SECTION 7

AIR QUALITY

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Section 7 Abbreviations

Abbreviation	Definition
CAAQS	Canadian Ambient Air Quality Standards
CAC	Criteria Air Contaminants
CAMS	continuous air monitoring station
CCME	Canadian Council of Ministers of Environment
CO	carbon monoxide
CO_2E	carbon dioxide equivalent
CWS	Canada-Wide Standards
DAR	Developer's Assessment Report
De Beers	De Beers Canada Inc.
Diavik Mine	Diavik Diamond Mine
Dominion Diamond	Dominion Diamond Ekati Corporation
e.g.	for example
Ekati Mine	Ekati Diamond Mine
Ekati A	Ekati Airport Monitoring Station
et al.	and more than one additional author
GNWT	Government of the Northwest Territories
H^+	hydrogen ions
i.e.	that is
Koala Station	Koala Meteorological Station
LSA	local study area
Lupin A	Lupin Airport Monitoring Station
MVRB	Mackenzie Valley Review Board
N	north
NAAQO	National Ambient Air Quality Objectives
NAD	North America Datum
NH_3	ammonia
NO	nitric oxide
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NW	northwest
NWT	Northwest Territories
NWT AAQS	Northwest Territories Ambient Air Quality Standards
O_3	ozone
PAH	polycyclic aromatic hydrocarbons
PAI	potential acid input
PM	particulate matter
$PM_{2.5}$	particulate matter of mean aerodynamic diameter less than 2.5 microns
PM_{10}	particulate matter of mean aerodynamic diameter less than 10 microns
Polar Station	Polar Lake Meteorological Station
Project	Jay Project

Abbreviation	Definition
RELAD	Regional Lagrangian Acid Deposition Model
RFD	Reasonably Foreseeable Development
RSA	regional study area
S	south
SO_2	sulphur dioxide
SON	Subject of Note
SW	southwest
TOR	Terms of Reference
TSP	total suspended particulate
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VC	valued component
VOC	volatile organic compounds

Section 7 Units of Measure

Unit	Definition
°	degrees
°C	degrees Celsius
%	percent
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
$\mu g/m^3$	micrograms per cubic metre
µm	microns
cm	centimetre
ha	hectare
keq	kiloequivalent
keq/ha/yr	kiloequivalent per hectare per year
kg/ha/y	kilograms per hectare per year
km	kilometre
km/hr	kilometres per hour
kmol	kilomole
kt	kilotonnes
kW/m^2	kilowatts per square metre
m	metre
mm	millimetre
ppmw	parts per million by weight
W/m^2	watts per square metre

7 AIR QUALITY

7.1 Introduction

7.1.1 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). Dominion Diamond proposes to develop the Jay Pit, with associated mining and transportation infrastructure to add 10 or more years of mine life to the Ekati Mine. The majority of the facilities required to support the Jay Pit 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 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 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 Jay Project (Project) will also require an access road, pipelines, and power lines to the Jay Pit from the Misery Pit.

7.1.2 Purpose and Scope

This section of the Developer's Assessment Report (DAR) for the Project consists solely of the Subject of Note (SON): Impacts to Air Quality from Project Components, identified in the Revised Terms of Reference (TOR) in Appendix 1A issued on July 17, 2014, by the Mackenzie Valley Review Board (MVRB). The SON requires a thorough analysis, including a cumulative effects assessment, but does not require as much detail as a Key Line of Inquiry. Air Quality was defined as a SON based on concerns expressed by various interested parties and the general public during the MVRB scoping exercise.

The purpose of this SON is to assess the effects of the Project on air quality and to meet the TOR issued by the MVRB. The entire TOR document is included in Appendix 1A, and the complete Table of Concordance for the DAR is in Appendix 1D.

DOMINION DIAMOND

7.1.2.1 *Regulatory and Policy Setting*

Air emissions introduced into the atmosphere by industrial activities can have direct and indirect effects on humans, wildlife, vegetation, soil, and water. For these reasons, environmental regulatory agencies have established ambient air quality criteria. The Government of Northwest Territories have set ambient air quality standards (GNWT-ENR 2014) to manage air quality in the Northwest Territories. The federal government has also set criteria such as Canada-Wide Standards (CWS; CCME 2000), the National Ambient Air Quality Objectives (NAAQO; Environment Canada 1981) and the Canadian Ambient Air Quality Standards (CAAQS; CCME 2012b). The ambient air quality criteria are summarized in Table 7.1-1.

7.1.2.1.1 Northwest Territories Ambient Air Quality Standards

The Northwest Territories Ambient Air Quality Standards (NWT AAQS; GNWT-ENR 2014) are applied to air quality assessments of proposed and existing developments in the NWT, and to reporting on the state of air quality in the NWT. Any actions to maintain or improve air quality will include consideration of factors such as the frequency and magnitude of exceeding these standards, the size of the affected area, availability of control options, and environmental, human health, and socio-economic impacts.

7.1.2.1.2 Canada-Wide Standards

The Canadian Council of Ministers of Environment (CCME) reached an agreement in 1998 (CCME 1998) on the harmonization of environmental regulations across Canada. As part of the process, the CCME has established a sub-agreement for the creation of CWS with respect to the environment including air quality guidelines.

The CWS are intended to be achievable standards that are based on sound science, and which take into consideration social implications and technical feasibility. The CWS do not have legal force under federal legislation. However, each provincial jurisdiction participating in the Harmonization Accord has committed to implementing the standards under existing provincial legislation, or through the drafting of new legislation. The NWT AAQS established under the Government of the Northwest Territories (GNWT) *Environmental Protection Act* (GNWT 1988) is more stringent than the CWS for the applicable ambient air quality criteria compound (particulate matter of mean aerodynamic diameter less than 2.5 microns [$PM_{2.5}$]), and covers a wider range of compounds.

The CWS process has progressed for a limited set of compounds, namely ozone and fine particulate matter ($PM_{2.5}$). The first set of CWS for air pollutants was ratified by the CCME in June 2000. The compounds for which CWS have been adopted include fine particulate matter ($PM_{2.5}$), ground-level ozone (O_3), benzene, and mercury. The CCME has not yet established an acceptable ambient air quality criterion for benzene, but set targets for reducing the emissions of benzene by approximately 40 percent (%) from the 1995 levels by the end of 2010 (CCME 2012a). The CWS for mercury emissions have been developed for the waste incineration sector in Canada.

7.1.2.1.3 National Ambient Air Quality Objectives

The Canadian federal government has established three levels of NAAQO (Environment Canada 1981). The levels are described as follows:

- The maximum desirable level defines the long-term goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of the country and for the continuing development of control technology.
- The maximum acceptable level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort, and well-being.
- The maximum tolerable level denotes an air contaminant concentration that requires abatement (mitigation) to avoid further deterioration to an air quality that endangers the prevailing Canadian lifestyle or, ultimately, that poses a substantial risk to public health.

The tolerable levels were not used in the assessment of effects on air quality for the Project because they represent the highest allowable concentrations, which are higher than corresponding NWT guidelines.

7.1.2.1.4 Canadian Ambient Air Quality Standards

In 2012, the Canadian government finalized a framework to improve air quality management called the Comprehensive Air Management System (CAMS). The CAMS is intended to replace the NAAQO and CWS with the more stringent CAAQS. The framework is designed to address various challenges of air quality management, including cross-jurisdiction issues, and deliver a Canada-wide approach that also provides flexibility to deal with differences in regional air quality issues, while at the same time ensuring a level of consistency so that Canadians can be assured of good air quality outcomes.

One of the key elements of the CAMS is the development of new CAAQS. The CAAQS for $PM_{2.5}$ will replace the current Canada-Wide Standard by 2015, and will be adopted in two stages, with a set of values being adopted in 2015 and another set of more stringent values being adopted in 2020. Standards for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) are under development.

7.1.3 Valued Components, Assessment Endpoints, and Measurement Indicators

The TOR identified air quality as a valued component (VC). The selected assessment endpoints for the air quality VC are based on compliance with the NWT AAQS. With the exception of the CAAQS, that will come into effect in 2020, the NWT AAQS present the most stringent criteria among all of the applicable criteria described in Section 7.1.2. Changes to air quality related to the cumulative Project and existing and approved developments, predicted using an air dispersion model, were compared against the NWT AAQS (Table 7.1-2). This provides a conservative approach to the assessment.

Table 7.1-1 Ambient Air Quality Criteria

Substance	NWT Ambient Air Quality Standards[a]	Canada-Wide Standards[b]	National Ambient Air Quality Objectives[c]			Canadian Ambient Air Quality Standards[d] (μg/m³)
			Desirable	Acceptable	Tolerable	
SO_2 (μg/m³)						
1-Hour	450	–	450	900	–	–
24-Hour	150	–	150	300	800	–
Annual	30	–	30	60	–	–
NO_2 (μg/m³)						
1-Hour	400	–	–	400	1,000	–
24-Hour	200	–	–	200	300	–
Annual	60	–	60	100	–	–
CO (μg/m³)						
1-Hour	15,000	–	15,000	35,000	–	–
8-Hour	6,000	–	6,000	15,000	20,000	–
TSP (μg/m³)						
24-Hour	120	–	–	120	400	–
Annual	60	–	60	70	–	–
$PM_{2.5}$ (μg/m³)						
24-Hour	28[e]	30[e]	–	–	–	28, 27[f]
Annual	10	–	–	–	–	10, 8.8[f]

a) Source: GNWT-ENR (2014).

b) Source: CCME (2000).

c) Source: Environment Canada (1981).

d) Source: CCME (2012b).

e) Compliance with the NWT ambient air quality standard is based on measured maximum value (Veale 2008), whereas compliance with the Canada-Wide Standard is based on the 98th percentile of the annual monitored data averaged over three years of measurements.

f) Canadian Ambient Air Quality Standards to be implemented in 2015 and 2020, respectively, which will replace the Canada-Wide Standards.

NWT = Northwest Territories; – = No guideline available; μg/m³ = micrograms per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; TSP = total suspended particulates; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns.

Table 7.1-2 Valued Component, Assessment Endpoint, and Measurement Indicators

Valued Component	Assessment Endpoints	Measurement Indicators
Air Quality	• Compliance with applicable regulatory ambient air quality standards and objectives.	Predicted maximum concentrations of: • sulphur dioxide (SO_2); • nitrogen dioxide (NO_2); • carbon monoxide (CO); and, • total suspended particulates (TSP) and fine particulate matter ($PM_{2.5}$) are compared against the applicable standards and objectives.

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns.

7.1.4 Spatial Boundaries

The Project is situated in the southeastern portion of the Ekati Mine property approximately 25 km from the main facilities at the Ekati Mine and approximately 7 km to the northeast of the existing Misery Pit. The existing Diavik Diamond Mine (Diavik Mine) is approximately 6 km south-southwest of the Misery Pit. The Project site is approximately 150 km east of the nearest community, Wekweètì, and 200 km northeast of Yellowknife (Map 7.1-1).

7.1.4.1 *Study Area*

The Subject of Note: Air Quality has two study areas, namely a regional study area (RSA) and a local study area (LSA), which are shown in Map 7.1-2.

The RSA defines the region over which dispersion modelling results are presented. The RSA for the Project is defined by a 107 km by 111 km area. The RSA for air quality was selected to capture the cumulative effects associated with emissions from existing and approved industrial sources (e.g., Ekati Mine and Diavik Mine) within the region in combination with the proposed Project. The RSA is offset marginally from centre to include as many selected sensitive receptors within the RSA as possible.

The LSA defines an area in the immediate vicinity of the Project where most of the Project's air quality effects are expected to occur. The LSA represents a subset of the RSA and allows a focused assessment of the effects associated with the Project. The LSA is defined by an area of 68 km by 60 km, which includes the Project as well as Ekati Mine and Diavik Mine. The LSA is centred on both the approved Ekati Mine and the planned Project rather than just the Project itself.

Two other areas that were considered in the assessment are the Project footprint and development area. The Project footprint represents the areas that will be physically disturbed due to the construction, operation, and reclamation of the Project. The development area is an area that includes the Project footprint and the mine footprints of the Ekati Mine and Diavik Mine. This area is either already physically disturbed by existing or planned mining activities, or has limited public access. The development area is used to determine compliance with applicable ambient air quality standards. These standards are applicable outside this area.

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_Air_001_GIS	
DESIGN	ANK	11/08/14	SCALE AS SHOWN	REV. 0
GIS	SM/AK	08/10/14	MAP 7.1-1	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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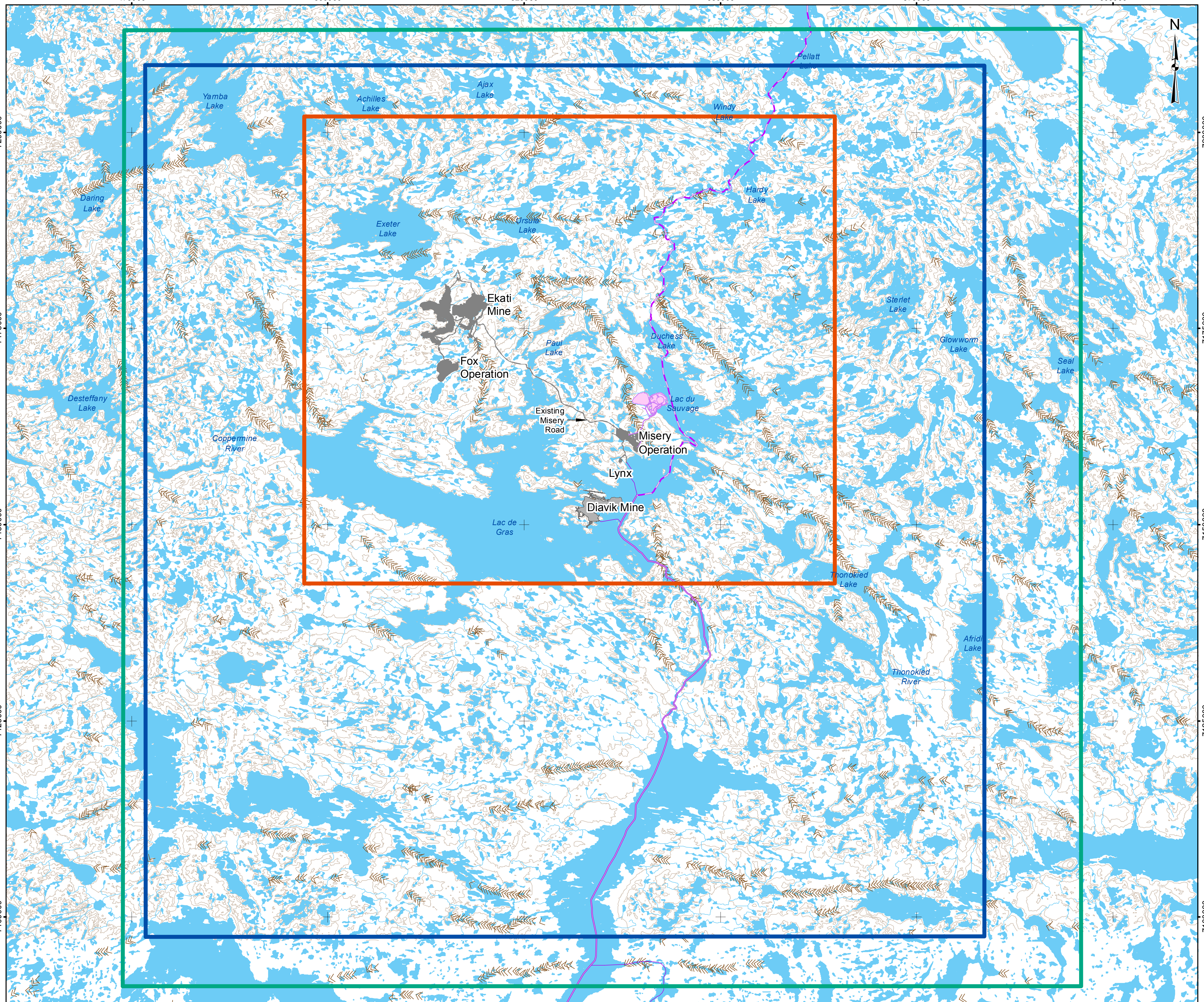


G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Air\DAR\DAR_Air_002_GIS.mxd

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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA
- REGIONAL STUDY AREA
- MODELLING DOMAIN

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 1:500,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

AIR QUALITY MODELLING DOMAIN AND STUDY AREAS

Golder Associates

PROJECT	13-1328-0041	FILE No. DAR_Air_002_GIS	
DESIGN	DC	11/08/14	SCALE AS SHOWN	REV 0
GIS	SBM/JR	25/09/14	
CHECK	ACP	16/10/14	MAP 7.1-2
REVIEW	CDM	16/10/14	

7.1.5 Temporal Boundaries

Based on the Project schedule, the temporal boundaries for the effects assessment for the air quality are as follows:

- Project construction – 2016 to 2019;
- Project operations – 2019 to 2029; and,
- Project closure – 2030 to 2033.

