SECTION 16

ENVIRONMENTAL EFFECTS ON THE PROJECT

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Section 16 Abbreviations

Abbreviation	Definition
DAR	Developer's Assessment Report
Dominion Diamond	Dominion Diamond Ekati Corporation
e.g.	for example
Ekati Mine	Ekati Diamond Mine
i.e.	that is
NWT	Northwest Territories
Project	Jay Project
spp.	multiple species
TCWR	Tibbitt to Contwoyto Winter Road
TOR	Terms of Reference
WFI	Winter Freezing Index

Section 16 Units of Measure

Unit	Definition
%	percent
°C	degrees Celsius
cm	centimetre
km	kilometre
m	metre

16 ENVIRONMENTAL EFFECTS ON THE PROJECT

16.1 Introduction

16.1.1 Background

The existing Dominion Diamond Ekati Corporation (Dominion Diamond) Ekati Diamond Mine (Ekati Mine) and its surrounding claim block are approximately 300 kilometres (km) northeast of Yellowknife in the Northwest Territories (NWT) (Map 16.1-1). 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 Ekati Mine. The majority of the facilities required to support the Project and process the kimberlite already exist at the Ekati Mine, including:

- Misery Pit mining infrastructure (e.g., fuel facility, explosives magazines);
- primary roads and transportation infrastructure (e.g., Ekati airstrip, Misery Haul Road);
- Ekati main camp and supporting infrastructure;
- Ekati 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 claim block, approximately 25 km southeast of 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 pipe. The isolated portion of Lac du Sauvage will be dewatered to allow 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.

16.1.2 Purpose, Scope, and Content

The purpose of this section of the Developer's Assessment Report (DAR) for the Project is to meet the Terms of Reference (TOR) issued by the Mackenzie Valley Review Board in July 2014. The TOR is included in Appendix 1A and the Table of Concordance for the DAR is provided in Appendix 1D. The TOR requires that the DAR provide a description of the potential effects of the physical environment on the Project, including the use of the Tibbitt to Contwoyto Winter Road (TCWR), such as:

- climate change impacts;
- changes in the permafrost regime;
- extreme precipitation;
- seasonal flooding and melt patterns; and,
- seismic events.

Any changes to the design or management of the Project due to potential effects from the environment must be noted in the relevant sections that assess effects from the Project on biophysical and socio-economic valued components.

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_EE_002_GIS	
DESIGN	LD	02/09/14	SCALE AS SHOWN	REV. 0
GIS	ANK	20/10/14	MAP 16.1-1	
CHECK	JV	20/10/14		
REVIEW	BC	20/10/14		

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\DAR Other\DAR Enviro Effects\DAR_EE_002_GIS.mxd

