) of plant communities (i.e., abundance and distribution of ELC map units);
- plant community health and diversity; and,
- abundance and distribution of habitat for listed and traditional use plants.

11.4.2.1 *Methods*

Development of the Project is expected to change the relative abundance and distribution of plant populations and communities. Communities or plants that are common (high relative abundance) or widely distributed are likely to be more resilient than those with low abundance and limited distribution. Project changes to the relative abundance and distribution of plant populations and communities generally occur at a local scale. Changes to the abundance and distribution of plant communities and populations were examined at the regional scale so that the assessment provides an ecologically relevant and confident assessment of the direct effects on vegetation from the Project and the potential cumulative effects from the Project and other previous and existing developments.

Fragmentation refers to the division of a landscape into smaller habitat patches that can be more isolated from each other and is generally thought to have a negative effect on biodiversity (Turner 1996; Swift and Hannon 2010). Fragmentation influences population resilience and species richness by increasing edge effects, and altering the relative abundance of habitat, landscape connectivity, and patch size and distribution (Debinski and Holt 2000; Fahrig 2003; Fletcher et al. 2007).

The changes from loss and fragmentation of plant populations and communities are expressed by changes to ELC map units. Locally, direct loss of ELC map units from the Project can affect biodiversity, including species richness, population abundance, and habitat distribution. To understand the range and sustainability of vegetation VCs, these environmental changes were examined at a regional scale. Habitat loss includes the direct removal or alteration of a landcover type (ELC map unit). Habitat loss has negative environmental effects on biodiversity (Fahrig 2003; Fletcher et al. 2007); as specific habitat decreases, species that rely on that habitat also decrease (Andrén 1994).

The area of ELC units and the direct loss of units caused by the Project footprint and previous and existing developments were quantified in a GIS platform to predict changes of ELC map units within the ESA. This was completed by determining a summary of areas of each ELC unit within the ESA for the reference condition, 2014 baseline condition, and Application Case. Landscape metrics such as number of patches, mean patch areas, and mean distance to nearest neighbour (MDNN) were determined for the reference condition, 2014 baseline condition, and Application Case in the ESA. These landscape metrics were calculated using the program FRAGSTATS (Version 4.0; McGarigal et al. 2012) in the GIS platform.

The FRAGSTATS analysis determined the extent of landscape fragmentation by calculating statistical outputs based on the values of each raster cell of the ELC data. The MDNN is calculated as the shortest straight-line Euclidean distance between the centroids of the closest cells of equivalent habitat patches (McGarigal et al. 2012). The reference condition represents the initial period of the Base Case (as far back as data are available), while the 2014 baseline condition of the Base Case includes all previous, existing, and approved developments up to 2014 and the Lynx Project (Section 11.4.1.2).

For the analysis, the proposed Project infrastructure was buffered by 200 m and the access roads and adjacent pipeline and power line were buffered by 100 m (200 m right-of-way) so that a maximum possible extent of disturbance is used in the analysis. The proposed infrastructure that was buffered for the Application Case also includes the expanded WRSA constructed for Lynx (included in the Base Case) as it is expected that it will also be used for the Jay Project as an Ore Stockpile and Transfer Pad area. The footprint was buffered so that the effects analysis results represent a conservative estimate of residual effects on vegetation (i.e., effects are likely overestimated).

The residual effects on vegetation are assessed using predicted changes to ELC map units (i.e., loss), habitat fragmentation, listed plant species habitat potential, and traditional use plant habitat potential. Changes to the relative abundance and distribution of plant populations and communities, including listed plant species and traditional use plant species, are assessed for the maximum possible extent of disturbance. The changes from the Project and other developments on vegetation were estimated by calculating the relative difference or net change in that map unit between the 2014 baseline and reference conditions, and between the Application Case and 2014 baseline condition:

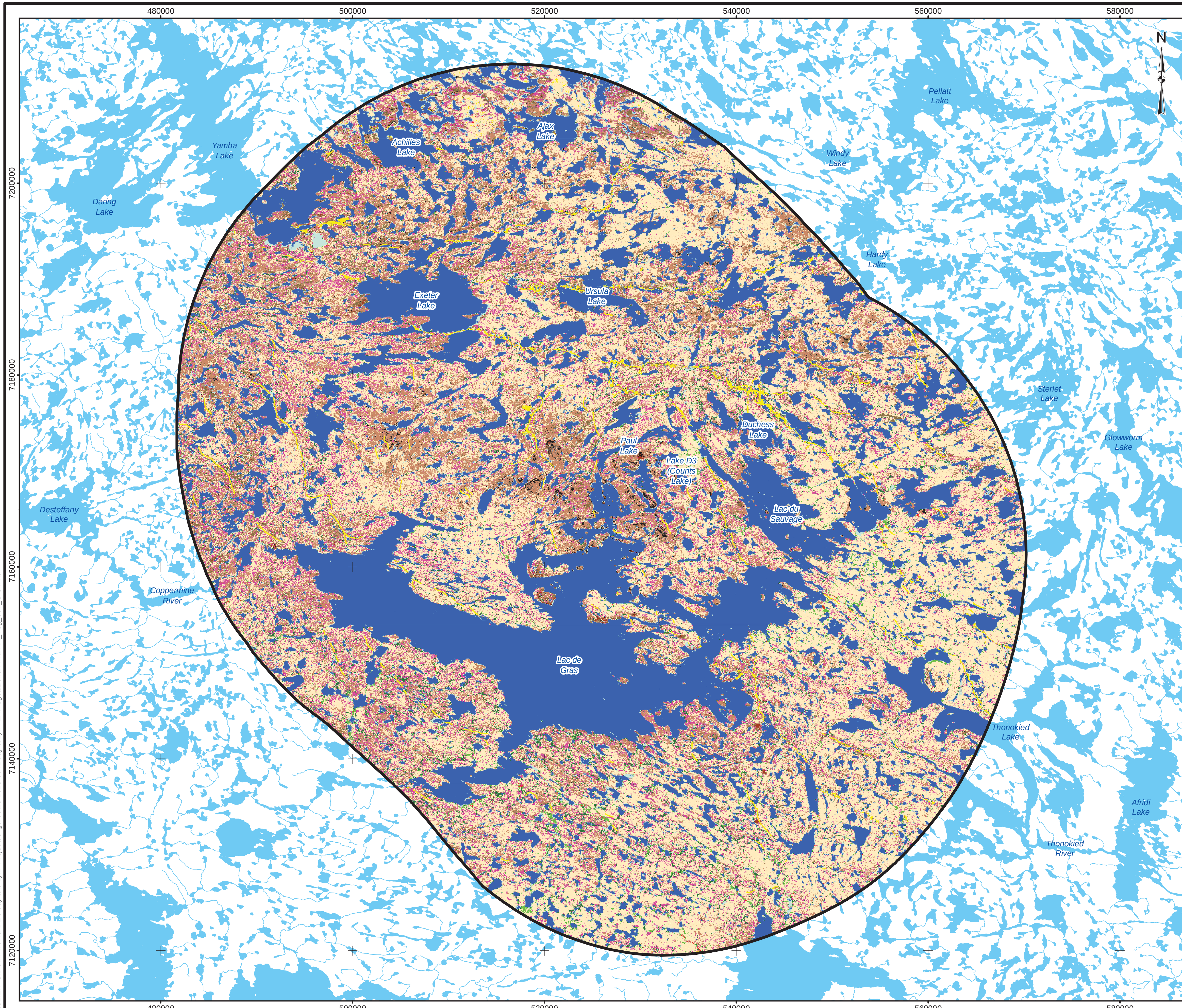
- (2014 baseline value – reference condition value) / reference condition value
- (Application Case value – 2014 baseline value) / 2014 baseline value

Each resulting value was then multiplied by 100 to give the percent change in a landscape metric for each comparison, providing both direction and magnitude of the effect. For example, a high negative value for an ELC area would indicate a substantial loss of that ELC map unit. Alternately, a negative value for MDNN indicates an increase in patch connectivity. Following final closure of the Project, it is assumed that there will be a net change to terrestrial areas of disturbance, but it is unknown what vegetation units these areas will become in the future. As such, the change to vegetation is considered to be a permanent disturbance.

11.4.2.2 *Results*

11.4.2.2.1 *Changes in Abundance and Distribution of Plant Communities*

Under the reference condition, the vegetation ESA (593,274 ha) is dominated by Health Tundra (37.7%) and Deep Water (28.9%) ELC map units (Map 11.4-2). Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulder, Tussock/Hummock, Sedge Wetland, and Shallow Water map units each account for from 2.5% to 12.8% of the vegetation ESA. Esker Complex, Bedrock Complex (>80% rock), Boulder Complex (>80% rock), Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub map units each comprise 1% or less of the ESA. Unclassified units (representing less than 1%) consisted of areas that could not be classified as a vegetation map unit.



LEGEND

- WATERCOURSE
- WATERBODY
- EFFECTS STUDY AREA

ECOLOGICAL LANDSCAPE CLASSIFICATION MAP UNITS

- ESKER COMPLEX
- BEDROCK COMPLEX (>80% ROCK)
- BOULDER COMPLEX (>80% ROCK)
- HEATH TUNDRA 30% TO 80% BEDROCK
- HEATH TUNDRA 30% TO 80% BOULDERS
- HEATH TUNDRA
- RIPARIAN TALL SHRUB
- BIRCH SEEP AND RIPARIAN SHORELINE SHRUB
- TUSSOCK/HUMMOCK
- SEDGE WETLAND
- SHALLOW WATER
- DEEP WATER
- UNCLASSIFIED

REFERENCE

VEGETATION CLASSIFICATION DATA: DIAVIK LANDSAT CLASSIFICATION 1997; WEST KITIKMEOT CLASSIFICATION 2001; MODIFIED BY GOLDER ASSOCIATES 2014
NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

10 0 10

SCALE 1:400,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ECOLOGICAL LANDSCAPE CLASSIFICATION MAP UNIT DISTRIBUTION FOR THE REFERENCE CONDITION

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_007_GIS	
DESIGN	JF	21/08/14	SCALE AS SHOWN	REV 0
GIS	LMR	07/10/14	MAP 11.4-2	
CHECK	JF	07/10/14		
REVIEW	CD	07/10/14		

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Relative to the reference condition, previous and existing developments have removed approximately 4,916 hectares (ha) (0.8%) of the ELC units within the ESA. Specific loss of any ELC map units from previous and existing disturbances in the ESA is less than or equal to 3.6%. The maximum area of ELC map units to be disturbed by the application of the Project is 1,132 ha and includes 510 ha of upland ELC units, 193 ha of wetland ELC units, and 430 ha of non-vegetation units (shallow and deep water). The ELC map units that will experience the greatest change from the Project are Deep Water (395 ha), Heath Tundra (251 ha), and Heath Tundra 30% to 80% Boulder (201 ha) (Table 11.4-3; Map 11.4-3).

The Project footprint covers approximately 1,132 ha (0.2% of the ESA). Approximately 62% of the physical footprint is terrestrial habitat and 38% is aquatic habitat. At closure, the terrestrial area that contains the Project footprint is considered a permanent disturbance on the landscape. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas. Plant cover is expected to be eventually re-established in areas of disturbance; however the time for vegetation VCs to recover is unknown.