Air quality effects during the construction phase of the Project are expected to be limited. Air emissions will be limited to vehicle exhaust emissions and fugitive particulate emissions associated with construction activities. The construction phase can be broken down into these overlapping stages:

- preparation of material processing areas, aggregate pits, and rock piles;
- road construction; and,
- construction of dikes, ponds, channel, dewatering ramps, and other infrastructure.

Emissions are expected to be intermittent throughout the construction phase, depending on the schedule of activities.

It is expected that the Project operations phase would result in the largest changes to air quality of the three Project phases (construction, operations, closure). Air emission sources at the Project would include mine fleet exhaust and fugitive emissions from roads, drilling, blasting, material handling, material movement, and storage activities.

Air emissions during the closure phase are expected to be less than those released during the construction phase.

7.2 Existing Environment

This section documents the existing climate, meteorological data relevant to atmospheric dispersion, and existing air quality in the region and at the Project. Climate data are presented to show long-term climatic trends over a 30-year period. Local meteorology influences the dispersion of emitted air pollutants in the atmosphere, and is important to validate the dispersion model used in the assessment. Existing air quality data are used to determine baseline concentrations for modelling, and can be used to compare with the results from dispersion modelling.

The information presented in this section was gathered from various sources, including meteorological and ambient air quality measurements collected by Dominion Diamond at the existing Ekati Mine and the proposed Project site, ambient air quality measurements collected by the GNWT from several locations in the region, and regional meteorological station data published by Environment Canada.

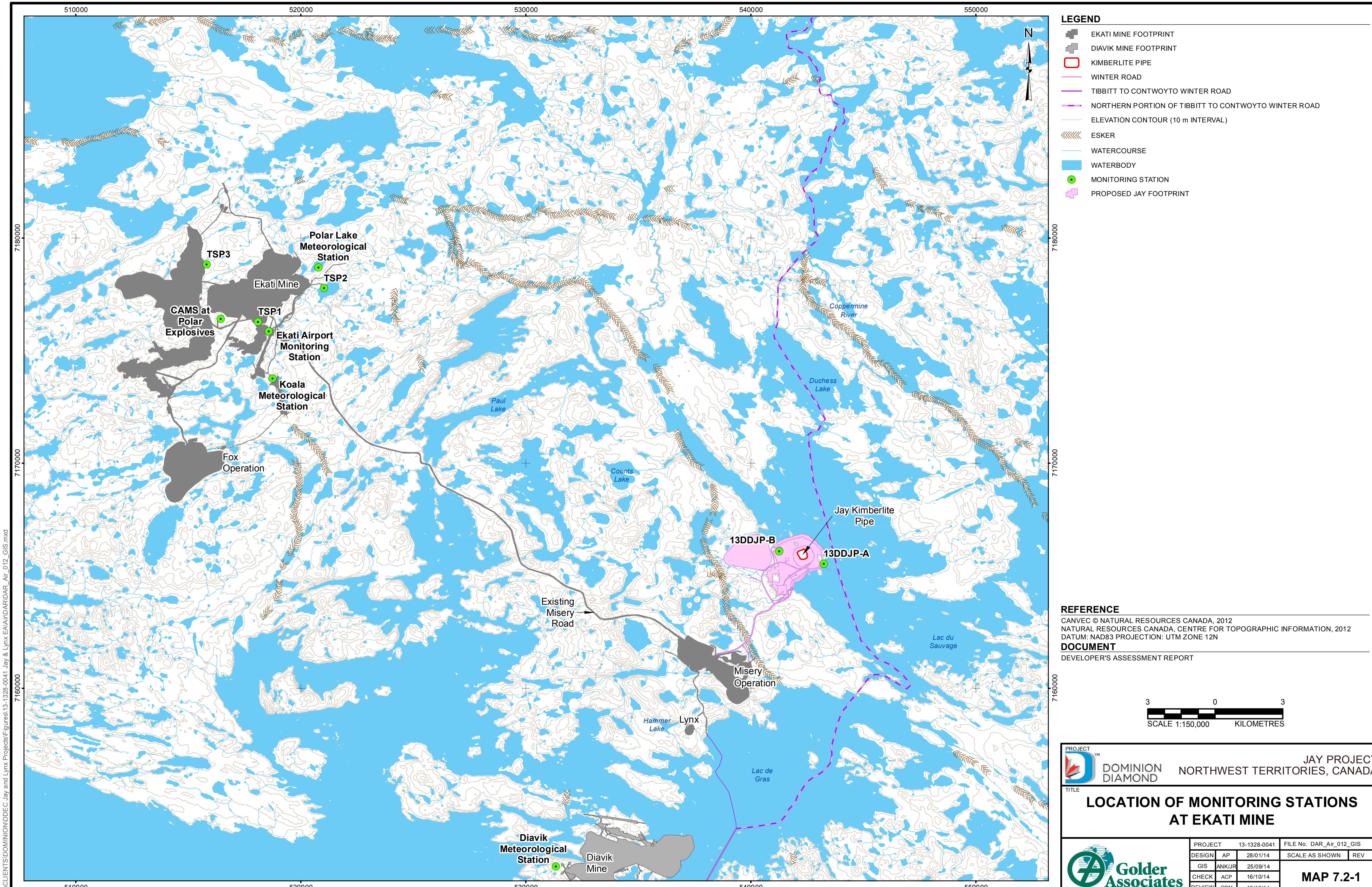
Long-term climate normals are presented from Lupin A (Airport) Station in Nunavut because it is the closest representative station with long-term climate data. Climate normals show long-term trends in the region, whereas the meteorological data show the shorter-term (daily to annual) variability. Climate normals smooth out these variations and establish ranges of minimum and maximum expected meteorological values.

Existing meteorological data for parameters such as wind direction, wind speed, air temperature, relative humidity, and solar radiation are summarized in this section because they influence the dispersion of potential pollutants emitted by the Project and, consequently, the air quality in the region. Data from stations near the Project at the Ekati Mine are used. These stations are Koala Station, Polar Station, and Ekati A (Airport) Station, shown in Map 7.2-1.

Existing air quality data are analyzed to establish background air concentrations that are added to modelled concentrations of various substances, or used in the chemistry of air dispersion modelling. These background concentrations result from emissions from natural sources (e.g., forest fire and wind-blown dust), and/or long-range transport from natural and anthropogenic sources outside the study area, and from local anthropogenic sources such as fossil fuel combustion (e.g., diesel) and industrial mine activities (e.g., blasting, road grading) from the Ekati Mine and the Diavik Mine. Regional air quality information was collected at the Project site at stations 13DDJP-A and 13DDJP-B, shown in Map 7.2-2; from stations at the Ekati Mine: CAMS, TSP1, TSP2, and TSP3, shown in Map 7.2-1; and at regional stations further from the Project including Fort Liard, Inuvik, Norman Wells, Yellowknife, Lupin, Daring Lake, Snare Rapids, and Snap Lake Mine.

The existing air quality data presented in these subsections deals primarily with the background concentrations derived from the Air Quality and Meteorological Baseline Report for the Jay Project (Annex I). Only the most relevant data presented in the Annex I are presented in Section 7. Refer to Annex I for full details on the baseline conditions.

A summary of local and traditional knowledge is also discussed in this section, as it pertains to the existing conditions and community concerns with Project-related air quality.


LEGEND
EKATI MINE FOOTPRINT
DIAVIK MINE 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
MONITORING STATION
PROPOSED JAY FOOTPRINT
TSP3
Polar Lake Meteorological Station
TSP2
Ekati Mine
CAMS at Polar Explosives
TSP1
Ekati Airport Monitoring Station
Koala Meteorological Station
Fox Operation
Paul Lake
Counts Lake
Coppermine River
Duchess Lake
Jay Kimberlite Pipe
13DDJP-B
13DDJP-A
Existing Misery Road
Misery Operation
Lac du Sauvage
Hammer Lake
Lynx
Lac de Gras
Diavik Meteorological Station
Diavik Mine
510000
520000
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7160000
N
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
LOCATION OF MONITORING STATIONS AT EKATI MINE
Golder Associates
PROJECT 13-1328-0041
FILE No. DAR_Air_012_GIS
DESIGN AP 28/01/14
SCALE AS SHOWN
REV 0
GIS ANK/JR 25/09/14
CHECK ACP 16/10/14
REVIEW CDM 16/10/14
MAP 7.2-1
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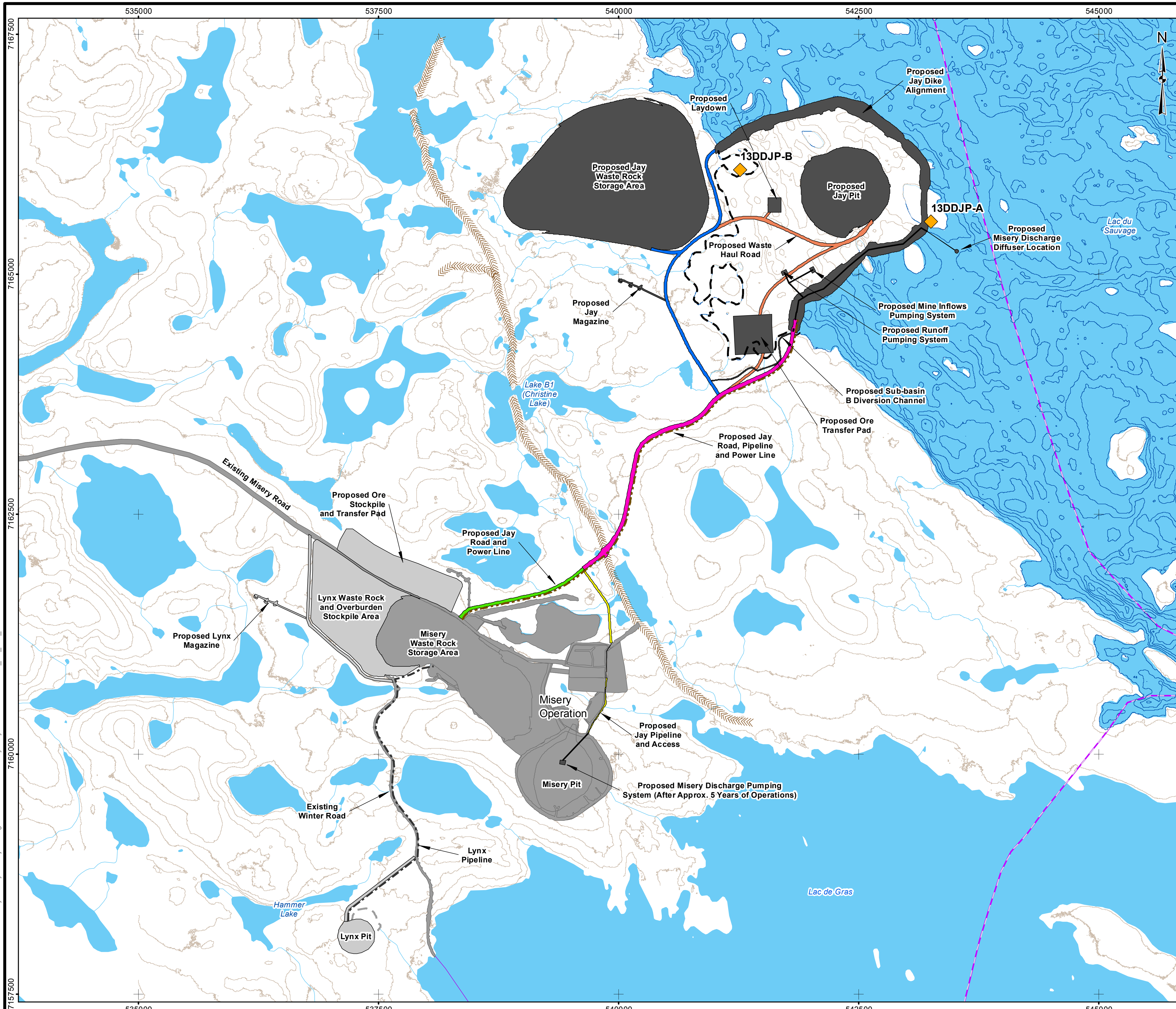


LEGEND

- EKATI MINE FOOTPRINT (MISERY OPERATION)
- WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- BATHYMETRY CONTOUR (5 m INTERVAL)
- ELEVATION CONTOUR (10 m INTERVAL)
- WATERCOURSE
- WATERBODY
- AIR QUALITY STATION

JAY PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED AREA
- POWER LINE
- PROPOSED JAY PROJECT INFRASTRUCTURE
- PROPOSED JAY ROAD NORTH (HAUL ROAD)
- PROPOSED JAY ROAD (HAUL ROAD AND POWER LINE)
- PROPOSED JAY ROAD (HAUL ROAD, PIPELINE AND POWER LINE)
- PROPOSED JAY PIPELINE ROAD (ACCESS ROAD AND PIPELINE)
- PROPOSED OPERATION ROADS

LYNX PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED LYNX LAKE
- LYNX PIPELINE
- LYNX PROJECT INFRASTRUCTURE

NOTES

ROAD, PIPELINES, AND POWER LINE ARRANGEMENT TO BE DETAILED AS PART OF FURTHER PRE-FEASIBILITY DESIGN. APPROXIMATE CORRIDOR WIDTHS ARE SHOWN.

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
JAY PROJECT DESIGN BASIS MEMORANDUM FOR PRE-FEASIBILITY DESIGN OF PROJECT ROADS AND PIPELINE BENCHES, DOC#: 1313280041-E14031-TM-REVD-2020, DATED: AUGUST 1, 2014
LIDAR AND BATHYMETRIC DATA OBTAINED FROM AURORA, 2013
WATER OBTAINED FROM CANVEC © NATURAL RESOURCES CANADA, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

1 0 1
SCALE 1:40,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATION OF MONITORING STATIONS AT JAY PROJECT

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_011_GIS	
DESIGN	AP	28/11/13	SCALE AS SHOWN	REV 0
GIS	ANK/JR	29/09/14	MAP 7.2-2	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

7.2.1 Climate

The climate of a region is described by long-term averages of observed meteorological variables. It is often characterized by 30 continuous years of meteorological observations at a given location. Climate data shows long-term trends in the region, whereas meteorological data can vary over short and mid-length time scales.