16.1.3 Spatial Boundaries

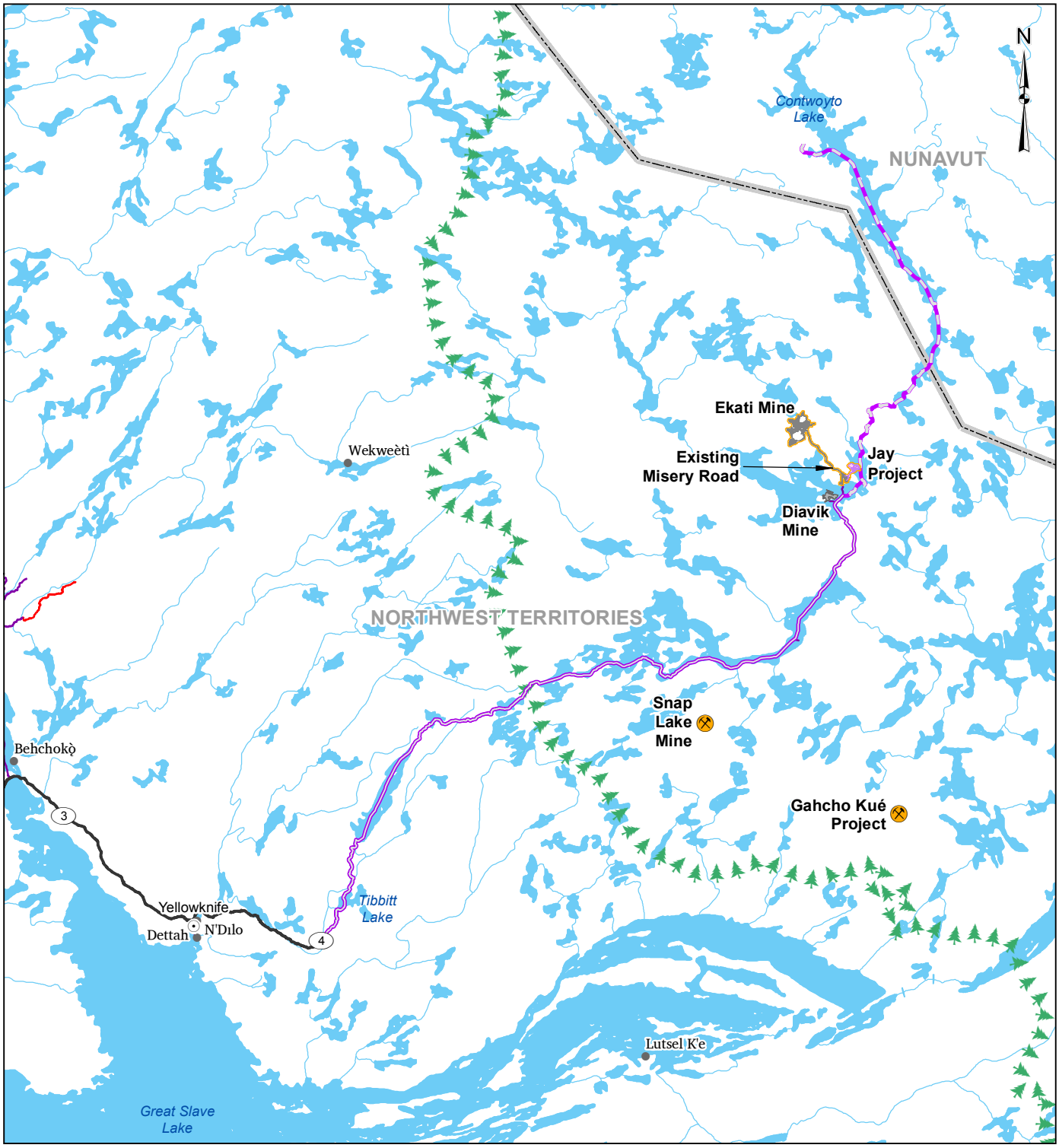
The effects study area to assess the environmental effects on the Project is the same area used to assess effects on terrain and geotechnical stability of engineered structures (Subject of Note: Terrain; Section 10.1.4.2), and the portion of the TCWR from Tibbitt Lake to the point where it is intersected by the access road to the Ekati Mine (Ekati Mine turn-off at kilometre 405; Map 16.1-2). The effects study area for terrain has eskers and kames that were formed by glaciofluvial processes associated with the transport and deposition of coarse material by glacial meltwater. These landforms are composed of well-sorted sand and gravel. The area 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 (mean annual temperature of approximately -9 degrees Celsius [°C]). Ice-wedge polygons, frost-shattered bedrock, high-centre polygons, and non-sorted circles are evidence of continuous permafrost in this ecoregion.

The western portion of the effects study area occurs within the Point Upland Ecoregion and is characterized by a rugged landscape dominated by exposed bedrock and extensive boulder tills. Small eskers are often associated with outwash plains, and both occur throughout the ecoregion. Turbic and Static Cryosolic soils have developed on the till veneers that overlie the bedrock. Organic Cryosol areas associated with the wetlands, and with high-centre peat polygons occur in low-lying areas (ECG 2012). The Coppermine River flows through the ecoregion to the northwest. Lac de Gras and Afridi, Courageous, Itchen, Mackay, Point, Thonokied, and Yamba lakes are the largest waterbodies in the ecoregion.

The Contwoyto Upland Ecoregion encompasses the eastern portion of the effects study area. Although rock exposures occur throughout the ecoregion, the bedrock is mostly overlain by deposits of bouldery till veneers and blankets and by hummocky till deposits, with nearly continuous tundra cover (ECG 2012). Small eskers and kame deposits are scattered throughout the region, and permafrost is continuous. Turbic and Static Cryosolic soils have developed on glacial till hummocks, veneers, and blankets. Cryosolic soils are characteristic of deep, well-drained, coarse-textured landforms, while Organic Cryosolic soils are associated with low-lying wetlands (ECG 2012). Lac du Sauvage and Contwoyto (Fry Inlet), Glowworm, Muskox, Pellatt, and Sterlet lakes are the largest waterbodies in this ecoregion.

The TCWR has been constructed annually since 1982. Before 2009, the 600 km winter road extended from the end of the Ingraham Trail, approximately 70 km northeast of Yellowknife at Tibbitt Lake in the NWT, to the Jericho Diamond Mine on Contwoyto Lake, Nunavut. Since closure of the Lupin and Jericho mines in 2006 and 2009, respectively, the winter road has extended to the Ekati Mine turn-off at kilometre 405 (Joint Venture 2014). The road is usually open from January to March, and 85 percent (%) of the route is constructed on frozen lakes. The primary use of this winter road is the re-supply of mines (e.g., Diavik Diamond Mine, Ekati Mine, and Snap Lake Diamond Mine), exploration camps, and lodges near the winter road. The road is also open to the public.