Approximately 4 ha of the Esker Complex unit will be disturbed by the Project. This map unit is restricted in distribution within the ESA (less than 0.1% of the ESA), which translates into approximately 0.1% of its current abundance within the ESA being disturbed (Table 11.4-3; Map 11.4-3). Similar to the Esker Complex ELC map unit, Bedrock Complex (>80% rock), Boulder Complex (>80% rock), Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub are also restricted in abundance (less than 0.1% of the ESA). Approximately 0.3% of Bedrock Complex (>80% rock) will be disturbed by the Project. Approximately 0.6% of Boulder Complex (>80% rock) and 0.2% of Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub abundance within the ESA will be disturbed by the Project.

The cumulative reduction in vegetation through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped ELC units in the ESA (Table 11.4-3). Cumulative changes to Heath Tundra, Riparian Tall Shrub, Birch Seep and Riparian Shoreline Shrub, Shallow Water and Deep Water units will all be less than 1.0% each. The largest magnitudes of cumulative reductions of vegetation are predicted to be 203 ha (3.7%) of Esker Complex and 49 ha (2.3%) of Boulder Complex (>80% rock). Cumulative reduction of Heath Tundra 30% to 80% Boulder (1,032 ha), Heath Tundra 30% to 80% Bedrock (160 ha), Bedrock Complex (17 ha), Tussock/Hummock (578 ha), and Sedge Wetland (175 ha) are predicted to be 1.4% or less of each map unit, relative to the reference condition in the ESA.

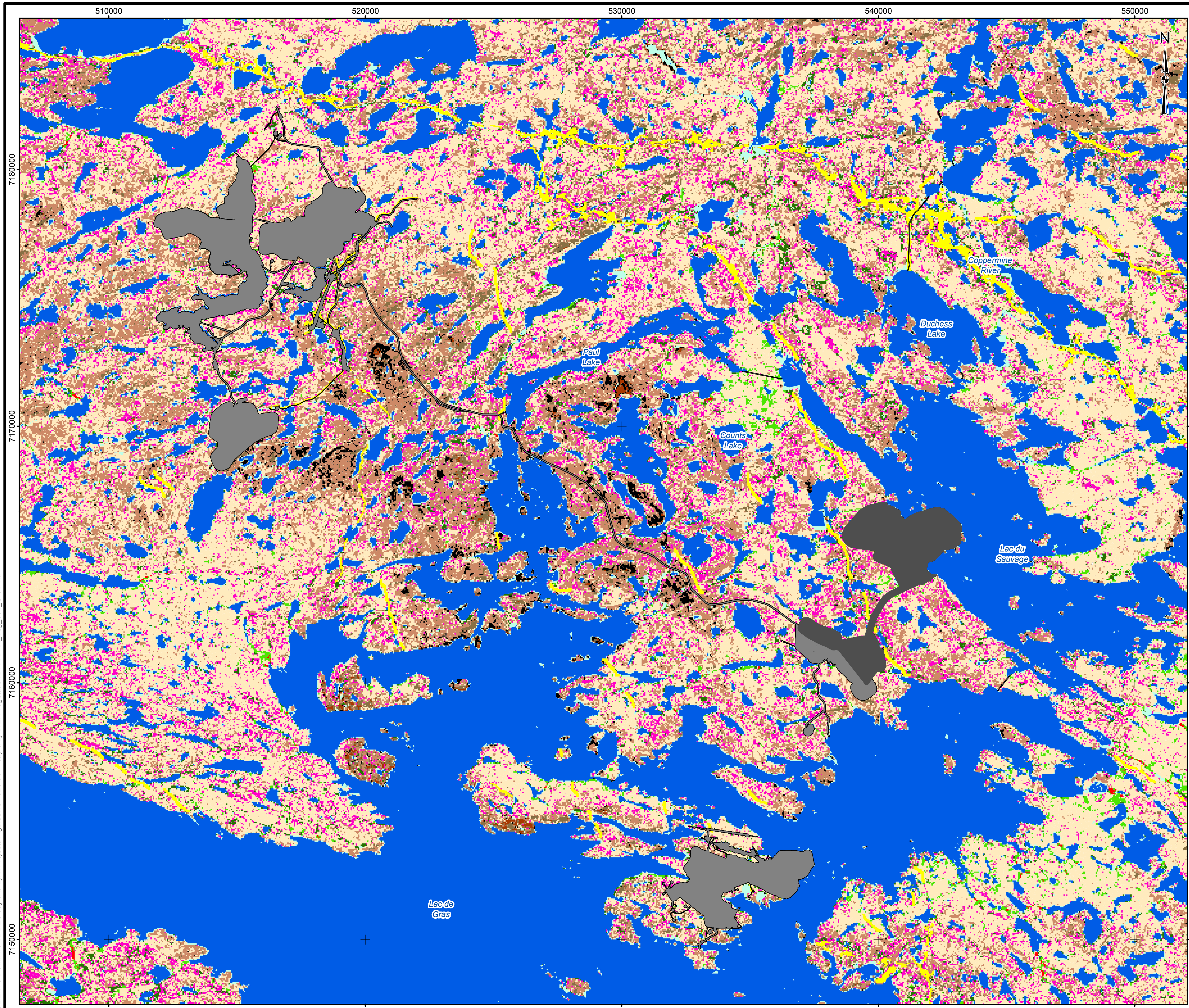
Table 11.4-3 Change in Area of Ecological Landscape Classification Map Units from Development within the Vegetation Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Reference Condition (ha)	2014 Baseline Condition (ha)	Percent Change Reference to Baseline (% unit)	Application Case (ha)	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
Upland ELC Map Units						
Esker Complex	5,522	5,322	-3.6	5,319	-0.1	-3.7
Bedrock Complex (>80% rock)	1,316	1,302	-1.0	1,299	-0.3	-1.3
Boulder Complex (>80% rock)	2,140	2,103	-1.7	2,091	-0.6	-2.3
Heath Tundra 30% to 80% Bedrock	14,946	14,825	-0.8	14,786	-0.3	-1.1
Heath Tundra 30% to 80% Boulder	76,041	75,211	-1.1	75,010	-0.3	-1.4
Heath Tundra	223,417	221,577	-0.8	221,326	-0.1	-0.9
Wetland ELC Map Units						
Riparian Tall Shrub	452	449	-0.6	448	-0.2	-0.8
Birch Seep and Riparian Shoreline Shrub	6,428	6,389	-0.6	6,373	-0.2	-0.8
Tussock/Hummock	50,994	50,553	-0.9	50,416	-0.3	-1.1
Sedge Wetland	16,440	16,305	-0.8	16,265	-0.2	-1.1
Non-Vegetated ELC Map Units						
Shallow Water	24,185	23,995	-0.8	23,960	-0.1	-0.9
Deep Water	171,237	170,173	-0.6	169,777	-0.2	-0.9
Unclassified ELC Map Unit						
Unclassified	156	154	-1.2	154	0	-1.2

Note: the vegetation ESA is 593,274 ha.

ha = hectare;% = percent.

In addition to direct loss of vegetation, the application of the Project will result in the fragmentation of the existing landscape. With the application of the Project, the number of patches is expected to decrease from 263,572 in the baseline condition to 263,082 (loss of 490 patches), while the mean patch size is expected to decrease by less than 0.1 ha (Table 11.4-4). The cumulative change in the number of patches from the Project and previous and existing disturbance is a decrease of 1,792 patches and a decrease in mean patch size of 1.3 ha. The only ELC map unit that increases in patch number during the Application Case is the Esker Complex (1 patch), an increase from baseline by 0.1% with the application of the Project. The mean esker patch size decreases by less than 0.1 ha and represents a 0.2% change. The largest changes in patch number from application of the Project are Tussock/Hummock (loss of 125 patches), Health Tundra (loss of 76 patches), and Heath Tundra 30% to 80% Boulder (loss of 76 patches) (Table 11.4-4).



LEGEND

ECOLOGICAL LANDSCAPE CLASSIFICATION MAP UNITS

- ESKER COMPLEX
- BEDROCK COMPLEX (>80% ROCK)
- BOULDER COMPLEX (>80% ROCK)
- HEATH TUNDRA 30% TO 80% BEDROCK
- HEATH TUNDRA 30% TO 80% BOULDERS
- HEATH TUNDRA
- RIPARIAN TALL SHRUB
- BIRCH SEEP AND RIPARIAN SHORELINE SHRUB
- TUSSOCK/HUMMOCK
- SEDGE WETLAND
- SHALLOW WATER
- DEEP WATER
- EXISTING DISTURBANCE
- UNCLASSIFIED
- PROPOSED PROJECT FOOTPRINT

REFERENCE

VEGETATION CLASSIFICATION DATA: DIAVIK LANDSAT CLASSIFICATION 1997; WEST KITIKMEOT CLASSIFICATION 2001; MODIFIED BY GOLDER ASSOCIATES 2014
NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

3 0 3

SCALE 1:150,000 KILOMETRES

PROJECT

DOMINION DIAMOND™

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ECOLOGICAL LANDSCAPE CLASSIFICATION MAP UNIT DISTRIBUTION FOR THE APPLICATION CASE

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_Veg_004_GIS
DESIGN	JF	24/02/14	SCALE AS SHOWN REV 0
GIS	LMR	07/10/14	MAP 11.4-3
CHECK	JF	07/10/14	
REVIEW	CD	07/10/14	

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DOMINION DIAMOND

Table 11.4-4 Change in Patch Number and Mean Patch Size of Ecological Landscape Classification Map Units from Development within the Vegetation Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Number of Patches					
	Reference Condition	2014 Baseline Condition	Percent Change Reference to Baseline (% unit)	Application Case	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
Upland ELC Map Units						
Esker Complex	1,028	1,147	11.6	1,148	0.1	11.7
Bedrock Complex (>80% rock)	3,082	3,051	-1.0	3,043	-0.3	-1.3
Boulder Complex (>80% rock)	4,200	4,150	-1.2	4,131	-0.5	-1.6
Heath Tundra 30% to 80% Bedrock	20,313	20,150	-0.8	20,117	-0.2	-1.0
Heath Tundra 30% to 80% Boulder	55,118	54,763	-0.6	54,687	-0.1	-0.8
Heath Tundra	22,816	22,937	0.5	22,861	-0.3	0.2
Wetland ELC Map Units						
Riparian Tall Shrub	1,109	1,101	-0.7	1,098	-0.3	-1.0
Birch Seep and Riparian Shoreline Shrub	10,027	9,971	-0.6	9,957	-0.1	-0.7
Tussock/Hummock	69,036	68,560	-0.7	68,435	-0.2	-0.9
Sedge Wetland	30,849	30,637	-0.7	30,582	-0.2	-0.9
Non-Vegetated ELC Map Units						
Shallow Water	40,514	40,283	-0.6	40,214	-0.2	-0.7
Deep Water	6,347	6,394	0.7	6,381	-0.2	0.5
Unclassified ELC Map Unit						
Unclassified	435	428	-1.6	428	0.0	-1.6
Upland ELC Map Units						
Esker Complex	5.4	4.6	-14.6	4.6	-0.2	-14.7
Bedrock Complex (>80% rock)	<0.4	<0.4	-0.3	<0.4	0	-0.3
Boulder Complex (>80% rock)	0.5	0.5	-1.2	0.5	-0.1	-1.3
Heath Tundra 30% to 80% Bedrock	0.7	0.7	-0.1	0.7	-0.1	-0.2
Heath Tundra 30% to 80% Boulder	1.4	1.4	-0.6	1.4	-0.1	-0.7
Heath Tundra	9.8	9.6	-1.4	9.7	0.2	-1.2
Wetland ELC Map Units						
Riparian Tall Shrub	<0.4	<0.4	<0.1	<0.4	<0.1	0.1
Birch Seep and Riparian Shoreline Shrub	0.6	0.6	-0.2	0.6	-0.1	-0.3
Tussock/Hummock	0.7	0.7	-0.3	0.7	-0.1	-0.4
Sedge Wetland	0.5	0.5	-0.2	0.5	-0.1	-0.3

Table 11.4-4 Change in Patch Number and Mean Patch Size of Ecological Landscape Classification Map Units from Development within the Vegetation Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Number of Patches					
	Reference Condition	2014 Baseline Condition	Percent Change Reference to Baseline (% unit)	Application Case	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
Non-Vegetated ELC Map Units						
Shallow Water	0.6	0.6	-0.4	0.6	<0.1	-0.4
Deep Water	27	26.6	-1.4	26.6	<-0.1	-1.4
Unclassified ELC Map Unit						
Unclassified	<0.4	<0.4	-0.3	<0.4	0	-0.3

ha = hectare; % = percent; < = less than; <-0.1 implies value approaches zero.