Climate normals, which present the average meteorological measurements at a given station for periods between 1961 and 1990, 1971 and 2000, and 1981 and 2010, are provided by Environment Canada. The climate normals smooth out shorter-term variations and establish ranges of minimum and maximum expected meteorological values. The station closest to the Project with a long enough record to provide climate normals is Lupin A Station in Nunavut. It is located approximately 130 km northwest of the Project. The key climate measurements that are available at Lupin A Station for the period 1981 to 2010 are summarized in Table 7.2-1.

7.2.1.1 *Wind*

The average winds at Lupin A Station are typically from the north or northwest, ranging between 14 kilometres per hour (km/hr) and 20 km/hr, with higher velocity winds in the winter months.

7.2.1.2 *Air Temperature*

Observations at Lupin A Station show the mean air temperature has a large seasonal dependence. For example, in January, a daily mean of -30 degrees Celsius (°C) was recorded, while in July the recorded daily mean was 12°C (Environment Canada 2012). By October, mean temperatures are generally well below freezing at -8°C, and remain at sub-freezing levels until June. The annual daily mean obtained from data recorded at the Lupin A Station from 1981 to 2010 was -10.9°C. The climatological extreme and average temperatures for 1981 to 2010 at Lupin A are summarized in Table 7.2-1.

7.2.1.3 *Precipitation*

Cold, Arctic air holds little moisture, resulting in low overall precipitation rates, with much of the precipitation occurring in the form of snow. At Lupin A Station, the mean annual total rainfall is 161 millimetres (mm), with most of this rainfall occurring from June to September (Environment Canada 2012). These months align with the time that the surrounding lakes are expected to be ice free and moisture will be exchanged to the atmosphere from the lakes. Snowfall occurs year-round, with most of it falling between September and May. October experiences the greatest amount of snowfall, consistent with the period when the lakes are not yet completely frozen, the air is colder than the open water, and there is enhanced moisture exchange resulting in snowfall. The average total annual precipitation at Lupin A Station is 299 mm.

7.2.1.4 *Summary*

The Lupin A Station climate normals for temperature, precipitation, and wind are summarized in Table 7.2-1.

DOMINION DIAMOND

Table 7.2-1 Lupin Airport Monitoring Station Climate Normals, 1981 to 2010

Parameter	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Temperature													
Daily average (°C)	-29.9	-28.5	-24.8	-15.8	-5.9	6.4	11.5	8.8	2.1	-8.4	-20.4	-26.2	-10.9
Average daily maximum (°C)	-26.3	-24.9	-20.9	-11.5	-2.1	10.8	16.3	12.6	4.8	-5.8	-16.9	-22.6	-7.2
Average daily minimum (°C)	-33.4	-32.1	-28.7	-20.1	-9.6	1.9	6.7	5.0	-0.6	-10.9	-23.9	-29.7	-14.6
Extreme maximum (°C)	-5.0	-5.0	0.5	6.0	17.5	27.5	31.0	27.5	21.0	13.0	0.0	-4.5	31.0
Extreme minimum (°C)	-49.0	-46.0	-44.0	-38.0	-29.5	-9.0	-1.5	-6.5	-13.5	-30.5	-40.5	-42.0	-49.0
Precipitation													
Rainfall (mm)	0.0	0.0	0.0	0.4	5.3	26.8	41.1	59.8	25.5	1.6	0.0	0	160.5
Snowfall (cm)	9.4	7.8	12.2	14.3	12.5	3.6	0.4	2.6	17.1	27.1	17.4	13.7	138.0
Total precipitation (mm)	9.4	7.8	12.2	14.6	17.8	30.4	41.5	62.5	42.6	28.7	17.4	13.7	298.5
Extreme daily total precipitation (mm)	11.6	14.2	10.0	13.8	14.3	36.8	41.8	38.6	34.2	31.8	14	10	41.8
Days with precipitation >0.2 mm	9	8.6	9.7	10.1	9.1	9.2	12.2	16.4	15.4	17.5	13.8	10.9	141.9
Wind													
Average speed (km/hr)	17.8	19.0	19.2	14.2	17.9	17.1	16.6	17.0	19.8	20.1	15.4	19.3	17.8
Most frequent direction	NW	NW	N	SW	N	NW	N	N	NW	SW	N	NW	NW

Source: Environment Canada (2012).

°C = degrees Celsius; mm = millimetre; cm = centimetre; >= greater than; km/hr = kilometres per hour; NW = northwest; N = north; SW = southwest.

7.2.2 Meteorology

Weather describes atmospheric conditions at a specific time, in contrast to the long-term averages used to describe climate. The following subsections describe the observed meteorology that may influence the air dispersion at the Project from Koala Station, Polar Station, and Ekati A (Airport) Station at the existing Ekati Mine. These stations are shown in Map 7.2-1. The three meteorological stations did not record data over the same periods over their yearly ranges. The station parameters measured and nominal measuring periods used for the existing conditions at the Project are listed in Table 7.2-2. Because Koala Station recorded data year-round, it is the primary reference for existing meteorological conditions.

Table 7.2-2 Meteorological Measurement Parameters at Ekati Mine Meteorological Stations

Station	Measured Parameters at Station						Measurement Period
	Temperature	Wind Speed	Rainfall	Snowfall	Relative Humidity	Solar Radiation	
Koala	Yes	Yes	Yes	Yes	Yes	No	2009 to 2013, year-round
Polar Lake	Yes	Yes	Intermittent [a]	No	Yes	Yes	2009 to 2013, summer months only
Ekati A	Yes	Yes	No [b]	No [b]	Yes	No	2009 to 2013, airport operational hours only

Source: BHP Billiton (2012).

a) Rainfall was monitored for intervals at the station, but not in all years.

b) Rainfall and snowfall were noted in the airport station records, but only as an estimation of magnitude.

7.2.2.1 *Wind*

A windrose is often used to illustrate the frequency of wind direction and the magnitude of wind velocity. The lengths of the bars on the windrose indicate the frequency and speed of wind. The direction from which the wind blows is illustrated by the orientation of the bar in 1 of 16 directions. In this section, windroses characterize the typical winds that have occurred at the Project location in the last five years (2009 to 2013).

Two monitoring stations at the Project, Koala Station and Polar Station, have measured wind speed and direction. The nearby Ekati Airport Environment Canada Station also measures wind speed and direction but only during airport operational hours. The following sections detail those measurements for the years 2009 to 2013.

7.2.2.1.1 Koala Meteorological Station

The location of Koala Station is shown in Map 7.2-1. At Koala Station, hourly wind speed and wind direction were measured year-round. The windrose for winds measured between 2009 and 2013 at Koala Station is shown in Figure 7.2-1.

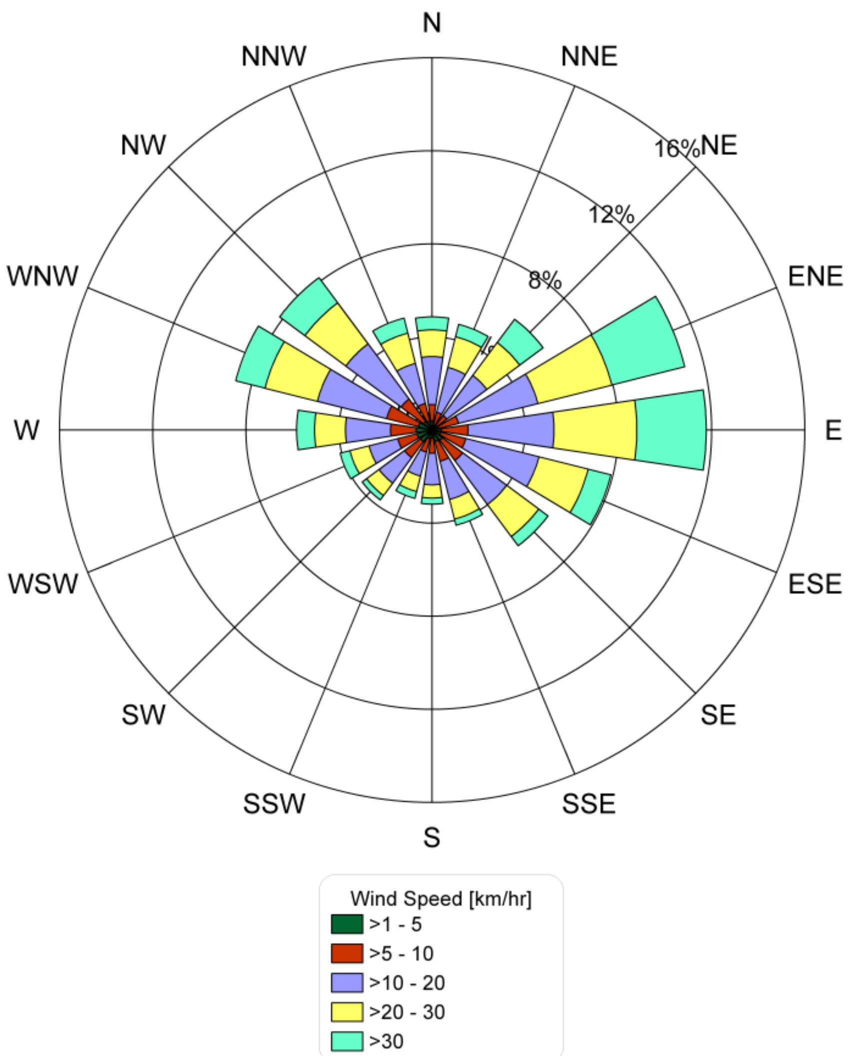
The predominant wind at Koala Station is from the east. An almost equal percentage of winds were measured from the east-northeast, and winds were observed from the west-northwest and northwest more than 8% of the time.

The dominant wind patterns change during the summer ice-free period, which occurs nominally between June and October, and the winter ice-bound period, which typically occurs between November and May.

During the summer, the predominant wind is from the east-northeast; a smaller percentage of winds was observed from the northwest than is seen in the full year windrose. The June to October windrose for winds observed at Koala Station is shown in Figure 7.2-2.

During the winter, winds from the east, east-northeast, west-northwest, and northwest dominate the wind pattern. The winter winds measured at Koala Station are shown in Figure 7.2-3.

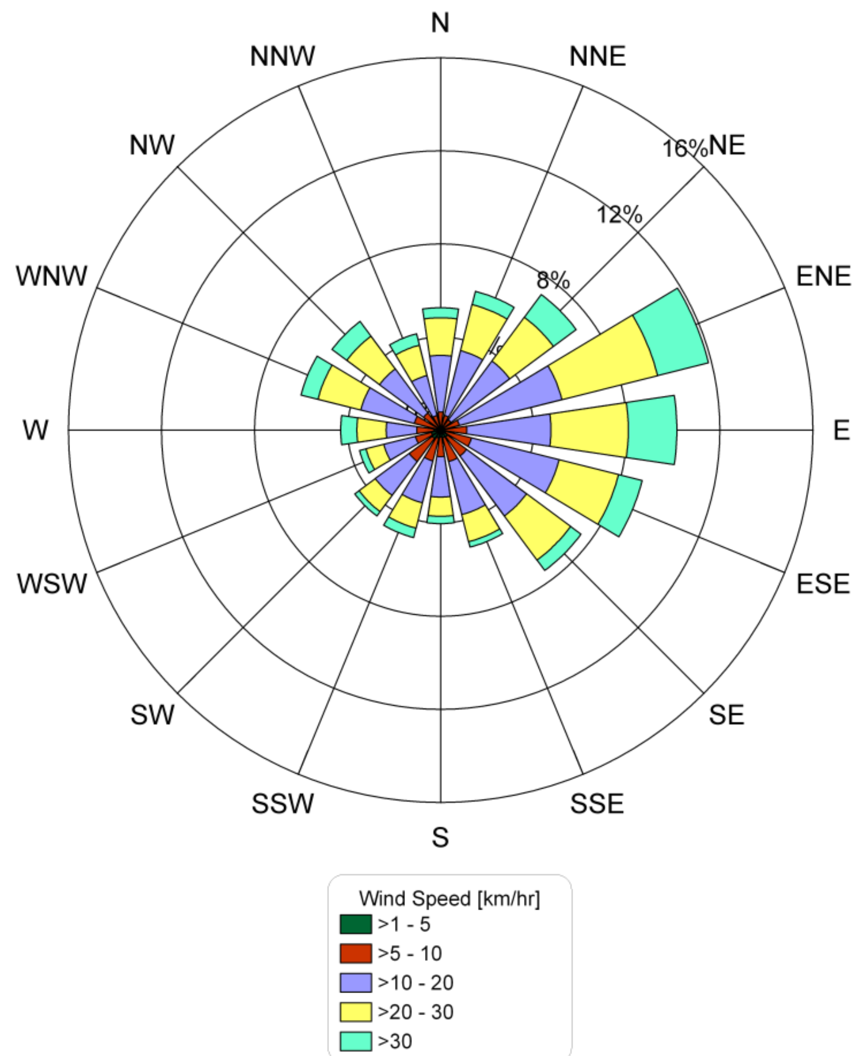
Figure 7.2-1 Koala Meteorological Station Windrose, 2009 to 2013



Note: Windrose is based on year-round measurements of wind speed and direction from 2009 to 2013.

km/hr = kilometres per hour; >= greater than;% = percent.

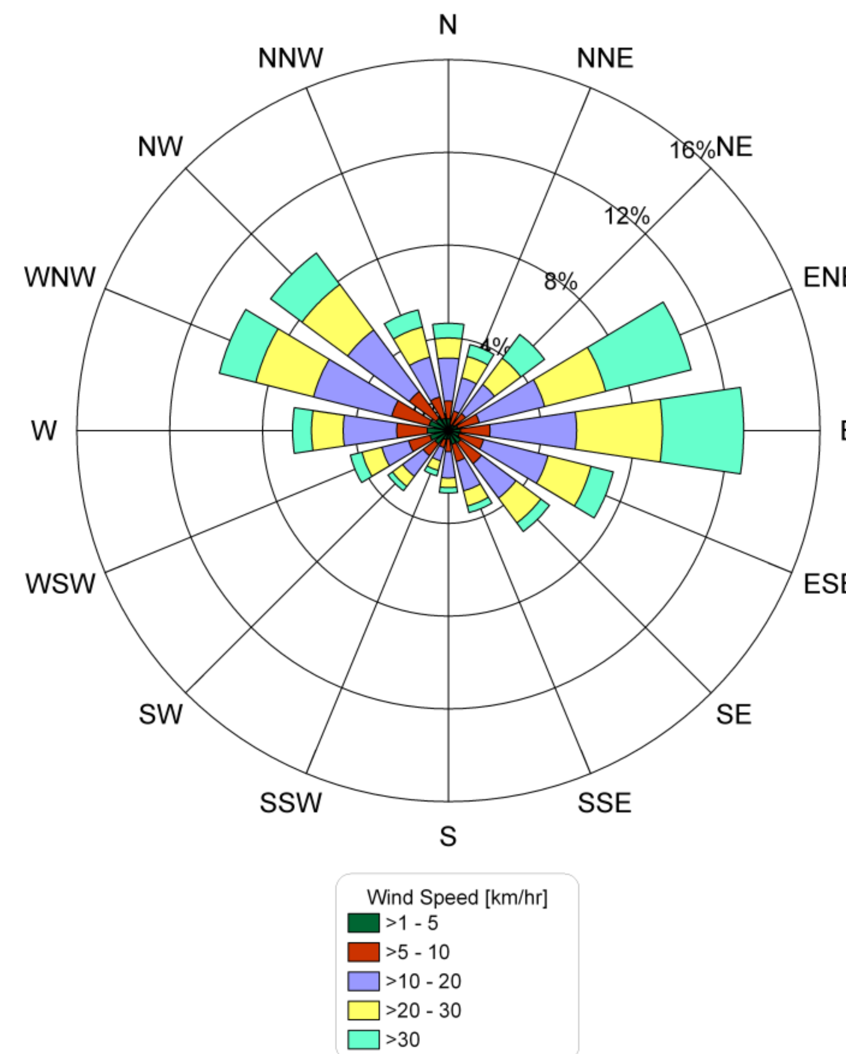
Figure 7.2-2 Koala Meteorological Station Summer Windrose, 2009 to 2013



Note: Windrose is based on measurements of wind speed and direction from June to October, each summer from 2009 to 2013.

km/hr = kilometres per hour; >= greater than;% = percent.