The TCWR from Tibbitt Lake to the Ekati Mine turn-off crosses the Taiga Shield and Southern Arctic Level II Ecoregions (ECG 2008, 2012). From south to north, the road crosses the Taiga Shield High Boreal Level III Ecoregion (ECG 2008), Taiga Shield Low Subarctic Level III Ecoregion (ECG 2008), Taiga Shield High Subarctic Level III Ecoregion (ECG 2008), and the Tundra Shield Low Arctic (south) Level III Ecoregion (ECG 2012).



LEGEND

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

STUDY AREA

- TIBBITT TO CONTWOYTO WINTER ROAD
- STUDY AREA

75 0 75

SCALE 1:2,250,000 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

STUDY AREA FOR EFFECTS OF ENVIRONMENT ON THE PROJECT

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_EE_001_GIS	
DESIGN	LD/JV	12/09/14	SCALE AS SHOWN	REV. 0
GIS	JE	20/10/14		
CHECK	JV	20/10/14		
REVIEW	BC	20/10/14		

MAP 16.1-2

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\DAR Other\DAR Enviro Effects\DAR_EE_001_GIS.mxd

The portion of the TCWR from Tibbitt Lake to the south end of Gordon Lake (34 km) is within the Great Slave Upland High Boreal Level IV Ecoregion. This ecoregion is a bedrock-dominated landscape that is mostly level and consists of a few hill systems. It contains numerous large lakes that occupy over 30% of the area. The dominant landscape type is fractured bedrock plain with subdued topography. The dominant soil type is variable-textured Brunisols on glacial deposits between bedrock exposures and in fractures (ECG 2008).

Vegetation in the Great Slave Lake Upland High Boreal Ecoregion consists of discontinuous forests (ECG 2008). Lichen woodland and rock lichen woodland with an overstorey of black spruce (*Picea marina*), jack pine (*Pinus banksiana*), and paper birch (*Betula papyrifera*) occur on thin soils overlying bedrock, in bedrock fractures, and on well-drained sandy outwash deposits. Moderately dense forests of black spruce that favours the development of a feather moss understory occur on deeper, moister soils. Mixed or pure forests of white spruce (*Picea glauca*), trembling aspen (*Populous tremuloides*), and paper birch also occur on moderately moist sites. Peat plateaus support an open black spruce-low shrub-lichen plant community, and sedge-moss fens occur in collapse scars.

The portion of the TCWR from the south end of Gordon Lake northward for 111 km to Drybones Lake is within the Great Slave Upland Low Subarctic Level IV Ecoregion (ECG 2008). The Great Slave Upland Low Subarctic Ecoregion consists of gently undulating to rolling till bedrock plains with low bedrock exposures occur on the plateaus. Lakes are common in the lowlands, while rock outcrops are common in the uplands. Well-drained Brunisols occur on stony, non-calcareous sandy loam to loamy sand till derived from granitic rock are the dominant soil. In the northeast part of the ecoregion, soils may be affected by frost action (Turbic Crysols) where the parent materials are thin (less than 1 metre (m) thick over bedrock). In areas where exposed bedrock is dominant, open-canopied and discontinuous black spruce and dwarf birch (*Betula glandulosa*) grow along bedrock fractures and on discontinuous deposits of glacial till. In till plains occurring on plateaus, a more continuous cover of spruce and dwarf birch is found. White spruce, dwarf birch, and lichen woodlands are common on outwash deposits.

Once the TCWR crosses the treeline, it enters the Mackay Upland Low Arctic South Level IV Ecoregion (ECG 2012). The Mackay Upland is a northern treeless extension of the Taiga Shield Mackay Upland High Subarctic Ecoregion, but the Mackay Upland is characterized by a less pronounced topography. It is characterized by an undulating to hummocky bouldery till in the east and a gently undulating till plain in the west. Upland permafrost features such as non-sorted circle are common. Turbic Cryosols and Static Cryosols are dominant soils and Organic Cryosols are associated with wetlands. The dominant vegetation includes erect dwarf-shrub tundra and low-shrub tundra. These vegetation types occur as a nearly continuous cover on finer-textured till veneers, except that where there is a higher proportion of bouldery till, the vegetation cover becomes discontinuous. Till boulders and exposed bedrock outcrops support rock lichen communities. Low lying areas and seepage zones support sedge-moss-low shrub and dwarf shrub wetlands. Tall willow (*Salix* spp.) and alder (*Alnus* spp.) shrublands occur in riparian areas along streams and lake shores.