The MDNN for the Esker Complex ELC map unit is expected to decrease by approximately 0.3 m relative to baseline conditions (Table 11.4-5), a result of the increase in the number or patches of this map unit. Heath Tundra 30% to 80% Boulders, Heath Tundra, and Deep Water map units are expected to decrease by less than 1 m relative to baseline conditions. The MDNN for the remaining map units is expected to increase by less than 1 m relative to baseline conditions. The cumulative change from previous and existing developments plus the Project is most pronounced in the Esker Complex, with a decrease in MDNN of 32.4 m. The largest cumulative increase in MDNN is in the Riparian Tall Shrub map unit (6.4 m).

Table 11.4-5 Change in Mean Distance to Nearest Neighbour of Ecological Landscape Classification Map Units from Development within the Vegetation Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Reference Condition (m)	Baseline Condition (m)	Percent Change Reference to Baseline (% unit)	Application Case (m)	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
Upland ELC Map Units						
Esker Complex	302.9	270.8	-10.6	270.5	-0.1	-10.7
Bedrock Complex (>80% rock)	246.0	245.3	-0.3	246.2	0.3	0.1
Boulder Complex (>80% rock)	280.4	281.5	0.4	282.1	0.2	0.6
Heath Tundra 30% to 80% Bedrock	148.8	149.1	0.2	149.2	0.1	0.3
Heath Tundra 30% to 80% Boulder	94.2	94.4	0.2	94.4	<-0.1	0.2
Heath Tundra	81.7	81.7	<-0.1	81.6	-0.1	-0.1

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Table 11.4-5 Change in Mean Distance to Nearest Neighbour of Ecological Landscape Classification Map Units from Development within the Vegetation Effects Study Area

Ecological Landscape Classification (ELC) Map Units	Reference Condition (m)	Baseline Condition (m)	Percent Change Reference to Baseline (% unit)	Application Case (m)	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
Wetland ELC Map Units						
Riparian Tall Shrub	742.5	748.4	0.8	748.9	0.1	0.9
Birch Seep and Riparian Shoreline Shrub	227.5	227.4	<-0.1	227.5	0.1	<0.1
Tussock/Hummock	96.2	96.3	0.1	96.3	<0.1	0.1
Sedge Wetland	145.0	145.2	0.1	145.2	<0.1	0.1
Non-Vegetated ELC Map Units						
Shallow Water	108.6	108.7	0.1	108.7	<0.1	0.1
Deep Water	215.0	214.1	-0.4	214.1	<-0.1	-0.4
Unclassified ELC Map Unit						
Unclassified	1,375.5	1,371.8	-0.3	1,371.8	0.0	-0.3

m = metres; % = percent; > = greater than; < = less than; <-0.1 implies value approaches zero.

The majority of plant communities (ELC map units) expected to be affected by the Project are widely distributed and not unique to areas to be disturbed. Those ELC map units that are restricted in distribution within the ESA at baseline including Esker Complex, Bedrock Complex (>80% rock), Boulder Complex (>80% rock), Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub are present elsewhere within the ESA (Map 11.4-3). The MDNN of Esker Complex is predicted to decrease by 0.3 m (0.1%), relative to the baseline condition (Table 11.4-5); however, this is a result of an increase in patch number (1 patch) and a slight decrease in patch size (0.2% relative to the baseline condition). The MDNN for Bedrock Complex (>80% rock), Boulder Complex (>80% rock), Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub are predicted to increase by 0.3%, 0.2%, 0.1%, and 0.1%, respectively.
All of these units are predicted to experience a decrease in patch number (0.5% or less), and patch size. The loss and fragmentation of these vegetation types can increase the isolation of individual plant species or populations within these map units and individual plant species will respond differently to loss or fragmentation effects. Although there is a potential increase in isolation in these map units, they are currently present in patches in the ESA. Therefore, it is likely that the plant species present in these isolated units are already adapted to the patchy nature of their habitats, which may increase their resilience to fragmentation effects.

11.4.2.2.2 *Changes to Listed Plant Species and Listed Plant Habitat Potential*

Listed plant species are considered rare either federally or territorially because of restricted spatial, ecological, and/or temporal distributions in variable or diverse environments (Harper 1981). Plants can be rare for many reasons; preferred habitat can be uncommon, or the location could be near the edge of that species' range. Rare plants are important to humans and ecosystems because they are an irreplaceable part of our natural heritage, can have scientific value (e.g., medicinal uses), contribute to the full diversity of life on Earth, can be indicators of good stewardship and ecosystem health, and contribute to the aesthetics of the natural landscape (Neely et al. 2009).

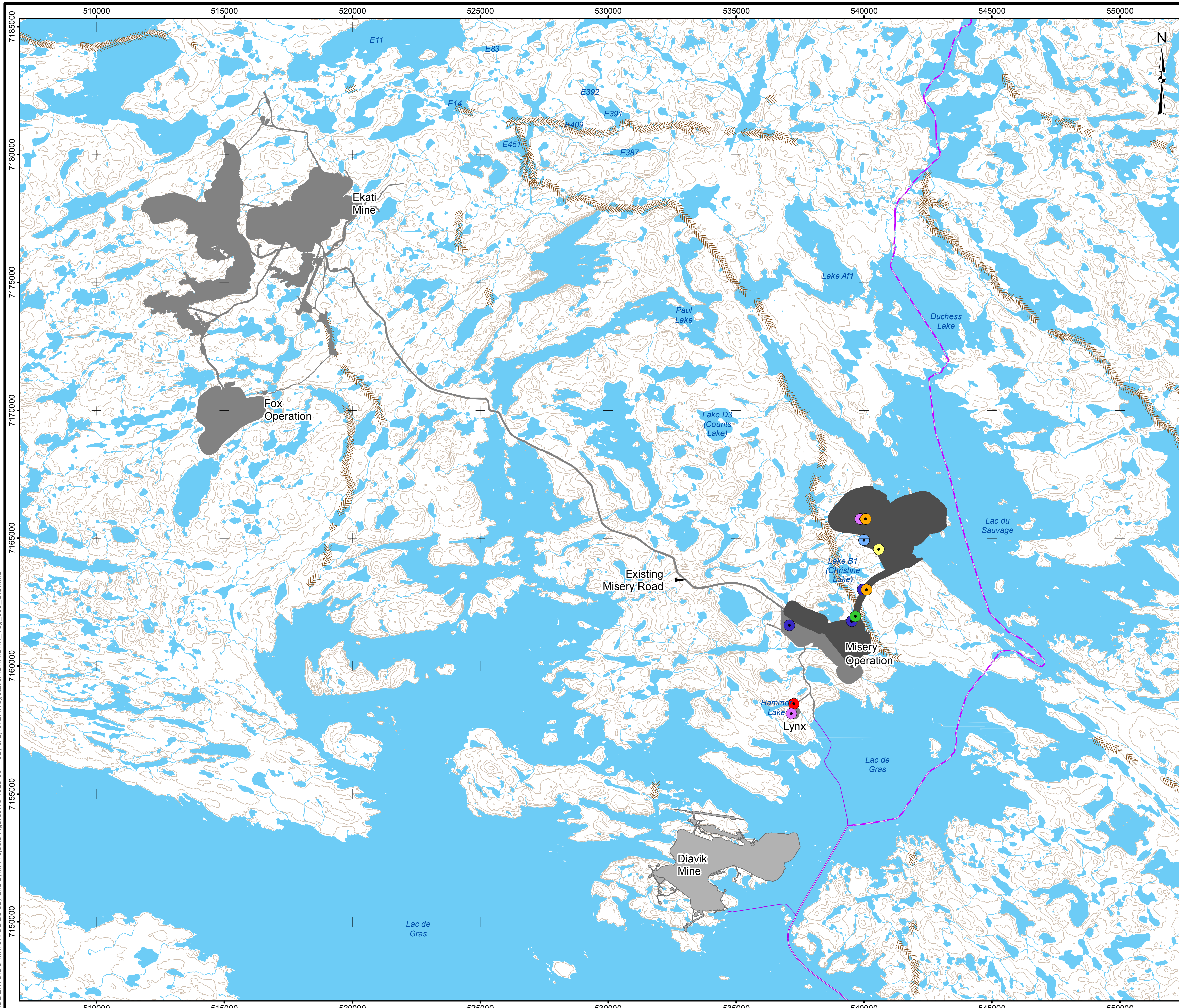
Two territorial listed vascular plant species and five non-vascular plants species were documented during the 2014 field program: one forb (Pallas' buttercup); one graminoid (Richardson's sedge); one bryophyte (tiny fork-moss); and, four lichens (Kamchatka Icelandmoss lichen, umber monk's hood lichen, silver-rimmed crottle lichen, and cushion coral lichen) (Section 11.2.2.2.1). All of these observations were in Shallow Water, Sedge Wetland, and microsites including rocky crevices and ecotones (i.e., transition areas between two vegetation types).

All of these species are listed as Sensitive, a status rank that is assigned to species that are not believed to be at risk of extirpation or extinction, but may require special attention or protection to prevent them from becoming At Risk (NWT Infobase 2012). Locations of territorial listed species identified during the 2014 field survey are within areas expected to be disturbed by the Project (Map 11.4-4). The following mitigation will be used to reduce effects on known locations containing listed plant species:

- Disturbance of vegetation will be limited to the minimum extent necessary for construction and operation of the Project.
- Locations of listed plant species will be avoided to the extent feasible.

Because field surveys cannot confirm the absence of listed plants and can only confirm their presence, there is potential for other listed species to be present in areas that may be disturbed by the Project. Therefore, the ELC map unit rankings for potential of ELC map units to support listed plant species were also used in the analysis (listed plant habitat potential; Section 11.2.2.2). A total of 36 ha of ELC units with high listed plant habitat potential will be disturbed during construction, resulting in a decrease of 0.1% relative to baseline conditions (Table 11.4-6). Habitat units with moderate listed plant habitat potential will decrease by approximately 43 ha (0.2%).

The Shallow Water unit comprises the majority of the high potential unit. Sedge Wetland comprises the majority of the moderate potential unit. It is predicted that approximately 35 ha of Shallow Water will be removed by the Project and approximately 40 ha of Sedge Wetland will be removed by the Project. Riparian Tall Shrub and Esker Complex are restricted in distribution in the ESA. A total of 1 ha of high listed plant potential is associated with the Riparian Tall Shrub ELC map unit (Table 11.4-6). Approximately 4 ha (rounded up) of moderate listed plant habitat potential is associated with the Esker Complex map unit. The largest cumulative change through application of the Project and previous and existing developments is within the moderate listed plant habitat potential ELC map units (1.7%) relative to the reference condition.