Figure 7.2-3 Koala Meteorological Station Winter Windrose, 2009 to 2013



Note: Windrose is based on measurements of wind speed and direction from November to May, each winter from 2009 to 2013.

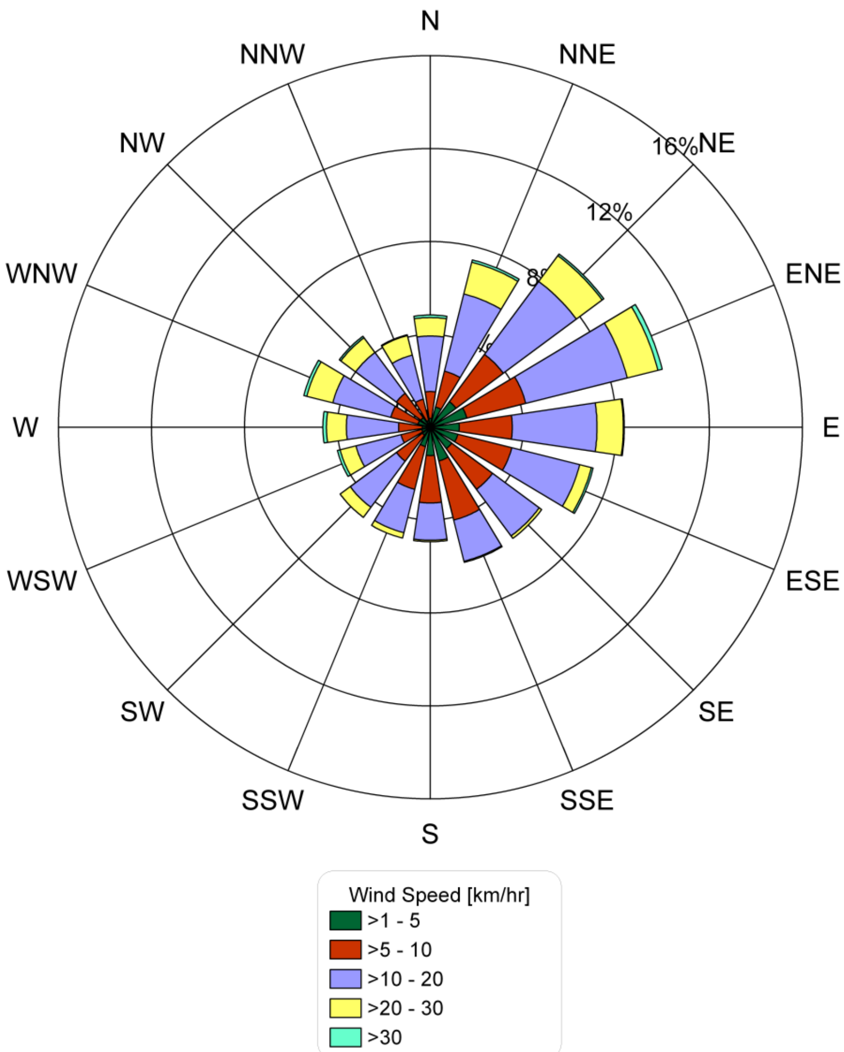
km/hr = kilometres per hour; >= greater than;% = percent.

7.2.2.1.2 Polar Lake Meteorological Station

The location of Polar Station is shown in Map 7.2-1. Wind speed and direction were measured at Polar Station over the summer months. Data were not collected at this station during the remainder of the year. The data collection period varied from year to year. The windrose for winds measured for the most recent five years, from 2009 to 2013, during this period is shown in Figure 7.2-4.

The dominant wind is from the east-northeast. Winds were also observed from the east and northeast more than 8% of the time. The winds observed at Polar Station are consistent with the winds observed at Koala Station during the summer months (Figure 7.2-2).

Figure 7.2-4 Polar Lake Meteorological Station Summer Windrose, 2009 to 2013

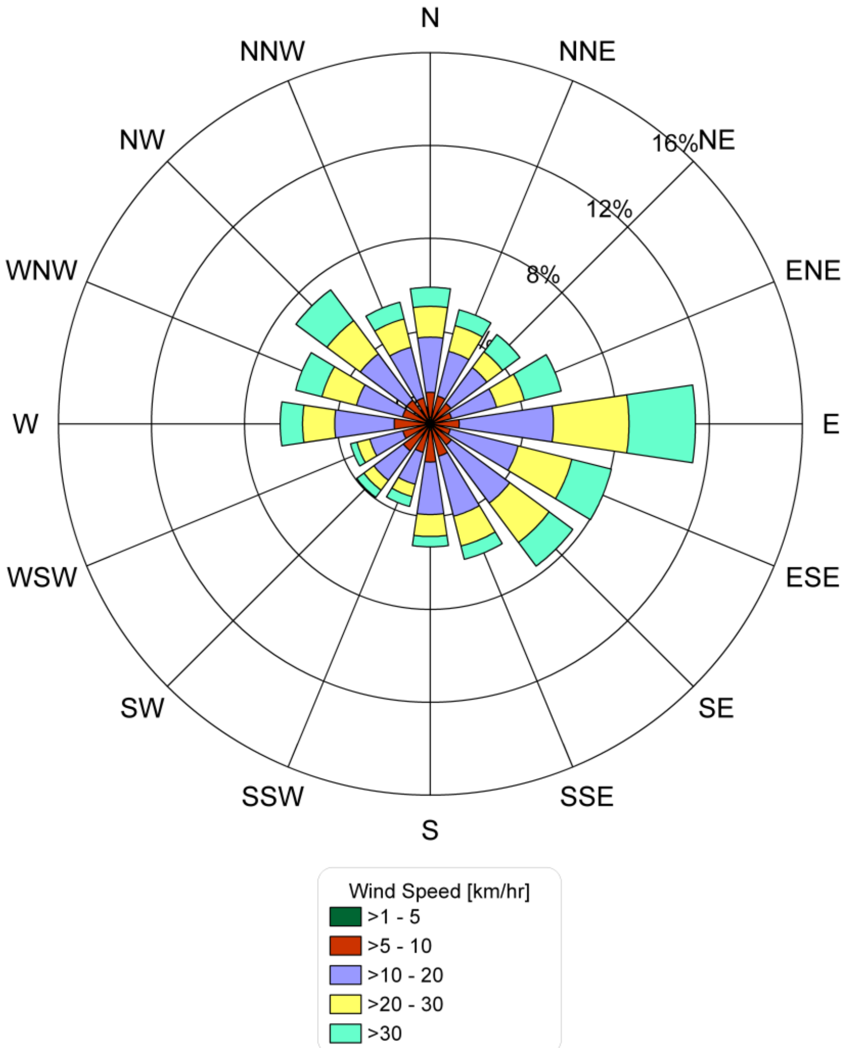


Note: Windrose is based on measurements of wind speed and direction from June to October, each summer from 2009 to 2013.
km/hr = kilometres per hour; >= greater than;% = percent.

7.2.2.1.3 *Ekati Airport Monitoring Station*

The location of Ekati A Station is shown in Map 7.2-1. The station is in operation only during the hours that the Ekati Airport is in operation, so the dataset is considered incomplete because it does not sample the majority of the nighttime winds. The station measures meteorological variables for approximately 12 hours of the day, but is presented herein for completeness. The windrose for Ekati A Station is shown in Figure 7.2-5. The predominant wind measured at Ekati A Station is from the east.

Figure 7.2-5 Ekati Airport Monitoring Station Windrose, 2009 to 2013



Note: Windrose is based on 12-hour measurements of wind speed and direction when the airport was in operation, from 2009 to 2013.

km/ hr = kilometres per hour; >= greater than;% = percent.

7.2.2.2 *Air Temperature*

This section presents the measured temperature at Koala Station between 2009 and 2013, because Koala Station monitored air temperature over almost all hours of each year. Less complete datasets were acquired at Polar Lake Station and Ekati A Station. The ranges of monthly mean temperatures at Koala Station between 2009 and 2013 are presented in Table 7.2-3.

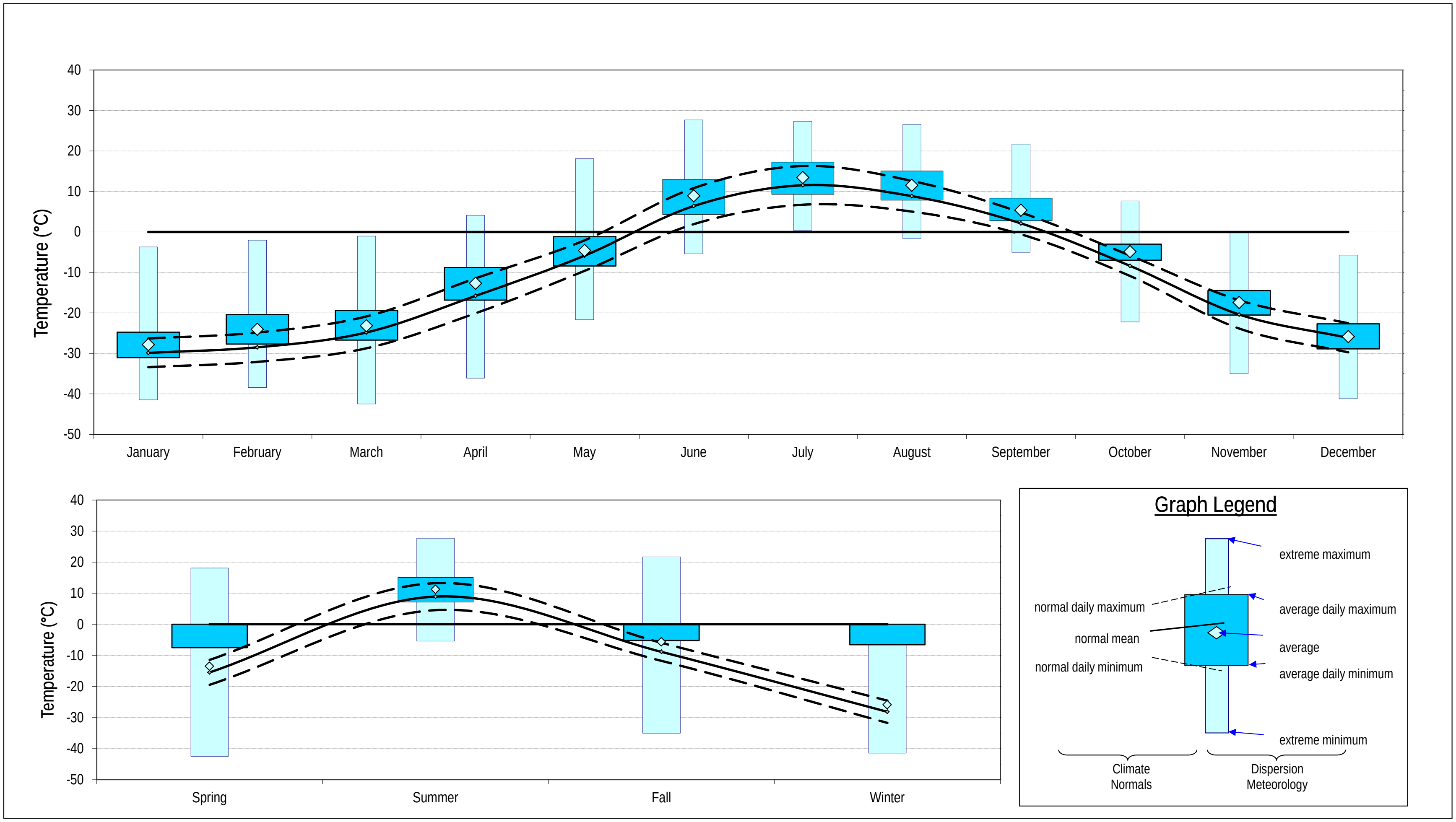
Table 7.2-3 Observed Temperatures at Koala Meteorological Station, 2009 to 2013

	Jan (°C)	Feb (°C)	Mar (°C)	Apr (°C)	May (°C)	Jun (°C)	Jul (°C)	Aug (°C)	Sep (°C)	Oct (°C)	Nov (°C)	Dec (°C)
Daily average	-27.8	-24.1	-23.2	-12.7	-4.6	8.9	13.4	11.5	5.3	-4.9	-17.4	-25.9
Standard deviation	7.0	7.3	9.3	7.1	6.9	6.5	4.7	4.7	4.5	5.6	6.6	6.6
Daily maximum	-24.8	-20.4	-19.4	-8.8	-1.2	13.0	17.3	15.1	8.4	-3.0	-14.5	-22.7
Daily minimum	-31.1	-27.7	-26.7	-16.8	-8.4	4.3	9.3	7.8	2.8	-7.0	-20.5	-28.9
Extreme maximum	-3.7	-2.0	-1.0	4.1	18.1	27.7	27.4	26.6	21.7	7.6	0.0	-5.7
Extreme minimum	-41.5	-38.4	-42.5	-36.1	-21.7	-5.4	0.3	-1.7	-5.1	-22.2	-35.1	-41.2

Source: Dominion Diamond (2014a).
°C = degrees Celsius.

The average temperatures observed from 2009 to 2013 are shown in Figure 7.2-6. The Lupin A Station climate normal data are plotted as dotted and solid lines, and the Koala temperature data as the coloured bars. The average temperatures observed at Koala Station are slightly higher than the Lupin A Station climate normals. This difference is expected because Koala Station is at a lower latitude than Lupin A Station.

Figure 7.2-6 Average Measured Temperatures at the Koala Meteorological Station, 2009 to 2013



°C = degrees Celsius.

7.2.2.3 *Precipitation*

Precipitation (i.e., snowfall, rainfall, and total precipitation) is measured at Koala Station. Precipitation is not measured over the full annual period at Polar Lake Station or Ekati A Station.

Snowfall was measured as snow-water equivalent during the winter at Koala Station from 2008 to 2012. For other meteorological parameters, 2009 to 2013 was generally used as a data interval, but the data for precipitation was not complete for 2013, so 2008 to 2012 was used instead. Data were retrieved approximately every two weeks. Rainfall was also measured at Koala Station; data were recorded automatically.

The majority of the rainfall at Koala Station occurs between June and October, while the majority of the snowfall occurs between November and April. The months of July through September experience the greatest amount of precipitation, and this result is consistent with the climate normal measured at Lupin A (Table 7.2-1). A summary of the monthly precipitation readings in millimetres at Koala Station from 2008 to 2012 is provided in Tables 7.2-4 to 7.2-6.

Table 7.2-4 Total Snowfall Measured at Koala Meteorological Station, 2008 to 2012

Year	Jan (mm)	Feb (mm)	Mar (mm)	Apr (mm)	May (mm)	June (mm)	Jul (mm)	Aug (mm)	Sep (mm)	Oct (mm)	Nov (mm)	Dec (mm)
2008	29.6	1.2	6.6	25.0	0.0	0.0	0.0	0.0	0.0	0.0	18.9	6.0
2009	6.8	16.6	18.9	41.0	16.0	0.0	0.0	0.0	0.0	16.1	58.1	13.9
2010	26.8	4.8	7.3	23.5	5.1	0.0	0.0	0.0	0.0	16.8	39.4	18.6
2011	11.0	23.6	3.4	13.6	0.0	0.0	0.0	0.0	0.0	56.1	49.8	52.8
2012	44.5	83.8	55.9	15.1	1.8	—	—	—	—	—	—	—

Source: Dominion Diamond (2014a).