At the northern edge of Mackay Lake, the TCWR crosses into the Point Upland Low Arctic South Level IV Ecoregion (ECG 2012). This ecoregion contains more extensive areas of exposed bedrock. West of Lac de Gras, the landscape is dominated by extensive areas of exposed fractured and ice-scoured granitic and sedimentary bedrock, often occurring with frost-shattered bouldery till plains. Bouldery tills are common east of Lac de Gras. However, surficial fine materials occur and permafrost features such as non-sorted circles are present. Dominant mineral soils include Turbic and Static Cryosols. Static Cryosolic soils are characteristic of eskers that occur throughout the ecoregion. Organic Cryosols are found in high-centre polygons and in wetlands. The dominant vegetation is shrub and sedge tundra. Common plant species include bilberry, dwarf birch, mountain cranberry, black crowberry, red bearberry, dwarf birch, lichens, sedges, and cotton grasses (*Eriophorum* spp.). Dwarf-shrub tundra and low-shrub tundra occur as a continuous cover on fine-textured glacial till veneers, but become discontinuous in the northwestern portion of the ecoregion where bouldery tills and bedrock become dominant.

16.1.4 Project Phases

The Project phases include:

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

Most effects from the environment on the Project will end when operations cease or at closure, but effects on the geotechnical stability of waste rock storage areas will likely continue after Project closure.

16.2 Effects from the Environment on the Project

Environmental effects on the stability of engineered structures for the Project (i.e., the waste rock storage area, dikes, and site access roads) are assessed in Section 10.3. The assessment includes climate change-related effects for the following variables:

- temperature and permafrost regime (Section 10.3.1.1 and Section 10.3.1.2);
- precipitation (average and extreme conditions) (Section 10.3.1.3); and,
- seasonal flooding and melt patterns (Section 10.3.1.4).

Project designs, and existing and proven weathering, oxidation, and erosion management practices (e.g., Waste Rock and Ore Storage Management Plan, Interim Closure and Reclamation Plan, Wastewater and Processed Kimberlite Management Plan) at the Ekati Mine, are expected to mitigate climate change-related effects on the Project. Long-term changes in environmental factors are predicted to have negligible effects on the Project, and to result in no impact on the assessments of biophysical and socio-economic valued components. Current and ongoing monitoring of engineered structures will be used to determine the effectiveness and success of Project designs and mitigation, and as input for adaptive management (Section 10.4).

The potential influence of seismic activity on the Project is evaluated in Section 10.3.2. Due to the geodynamical stability of the cratonic area and the absence of seismogenic faults, the Project has been classified by Natural Resources Canada (2013a,b) as belonging to a low seismic hazard zone.

16.3 Effects from the Environment on the Tibbitt to Contwoyto Winter Road

Climate change and the resulting increase in winter air temperatures could result in a shorter operating season for the TCWR, which could lead to increased traffic on the road when it is open and could adversely influence the transportation of supplies for the Project.

According to the Tibbitt to Contwoyto Winter Road Joint Venture (Joint Venture 2014), the 2007 operating season was the best on record, when more than 10,000 trucks transported supplies to developments over 72 days (Table 16.3-1). In contrast, the 2006 operating season was the warmest winter on record in the region. The season opened late and closed early because of unsafe ice conditions, resulting in 49 days of operation. Due to unseasonably warm conditions, the road failed to deliver all of the scheduled fuel and materials to the mine sites in 2006, requiring more costly air deliveries at the end of the season (McGregor et al. 2008).