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY

LISTED PLANT SPECIES OBSERVATION

- PALLAS' BUTTERCUP
- RICHARDSON'S SEDGE
- TINY FORK-MOSS
- KAMCHATKA ICELANDMOSS LICHEN
- UMBER MONK'S HOOD LICHEN
- SILVER-RIMMED CROTTLE LICHEN
- CUSHION CORAL LICHEN
- PROPOSED PROJECT FOOTPRINT

NOTES

1. FOR OBSERVATION LOCATIONS SEE APPENDIX 11B, TABLE 11B-2.

REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
LOCATIONS OF LISTED PLANT SPECIES OBSERVATIONS FOR THE APPLICATION CASE

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Veg_008_GIS	
DESIGN	JF	21/08/14	SCALE AS SHOWN	REV 0
GIS	LMR	07/10/14	MAP 11.4-4	
CHECK	JF	07/10/14		
REVIEW	CD	07/10/14		

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Table 11.4-6 Change in Area of Listed Plant Habitat Potential from Development of the Project

Listed Plant Habitat Potential	Reference Condition (ha)	2014 Baseline Condition (ha)	Percent Change Reference to Baseline (% unit)	Application Case (ha)	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
High Potential ELC Map Units	24,637	24,444	-0.8	24,408	-0.1	-0.9
Moderate Potential ELC Map Units	21,962	21,627	-1.5	21,584	-0.2	-1.7
Low Potential ELC Map Units	375,282	371,960	-0.9	371,302	-0.2	-1.1
Non-ranked ELC Map Units	171,393	175,243	2.2	175,980	0.4	2.7

Note: High potential units are Riparian Tall Shrub and Shallow Water. Moderate potential units are Esker Complex and Sedge Wetland. Low potential units are Bedrock Complex (>80% rock), Boulder Complex (>80% rock), Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders, Heath Tundra, Birch Seep and Riparian Shoreline Shrub, and Tussock/Hummock. Non-ranked units are Deep Water, Unclassified, and Existing Disturbance.

ha = hectare;% = percent; ELC = ecological landscape classification.

The listed plant species that prefer habitats in Riparian Tall Shrub and Esker Complex are likely uncommon because of the restricted spatial distributions in these habitats. In addition, it is likely that the plant species present in these units are already adapted to the patchy nature of their habitats within the ESA. The Riparian Tall Shrub map unit occurs as linear bands along the banks of watercourses, typically associated with the inflow or outflow of a lake, or along the drainages that connect one lake to another. Riparian microsites likely exist in association with other wetland map units and, although not mapped, other map units may have potential to contain some of the plant species associated with the Riparian Tall Shrub map unit. For example, some of the listed sedges that prefer wet habitats could also occur in microsites contained in the Birch Seep and Riparian Shoreline Shrub, Sedge Wetland, or Shallow Water map units. The Esker Complex is characterized by a complex of plant communities rather than a single community, because of the associated diverse microclimates created by their structures. The crests and upper slopes of eskers are sparsely vegetated, whereas the plant communities on the mid to lower slopes that are less exposed to wind tend to be moister and more densely vegetated with a greater diversity of plant species. Similar to the potential for riparian microsites to occur in other map units, so may the microsites associated with the Esker Complex unit.

11.4.2.2.3 *Changes to Traditional Use Plant Species and Traditional Use Plant Habitat Potential*

There are 11 traditional use plants known to occur within the ESA (Section 11.2.2.3). The local and traditional knowledge studies have identified that many plants and berries are harvested in the ESA, with traditional lands overlapping the Project footprint (summarized in Section 11.2.2.3).

Those ELC map units predicted to contain the most traditional use species are Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders, Heath Tundra, and Birch Seep and Riparian Shoreline Shrub. Relative to the reference condition, previous and existing developments have removed approximately 2,829 ha (0.9%) of the high potential ELC units and 580 ha (0.9%) of moderate potential units within the ESA (Table 11.4-7).

A total of 507 ha of ELC units with high traditional use plant habitat potential will be disturbed by the Project, resulting in a decrease of 0.2% relative to baseline conditions (Table 11.4-7). Habitat units with moderate potential will decrease by approximately 177 ha (0.3%). The cumulative reduction in vegetation through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped units in the ESA (Table 11.4-3). Cumulative changes to high and moderate traditional use plant habitat potential will be 1.0% and 1.1%, respectively, relative to the reference condition in the ESA (Table 11.4-7).

Table 11.4-7 Change in Area of Traditional Use Plant Habitat Potential from Development of the Project within the Vegetation Effects Study Area

Traditional Use Plant Habitat Potential	Reference Condition (ha)	2014 Baseline Condition (ha)	Percent Change Reference to Baseline (% unit)	Application Case (ha)	Percent Change Baseline to Application (% unit)	Percent Change Reference to Application (% unit)
High Potential ELC Map Units	320,832	318,003	-0.9	317,496	-0.2	-1.0
Moderate Potential ELC Map Units	67,886	67,307	-0.9	67,129	-0.3	-1.1
Low Potential ELC Map Units	27,641	27,400	-0.9	27,350	-0.2	-1.1
Very Low Potential ELC Map Units	171,237	175,088	2.2	175,826	0.4	2.7
Non-ranked ELC Map Units	156	154	-1.2	154	0	-1.2

Note: High potential units are Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders, Heath Tundra, and Birch Seep and Riparian Shoreline Shrub. Moderate potential units are Esker Complex, Riparian Tall Shrub, Tussock/Hummock, and Sedge Wetland. Low potential units are Bedrock Complex (>80% rock), Boulder Complex (>80% rock), and Shallow Water. Very low potential units are Deep Water and Existing Disturbance.

ha = hectare;% = percent; ELC = ecological landscape classification.

The terrestrial area disturbed by the Project is considered permanent because it is not known what the landscape will look like in the future once re-vegetated. Although the future re-vegetated landscape is unknown, traditional use species such as willow, dwarf birch, hair cap moss (*Polytrichum piliferum*), and lichen (specifically *Cladonia cariosa* [a club-lichen] and *Stereocaulon tomentosum* [a wooly lichen]) have been observed to successfully colonize disturbed areas throughout arctic environments (Kershaw and Kershaw 1987; Bishop and Chapin 1989). The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas.

11.4.3 Residual Effects Summary

The effect from the Project on ELC map unit distribution will be confined to the Jay Project footprint. Relative to the reference condition, previous and existing developments have removed approximately 0.8% of the ELC map units within the ESA. Specific loss of any ELC map units from the Project is less than or equal to 3.6%. The maximum area of ELC map units to be disturbed by the application of the Project is 1,132 ha (0.2% of the ESA), including 510 ha of upland ELC units, 193 ha of wetland ELC units, and 430 ha of non-vegetation units (shallow and deep water). The ELC map units that will experience the greatest change from the Project are Deep Water (395 ha), Heath Tundra (251 ha), and Heath Tundra 30% to 80% Boulder (201 ha).

The Project footprint covers approximately 1,132 ha (0.2% relative to the ESA), of which 62% is terrestrial habitat and 38% is aquatic habitat. At closure, the terrestrial area that contains the Project footprint is considered a permanent disturbance on the landscape. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas. Plant cover is expected to be eventually re-established in areas of disturbance; however the time for vegetation VCs to recover is unknown

The cumulative reduction in vegetation through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped ELC units in the ESA. Cumulative changes to Heath Tundra, Riparian Tall Shrub, Birch Seep and Riparian Shoreline Shrub, Shallow Water and Deep Water units will all be less than 1.0% each. The largest magnitudes of cumulative reductions of vegetation are predicted to be 203 ha (3.7%) of Esker Complex and 49 ha (2.3%) of Boulder Complex (>80% rock). Cumulative reductions of Heath Tundra 30% To 80% Boulder (1,032 ha), Heath Tundra 30% To 80% Bedrock (160 ha), Bedrock Complex (17 ha), Tussock/Hummock (578 ha), and Sedge Wetland (175 ha) are predicted to be no greater than 1.4% each relative to the reference condition in the ESA.

Two territorial listed vascular plant species and five non-vascular plants species were documented during the 2014 field program, specifically one forb (Pallas' buttercup), one graminoid (Richardson's sedge), one bryophyte (tiny fork-moss), and four lichens (Kamchatka Icelandmoss lichen, umber monk's hood lichen, silver-rimmed crottle lichen, and cushion coral lichen) (Section 11.2.2.2.1). All of these observations were in Shallow Water, Sedge Wetland, and microsites including rocky crevices and ecotones (i.e., transition area between two vegetation types).

Of the area directly disturbed by the Project, 36 ha of ELC units with high listed plant species potential will be disturbed during construction, resulting in a decrease of 0.1% relative to baseline conditions. Habitat units with moderate listed potential will decrease by approximately 43 ha (0.2%). Map units with a high potential to support listed plants are Shallow Water and Riparian Tall Shrub. Map units with a moderate potential to support listed plant species are Esker Complex and Sedge Wetland. The largest cumulative change through application of the Project and previous and existing developments is within the moderate plant potential ELC map units (1.7%) relative to the reference condition.

There are 11 traditional use plants known to occur within the ESA. The local and traditional knowledge studies have identified that many plants and berries are harvested in the ESA, with traditional lands overlapping the Project footprint. Those ELC map units predicted to contain the most traditional use species are Esker Complex, Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders, Heath Tundra, and, Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub. Relative to the reference condition, previous and existing developments have removed approximately 2,829 ha (0.9%) of the high potential ELC units and 580 ha (0.9%) of moderate potential units within the ESA. A total of 507 ha of ELC units with high traditional use plant habitat potential will be disturbed by the Project, resulting in a decrease of 0.2% relative to baseline conditions. Habitat units with moderate listed potential will decrease by approximately 177 ha (0.3%). The cumulative reduction in vegetation through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped units in the ESA. Cumulative changes to high and moderate traditional use plant habitat potential will be 1.0% and 1.1%, respectively, relative to the reference condition in the ESA.

Traditional use species such as willow, dwarf birch, hair cap moss (*Polytrichum piliferum*), and lichen (specifically *Cladonia cariosa* [a club-lichen] and *Stereocaulon tomentosum* [a wooly lichen]) have been observed to successfully colonize disturbed areas throughout arctic environments (Kershaw and Kershaw 1987; Bishop and Chapin 1989). The Ekati Mine ICRP works to facilitate and promote this nature of natural colonization of disturbed areas.

11.5 Prediction Confidence and Uncertainty

Ecosystems are complex and interactions among abiotic and biotic components occur across multiple scales and are typically nonlinear (Boyce 1992; Holling 1992; Levin 1998; Wu and Marceau 2002). These characteristics can confound the understanding of ecosystem processes and limit capacity to make predictions. Like all scientific results and inference, residual effects predictions will have uncertainty associated with the data and current knowledge of the system. The confidence in residual effect predictions to vegetation VCs is related to:

- adequacy of baseline data for understanding current conditions and future changes;
- limitations of the ELC mapping process;
- the understanding of Project-related effects on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the Project will influence plant species and the endpoint of re-established vegetation communities); and,
- knowledge of the effectiveness of the mitigation for limiting effects on vegetation (e.g., revegetation of disturbed areas).