Notes: Snowfall was measured as snow-water equivalent. Data are unavailable from June to December 2012.

mm = millimetre; — = not available.

Table 7.2-5 Total Rainfall Measured at Koala Meteorological Station, 2008 to 2012

Year	Jan (mm)	Feb (mm)	Mar (mm)	Apr (mm)	May (mm)	June (mm)	Jul (mm)	Aug (mm)	Sep (mm)	Oct (mm)	Nov (mm)	Dec (mm)
2008	0.0	0.0	0.0	0.0	5.6	45.0	37.6	156.5	62.0	8.6	0.0	17.0
2009	0.0	0.0	0.0	0.0	0.0	17.3	41.9	20.1	38.9	3.3	1.0	0.0
2010	0.0	0.0	0.0	0.0	8.0	32.4	58.0	7.2	26.2	1.2	0.0	0.0
2011	0.0	0.0	0.3	0.0	0.0	5.3	47.8	91.7	98.6	17.8	0.0	0.0
2012	0.0	0.0	0.0	2.0	8.9	0.8	22.1	50.0	45.5	13.0	0.0	0.0

Source: Dominion Diamond (2014a).

mm = millimetre.

Table 7.2-6 Total Precipitation Measured at Koala Meteorological Station, 2008 to 2012

Year	Jan (mm)	Feb (mm)	Mar (mm)	Apr (mm)	May (mm)	June (mm)	Jul (mm)	Aug (mm)	Sep (mm)	Oct (mm)	Nov (mm)	Dec (mm)	Year
2008	29.6	1.2	6.6	25.0	5.6	45.0	37.6	156.5	62.0	8.6	18.9	23.0	419.6
2009	6.8	16.6	18.9	41.0	16.0	17.3	41.9	20.1	38.9	19.4	59.1	13.9	309.9
2010	26.8	4.8	7.3	23.5	13.1	32.4	58.0	7.2	26.2	18.0	39.4	18.6	275.3
2011	11.0	23.6	3.6	13.6	0.0	5.3	47.8	91.7	98.6	73.9	49.8	52.8	471.7
2012	44.5	83.8	55.9	17.1	10.7	0.8	22.1	50.0	45.5	13.0	0.0[a]	0.0[a]	343.4
Average	23.7	26.0	18.5	24.0	9.1	20.1	41.5	65.1	54.2	26.6	33.4	21.7	363.9

Source: Dominion Diamond (2014a).
a) No snowfall data were available, and no rainfall was expected during these months.
mm = millimetre.

7.2.2.4 *Relative Humidity*

Relative humidity is the ratio of the amount of water vapour present in the air to the amount of vapour necessary for saturation at the same temperature and pressure. Relative humidity was measured at Koala Station from 2009 to 2013; monthly average relative humidity at Koala Station, expressed as a percentage of saturation, is summarized in Table 7.2-7.

Table 7.2-7 Monthly Average Relative Humidity at Koala Meteorological Station, 2009 to 2013

Year	Jan (%)	Feb (%)	Mar (%)	Apr (%)	May (%)	Jun (%)	Jul (%)	Aug (%)	Sep (%)	Oct (%)	Nov (%)	Dec (%)
2009	76.3	76.9	75.6	86.5	82.8	74.7	70.7	75.8	84.1	87.8	86.6	77.2
2010	76.5	81.7	84.5	87.7	84.9	69.8	73.3	72.0	86.8	90.7	86.5	81.7
2011	79.7	78.1	78.0	—[a]	63.5	65.7	62.0	77.9	86.3	95.9	88.8	83.2
2012	79.5	82.5	81.7	85.3	89.0	62.5	62.6	75.2	80.9	92.6	85.2	78.0
2013	74.2	79.7	80.7	82.3	85.7	62.7	72.6	69.0	87.4	91.4	89.0	61.5
Average	77.2	79.8	80.1	85.5	81.2	67.1	68.2	74.0	85.1	91.7	87.2	76.3

Source: Dominion Diamond (2014a).
a) Measurement unavailable due to instrument failure.
% = percent; — = not available.

7.2.2.5 *Solar Radiation*

Solar radiation levels measured at the surface are a function of hours of sunlight and sun azimuth angle, and a function of local weather conditions. Changes in weather variables may cause the annual peak in solar radiation to fluctuate from year to year.

Solar radiation was measured at Polar Station during the summer months while the station was active. The average solar radiation measured each year between 2009 and 2013 is presented in Table 7.2-8.

Table 7.2-8 Average Solar Radiation During the Summer at the Polar Lake Meteorological Station, 2009 to 2013

	2009	2010	2011	2012	2013
Start date (dd/mm/yyyy)	06/12/2009	06/17/2010	06/24/2011	07/11/2012	07/8/2013
End date (dd/mm/yyyy)	10/6/2009	10/9/2010	10/11/2011	10/12/2012	09/30/2013
Average (kW/m^2)	0.167	0.148	0.177	0.144	0.148
Maximum (kW/m^2)	0.800	0.774	0.828	0.811	0.764

Source: Dominion Diamond (2014a).
kW/m^2 = kilowatts per square metre; dd/mm/yyyy = day/month/year

7.2.2.6 *Summary*

Baseline meteorological information on wind speed and wind direction, precipitation, temperature, relative humidity, and solar radiation were available from observations made at stations located at the Ekati Mine. Long-term measurements of wind speed and wind direction, precipitation, and temperature were also available from Lupin A Station in Nunavut. This baseline information is summarized as follows:

- **Wind Speed and Wind Direction:** Seasonal variation was observed, with the summer or primarily ice-free months being from June to October, and the winter months being primarily from November to May. Prevailing winds at the Project were from the east, with east winds more common in winter and east-northeast winds more common in summer. Winds were frequently recorded during the measurement period at greater than 30 km/hr.
- **Precipitation:** Rainfall occurred primarily in the summer months, and snowfall occurred primarily in the winter months. The months of July through September experienced the greatest amount of precipitation.
- **Temperature:** Median ambient temperatures at the Project ranged from a low of near -28°C in January to a high of near 13°C in July. Temperatures at the Project were similar to temperatures recorded at Lupin A Station.
- **Relative Humidity:** Substantial seasonal variation in relative humidity was recorded at the Project, with average values ranging from near 67% in June to near 92% in October.
- **Solar Radiation:** Solar radiation was only recorded during the summer months. Average solar radiation measured was 157 watts per square metre (W/m^2), with average peak solar radiation of 795 W/m^2.

7.2.3 Air Quality

Existing air quality at the Project is affected by anthropogenic and non-anthropogenic sources, both from local sources and from regional and long-range transport. Because the proposed Jay Pit is in an undeveloped location and is not in the immediate vicinity of the existing Ekati Mine or Diavik Mine, the assumption is that background conditions of the selected compounds are low in the absence of development in the immediate area of the Project.

To acquire air quality data at the location of the Project, a short season of baseline air quality monitoring was performed at the proposed Jay Pit in 2013, at stations 13DDJP-A and 13DDJP-B as shown in Map 7.2-2. Because this dataset is not exhaustive, data used for estimation of the existing air quality are taken primarily from GNWT or Environment Canada monitoring locations in the NWT that are not located at or near the Project.

Emissions from the Ekati Mine and Diavik Mine operations are expected to contribute to the existing air quality at the proposed Project location, but the contributions are expected to be low given the distance between the Project and the existing operations. A review of the predictive modelling from previous assessment work at the Ekati Mine supports this expectation (BHP Billiton 2006).

A description of possible emission sources of existing air quality components discussed in this section are briefly described as follows:

- Diesel fuel combustion is a source of nitrogen oxides (NO_X) and sulphur dioxide (SO_2), and other industry-related activities such as blasting contribute to these pollutant concentrations in the airshed, in addition to contributions from naturally occurring sources.
- Combustion sources also contribute to carbon monoxide (CO) emissions.
- A variety of emission sources produce suspended particles less than 2.5 microns (µm) in diameter ($PM_{2.5}$) and total suspended particulate (TSP). Among the sources are forest fires, wind-blown dust from Project activity, vehicle exhaust, and stationary combustion processes.
- Dioxins and furans considered are produced by natural sources such as forest fires, and by incomplete waste incineration.
- Ammonia (NH_3) is considered in the existing air quality conditions because it is important in the simulation of atmospheric chemistry of the air dispersion modelling. It naturally occurs in the atmosphere, and it is also a constituent in blasting agents.
- Ozone (O_3) is directly a key element in the chemical transformation of NO_X to NO_2, and is created at ground level by photoreactive processes with nitrogen oxides and hydrocarbons. Ozone also occurs naturally in the upper atmosphere.

The following subsections describe the existing air quality conditions at the Project and within the study areas.

7.2.3.1 *Nitrogen Oxides and Nitrogen Dioxide*

Concentrations of NO_X and NO_2 are continuously monitored at four communities in the NWT: the GNWT Air Quality Monitoring Network stations at Fort Liard, Inuvik, Norman Wells, and Yellowknife. Although the data collected from these stations were influenced by anthropogenic sources within the communities, their concentrations were low, and they were used to provide insight into the existing air quality background concentration for NO_X and NO_2 for the Project in the absence of a robust dataset from the Project location. Two monitoring stations at the Project location were established to acquire NO_2 data, but the sample size was limited due to the short duration of the monitoring program, which occurred over several months in the summer and fall seasons of 2013.

7.2.3.1.1 Nitrogen Oxides

Concentrations of NO_X are monitored in the NWT at Fort Liard, Inuvik, Norman Wells, and Yellowknife. While there were gaps in the existing monitored data, a large dataset exists for the four stations, so an average result was taken from the four stations considering years with more than 75% of data availability at a station. The average background NO_X concentration at the GNWT stations was 6.8 micrograms per cubic metre (µg/m³). There is no ambient air quality standard for NO_X in the NWT. Concentrations are presented in Table 7.2-9, and the data do not show an obvious trend of increasing or decreasing concentrations. Though these stations are influenced by anthropogenic sources, the background value of 6.8 µg/m³ NO_X is low, and provides insight into the existing air quality of the Project location.

7.2.3.1.2 Nitrogen Dioxide

Concentrations of NO_2 are monitored in the NWT at Fort Liard, Inuvik, Norman Wells, and Yellowknife. While there were gaps in the existing monitored data, a large dataset exists for the four stations, so an average result was taken from the four stations considering years with more than 75% of data availability at a station. The average background NO_2 concentration at the GNWT stations was 4.0 µg/m³, as compared with the annual NWT AAQS of 60 µg/m³ (GNWT-ENR 2014). Concentrations are presented in Table 7.2-10, and the data do not show an obvious trend of increasing or decreasing concentrations. Though these stations are influenced by anthropogenic sources, the background value of 4.0 µg/m³ NO_2 is low, and provides insight into the existing air quality of the Project location.

Table 7.2-9 Government of the Northwest Territories Stations Nitrogen Oxides Concentrations, 2003 to 2013

Station	Averaging Time	Parameter	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fort Liard	all	data availability (%)	0.0	0.0	73.4	95.8	52.3	0.8	0.0	75.9	60.1	95.8	64.3
	annual	average (µg/m³)	—	—	5.0	0.9	1.3	35.9	—	3.6	3.3	5.5	1.3
Inuvik	all	data availability (%)	0.0	23.8	95.5	67.1	76.5	72.2	9.7	97.1	95.7	87.4	89.7
	annual	average (µg/m³)	—	14.4	7.4	4.6	4.0	2.4	16.3	8.5	7.9	8.6	8.0
Norman Wells	all	data availability (%)	0.0	0.0	54.8	95.6	95.8	96.0	95.9	73.4	95.0	93.0	93.9
	annual	average (µg/m³)	—	—	2.9	3.9	3.7	2.2	1.8	3.1	2.3	3.8	5.0
Yellowknife	all	data availability (%)	15.0	96.3	97.6	98.1	98.1	98.7	98.8	95.8	93.6	98.1	97.5
	annual	average (µg/m³)	30.8	15.0	13.1	10.7	8.3	7.2	6.4	13.9	10.0	5.7	10.3

Source: GNWT (2014).
% = percent; µg/m³ = micrograms per cubic metre; — = not available.

Table 7.2-10 Government of the Northwest Territories Stations Nitrogen Dioxide Concentrations, 2003 to 2013

Station	Averaging Time	Parameter	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fort Liard	all	data availability (%)	0.0	0.0	73.4	95.8	52.3	0.8	0.0	75.9	60.1	95.8	64.3
	annual	average (µg/m³)	—	—	0.4	0.5	0.8	20.1	—	2.2	2.2	5.1	0.7
Inuvik	all	data availability (%)	0.0	23.8	95.5	67.1	76.5	72.2	9.7	97.1	95.7	87.4	89.7
	annual	average (µg/m³)	—	8.6	4.3	2.6	1.5	1.1	10.1	5.3	4.4	4.8	5.0
Norman Wells	all	data availability (%)	0.0	0.0	54.8	95.6	95.8	96.0	95.9	73.4	95.0	93.0	93.9
	annual	average (µg/m³)	—	—	1.2	2.5	2.4	1.4	2.1	2.5	2.8	2.8	3.8
Yellowknife	all	data availability (%)	15.0	96.3	97.6	98.1	98.1	98.7	98.8	95.8	93.6	98.1	97.5
	annual	average (µg/m³)	11.6	8.2	7.4	7.2	5.3	3.6	3.9	8.9	6.5	4.2	6.0

Source: GNWT (2014).
% = percent; µg/m³ = micrograms per cubic metre; — = not available.

NO_2 was also monitored at the two Project stations, 13DDJP-A and 13DDJP-B. The average NO_2 concentration recorded at the Project stations was 0.5 µg/m³ (Table 7.2-11), as compared to the annual NWT AAQS of 60 µg/m³.

Table 7.2-11 Jay Pit Air Quality Stations Nitrogen Dioxide Results, 2013

Station	Month[a]	Sample Concentration (µg/m³)	Sample Concentration (ppb)
13DDJP-A	August	1.5	0.8
	September	<0.6	<0.3
	October	<0.2	<0.1
13DDJP-B	August	0.9	0.5
	September	<0.6	<0.3
	October	<0.2	<0.1
	Average[b]	**0.5**	**0.3**

a) Nominal monthly values; start and end dates varied to accommodate site logistics.
b) Sample concentrations below the detectable limit are treated as half the detectable limit for calculating the average.
µg/m³ = micrograms per cubic metre; ppb = parts per billion; <= less than.

The average NO_2 concentrations recorded at the two Project stations were lower than the average concentration from the GNWT Air Quality Monitoring Network stations, and could be considered to represent existing conditions at the Project. However, the dataset from the Project stations was limited in scope, and because the Project is not located near any expected anthropogenic sources that are not included in the air dispersion modelling, a background of 0.0 µg/m³ NO_2 is assumed to be representative of existing conditions at the Project.

7.2.3.2 *Sulphur Dioxide*

Concentrations of SO_2 are continuously monitored at four locations in the NWT: the GNWT Air Quality Monitoring Network stations at Fort Liard, Inuvik, Norman Wells, and Yellowknife. While there were gaps in the existing monitored data, a large dataset exists for the four stations, so an average result was taken from the four stations considering years with more than 75% of data availability at a station. The average background SO_2 concentration at the GNWT stations was 1.3 µg/m³, as compared to the annual NWT AAQS of 30 µg/m³. Concentrations are presented in Table 7.2-12, and the data do not show an obvious trend of increasing or decreasing concentrations.

Though these stations are influenced by anthropogenic sources, the background value of 1.3 µg/m³ SO_2 is low, and provides insight into the existing air quality of the Project location. Because the Project is not located near any expected anthropogenic sources that are not included in the air dispersion modelling, a background of 0.0 µg/m³ SO_2 is assumed at the Project.