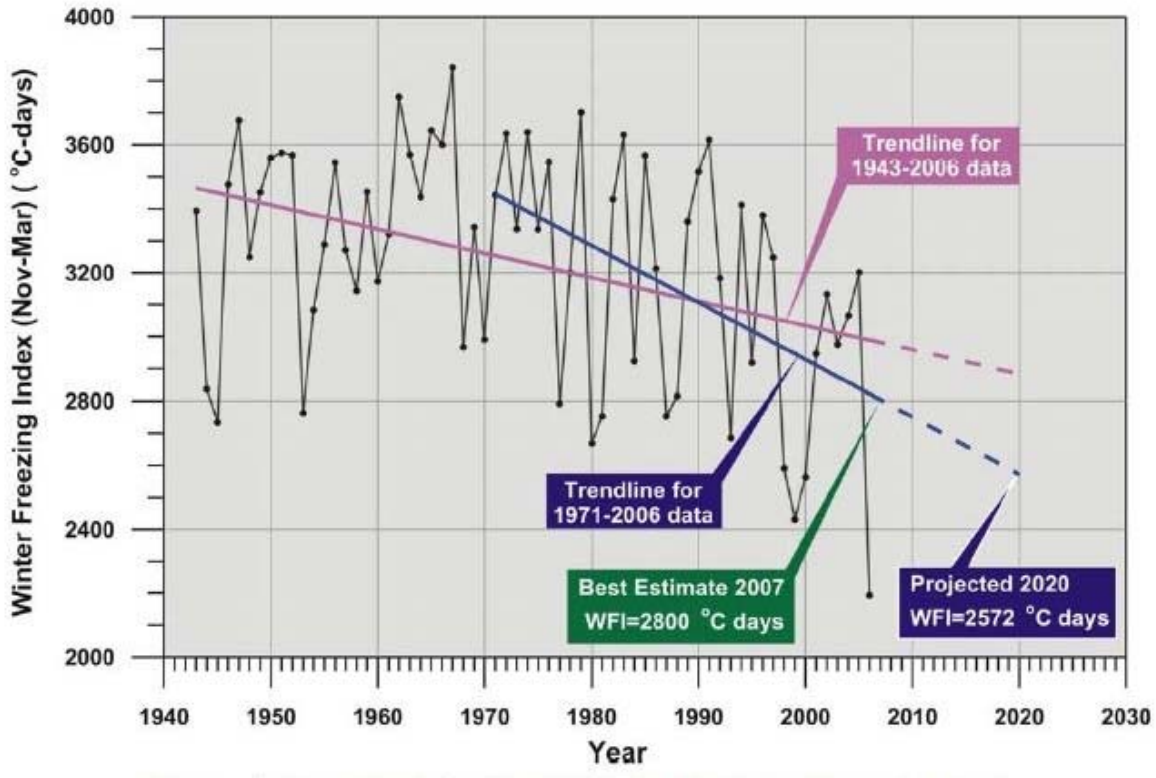
Table 16.3-1 Historical Winter Road Statistics (2002 to 2012)

Year	Operating Period	Total Tonnes Hauled (northbound)	Number of Truckloads (northbound)	Number of Backhauls (southbound)
2002	Jan 26 – Apr 16	256,915	7,735	433
2003	Feb 1 – Apr 2	198,818	5,243	883
2004	Jan 28 – Mar 31	179,144	5,091	165
2005	Jan 26 – Apr 5	252,533	7,607	243
2006	Feb 5 – Mar 26	177,674	6,841	469
2007	Jan 27 – Apr 9	330,002	10,922	818
2008	Jan 29 – Mar 31	245,585	7,484	890
2009	Feb 1 – Mar 22	173,195	4,847	530
2010	Feb 4 - March 21	120,020	3,508	429
2011	Jan 28 - March 31	239,000	6,832	530
2012	Feb 1 - March 31	210,188	6,551	648

Source: Joint Venture (2014).

A study by EBA Engineering Consultants Ltd. (EBA 2007) examined the risks from climate warming on future operations of the TCWR by developing a correlation between length of operating season and the cumulative air freezing index for the season (McGregor et al. 2008). The combination of winter freezing index and snow cover controls the rate of natural ice growth and the ability of the ice sheet to sustain loads late in the season. The freezing index variability for the southern route segment is represented by the historic data from Yellowknife shown in Figure 16.3-1, and the freezing index is roughly correlated with the historic operating season in Figure 16.3-2 (from McGregor 2008). These data indicate that the current operational winter road season consists of approximately 65 days; however, projected winter freezing index suggests that the operational days may decrease approximately to 54 days by 2020 or beyond.