A source of uncertainty for the Project is the degree to which residual effects could occur (e.g., magnitude and duration). There is a high degree of confidence that the Project will disturb plant populations and communities; however, it is not known what the rate of recovery or final plant community composition will be in the previously disturbed areas. There are also uncertainties in the direction, magnitude, and spatial extent of future natural fluctuations in plant populations and communities, independent of residual effects from the Project and from cumulative effects from previous and existing disturbances. The identified sources of uncertainty affect the magnitude and duration (which include reversibility) of predictions.

There is uncertainty associated with the ELC because it was developed using satellite imagery. Uncertainty in the ELC was reduced using field ground-truthing and professional experience in increasing the accuracy of the ELC. Vegetation survey plots completed in 2013 confirmed that the existing mapping in the ESA was representative of the vegetation present at the plot locations. The accuracy assessment results and correlations with field survey locations provided a high degree of confidence in the use of the existing classification for this Project. The ELC represents an accurate representation of the distribution of land cover units.

There is uncertainty associated with potential effects of disturbance or removal of known listed species occurrences. All of the species documented in 2014 are listed as sensitive, a status rank assigned to species that are not believed to be at risk of extirpation or extinction, but which may require special attention or protection to prevent them from becoming at risk (NWT Infobase 2012). It is unknown as to the location or proximity of other locations of these species in the ESA. It is also unknown whether the Project will remove or avoid the documented and unknown patches of listed plants.

The ELC map units were used to assess changes to plant community abundance and distribution on the landscape, and were assigned listed and traditional use plant species potentials to approximate the residual effects on these VCs. Listed plant species habitat potentials were developed using field data and professional judgement; however, uncertainty remains because each listed plant species will have different habitat preferences and vulnerability. The ELC was also used to estimate changes to traditional use species. This uncertainty was reduced by understanding that these traditional species are typically widely distributed through the ESA; therefore, effects on these species could be predicted qualitatively. Similar to listed plant species, uncertainty remains because each traditional use plant species has different habitat preferences and resilience limits to disturbance of those plant communities in which they occur.

Adding to the challenges of understanding complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions (Walther et al. 2002). For example, natural factors such as the 2014 forest fires in the NWT can influence vegetation VCs. The number, frequency, and severity of wildfires in many parts of the world have increased from 1960 to 2013 (Bladon et al. 2014). Climate change and fire suppression practices are thought to be the largest contributors to the trend. A recent prediction for Canada indicates the potential for a 74% to 118% increase in average burn area by the end of this century (Flannigan et al. 2005). Fire alters many components of the environment including air quality, water quality, soil characteristics, vegetation cover, and hydrological processes.

Fire is a natural part of arctic and boreal ecosystems, and soils and plants have adapted to them. Fires are generally larger, more intense, and more severe in forested areas and near the treeline than in open tundra areas (Wein 1976; Gustine et al. 2014) because there is more fuel and fire can generate enough energy to jump streams, lakes and areas of wet or moist vegetation (Wein 1976). Further north in tundra areas the amount of fuel is limited and so fire cannot generate enough energy to burn through moist areas, into the wind, or downhill (Wein 1976). As such, most fires that occur in the tundra are small (less than 1 km^2), although large fires (covering tens of thousands of square kilometres) have occurred (Wein 1976; Gustine et al. 2014). The risk of a large fire near the Project is low because of its northern location in the tundra of the NWT. However, long-range transport of smoke from large fires in the circumpolar boreal forest can change air quality near the Project (Warneke et al. 2010). Atmospheric deposition of soluble gases and particulates produced by boreal fires can change soil and vegetation characteristics (Bobbink et al. 1998; Rusek and Marshall 2000; Jung et al. 2011).

Smoke from boreal forest fires can contain hundreds of different compounds in both the gas and particulate phases (Mahaffey and Miller 1994; Core and Peterson 2001). Smoke composition depends on fuel composition and fire type (e.g., active flaming fires versus smoldering fires), but is dominated by emissions of water vapour, oxides of carbon (CO, CO_2), oxides of nitrogen (NO_x), non-methane hydrocarbons (NMHC), volatile organic compounds (VOCs), and fine particulate matter ($PM_{2.5}$). Atmospheric lifetimes of soluble gases and $PM_{2.5}$ emitted from boreal forest fires are three to ten days. Their emission can create regional hazes that can be transported thousands of kilometres in the lower troposphere (McKeen et al. 2002). Fine particulates serve as cloud condensation nuclei and are removed via wet deposition (e.g., rain or snow). Most soluble gases are also removed by precipitation events. Dry deposition rates are typically low, but can be high close to active fires, and during intense or persistent regional haze events. Overall, changes to air quality from forest fire smoke, especially large fires in the boreal forest, are predicted to result in short-term changes to soil and vegetation quality in the ESA, and are not anticipated to alter the predictions of effects from the Project on vegetation.

Uncertainty was addressed in the assessment by incorporating information from available and applicable literature, and using past experience in similar areas. Conservative estimates were used so that residual effects were not underestimated. A conservative estimate of the Project footprint (1,132 ha) was used to assess changes to vegetation, as this is larger than the actual area expected to be disturbed during construction. It was also assumed that the Project will remove the listed species documented during the 2014 field survey, so that effects on the local populations are likely overestimated. Best management practices during construction, operations, and reclamation activities will be implemented to mitigate residual effects on vegetation.

11.6 Residual Impact Classification and Significance

11.6.1 Methods

11.6.1.1 *Residual Impact Classification*

The purpose of the residual impact classification is to describe the residual incremental and cumulative adverse effects from the Project and other developments (Application Case) on VCs using a scale of common words rather than numbers and units. The use of common words or criteria is accepted practice in environmental assessment.

Results from the residual impact classification are then used to determine the environmental significance from the Project and other developments on the assessment endpoint for vegetation (self-sustaining and ecologically effective plant populations and communities). Effects are described using the criteria defined in Table 11.6-1, and reflect the impact descriptors provided in the TOR (Appendix 1A, Section 4.1). Together, these criteria are used to describe the nature (e.g., severity or intensity of change, and the area and amount of time over which the change occurs) and type (e.g., direction of the change) of an effect on a VC. The main focus of the DAR is to predict whether the Project is likely to cause a significant adverse (i.e., negative) effect on the environment. Therefore, positive effects are not assessed for significance.

Table 11.6-1 Definitions of Residual Impact Criteria Used to Evaluate Significance for Plant Populations and Communities

Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Low: Amount of change to measurement indicator results in no measurable effect on the plant population or community, or results in a minor measurable residual effect on a plant population or community. **Moderate:** Amount of change to measurement indicator results in a clearly defined change to the plant population or community, but the residual effects are well within the predicted resilience limits of the plant population or community. **High:** Amount of change to the measurement indicator is sufficiently large that the resulting range of residual effects are near or exceeding the predicted resilience limits of the plant population or community.	**Local:** Predicted maximum spatial extent of direct and indirect effects from changes to measurement indicators due to a project or activity. **Regional:** Residual effects from changes to measurement indicator due to a project or activity exceed the local scale and can include cumulative effects from other developments in the effects study area. **Beyond Regional:** Residual cumulative effects from changes to measurement indicator due to a number of developments extend beyond the effects study area.	**Short-term:** Residual effect from change to measurement indicator is reversible at end of construction of Project. **Medium-term**: Residual effect from change to measurement indicator is reversible at end of operations of Project. **Long-term:** Residual effect from change to measurement indicator is reversible within a defined length of time past closure of a Project. **Permanent:** Residual effect from change to measurement indicator is irreversible.	**Infrequent:** Residual effect from change to measurement indicator is confined to a specific discrete event. **Frequent:** Residual effect from change to measurement indicator occurs intermittently over the life of the Project. **Continuous:** Residual effect from change to measurement indicator occurs continuously.	**Reversible:** Residual effect from change to measurement indicator is reversible within a time period that can be identified when a development or activity no longer influences the plant population or community. **Irreversible:** Residual effect from change to measurement indicator is predicted to influence the plant population or community indefinitely (duration is permanent or unknown).	**Unlikely:** Residual effect from change to measurement indicator is possible but unlikely (less than 10% chance of occurrence). **Likely:** Residual effect from change to measurement indicator may occur, but is not certain (10% to 80% chance of occurring. **Highly Likely:** Residual effect from change to measurement indicator is likely to occur or is certain (greater than 80% chance of occurring).

Note: resilience is the ability of a population or community to recover or bounce back from disturbance; it varies among VCs.

Magnitude – Magnitude is a measure of the intensity of a residual effect on a VC, or the degree of change caused by the Project relative to baseline conditions (i.e., effect size). Magnitude is specific to each VC and is classified into three scales: low, moderate, and high. For vegetation, magnitude is a function of the numerical and qualitative changes in measurement indicators (e.g., numerical changes in the abundance and distribution of ELC units, abundance and distribution of habitat for listed plant species, traditional use plants, and presence of non-native invasive plant species). Changes in measurement indicators are used to predict effects on the abundance and distribution of plant populations and communities (vegetation VCs), and the ability of VCs to be self-sustaining and ecologically effective. Therefore, the magnitude of residual effects is assessed at the population and community levels (e.g., the ESA).

To provide an ecologically relevant classification of effect sizes of changes in measurement indicators for a particular VC, the assessment of magnitude includes the known or inferred ability of the associated plant populations and/or communities to recover from, or otherwise accommodate disturbance. Long-term population viability is frequently applied as an ecologically relevant target by conservation biologists and resource managers (Ruggiero et al. 1994; With and Crist 1995; Fahrig 2001; Nicholson et al. 2006). Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating stochastic demographic processes (Reed et al. 2003). Maintaining ecologically effective populations and communities goes beyond what may be required only to achieve a self-sustaining population and also requires that healthy ecological relationships are maintained among species to prevent unexpected biodiversity loss due to changes in properties of highly interactive species (Soulé et al. 2003, 2005).

Plant populations and communities will often continue to function after disturbance up to the point where the disturbance becomes severe enough that the plant population or community changes. The evaluation and classification of magnitude considers the ability of VCs to absorb effects from the Project and other disturbances and function as self-sustaining and ecologically effective populations and communities. Resilience is the ability of the population or ecosystem to recover or bounce back from the Project and other disturbances, and function as self-sustaining and ecologically effective populations and communities. Therefore, resilience reflects the capacity of a system to adapt to stress or change (Turetsky et al. 2012).

Because effects threshold levels on the abundance and distribution of plant populations and communities have not been estimated for the ESA, the magnitude of residual effects is assessed qualitatively for vegetation using a reasoned narrative. Evaluating magnitude considers the residual effects on altering the state of a self-sustaining plant population and community and incorporated conservatism. For example, in cases where species life history traits, such as reproduction, seed production and dispersal, and resiliency information was available, a qualitative evaluation was completed to determine whether the response of the species and community to disturbance is large enough to cause a change in state of plant populations and communities.

Responses to disturbance within a system can vary both between plant communities and between species. The ecological characteristics of a particular plant population could provide it with the defences and adaptive capacity to withstand stresses associated with landscape change, such as physical damage, changes in lighting levels and temperature, and increased competition. Alternately, species that are sensitive to change could respond by declining in abundance gradually or immediately after a disturbance. Where biological information was lacking for a species, general ecological principles are discussed in context of the magnitude of the residual effects from changes to the physical environment on vegetation. Quantitative measures (vegetation loss and fragmentation) of the change in the physical environment were used to aid in assessing the magnitude of change.