Table 7.2-12 Government of the Northwest Territories Stations Sulphur Dioxide Concentrations, 2003 to 2013

Station	Averaging Time	Parameter	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fort Liard	all	data availability (%)	0.0	0.0	27.8	95.0	95.7	95.6	95.9	95.9	95.5	95.5	95.7
	annual	average (µg/m³)	—	—	3.0	0.3	0.1	0.0	0.8	1.9	1.0	0.7	0.3
Inuvik	all	data availability (%)	0.0	0.0	23.8	94.7	93.2	95.1	85.7	89.4	58.4	94.3	54.6
	annual	average (µg/m³)	—	—	2.6	1.7	1.5	0.7	1.6	0.5	1.2	2.2	0.2
Norman Wells	all	data availability (%)	0.0	0.0	22.6	95.7	95.6	95.8	96.0	96.0	91.8	82.9	81.1
	annual	average (µg/m³)	—	—	0.1	1.0	1.8	1.0	1.6	1.9	1.3	0.9	1.9
Yellowknife	all	data availability (%)	6.1	92.8	92.5	91.8	90.7	98.1	99.2	98.2	97.4	96.8	84.3
	annual	average (µg/m³)	3.8	1.8	1.9	2.6	0.4	0.9	1.9	2.0	1.6	0.4	0.5

Source: GNWT (2014).

% = percent; $\mu g/m^3$ = micrograms per cubic metre; — = not available.

7.2.3.3 *Carbon Monoxide*

Carbon monoxide concentrations are continuously monitored at two locations in the NWT: the GNWT Air Quality Monitoring Network stations at Inuvik and Yellowknife.

While there were gaps in the existing monitored data, a large dataset exists for the two stations, so an average result was taken from the two stations considering years with more than 75% of data availability at a station. The average background CO concentration at the GNWT stations was 259.2 µg/m³, as compared to the eight-hour NWT AAQS of 6,000 µg/m³. Concentrations are presented in Table 7.2-13, and the data from the Yellowknife Station shows a trend of increasing concentrations through time.

Though these stations are influenced by anthropogenic sources, the background value of 259.2 µg/m³ provides insight into the existing air quality of the Project location. Because the Project is not located near any expected anthropogenic sources that are not included in the air dispersion modelling, a background of 0.0 µg/m³ CO is assumed at the Project.

7.2.3.4 *Ozone*

Ozone data were not available at the Project location. However, monitoring stations at Snare Rapids (Stevens 2014) and Yellowknife (GNWT 2014) recorded hourly ozone concentrations. To assess existing conditions at the Project and to determine background ozone values for the conversion of NO_X to NO_2 in the model predictions (Section 7.4.2.3), average hourly concentrations for each month of the year were assessed over the period of 2010 to 2012.

The seasonal variations of ozone data recorded at Snare Rapids and Yellowknife are shown in Figures 7.2-7 and 7.2-8. The data are presented as simplified box-and-whisker plots. The box on the figures represents the bounds of the middle 50% of the data points, with the top of the box and the bottom of the box representing the 75^{th} and 25^{th} percentile concentrations respectively. The blue diamond represents the average concentration, while the red square represents the 90^{th} percentile value. The whiskers extend up to the maximum concentration, and down to the minimum concentration.

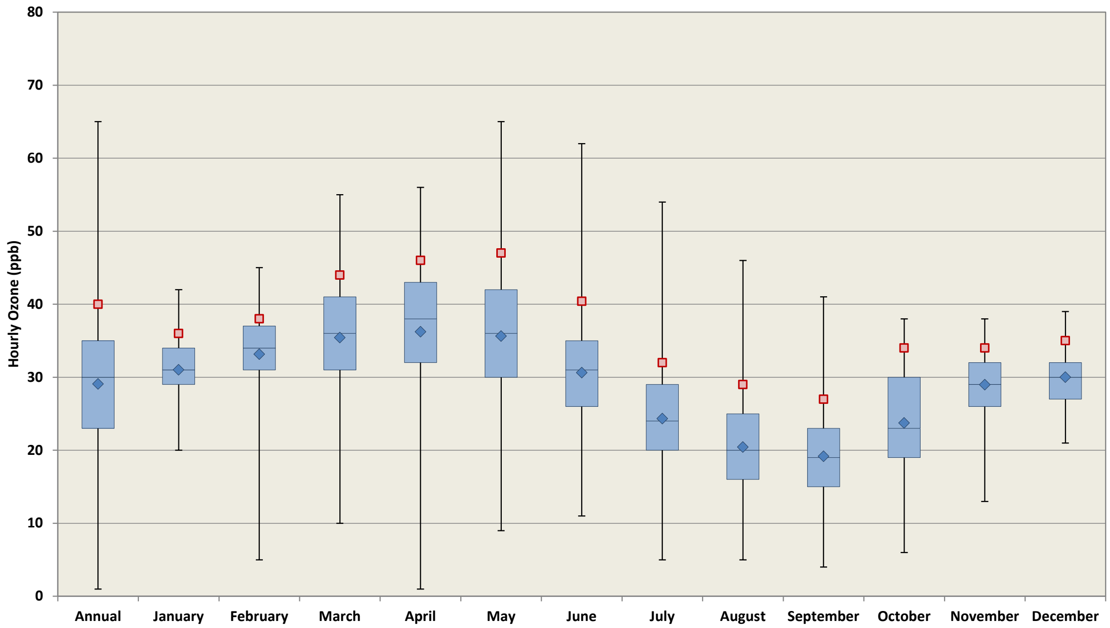
Table 7.2-13 Government of the Northwest Territories Ambient Carbon Monoxide Concentrations, 2004 to 2013

Station	Averaging Time	Parameter	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Inuvik	all	data availability (%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.1	89.7
		average (µg/m³)	—	—	—	—	—	—	—	—	181.9	100.7
Yellowknife	all	data availability (%)	98.6	90.1	82.2	99.2	98.1	96.6	94.0	97.9	98.8	97.1
		average (µg/m³)	76.6	117.3	174.1	451.2	252.2	367.1	175.0	207.9	479.9	449.1

Source: GNWT (2014).

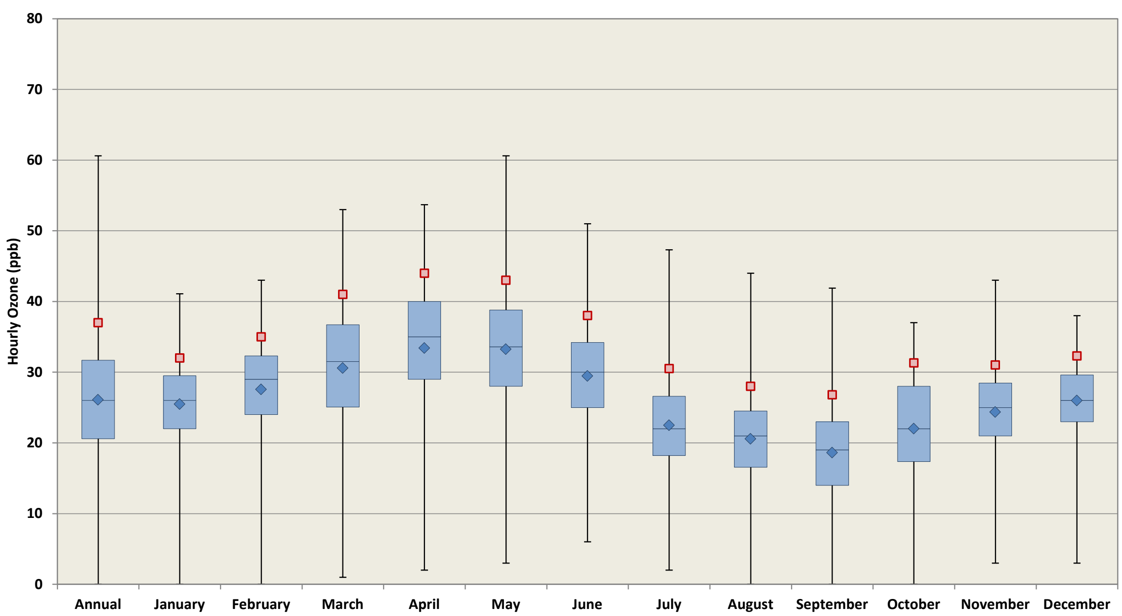
% = percent; µg/m^3 = micrograms per cubic metre; — = not available.

Figure 7.2-7 Snare Rapids Hourly Ozone by Month, 2010 to 2012



Source: Stevens (2014).
ppb = parts per billion.

Figure 7.2-8 Yellowknife Hourly Ozone by Month, 2010 to 2012



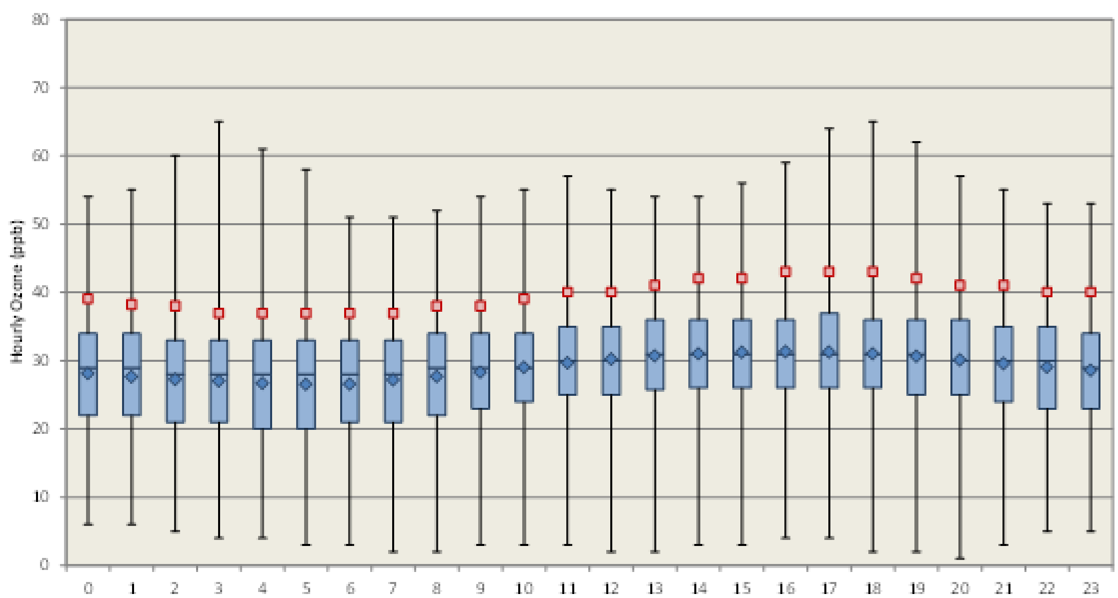
Source: GNWT (2014).
ppb = parts per billion.

The above figures confirm the validity of using different ozone values for each of the months, because Snare Rapids and Yellowknife have considerable month-to-month variation.

Ozone concentrations also vary diurnally, and can vary from hour to hour. In areas where photochemical reactions dominate, photochemical ozone tends to break down at night because sunlight is absent. The typical diurnal pattern in an area dominated by photochemical ozone is to have the ozone concentrations rise from an early morning low to the highest concentrations of the day in the early afternoon. These concentrations then fall as the sun begins to set. In large urban areas, there are usually two distinct dips in ozone concentrations corresponding with the early morning and late-afternoon traffic density. The dips result from the increased emissions of oxides of nitrogen that can have a scavenging effect on the ground-level ozone, effectively reducing the ozone concentrations.

An analysis of the diurnal variations in the observed concentrations at Snare Rapids and Yellowknife is shown in Figures 7.2-9 and 7.2-10. Although a slight diurnal pattern occurs at Snare Rapids (Figure 7.2-9), it is relatively minor and consistent with the patterns expected in areas where photochemical ozone formation is a secondary source of ozone.

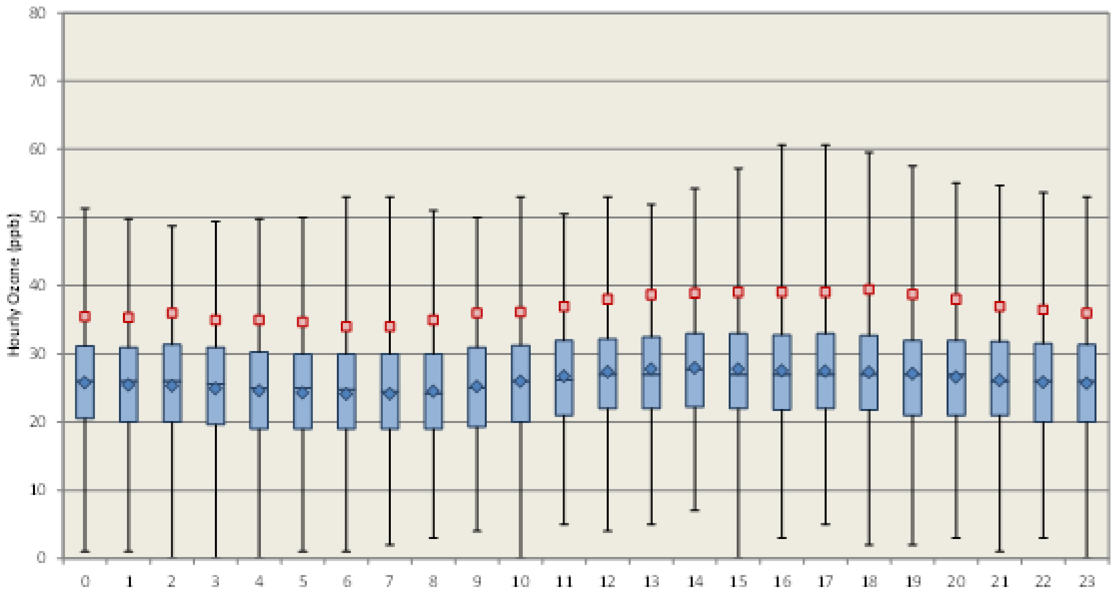
Figure 7.2-9 Snare Rapids Hourly Ozone by Hour, 2010 to 2012



Source: Stevens (2014).
ppb = parts per billion.

The diurnal ozone pattern monitored at Yellowknife is shown in Figure 7.2-10. There is a similar hour-to-hour fluctuation to the Snare Rapids data; however, the diurnal patterns are much less than would be expected if photochemical reactions were the dominant source of ozone at the station. The data from Yellowknife shows a slight early morning dip in the ozone levels and a slight rise in the early afternoon, indicating that photochemical reactions may be occurring at this station.

Figure 7.2-10 Yellowknife Hourly Ozone by Hour, 2010 to 2012



Source: GNWT (2014).
ppb = parts per billion.

Because the Yellowknife monitoring data are from a station location where it is expected that there is a higher influence from anthropogenic sources, the Snare Rapids Monitoring Station is more representative of existing conditions at the Project location, and is used for background concentrations in the dispersion modelling. The hourly concentrations of ozone used are summarized in the Dispersion Modelling Approach, Appendix 7C, Table 7C5-3.

7.2.3.5 *Dioxins and Furans*

Dioxins and furans are not monitored at the Project location or in the region. Existing concentrations other than from modelled sources are assumed to be very low at the Project site, and no background source contributions outside of the modelled emission sources are included in the air dispersion modelling.

7.2.3.6 *Particulate Matter*

Two monitoring stations at the Project location measured particulate matter data, at stations 13DDJP-A and 13DDJP-B, but the sample size was limited and was used to corroborate other data rather than establish existing conditions. Larger datasets from monitoring stations in northern locations were instead used to determine existing conditions for particulate matter at the Project. Seasonal particulate monitoring data from the NWT Tundra Ecological Research Station located at Daring Lake were analyzed for particulate matter of mean aerodynamic diameter less than 10 microns (PM_{10}) and $PM_{2.5}$ concentrations, and particulate monitoring data from the De Beers Canada Inc. (De Beers) Snap Lake Mine were analyzed for TSP concentrations.