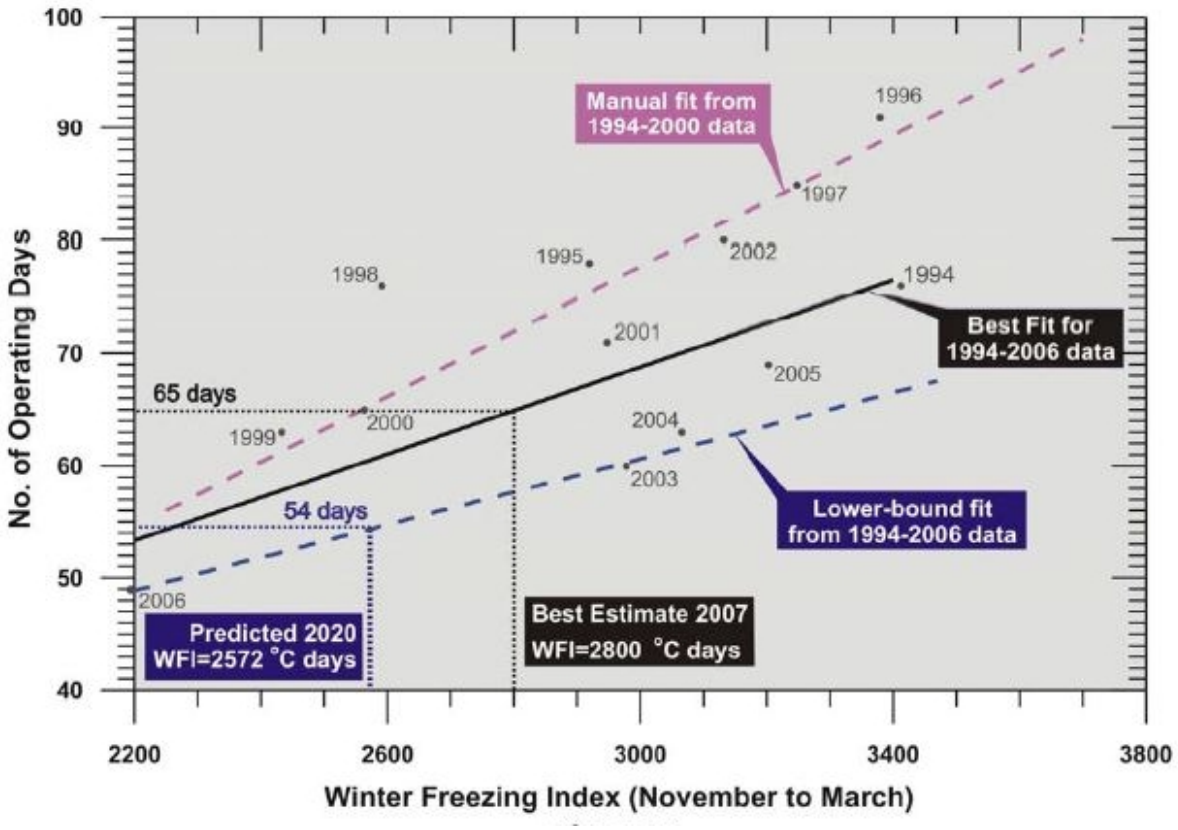
Figure 16.3-1 Freezing Index Variability for Southern Route Segment



Source: McGregor et al. (2008).

°C = degrees Celsius; WFI = Winter Freezing Index.

Figure 16.3-2 Freezing Index Correlated with Historical Operating Season



Source: McGregor et al. (2008).

No. = number; °C = degrees Celsius; WFI =Winter Freezing Index.

Analysis of annual air temperatures from 1959 to 2013 indicated a positive statistically significant trend (Section 10.3.1). Annual air temperatures have increased at an estimated rate of 0.05°C per year. The trend suggests that an increase in average annual temperature for the duration of the Project will be negligible. The increase is likely to occur gradually over the life of the Project and beyond, and variability in the operational period of the TCWR resulting from climate change would be difficult to distinguish from the expected natural year-to-year variability.

The mean number of annual northbound haul trucks along the TCWR from 2002 to 2012 was 6,606, with a standard deviation of 1,965 (Table 16.3-1). The average number of haul trucks associated with Ekati Mine operations is currently up to 4,000 trucks per winter road season. An estimated increase of approximately 200 trucks per operating season will be required during the construction phase of the Project, which will not cause winter road traffic to exceed the range of historic numbers. No change in the current number of northbound loads for the Ekati Mine is expected during operation and closure of the Project, which is the predicted period when potential effects from climate warming may occur. Overall, the influence of climate change on the operational period of the TCWR is not anticipated to result in adverse effects on the Project.

16.4 Summary

Environmental effects on the stability of engineered structures for the Project (i.e., the waste rock storage area, dikes, and site access roads) are assessed in Section 10.3. Project designs, and existing and proven weathering, oxidation, and erosion management practices (e.g., Waste Rock and Ore Storage Management Plan, Interim Closure and Reclamation Plan, Wastewater and Processed Kimberlite Management Plan) at the Ekati Mine, are expected to mitigate climate change-related effects on the Project. Long-term changes in environmental factors are predicted to have negligible effects on the Project, and result in no impact on the assessments of biophysical and socio-economic valued components.

As presented in Section 10.3.2, the Project has been classified as belonging to a low seismic hazard zone due to the geodynamical stability of the cratonic area and the absence of seismogenic faults.