Geographic Extent – Geographic extent refers to the spatial extent of the area affected and is different from the spatial boundary (i.e., ESA) for the effects analysis. The study area for the effects analysis represents the maximum area used for the assessment and is related to the spatial distribution of VCs (Section 11.1.4). However, the geographic extent of effects can occur on a number of scales within the spatial boundary of the assessment and is VC-specific. Effects at the local scale are largely associated with the predicted maximum spatial extent of combined direct and indirect changes from the Project (i.e., cumulative effects that are specific to the Project). Effects at the regional scale occur within the ESA, and are associated with incremental and cumulative changes from the Project and other developments. The beyond regional scale includes cumulative residual effects from the Project and other developments that extend beyond the ESA. The principle applied when using geographic extent to understand magnitude is that local effects from the Project are less severe than effects that extend to the regional or beyond regional scales, all other factors being equal.

Duration – Duration is VC-specific and defined as the amount of time from the beginning of a residual effect to when the residual effect on the vegetation is reversed. It is usually expressed relative to Project phases (usually in years). Duration has two components, the amount of time between the start and end of a Project activity or stressor (which is related to Project development phases), plus the time required for the effect to be reversible. Essentially, duration is a function of the length of time that VCs are exposed to Project activities and reversibility of the effect. By definition, residual effects that are short-term, medium-term, or long-term in duration are reversible.

In some cases, available scientific information and experienced opinion may predict that the residual effect is irreversible. Alternately, the duration of the residual effect may not be known, except that it is expected to be extremely long and well beyond the temporal boundary of the Project. Any number of factors could cause a VC to never return to a state that is unaffected by the Project. In other words, science and logic predict that the likelihood of reversibility is so low or uncertain that the residual effect is classified as irreversible.

11.6.1.2 *Determination of Significance*

The classification of primary pathways and the associated predicted changes in measurement indicators provide the foundation for determining the significance of incremental and cumulative effects from the Project and other existing and approved developments on the assessment endpoint for vegetation VCs. The significance of the contribution of incremental effects from the Project on VCs is provided, but the evaluation is focused on determining the significance of cumulative effects on self-sustaining and ecologically effective plant populations and communities.

Magnitude is the primary criterion used to determine environmental significance, while other criteria are used as modifiers and to provide context when assigning magnitude. Geographic extent and duration provide important ecological context for classifying the magnitude of effects on VC assessment endpoints. For example, determining the magnitude of an effect from changes in plant community connectivity on a vegetation VC depends on the spatial extent (amount of area or proportion of the population) and duration of the changes. Duration includes reversibility; a reversible effect from a development is one that does not result in a permanent adverse effect on population processes (e.g., survival and reproduction) and properties (e.g., stability and resilience). Frequency and likelihood are also considered as modifiers when determining significance, where applicable.

Duration is also a function of resilience, which is the ability of the population to recover or bounce back from a disturbance. The capacity or ability of individuals in a population to change and accommodate disturbance is also related to resilience. Resilience can vary with population size, stability, and the likelihood of demographic rescue from neighbouring populations. During periods of low abundance or limited pollinator abundance, plant populations can become less resilient to natural environmental and human-related disturbances, which may reduce stability. Stable populations exhibit no long-term increasing or declining trend in abundance outside of natural fluctuations and cycles. Resilience and stability are properties of a population that influence the amount of risk to VCs from development (Turetsky et al. 2012). The duration of development-related effects may be shorter for VCs that are highly resilient and stable.

In accordance with the TOR (Appendix 1A), for those environmental effects that are determined to be not significant, a reasoned narrative is given that provides a potential qualitative significance threshold level. For vegetation, ecological benchmarks or effects thresholds are not known and are challenging to define, which creates uncertainty in determining the significance of predicted effects. For example, critical thresholds and screening levels for measurement indicators such as habitat quantity, arrangement, and connectivity are frequently not available for plant species, and the significance of effects may not be within the plant community itself, but linked to other VCs that depend on plant communities for habitat, food, and survival (i.e., ecological services).

Because of the uncertainty regarding the effects of development on VCs, magnitude classification was applied conservatively to increase the level of confidence that effects will not be worse than predicted (Section 6.6). Furthermore, the determination of significance considers the key sources of uncertainty in the effects analysis, the management of uncertainties, and the corresponding level of confidence in effects predictions.

The following is a summary of the key factors considered in the determination of environmental significance on vegetation VCs:

- results from the residual impact classification of the primary pathway and associated predicted changes in measurement indicators;
- magnitude is the primary criterion used to determine significance with geographic extent and duration providing important context for assigning magnitude. Frequency and likelihood act as modifiers for determining significance, where applicable; and,

- the level of confidence in predicted effects, scientific principles (e.g., resilience and stability), and experienced opinion are also included in the evaluation of determining environmental significance for each VC. Where uncertainty was high and the cumulative effect might be either significant or not significant, the assessment conservatively identified the effect as significant and provided additional follow-up actions to reduce uncertainty.

This method is used to identify predicted residual adverse effects that have sufficient magnitude, duration, and geographic extent to cause fundamental changes to vegetation VCs and, therefore, result in significant impacts. The following definitions are used for assessing the significance of impacts on self-sustaining and ecologically effective plant populations and communities:

Not significant – impacts are measurable at the population and community level, but are not likely to result in decreased resilience and increased risk to self-sustaining and ecologically effective plant populations and communities.

Significant – impacts are measurable at the population and community levels and are likely to result in decreased resilience and increased risk to the maintenance of self-sustaining and ecologically effective plant populations and communities. A number of high magnitude and irreversible impacts at the population or community level (regional scale) would likely be significant.

11.6.2 Results

11.6.2.1 *Abundance and Distribution of Plant Communities*

Ecosystems are dynamic and are continually undergoing compositional changes as a result of disturbance and succession. Disturbance and succession in plant ecology are closely linked because a disturbance in a system is often the mechanism for creating an early successional plant community, allowing different species to coexist (Turetsky et al. 2012). In areas of vegetation loss, the resilience of plant species and plant communities depends on the response of neighbouring plants to the disturbance (Callaway et al. 2002). Disturbances can have a positive effect for some plant species by increasing the potential for seed germination and seedling establishment by creating structural diversity in the plant community (Saunders et al. 1991; Donaldson et al. 2002; Cooper et al. 2004). Conversely, it can be considered negative because disturbances can also decrease seed germination in other plant species (Cooper et al. 2004). The response of individual plant species in a community is dependent on the nature and magnitude of the disturbance and the characteristics of the plant species (e.g., growth form and reproductive strategy).

The effect of the disturbance and subsequent recovery is related to the type, size, and intensity of the disturbance. Speed et al. (2010) found that species richness decreased with increasing disturbance intensity and led to changes in plant community composition, but this change was a response of plant community type indicating that some communities are more resilient to disturbance than others. In the Speed et al. (2010) study, species richness from disturbance in plant communities occurring in wetter areas was unchanged compared to plant communities in drier areas. Recovery appeared to be influenced by the magnitude of the disturbance and proximity to intact edges.

Relative to the reference condition, the magnitude of the regional extent of effects from previous and existing developments is approximately 0.8% of the ELC units within the ESA. Specific loss of any ELC map units from previous and existing disturbances in the ESA is less than or equal to 3.6%. The maximum area of ELC map units to be disturbed by the application of the Project is 1,132 ha and includes 510 ha of upland ELC units, 193 ha of wetland ELC units, and 430 ha of non-vegetation units (shallow and deep water). Within the ESA, Deep Water, Heath Tundra, and Heath Tundra 30% to 80% Boulder are predicted to experience the largest change (395 ha, 251 ha and 201 ha, respectively).

The majority of the mapped ELC units are well distributed across the ESA. For those map units that have a limited abundance in the ESA, it was estimated that approximately 0.1% of the current abundance of Esker Complex within the ESA will be disturbed by the Project. Approximately 0.3% of the Bedrock Complex (>80% rock) map unit’s current abundance within the ESA will be disturbed. Approximately 0.6% of the Boulder Complex (>80% rock) map unit and 0.2% of Riparian Tall Shrub, and Birch Seep and Riparian Shoreline Shrub unit current abundance within the ESA will be disturbed. Although some plant communities will be removed by the Project, the magnitude of residual changes on plant populations is predicted to be low and should not have a significant adverse effect on self-sustaining and ecologically effective plant populations and communities.

The cumulative reduction in vegetation through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped units in the ESA relative to reference conditions. Cumulative changes to Heath Tundra, Riparian Tall Shrub, Birch Seep and Riparian Shoreline Shrub, Shallow Water and Deep Water units will all be less than 1.0% each. The largest magnitudes of cumulative reductions of ELC land cover types are 203 ha (3.7%) of Esker Complex and 49 ha (2.3%) of Boulder Complex (>80% rock). Cumulative reduction of Heath Tundra 30% to 80% Boulder (1,032 ha), Heath Tundra 30% to 80% Bedrock (160 ha), Bedrock Complex (17 ha), Tussock/Hummock (578 ha), and Sedge Wetland (175 ha) are predicted to be no greater than 1.4% each relative to the reference condition in the ESA.

In areas where disturbances not only remove vegetation, but also cause permanent loss of soil, organic layers and vegetative propagules are also lost, and recovery is slower than areas where soils and organic layers are not disturbed (Speed et al. 2010). Because the Project is expected to remove soils and vegetation, the recovery of plant populations and communities in the absence of soil and organic materials will take more time.

The Project footprint covers approximately 1,132 ha (0.2% of the ESA). Approximately 62% of the physical footprint is terrestrial habitat and 38% is aquatic habitat. At closure, the terrestrial area that contains the Project footprint is considered a permanent disturbance on the landscape. The time for vegetation VCs to recover in areas of disturbance is unknown and it is not known what the revegetated landscape will look like in the future, even though a plant cover is expected to be eventually re-established. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas..

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In addition to direct loss of vegetation, the application of the Project will result in the fragmentation of the existing landscape. With the application of the Project, the number of patches is expected to decrease from 263,572 in the baseline condition to 263,082 (loss of 490 patches); the mean patch size is expected to decrease by less than 0.1 ha. The cumulative change in number of patches from the Project and previous and existing disturbance is a decrease of 1,792 patches and a decrease in mean patch size of 1.3 ha. The MDNN for the Esker Complex map unit is expected to decrease by approximately 0.3 m relative to baseline conditions. Heath Tundra 30% to 80% Boulders, Heath Tundra, and Deep Water map units are expected to decrease by less than 1 m relative to baseline conditions. A decrease in MDNN indicates the distance between patches is becoming smaller, which is the result of an increase in patch number and the patch size getting smaller. However, there is a poor correlation between patch size and plant species diversity (Donaldson et al. 2002). This poor correlation implies that plants could be more resilient to habitat fragmentation than other taxa, such as insects or wildlife (i.e., plant pollinators).
An increase in the distance between plant populations and pollinator habitat can result in a decrease in pollinator visitation and increase in genetic isolation of plant populations (Newman et al. 2013). Where the distance between patches is decreasing, it would have the opposite effect. The MDNN for the remaining map units is expected to increase by less than 1 m relative to baseline conditions. The cumulative effects of fragmentation on the abundance and distribution of plant populations and communities were limited to disturbance through the Application Case because no reasonably foreseeable developments are expected in the ESA at the time of producing the DAR.