7.2.3.6.1 $PM_{2.5}$ and PM_{10}

The Daring Lake Station monitored $PM_{2.5}$ concentrations during the summer months from 2003 to 2008. The PM_{10} data recorded in 2002 from Daring Lake were not used to establish existing conditions at the Project because the PM_{10} dataset was limited and was averaging less than the $PM_{2.5}$ dataset. Because $PM_{2.5}$ is a subset of PM_{10}, PM_{10} concentrations should not be considered if they are less than $PM_{2.5}$ concentrations. Instead, PM_{10} background values were estimated from the Daring Lake $PM_{2.5}$ values to determine an approximate concentration of PM_{10} at Daring Lake over the same time frame as the $PM_{2.5}$ data. Refer to Annex I for a more detailed description on the treatment of the $PM_{2.5}$ and PM_{10} datasets. The $PM_{2.5}$ stations from Daring Lake are remote from industrial emission sources, and can be reasonably considered for background concentrations at the Project.

The average background $PM_{2.5}$ concentration at the Daring Lake Station was 1.8 µg/m³, as compared with the annual NWT AAQS of 10 µg/m³. Concentrations are presented in Table 7.2-14. The PM_{10} background concentration estimated from the Daring Lake $PM_{2.5}$ data is 2.7 µg/m³. There is no NWT AAQS for PM_{10}.

Table 7.2-14 Daring Lake 24-Hour Particulate Concentrations, 2003 to 2008

Sample Date (day-month)	$PM_{2.5}$ (µg/m³)					
	2003	2004	2005	2006	2007	2008
08-Jun	—	3.9	—	—	—	—
11-Jun	0.8	4.7	—	—	—	—
14-Jun	3.1	2.5	—	—	—	—
17-Jun	2.2	4.6	—	—	—	—
18-Jun	—	—	—	—	—	—
20-Jun	0.1	7.9	—	—	—	—
21-Jun	—	—	—	0.3	—	—
23-Jun	1.9	1.8	—	—	—	—
24-Jun	—	—	—	5.4	—	—
26-Jun	1.7	9.3	—	—	—	—
27-Jun	—	—	0.0	2.8	—	—
29-Jun	1.0	14.2	—	—	—	—
30-Jun	—	—	2.5	—	—	—
02-Jul	—	1.9	—	—	—	—
03-Jul	1.3	—	—	—	—	—
05-Jul	—	5.6	0.6	—	—	—
06-Jul	0.6	—	—	—	—	—
08-Jul	—	1.1	2.4	—	—	—
09-Jul	6.8	—	—	1.5	1.0	—
11-Jul	—	5.4	3.8	—	—	0.6
13-Jul	—	—	—	—	1.7	—

Table 7.2-14 Daring Lake 24-Hour Particulate Concentrations, 2003 to 2008

Sample Date (day-month)	$PM_{2.5}$ ($\mu g/m^3$)					
	2003	2004	2005	2006	2007	2008
14-Jul	—	2.8	3.6	—	—	0.8
15-Jul	2.5	—	—	0.9	—	—
16-Jul	—	—	—	—	1.1	1.5
17-Jul	—	2.9	0.3	—	—	—
18-Jul	3.3	—	—	—	—	—
19-Jul	—	—	—	0.9	—	5.7
21-Jul	—	—	—	—	—	5.3
23-Jul	5.7	17.2	1.5	4.1	0.0	—
24-Jul	—	—	—	—	—	3.4
26-Jul	15.4	5.4	0.1	1.3	0.4	—
27-Jul	—	—	—	—	—	5.5
29-Jul	—	41.5	1.0	1.3	1.7	—
01-Aug	—	1.8	2.8	—	0.7	—
02-Aug	—	—	—	1.9	—	—
04-Aug	—	6.4	1.8	—	3.7	1.9
07-Aug	—	—	0.6	—	—	—
08-Aug	—	1.0	—	—	—	—
09-Aug	—	—	—	—	0.1	—
10-Aug	—	—	0.1	—	—	7.0
11-Aug	—	—	—	0.4	—	—
12-Aug	—	—	—	—	0.0	—
14-Aug	—	—	—	1.2	—	—
16-Aug	—	—	0.8	—	—	—
17-Aug	—	—	—	1.3	—	—
18-Aug	—	—	1.4	—	—	—
19-Aug	—	—	—	—	0	—
Minimum	**0.1**	**1.0**	**0.0**	**0.3**	**0.0**	**0.6**
Maximum	**15.4**	**41.5**	**3.8**	**5.4**	**3.7**	**7.0**
Median	**2.1**	**4.7**	**1.2**	**1.3**	**0.7**	**3.4**
Average	**3.3**	**7.1**	**1.5**	**1.8**	**0.9**	**3.5**

Source: Fox (2014).

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; $\mu g/m^3$ = micrograms per cubic metre;
— = not available.

The average $PM_{2.5}$ concentration recorded at the Project stations was 1.3 µg/m³ (Table 7.2-15). These data indicate that background concentrations of $PM_{2.5}$ are low near the Project, and match well with the Daring Lake $PM_{2.5}$ average concentration of 1.8 µg/m³ used as background concentration for the Project.

Table 7.2-15 Jay Pit Air Quality Stations $PM_{2.5}$ Results, 2013

Station	Month[(a)]	Sample Concentration (µg/m³)
13DDJP-A	July	1.0
	August	0.5
	September	0.6
	October	—
13DDJP-B	July	5.9
	August	0.4
	September	0.5
	October	0.3
	Average	**1.3**

a) One 24-hour sample was taken at each station per month.

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; µg/m³ = micrograms per cubic metre;
— = not available.

7.2.3.6.2 Total Suspended Particulate

The average 24-hour TSP concentration observed at the two Project stations during the 2013 monitoring program was 1.8 µg/m³ (Table 7.2-16). These data indicate that background concentrations of TSP are low in the Lac du Sauvage region of the Project.

Table 7.2-16 Jay Pit Air Quality Stations Total Suspended Particulates Results, 2013

Station	Month[(a)]	Sample Concentration (µg/m³)
13DDJP-A	July	7.4
	August	1.0
	September	0.2
	October	0.8
13DDJP-B	July	—
	August	0.9
	September	0.5
	October	—
	Average	**1.8**

a) One 24-hour sample was taken at each station per month.

µg/m³ = micrograms per cubic metre; — = no data collected or invalid measurement.

Because the Project sampling at the Jay Pit stations was limited in scope, Snap Lake Mine TSP monitoring data were reviewed to assist in determining existing TSP background concentrations for the Project. The TSP samples were recorded with high-volume air samplers during low activity periods from 2001 to 2004 and 2006. Concentrations are presented in Table 7.2-17. Because site activity was minimal during the sampling period, and anthropogenic sources were not primary contributors to TSP (De Beers 2010), the TSP data recorded during 2002 best represent existing air quality for the Project from the Snap Lake TSP monitoring program. The median background concentration recorded in 2002 was 3.1 μg/m³. Refer to Annex I for full details on the treatment of TSP data.

Table 7.2-17 Snap Lake Mine Total Suspended Particulate Concentrations, 2001 to 2006

Year	Concentration (μg/m³)														
	Minimum					Median					Maximum				
	HV001	HV002	HV003	HV004	HV005	HV001	HV002	HV003	HV004	HV005	HV001	HV002	HV003	HV004	HV005
2001	2.1	1.1	5.4	-	-	26	7.1	15	-	-	146	69	34	-	-
2002	0.3	0	0	-	-	5.2	3.1	2.7	-	-	22	26	12	-	-
2003	0.4	0.2	0.2	-	-	6	4.1	4.9	-	-	37	32	32	-	-
2004	0.1	1.1	0.4	-	-	13.6	18	6.6	-	-	140	73	86	-	-
2006	-	0	-	7	3	-	16	-	14	11	-	221	-	65	155
2001 to 2004, 2006	0.1	0	0	7	3	10	7.1	5.4	14	11	146	221	86	65	155

Source: De Beers (2010).
μg/m³ = micrograms per cubic metre; - = not available.

7.2.4 Summary of Local and Traditional Knowledge

Information for five groups of Aboriginal peoples whose traditional lands overlap the Ekati claim block is provided in the Traditional Land Use and Traditional Knowledge Baseline Report (Annex XVII). Local and traditional knowledge with respect to air quality has been considered in the Traditional Land Use and Traditional Knowledge Baseline Report, as summarized in this subsection.

Important effects pathways that were identified as of concern include wildlife, vegetation, fish and water, and impacts to air quality in general.

As noted in the Traditional Land Use and Traditional Knowledge Baseline Report, concern exists that effects from the Project could include dust affecting animal migration (e.g., caribou), small furbearing animals, birds, hatching birds and birthing animals, vegetation, fish (and specifically in the Lac de Gras area), plants and water (and specifically plants and water to the east of development activity). Avoidance of the Project by local game due to dust was raised as a potential effect of the Project, as was accumulation or deposition of dust in water.

The original planning of the Project included a larger lakebed drainage area, and community concerns over possible air quality impacts from the Project at this planning stage were taken into account by Dominion Diamond in the change to make the Project footprint much smaller. Mitigations such as continuation of existing practices for dust suppressant application and speed limits on roads at the Project also take into account community concerns of possible dust emissions from the Project, and the air quality assessment included the mitigation effects of dust suppression and speed limits in the modelling.

7.3 Pathway Analysis

7.3.1 Methods

Pathway analysis identifies and assesses the linkages between Project components or activities, and the corresponding changes to the environment and potential residual effects (after mitigation) on air quality. 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 air quality. Potential pathways through which the Project could affect air quality were identified from several sources including the following:

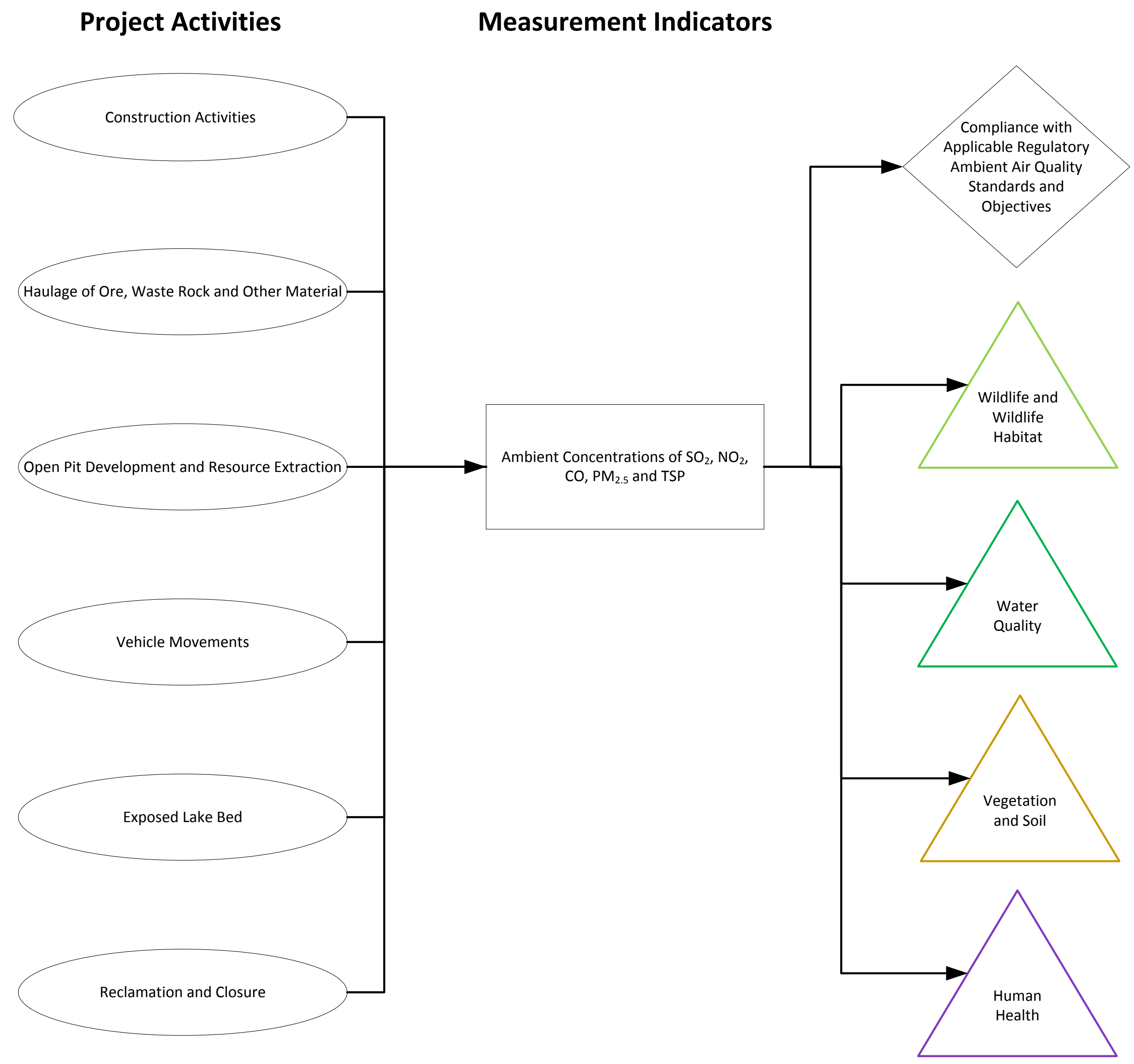
- a review of the Project description and scoping of potential effects by the environmental and engineering teams for the Project;
- information from past and ongoing consultations with Aboriginal communities that are part of the Ekati Mine Community Engagement Programs;
- local and traditional knowledge 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 corresponding effect on air quality.

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

Potential effects from Project activities on air quality before mitigation are shown in Figure 7.3-1. Each pathway or line in the diagram was initially considered to have a linkage to the air quality VC.

Figure 7.3-1 Linkage Diagram Identifying Potential Effects on Air Quality



Note: Ovals represent Project activites; 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 may reduce or eliminate potential effects of the Project to air quality, and includes application of the precautionary principle (Section 6.4). Environmental design features include engineering design elements, environmental best practices, management policies and procedures, 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 and is intended to focus the effects analysis on pathways that require a more comprehensive assessment of effects on air quality. Pathways are determined to be primary, secondary (minor), or as having no linkage, using scientific, local and traditional knowledge, logic, 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 air quality relative to the Base Case or guideline values; or
- secondary – pathway could result in a measurable minor environmental change, but would have a negligible residual effect on air quality relative to the Base Case or guideline values and is not expected to contribute to effects of other existing, approved, or reasonably foreseeable projects to cause a significant effect; or,
- primary – pathway is likely to result in environmental change that could contribute to residual effects on air quality relative to the Base Case or guideline values.

Pathways with no linkage to air quality 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 air quality through simple qualitative or semi-quantitative evaluation of the pathway are also not advanced for further assessment. In summary, pathways determined to have no linkage to air quality or those that are considered secondary are not expected to result in environmentally significant effects for compliance with regulatory air emission guidelines and standards. Primary pathways require further evaluation through more detailed quantitative and qualitative effects analysis (Section 7.4).

7.3.2 Results

7.3.2.1 *Pathway Screening*

Project components and activities, effect pathways, and environmental design features and mitigation are summarized in Table 7.3-1. Air quality effects from the Project will be compared to NWT AAQS, and changes in air quality will be included in the assessment of water quality, soils, vegetation, wildlife, aquatic, and human health. Environmental design features and mitigation incorporated into the Project to remove a pathway or limit the effects to air quality are listed and described in detail below, and pathways are determined to be primary, secondary, or as having no linkage. Classification of effects pathways to air quality is also summarized in Table 7.3-1. The following section discusses the potential pathways relevant to effects on air quality.