Climate change and the resulting increase in winter air temperatures could result in a shorter operating season for the TCWR, which could lead to increased traffic on the road when it is open and could adversely influence the transportation of supplies for the Project. Analyses detected a statistically significant positive trend in temperature of approximately 0.05°C per year. The increase is likely to occur gradually over the life of the Project and beyond, and variability in the operational period of the TCWR resulting from climate change would be difficult to distinguish from the expected natural year-to-year variability. During construction of the Project, the number of northbound loads is expected to increase by 200 trucks per winter road season, and no changes are predicted during operation and closure. Overall, the influence of climate change on the operational period of the TCWR is not anticipated to result in adverse effects on the Project.

16.5 References

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McGregor RV, Hassan M, and Hayley D. 2008. Climate Change Impacts and Adaptations: Case Studies of Roads in Northern Canada. EBA Engineering Consultants Inc. Paper prepared for presentation at the “Climate Change and the Design and Management of Sustainable Transportation” Session of the 2008 Annual Conference of the Transportation Association of Canada, Toronto, ON, Canada.

16.6 Glossary

Term	Definition
Average	A single statistical value used to characterize a series of data values. The average value is calculated as the sum of the data values divided by the number of data values. It represents the data centre value of a series of values, and does not differ substantially from the statistical median value when the data values are evenly and symmetrically distributed.
Bedrock	The solid rock (harder than 3 on Moh's scale of hardness) underlying soils and the regolith in depths ranging from zero m (where exposed to erosion) to several hundred metres.
Biophysical	The biological components (e.g., plants, animals) and physical components (e.g., air, water, soil) of the natural environment.
Blanket	A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but which still conforms to the general underlying topography. As used in this report, a blanket is generally greater than 100 centimetres (cm) thick and has a surface form similar to a particular material's genesis.
Boulder	A large rounded mass of rock lying on the surface of the ground or embedded in the soil.
Claim Block	Publicly owned land that Dominion Diamond has leased from the government of the Northwest Territories.
Climate	Weather averaged over a long period of time.
Climate Change	Refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from: • natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun; • natural processes within the climate system (e.g., changes in ocean circulation); and, • human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanization, desertification).
Collapse Scars	Areas where permafrost has melted, causing the ground above to slump below the surrounding area, often with ripped edges.
Continuous permafrost	Permafrost occurring everywhere beneath the exposed land surface throughout a geographic region with the exception of widely scattered sites, such as newly deposited unconsolidated sediments, where the climate has just begun to impose its influence on the thermal regime of the ground, causing the development of continuous permafrost.
Continuous permafrost zone	The major subdivision of a permafrost region in which permafrost occurs everywhere beneath the exposed land surface with the exception of widely scattered sites.
Craton	Part of the Earth's crust that has been stable and little deformed for a prolonged period of time.
Deposition, deposit	The accumulation of material left in a new position by a natural transporting agent such as water, wind, ice, or gravity, or by the activity of man.
Developer's Assessment Report (DAR)	A stand-alone report that describes the development, the environmental setting, predicts impacts, and proposes mitigations. The report is submitted to the Mackenzie Valley Review Board for the purpose of an environmental assessment.
Dewatering	Removal of water from a natural waterbody by pumping or draining.
Dike	A long wall or embankment built to prevent flooding.
Ecoregion	Subdivisions of ecozones that are relatively homogeneous with respect to soil, terrain, and dominant vegetation.
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.
Effects Study Area (ESA)	The area where direct effects from the Project are expected to occur.
Esker	A long, winding ridge of stratified sand and gravel believed to form in ice-walled tunnels by streams that flowed within and under glaciers. After the retaining ice walls melt away, stream deposits remain as long winding ridges.