Plant species respond to fragmentation and edge habitats in a variety of ways. Many plant species can increase and become more common in edge habitats, resulting in a positive effect on species diversity (Landenberger and McGraw 2004; Lin and Cao 2009). Another factor that can influence plant reproduction in fragmented habitats is plant population size, which is not always correlated with patch size (Donaldson et al. 2002). For some species, fragmentation can promote seed germination of certain plants because the disturbance creates microsites suitable for some species (i.e., shade-intolerant species), while in other plant species, rates of germination can decrease (e.g., shade-tolerant species) (Saunders et al. 1991; Donaldson et al. 2002; Cooper et al. 2004). Although there can be a positive response by some plant species to edge habitats, negative ecological consequences, such as the introduction of non-native invasive plant species can result in deleterious effects on a plant community (Lin and Cao 2009) and the effect of an increase in edge can have negative effects on wildlife that use these areas (Sections 12.4 and 13.4).

Fragmentation can influence population and community processes, but fragmentation effects have less influence than direct loss when there is a large proportion of continuous land cover types on the landscape (Fahrig 2001, 2003; Swift and Hannon 2010). Habitat fragmentation and changes in patch size results in changes to the functional interactions within an ecosystem, which can have a direct effect on some plant species reproductive success and spread (Donaldson et al. 2002; Hobbs and Yates 2003; Dauber et al. 2010; Newman et al. 2013). The magnitude of the effects of fragmentation is a function of the reliance of a plant species' reproductive dependence on specific pollinators and seed dispersers, which influences the reproductive success and spread of plants.

Although fragmentation can change plant population and community processes, the magnitude of cumulative effects on plant populations and communities is assessed as low because it is expected that associated plant populations and communities in the ESA are able to accommodate disturbances associated with the Project and other developments. The Project footprint does not support isolated plant populations and communities that are endemic to the region. Project-related disturbances are expected to occur once and, although the effect is permanent for the Project footprint, the net incremental change in ELC units from loss and fragmentation in the ESA will be confined to the Project footprint (local scale). The magnitude of regional cumulative effects of the Project and previous and existing disturbances on the relative abundance and quality of plant populations and communities is adverse, but small (approximately 1.2% of the mapped units in the ESA). Although map units with restricted distribution have been and will be disturbed, these units are widely distributed throughout the ESA. The previous and existing disturbances across the landscape, although spread across the ESA, are also localized and small (Map 11.4-1). These localized disturbances in the ESA have likely created early successional plant communities or gaps for other plant species establishment, especially if these disturbances have occurred in plant communities that are resilient to the disturbance. The cumulative effects from the direct loss, alteration, and fragmentation of vegetation from the Project and from previous and existing developments are expected to be low in magnitude (Table 11.6-2).

For cumulative effects of development to have a significant impact on self-sustaining and ecologically effective plant populations and communities, there would need to be sufficient change that plant populations and communities would no longer be resilient to natural selection pressures (e.g., weather and competition). Although specific effects thresholds for vegetation in the ESA are not known, the literature indicates that abrupt and non-linear, negative changes in population parameters occur at levels of more than 40% habitat loss (Andrén 1994; Monkkonen and Reunanen 1999; Swift and Hannon 2010). Variation in the response of plant populations and communities to disturbances can lead to community changes. Abundant species within a community can decrease in response to disturbance and those previously less abundant may increase, resulting in a change in the ecosystem properties and function (Speed et al. 2010). In cases where all plant species in the plant communities are negatively affected and plant community function is reduced, a shift in the state of the plant population and community is likely, and would be considered a significant effect.

No significant adverse effects are predicted for the ability of plant populations and communities to remain self-sustaining and ecologically effective as a result of the Project or in combination with previous and existing developments in the ESA (Table 11.6-2). Confidence in this prediction is high as the majority of these ecosystems are well distributed in the ESA and plant species within already uncommon map units are expected to be adapted to the patchy nature of their habitats.

Table 11.6-2 Summary of Residual Impact Classification of the Primary Pathway and Predicted Significance of Cumulative Effects on Vegetation Valued Components

Pathway	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Significance for Assessment Endpoint[(a)]
Direct loss, alteration, and fragmentation of vegetation from the Project footprint	Low for plant communities and traditional use plant species Moderate for listed plant populations	Regional	Permanent	Continuous	Irreversible	Highly Likely	Not Significant

a) self-sustaining and ecologically effective plant populations and communities.

11.6.2.2 *Listed Plant Species and Listed Plant Habitat*

Two territorial listed vascular plant species and five non-vascular plant species were documented during the 2014 field program, specifically one forb (Pallas' buttercup), one graminoid (Richardson's sedge), one bryophyte (tiny fork-moss), and four lichens (Kamchatka Icelandmoss lichen, umber monk's hood lichen, silver-rimmed crottle lichen, and cushion coral lichen) (Section 11.2.2.2.1). All of these observations were in Shallow Water, Sedge Wetland, and microsites including rocky crevices and ecotones (i.e., transition area between two vegetation types). Microsites can occur within any mapped unit in the ESA; Shallow Water (high potential habitat) and Sedge Wetland (moderate potential habitat) are widely distributed and abundant in the ESA.

Of the area directly disturbed by the Project, 36 ha of ELC units with high listed plant species potential will be disturbed during construction, resulting in a decrease of 0.1% relative to baseline conditions. Habitat units with moderate listed potential will decrease by approximately 43 ha (0.2%). The largest cumulative change through application of the Project and previous and existing developments is within the moderate plant potential ELC map units (1.7%). The magnitude of the cumulative change within the high potential map units is 0.9% relative to the reference condition.

For cumulative effects of the Project to have a significant effect on self-sustaining and ecologically effective listed plant populations and communities, preferred habitats for listed species would have to be removed to the extent that there would be a permanent adverse change to survival and reproduction at the population level. Significant effects could also occur if individual patches become isolated to the extent that populations would no longer be resilient to other environmental pressures or changes. The natural abundance of a species can influence the effects of loss and fragmentation of listed plant habitat on specific groups of plant species (Hobbs and Yates 2003). For example, loss and fragmentation can have more pronounced effects on uncommon and rare species where a small patch can contain a population and the distance to another area containing the same species has increased (Donaldson et al. 2002). The effect of fragmentation can be enhanced simply because the abundance of rare or uncommon species is naturally restricted (Donaldson et al. 2002; Hobbs and Yates 2003). Although high and moderate potential habitats have been previously affected and will be adversely altered by the Project, these habitats are not unique to areas on the landscape. For example, some of the listed species that prefer Shallow Water and Sedge Wetland habitats could also occur in microsites contained in the Birch Seep and Riparian Shoreline Shrub map units. If all listed plant species were negatively affected or removed from the ESA, and function of these species were reduced, it would be considered a significant effect on listed plants.

Not all areas that were assessed to be disturbed by the Project are expected to be altered during construction; therefore, the assessment of effects from direct loss of listed plant species and the loss or alteration and fragmentation of preferred habitat is overestimated. Project-related disturbances are expected to occur once, and although the effect is considered permanent, the net incremental change in ELC units with the highest potential to support listed plant species will be confined to the Project footprint (local scale). The cumulative effects of the Project and previous and existing disturbances on the relative abundance of listed plant populations and communities are adverse and regional, but small (approximately 2.6% of the high and moderate mapped units in the ESA).

With appropriate mitigation it is expected that the residual effect of the Project to listed plant populations would be low in magnitude, because if a patch of listed plants is removed, it could be measurable at the regional level, but would not be predicted to alter the state of self-sustaining and ecologically effective listed plant populations. It is unknown whether previous and existing disturbances in the ESA have removed other patches of listed plant species; therefore, the magnitude of cumulative effects on listed plants is considered moderate to be conservative (Table 11.6-2). Incremental and cumulative changes to listed plant habitat from the Project and other developments are predicted to not have significant adverse effects on listed plant populations and communities to remain self-sustaining and ecologically effective. Confidence in this prediction is moderate because of limited knowledge about the reproductive capacity and resilience of the observed listed species, and the level of occurrence of these species in the ESA; however, there is a large amount of suitable habitat for listed plant species in the region.

11.6.2.3 *Traditional Use Plants and Traditional Use Plant Habitat Potential*

There are 11 traditional use plants known to occur within the ESA. Local and traditional knowledge studies identified that many plants and berries are harvested in the ESA, with traditional lands overlapping the Project footprint. Those ELC map units predicted to contain the most traditional use species are Heath Tundra 30% to 80% Bedrock, Heath Tundra 30% to 80% Boulders, and Heath Tundra, which are the most abundant habitats in the ESA compared to other land cover types. Relative to the reference condition, previous and existing developments have removed approximately 2,829 ha (0.9%) of the high potential ELC units for traditional use plants and 580 ha (0.9%) of moderate potential units within the ESA. A total of 507 ha of ELC units with high traditional use plant habitat potential will be disturbed by the Project, resulting in a decrease of 0.2% relative to baseline conditions. Habitat units with moderate listed potential will decrease by approximately 177 ha (0.3%). The cumulative reduction in land cover types through application of the Project and previous and existing developments is predicted to remove 6,048 ha or approximately 1.2% of the mapped units in the ESA. The magnitude of the cumulative changes to high and moderate traditional use plant habitat potential will be 1.0% and 1.1%, respectively, relative to the reference condition in the ESA. The permanent loss from the Project footprint is expected to be 1,132 ha (0.2% of the ESA) (Table 11.6-2). Residual effects from the Project are expected to be small and at the local scale, and have no significant effect on traditional use plants.

The Project footprint does not support isolated traditional plant populations and communities. The effects on traditional use plant species are expected to be the same as the effects predicted for the abundance and distribution of plant communities (Section 11.6.2.1). Project-related disturbances are expected to occur once, and although the effect is permanent, the net incremental change in traditional use plants and traditional use plant habitat in the ESA will be confined to the Project footprint (local scale). The cumulative effects from the direct loss, alteration, and fragmentation of traditional use plant habitat from the Project and previous and existing developments are expected to be adverse, regional, and low in magnitude. The cumulative effects are predicted to have no significant influence on self-sustaining and ecologically effective traditional use plant populations and communities (Table 11.6-2). The scale of residual effects from the Project interactions, independently or combined, should not be large enough to cause irreversible changes at the population and community level and decrease the resilience of plant populations and communities. Confidence in this prediction is high as the majority of the traditional use plant species and the land cover types that support them are well distributed throughout the ESA.

11.7 Follow-up and Monitoring

Typically, monitoring includes one or more of the following categories, which may be applied during the development of the Project:

- **Compliance monitoring** – monitoring activities, procedures, and programs undertaken to confirm the implementation of approved design standards, mitigation, and conditions of approval and company commitments (e.g., inspecting the installation and effectiveness of a silt fence).
- **Follow-up monitoring** – programs designed to test the accuracy of effects predictions, reduce/address uncertainties, determine the effectiveness of environmental design features, and/or provide appropriate feedback to operations for modifying or adopting new mitigation designs, policies, and practices (e.g., monitoring of downstream lakes for aquatic effects, wildlife effects monitoring, and socio-economic monitoring). Results from these programs can be used to increase the certainty of effect predictions in future environmental assessments.

These programs form part of the environmental management system for the Project. If monitoring or follow-up detect effects that are different from predicted effects, or the need for improved or modified design features and mitigation, adaptive management will be implemented. This may include increased monitoring, changes in monitoring plans, and additional mitigation. Monitoring for vegetation will involve:

- As part of the annual Wildlife Effects Monitoring Program, once the Project is constructed, the Project footprint will be delineated to determine the actual extent of the physical footprint and associated loss of plant communities (habitat) for comparison with that predicted in the DAR.
- Monitoring will be continued during the Project as part of the ICRP. Lessons-learned will be applied to the reclamation of the Jay Project components.
- Monitoring will also include surveys for non-native invasive plant species following construction.