Term	Definition
Fault	Planar fracture or discontinuity in a volume of rock, across which there has been significant displacement along the fractures as a result of earth movement.
Fen	A peat-covered or peat-filled wetland with a high water table, which is not hydrologically isolated and receives water from streams and/or groundwater.
Frost-Shattered	The body of rock that underlies gravel, soil, or other material, that has undergone weathering processes induced by stresses caused by freezing of water into ice.
Geotechnical	Field of study concerned with the engineering behaviour of earth materials.
Glacial till	Unsorted and unstratified glacial drift (generally unconsolidated) deposited directly by a glacier without subsequent reworking by water from the glacier. Consisting of a heterogeneous mixture of clay, silt, sand, gravel, and boulders (i.e., drift) varying widely in size and shape.
Glaciofluvial	Sediments or landforms produced by melt waters originating from glaciers or ice sheets. Glaciofluvial deposits commonly contain rounded cobbles arranged in bedded layers.
Glaciofluvial deposits	Glaciofluvial deposits left behind by rivers that helped drain melting glaciers.
Granite	A coarsely crystalline igneous intrusive rock composed of quartz, potassium feldspar, mica, and/or hornblende.
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 4.75 and 75 millimetres (mm) diameter with rounded, subrounded, angular, or irregular shapes.
Historic	Refers to the period of time for which there are written records.
Hummocky	A very complex sequence of slopes extending from somewhat rounded depression or kettles of various sizes to irregular to conical knolls or knobs. There is a general lack of concordance between knolls and depressions.
Ice-wedge polygons	The surface expression of permafrost crosscut by intersecting polygon fractures filled with ice.
Infrastructure	Basic facilities, such as transportation, communications, power supplies, and buildings that enable an organization, project or community to function.
Kame	A steep-sided mound of stratified material deposited against an ice-front.
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.
Kimberlite pipe	A more or less vertical, cylindrical body of kimberlite that resulted from the forcing of the kimberlite material to the Earth‘s surface.
Landform	A particular type of land formation.
Mean	Arithmetic average value in a distribution.
Non-Sorted Circles	A type of patterned ground where alternating freeze and thaw of soils develop geometric circular patterns surrounded by a circular margin of vegetation. Consists of unsorted mineral material.
Organic matter, soil	The organic fraction of the soil; included are plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is estimated by multiplying the soil organic carbon content by 1.724.
Outcrop	That part of a geologic formation or structure that appears at the surface of the Earth.
Outwash	Stratified sediments (chiefly sand and gravel) deposited by meltwater streams in front of the end moraine or at the margin of an active glacier.
Overstorey	Those trees that form the upper canopy in a multi-layered forest.
Parent Material	Underlying bedrock or drift deposit on which soil horizons form and which are made up of consolidated or unconsolidated mineral material that has undergone some degree of physical or chemical weathering.
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.

Term	Definition
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.
Permafrost Regime	A general term summarizing thermal parameters of permafrost, including its aggradation/degradation, temperature gradient, and mean annual temperature.
Polygons	A map delineation that represents a tract of land with certain landform, soil, hydrologic, and vegetation features. The smallest polygon on a 1:50,000 scale map is about 0.5 square centimetres and represents a tract of about 12.5 hectares.
Riparian	Refers to terrain, vegetation or simply a position next to or associated with a stream, floodplain, or standing waterbody.
Rock	Any naturally formed, consolidated or unconsolidated material, other than soil, composed of two or more minerals or occasionally of one mineral, and having some degree of chemical and mineralogical constancy.
Sand	As a particle size term: a size fraction between 0.05 and 2.0 mm equivalent diameter, or some other limit (geology or engineering).
Seismic events	Occurrences pertaining to or caused by an earthquake or vibration of the earth. Can be due to natural or artificial causes.
Seismogenic faults	Fault capable of generating seismic activity.
Socio-economic	Relating to social and economic factors.
Soil	The naturally occurring, unconsolidated mineral or organic material at least 10 cm thick that occurs at the Earth's surface and is capable of supporting plant growth. Soil extends from the Earth's surface through the genetic horizons, if present, into the underlying material, normally approximately 1 to 2 m. Soil development involves climatic factors and organisms, conditioned by relief and water regime, acting through time on geological materials.
Standard deviation (SD)	A measure of the spread or dispersion of a set of data. It is calculated by taking the square root of the variance.
Terms of Reference (TOR)	The Terms of Reference identify the information required by government agencies for an Environmental Assessment.
Terrain	The landscape or lay of the land. The term comprises specific aspects of the landscape, namely genetic material, material composition, landform (or surface expression), active and inactive processes (e.g., permafrost, erosion) that modify material and form, slope, aspect, and drainage conditions.
Till	An unstratified, unconsolidated mass of boulders, pebbles, sand, and mud deposited by the movement or melting of a glacier.
Topography	The physical features of a district or region, such as those represented on a map, taken collectively; especially the relief and contours of the land. On most soil maps topography may also mean topography classes that describe slopes according to standard ranges of percent gradient.
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, and lichens.
Understory	A layer of vegetation beneath the main canopy of a forest.
Valued Component (VC)	Represents physical, biological, cultural, and economic properties of the social-ecological system that is considered to be important by society.
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.
Waste rock	Rock moved and discarded to access resources.

Term	Definition
Waste Rock Storage Area (WRSA)	Engineered landforms in which waste rock from mining activities is stored.
Waterbody	An area of water such as a river, stream, lake, or sea.
Watercourse	Riverine systems such as creeks, brooks, streams, and rivers.
Wetland	Land having the water table at, near, or above the land surface or which is saturated for a long enough period to promote wetlands or aquatic processes as indicated by hydric soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to the wet environment.