DOMINION DIAMOND

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11.9 Glossary

Term	Definition
Abundance	The number of individuals.
Adverse effect	An undesirable or harmful effect to an organism (human or animal) indicated by some result such as mortality, altered food consumption, altered body and organ weights, altered enzyme concentrations, or visible pathological changes.
Babiche	A type of cord or lacing made from rawhide
Basin	A large area that is lower in elevation than surrounding areas and contains water. Basins are separated by land or shallow channels.
Bedrock	The solid rock (harder than 3 on Moh's scale of hardness) underlying soils and the regolith in depths ranging from zero (where exposed to erosion) to several hundred metres.
Boulder	A large rounded mass of rock lying on the surface of the ground or embedded in the soil.
Bryophytes	Non-vascular plants from the phylum Bryophyta (a division of the plant kingdom). Species within this phylum include mosses, liverworts and hornworts.
Classification, vegetation	The systematic arrangement of plant communities into categories according to their inherent characteristics. Groupings are made on the basis of dominant vegetation species, in association with commonly associated species and a commonly associated set of site and soil conditions.
Community (biology)	Group of co-existing organisms in an ecosystem.
Developer's Assessment Report (DAR)	A report that documents the information required to evaluate the environmental impact of a project.
Diavik Diamond Mines Inc. (Diavik Mine)	A diamond mine located on East Island in Lac de Gras, approximately 30 km southeast of the Ekati main camp and 10 km southwest of the Misery Pit.
Distribution	The pattern of dispersion of an entity within its range.
Diversity	A numerical index that incorporates evenness and richness; diversity measures the proportional distribution of organisms in the community.
Dominant	In natural resources mapping, the feature (soil type, terrain, or other feature) that constitutes the majority of a mapping unit (generally 40% or more, and usually 50% or more).
Drainage	The removal of excess surface water or groundwater from land by natural runoff and percolation, or by means of surface or subsurface drains.
Drainage basin	The area drained by a river or stream; see also watershed.
Ecological Landscape Classification (ELC)	A means of classifying landscapes by integrating landforms, soils and vegetation components in a hierarchical manner.
Ecoregion	Subdivisions of ecozones that are relatively homogeneous with respect to soil, terrain, and dominant vegetation.
Ecosystem	An integrated and stable association of living and non-living resources functioning within a defined physical location. A community of organisms and its environment functioning as an ecological unit. For the purposes of assessment, the ecosystem must be defined according to a particular unit and scale.
Ecosystem Type	An ecosystem type is a standardized name that is given to an identifiable group of living organisms (defined by and named using the most common plant species) that interact among themselves and which, together with their environment (soil, climate, water, and light), function as a unit.
Ecotone	The transition of physical and biological characteristics, from one community to the next.
Ecozone	Areas of the earth's surface representative of large and very generalized units characterized by interactive and adjusting abiotic and biotic factors. The ecozone lies at the top of the ecological hierarchy and defines, on a subcontinental scale, the broad mosaics formed by the interaction of macroscale climate, human activity, vegetation, soils, geological, and physiographic features of the country.

Term	Definition
Effect (DAR)	In the DAR, the term "effect," used in the effects analyses, is regarded as an "impact" in the residual impact classification. An effect represents a change in a valued component (VC); Any response by an environmental or social component to an action's impact. Under the *Canadian Environmental Assessment Act*, "environmental effect" means, in respect of a Project, "(a) any change that the Project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by Aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance and (b) any change to the Project that may be caused by the environment, whether any such change occurs within or outside of Canada.
Effects study area (ESA)	A broad area defined for the description of vegetation conditions generally centered on the Project and surroundings.
Ekati Mine	Ekati Diamond Mine, Canada's first diamond mine.
Esker	A long, winding ridge of stratified sand and gravel believed to form in ice-walled tunnels by streams, which flowed within and under glaciers. After the retaining ice walls melt away, stream deposits remain as long winding ridges.
Footprint	The proposed development area that directly affects the soil and vegetation components of the landscape.
Forb	An herbaceous plant that is not a grass, sedge, or rush.
Frequency	Refers to how often an effect will occur.
Geographic Information System (GIS)	Computer software designed to develop, manage, analyze and display spatially referenced data.
Glacial	(i) Of or relating to the presence and activities of ice or glaciers, such as glacial erosion. (ii) Pertaining to distinctive features and materials produced by or derived from glaciers and ice sheets, such as glacial lakes. (iii) Pertaining to an ice age or region of glaciation.
Graminoid	An herbaceous plant with narrow leaves growing from the base. These include "true grasses" of the family Poaceae (Gramineae), as well as sedges (Cyperaceae) and rushes (Juncaceae). True grasses include cereals, bamboo and the grasses of lawns (turf) and grassland.
Gravel	(i) As a deposit term: glaciofluvial or fluvial materials with 60% or more coarse fragments, usually subrounded to rounded and of variable size. (ii) As a particle size term: a size fraction between 2 and 75 mm diameter with rounded, subrounded, angular, or irregular shapes.
Gravelly	Containing appreciable amounts of rounded or subrounded rock or mineral fragments 2 mm to 8 cm in diameter. 'Angular gravelly' is used when the fragments are less rounded.
Ground-truthing	Visiting locations in the field to confirm or correct information produced from remote sources such as interpreted aerial photographs or classified satellite imagery.
Habitat	The physical location or type of environment in which an organism or biological population lives or occurs.
Heath	Vegetation typical of the Arctic, often characterized by lichens, mosses, sedges, and dwarf trees and shrubs.
Heath tundra	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 family, the Ericaceae. The vegetation layer forms a mat of low shrubs dominated by dwarf birch and Labrador tea.
Herb	Any flowering plant except those developing persistent woody bases and stems.
Hummock	A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various sizes to irregular to conical knolls or knobs. There is a lack of concordance between knolls and depressions. Slopes are generally 9% to 70%.
Inflow	Water flowing into a lake.
Kimberlite	Igneous rocks that originate deep in the earth's mantle and intrude the Earth's crust. These rocks typically form narrow pipe-like deposits that sometimes contain diamonds.
Landscape	A heterogeneous land area with interacting ecosystems that are repeated in similar form throughout. From a wildlife perspective, a landscape is an area of land containing a mosaic of habitat patches within which a particular "focal" or "target" habitat patch is embedded.

Term	Definition
Lichen veneer	A continuous mat of lichen that appears as a “veneer.” These sites are windswept and dry, allowing very little other plant growth. Lichen veneer consists mainly of Iceland moss, several other species of Cetraria, green and black hair lichens, grey mealy lichen, worm lichens and other species.
Map unit	A combination of kinds of soil, terrain, or other feature that can be shown at a specified scale of mapping for the defined purpose and objectives of a particular survey.
Meandering	Following a winding or intricate course.
Mitigation	The elimination, reduction or control of the adverse environmental effects of a project, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means.
Moisture regime	Represents the available moisture supply for plant growth on a relative scale. It is assessed through an integration of species composition and soil and site characteristics. Moisture regime ranges from very dry to wet.
Non-sorted circle	A patterned ground form that is equidimensional in several directions, with a dominantly circular outline which lacks a border of stones. Nonsorted circles characteristically have margins of vegetation, they occur singly or in groups, and their diameter is commonly between 0.5 and 3.0 m. Their central areas tend to be slightly dome-shaped and may be cracked into small nonsorted polygons. The term covers both mud circles, developed in fine-grained materials, and stony earth circles, developed in gravelly materials.
Non-vascular plant	Plants that do not possess conductive tissues (e.g., veins) for the transport of water and food.
Nutrients	Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals.
Outflow	Water flowing out of a lake.
Peat	A deposit consisting of decayed or partially decayed humified plant remains. Peat is commonly formed by the slow decay of successive layers of aquatic and semi-aquatic plants in swampy or water-logged areas, where oxygen is absent.
Permafrost	Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years. Permafrost is defined on the basis of temperature. It is not necessarily frozen, because the freezing point of the included water may be depressed several degrees below 0°C; moisture in the form of water or ice may or may not be present.
Plant community	A collection of plants that live together on a relatively uniform area of land with a floristic composition and structure that is distinct from surrounding vegetation.
Population	A group of individuals of the same species that is primarily affected by natural and human-related factors that change survival and reproduction of individuals
Range	The geographic limits within which an organism occurs.
Rare plant	A native plant species found in restricted areas, at the edge of its range or in low numbers within a province, state, territory or country.
Riparian	Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain or standing waterbody.
Scale	The resolution at which patterns are measured, perceived, or represented. Scale can be broken into several components, including geographic extent, resolution, and other aspects.
Sedge	A grass-like plant with a triangular stem often growing in wet areas. Sedge wetland habitats are typically wet sedge meadows and other sedge associations of non-tussock plant species. Sedge species such as *Carex aquatilis* and *C. bigelowii*, and cotton-grass (*Eriophorum angustifolium*) are the dominant vegetation types. Plant species occupy wet, low lying sites where standing water is present throughout much of the growing season.
Sediment	Solid particles of material that have been derived from rock weathering. They are transported and deposited from water, ice, or air as layers at the Earth's surface.
Seepage	Slow water movement in subsurface. Flow of water from man-made retaining structures. A spot or zone, where water oozes from the ground, often forming the source of a small spring.

Term	Definition
Sensitive	1. Sites or organisms that are particularly vulnerable to harm 2. A general status rank for a species with one or more of the effects.3. in statistics, parameter sensitivity refers to a series of tests in which different parameter values are set to see how a change in the parameter causes a change in the dynamic behaviour of the system in question (e.g., how much does a change in adult female survival affect population growth of a caribou herd).
Shrub	A woody perennial plant differing from a tree by its low stature and by generally producing several basal shoots instead of a single trunk.
Species	A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus.
Temporal	Related to time.
Traditional Knowledge	The knowledge, innovations, and practices of indigenous people; refers to the matured long-standing traditions and practices of certain regional, indigenous, or local communities.
Traditional Land Use	The practices and traditions of land use and resource harvesting by regional, indigenous, and local communities.
Tundra	A vast, mostly flat, treeless Arctic region of Europe, Asia, and North America in which the subsoil is permanently frozen. The dominant vegetation is low-growing stunted shrubs, mosses, lichens.
Tundra heath	The treeless area to the north of the boreal forest. Vegetation includes low, matted and erect shrubs and herbs such as cotton-grass
Tussock-hummock	A tussock is a tuft of grass or grasslike plants like sedges. Tussock-hummock refers to a type of tundra consisting of acre upon acre of sedge tussocks, usually located on flat, poorly drained land or gentle slopes.
Uncertainty	Imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution.
Understory	Trees or other vegetation in a forest that exist below the main canopy level.
Upland Area	Ground elevated above the lowlands along rivers or between hills; highland or elevated land; high and hilly country.
Vascular plant(s)	Plants possessing conductive tissues (e.g., veins) for the transport of water and food.
Vegetation Type	Base unit of identification during field surveys. Can be analogous to ecosystem type but is generally used to describe vegetation at the site-level.
Veneer	Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10 cm to 1 m in thickness and possesses no form typical of the materials' genesis.
Watershed	The area drained by a river or stream; see also drainage basin.
Wetland	Land having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetland or aquatic processes as indicated by hydric soils, hydrophytic vegetation and various kinds of biological activity which are adapted to the wet environment.
Wildlife	A term to describe all undomesticated animals living in the wild.