All pathways were considered primary pathways for effects to the air quality VC and will be carried through the effects assessment (Table 7.3-1). They are as follows:

- emissions of SO_2, NO_X, CO, and particulate matter ($PM_{2.5}$, TSP) from construction equipment, mining operations and processing equipment, and vehicle fleet; and,
- fugitive dust emissions from mining activities, material movement and storage, drained lakebed, and haul roads.

Table 7.3-1 Potential Pathways for Effects to Air Quality

Project Component/ Activity	Effects Pathway	Environmental Design Features and Mitigation	Pathway Assessment
Construction	Emissions of SO_2, NO_X, CO, and Particulate Matter ($PM_{2.5}$, PM_{10}, TSP) from construction equipment and vehicle fleet	Compliance with regulatory emission requirements. Implementation of good design and operational practices to mitigate and reduce emissions, and to improve energy efficiencies (details in Section 7.3.2.2)	Primary
	Fugitive dust emissions from roads and material movement and storage		Primary
Mining Operations	Emissions of SO_2, NO_X, CO, and particulate matter ($PM_{2.5}$, PM_{10}, TSP) from mining operations and processing equipment, and fleet	Compliance with regulatory emission requirements. Implementation of good design and operational practices to mitigate and reduce emissions, and to improve energy efficiencies (details in Section 7.3.2.2)	Primary
	Fugitive dust emissions from roads, mining operations, and material movement and storage		Primary
Material Transport and Access Roads	Emissions of SO_2, NO_X, CO, and particulate matter ($PM_{2.5}$, PM_{10}, TSP) from vehicle fleet	Compliance with regulatory emission requirements. Implementation of good design and operational practices to mitigate and reduce emissions, and to improve energy efficiencies (details in Section 7.3.2.2)	Primary
	Fugitive dust emissions from roads and material movement		Primary

DOMINION DIAMOND

Table 7.3-1 Potential Pathways for Effects to Air Quality

Project Component/ Activity	Effects Pathway	Environmental Design Features and Mitigation	Pathway Assessment
Exposed Lakebed	Fugitive dust emissions from lakebed	None	Primary
Decommissioning	Emissions of SO_2, NO_X, CO, and Particulate Matter ($PM_{2.5}$, PM_{10}, TSP) from fleet	Compliance with regulatory emission requirements Implementation of good design and operational practices to mitigate and reduce emissions, and to improve energy efficiencies (details in Section 7.3.2.2)	Primary
	Fugitive dust emissions from roads and material movement		Primary

SO_2 = sulphur dioxide; NO_X = nitrogen oxides; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; PM_{10} = particulate matter of mean aerodynamic diameter less than 10 microns; TSP = total suspended particulate.

7.3.2.2 Review of Mitigation Effectiveness

7.3.2.2.1 Good Practices to Mitigate and Reduce Emissions

In keeping with its focus on responsible and sustainable development, Dominion Diamond has identified a series of good practices to minimize air quality impacts that it will employ.

Continuous improvement and emission reduction are key management approaches that support the principle of keeping clean areas clean and encompass the Dominion Diamond goal of using best available technology economically achievable.

Dominion Diamond will follow general management approaches for air emissions from the Project:

- Project mine equipment and haul vehicles will be regularly maintained to reduce emissions and maximize fuel efficiency.
- Low sulphur (15 parts per million by weight [ppmw]) diesel will be used in fleet vehicles.
- Site road topping surfaces will be regularly maintained for operational efficiencies and to minimize fuel consumption.
- Energy conservation initiatives such as maintaining site road topping surfaces for energy efficiency will be undertaken.

Specifically with respect to dust control, the largest emissions are transport related. Dominion Diamond will manage dust and particulate emissions by continuing and evolving the following management practices:

- water spray and chemical suppressant application to control dust emissions on haul roads during summer or non-frozen season; and,
- managing vehicle speed to limit road dust from vehicle wheel entrainment.

Dominion Diamond plans to incorporate the results of its ambient air quality monitoring program into its environmental management plans as part of its response to the principle of continuous improvement.

7.4 Residual Effects Analysis

7.4.1 General Approach

7.4.1.1 *Project Phases*

The Project includes three phases:

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

The direct effects of the air emissions from the Project are only present when the Project activities result in air emissions. As soon as the activities resulting in air emissions cease, the direct effects to air quality will also cease.

The effects to air quality are expected to be highest when the Project emissions are at the highest. For the Project, this will occur during the operation phase. Therefore, the air quality effect assessment focused on a specific period in the Project timeline, a year with the maximum Project emissions.

7.4.1.2 *Assessment Cases*

The effects assessment consists of three cases: Base Case, Application Case, and the Reasonably Foreseeable Development (RFD) Case. A fourth case, Construction Case, was also assessed as per the requirements in the TOR.

Cumulative effects could occur in all four 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.

Base Case represents a range of conditions over time within the effects assessment (study) area (ESA) before application of the Project. 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 (2015 baseline) conditions include the cumulative effects from all previous and existing developments and activities that are planned and approved (e.g., Lynx Project). The expanded WRSA for the crusher is included in the 2015 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.

Construction Case represents predictions of the cumulative effects of the developments in the Base Case combined with the effects from the Project's construction activities. Because the construction phase is expected to last up to three years, the effects of the Construction Case are expected to be temporary relative to the effects of the Application Case. Construction Case in the air quality assessment is based on Base Case emission profile (Year 2015) plus the maximum emission profile for the Project's construction activities.

Application Case represents predictions of the cumulative effects of the developments in the Base Case combined with the effects from the Project. This case also was used to identify the incremental changes from the Project that are predicted to occur between the Base and Application cases. The Application Case in the air quality assessment is based on the Base Case emission profile but with the emissions associated with mining activates at Base Case Ekati Mine replaced by the emissions associated with the Project's mining activities.

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/or,
- have the potential to change the Project or the effects predictions.

No reasonably foreseeable developments in the region are located in the LSA, or are likely to have any impact on the air quality of the Project. Therefore, the RFD Case is excluded from the air quality assessment.

7.4.1.3 *Selected Air Contaminants*

A thorough review was conducted of emissions associated with mines in the NWT, including the existing Ekati Diamond Mine (BHP 1995) and Diavik Diamond Mine (DDMI 1998, 2012). Relevant air quality guidelines were also reviewed, including the NWT AAQS (GNWT-ENR 2014), the CWS (CCME 2000), the NAAQO (Environment Canada 1981), and the CAAQS (CCME 2012b). A list of substances was developed from these reviews. They included SO_2, NO_2, CO, particulate matter, volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), trace metals, dioxins and furans, and deposited potential acid input (PAI) and nitrogen.

The air quality assessment encompassed modelling of the following types of Project and regional emission sources:

- exhaust from stationary combustion sources (power generators, boilers, heaters, and waste incinerators);
- diesel engine exhaust from mobile mine equipment (excavators, loaders, graders, haul trucks, and dozers);

- fugitive dust from mining activities (i.e., blasting, drilling, loading/unloading, and dozing), haul road grading and on-site vehicle traffic and ore processing;
- wind-blown lake-bed dust from dewatered Lac du Sauvage area; and,
- diesel engine exhaust from vehicle traffic on and the Tibbitt to Contwoyto Winter Road.

Stationary and mobile combustion exhaust is the primary source of SO_2 and NO_X emissions from the Project. Particulate matter emissions are associated with mining activities, which generate fugitive particulate matter emissions. The PAH and VOC emissions are predominantly from combustion exhausts, and metal emissions are associated with all sources (combustion and fugitive particulate matter [PM]) but in varying degrees. Details of these emission sources and substance emission rates are included in Air Emission Results, Appendix 7B.

7.4.1.4 *Dispersion Modelling*

The modelling approach used for the Project is generally consistent with the approaches used for the recent assessment of the De Beers Gahcho Kué Project (De Beers 2010, 2012) in the NWT. The Gahcho Kué assessments used an earlier version of the CALPUFF and CALMET models.

The Project modelling approach includes the following key aspects:

- The assessment utilized a CALPUFF dispersion model (version 6.42).
- One year of meteorological data were used in the dispersion modelling. The meteorological dataset was developed from the 2002 MM5 data provided by Environment Canada and further processed using CALMET in no observation mode.
- For the purpose of evaluating dry deposition, non-uniform land use types were assumed in the study area. Model results were obtained for foliage (June 1 to September 30, 2002) and non-foliage (January 1 to May 31, 2002 and October 1 to December 31, 2002) periods. Primary cover types included lakes, barrenland, and tundra. Other surface parameters were made functions of the ground cover. Details are provided in Appendix 7C.
- NO_X to NO_2 conversion was based on Ozone Limited Method as described in Appendix 7C.
- The background PAI was based on wet deposition data collect by Environment Canada at Snare Rapids, NWT, and dry deposition data derived from Regional Lagrangian Acid Deposition Model (RELAD) modelling runs conducted by Alberta Environment (NAtChem 2003, 2004, 2005, 2006, 2007; Cheng et al. 1997, 1995; Cheng and Angle 1996, 1993). A single PAI value of 0.064 kiloequivalent per hectare per year (keq/ha/yr) was applied throughout the RSA.

Model results are presented inside and outside the development area for the existing Ekati Mine and Diavik Mine and the Project. Further details of the modelling approach are provided in Appendix 7C.

DOMINION DIAMOND

7.4.1.5 *Receptors*

Ground-level concentrations and deposition rates were modelled at selected locations within the modelling domain. In the absence of NWT-specific air quality modelling guidelines, the receptor locations were primarily based in general accordance with the Alberta Air Quality Model Guideline (ESRD 2013). The receptor placements are as follows:

- spacing of 50 metres (m) within 1 km of the sources of interest;
- spacing of 250 m within 2 km of the sources of interest;
- spacing of 500 m within 5 km of the sources of interest;
- spacing of 1,000 m between 5 and 10 km from the sources of interest;
- spacing of 5 km beyond 10 km from the sources of interest; and,
- spacing of 100 m along the Project footprint boundary and at 100 m and 200 m outside of the Project footprint boundary.

Maximum air quality concentrations were also predicted at discrete receptor locations near the Project. These discrete receptors can be nominally categorized as health receptors, station receptors, and lake receptors. They are presented in Table 7-4.1 and graphically shown in Appendix 7C, Map 7C5-3.

A total of 10 health receptor locations were assessed. The list includes five recreational areas and cabins; the camp locations for Ekati Mine, Misery Pit, and Diavik Mine; the winter road rest stop nearest to the Project; and the traditional knowledge camp near Diavik Mine.

Air quality and meteorological stations located at the Ekati Mine and Project were also included as station receptors, because data from these stations were utilized for the Air Quality and Meteorological Baseline Report (Annex I) and for the air dispersion model. Six air quality stations and three meteorological stations were included.

Discrete lake receptors were included to predict potential air concentrations and deposition rates at specific lakes within the RSA. The predictions from these receptors are utilized in the water quality models (Section 8). A total of 101 lake receptors were assessed.

Table 7.4-1 Select Receptors Included in the Air Quality Assessment

Receptor	Receptor Type	Coordinates[a]	
		Northing (m)	Easting (m)
Courageous Lake Lodge	Health Receptor	477,486	7,114,030
Diavik Camp	Health Receptor	534,285	7,150,820
Diavik Traditional Knowledge Camp	Health Receptor	541,143	7,152,262
Ekati Camp/Administration	Health Receptor	518,138	7,176,305
Lac de Gras Winter Road Rest Stop	Health Receptor	542,862	7,144,018
Lac de Gras Hunting Camp	Health Receptor	549,002	7,157,167

Table 7.4-1 Select Receptors Included in the Air Quality Assessment

Receptor	Receptor Type	Coordinates[a]	
		Northing (m)	Easting (m)
Misery Camp	Health Receptor	539,804	7,161,108
Pellatt Lake Cabin	Health Receptor	560,000	7,211,000
Salmita Airstrip	Health Receptor	492,136	7,105,248
Treeline Lodge	Health Receptor	488,113	7,105,679
13DDJPA	Air Quality Station	543,253	7,165,551
13DDJPB	Air Quality Station	541,267	7,166,089
CAMS Polar Explosives	Air Quality Station	516,438	7,176,428
TSP1	Air Quality Station	518,101	7,176,292
TSP2	Air Quality Station	521,031	7,177,782
TSP3	Air Quality Station	515,812	7,178,835
Ekati Airport Station	Meteorological Station	518,573	7,175,862
Koala Station	Meteorological Station	518,743	7,173,772
Polar Lake Station	Meteorological Station	520,796	7,178,714
AA-1	Lake Receptor	552,282	7,165,025
AA-2	Lake Receptor	552,773	7,165,665
AB-1	Lake Receptor	547,766	7,162,266
AB-2	Lake Receptor	548,215	7,161,177
AC-1	Lake Receptor	543,339	7,165,138
AC-2	Lake Receptor	545,832	7,165,447
AC-4	Lake Receptor	543,695	7,162,938
AC-5	Lake Receptor	543,149	7,163,287
AC-7	Lake Receptor	544,247	7,165,068
AC-8	Lake Receptor	544,777	7,165,855
AD-1	Lake Receptor	539,898	7,168,781
AD-2	Lake Receptor	539,868	7,168,991
AE-1	Lake Receptor	542,494	7,170,252
AE-2	Lake Receptor	542,589	7,170,675
AF-1	Lake Receptor	542,155	7,173,731
AF-10	Lake Receptor	538,299	7,176,361
AF-2	Lake Receptor	542,074	7,173,542
AF-4	Lake Receptor	544,360	7,173,181
AF-7	Lake Receptor	541,367	7,174,902
CL-1	Lake Receptor	539,465	7,163,731
C-L1	Lake Receptor	537,612	7,167,085
Counts	Lake Receptor	533,815	7,169,863
Cujo	Lake Receptor	538,730	7,162,008
D-L3	Lake Receptor	534,303	7,169,862
E-L1-1	Lake Receptor	535,065	7,174,657
E-L1-2	Lake Receptor	535,292	7,174,406

Table 7.4-1 Select Receptors Included in the Air Quality Assessment

Receptor	Receptor Type	Coordinates[a]	
		Northing (m)	Easting (m)
F1	Lake Receptor	537,042	7,157,119
FF1-1	Lake Receptor	525,430	7,161,043
FF1-2	Lake Receptor	524,932	7,159,476
FF1-3	Lake Receptor	526,407	7,160,492
FF1-4	Lake Receptor	526,493	7,159,058
FF1-5	Lake Receptor	526,683	7,161,824
FF2-2	Lake Receptor	541,588	7,158,561
FF2-5	Lake Receptor	544,724	7,158,879
FFA-1	Lake Receptor	506,453	7,154,021
FFA-2	Lake Receptor	506,315	7,155,271
FFA-3	Lake Receptor	505,207	7,153,887
FFA-4	Lake Receptor	503,703	7,154,081
FFA-5	Lake Receptor	505,216	7,156,657
FFB-1	Lake Receptor	516,831	7,148,207
FFB-2	Lake Receptor	518,473	7,150,712
FFB-3	Lake Receptor	518,048	7,147,557
FFB-4	Lake Receptor	515,687	7,150,036
FFB-5	Lake Receptor	516,533	7,150,032
Fisher	Lake Receptor	536,271	7,158,344
G-L2	Lake Receptor	546,706	7,174,698
Grizzly	Lake Receptor	521,305	7,177,725
H-L1	Lake Receptor	552,899	7,169,950
Kodiak	Lake Receptor	518,328	7,175,525
LDG-48	Lake Receptor	490,900	7,161,750
LdS1	Lake Receptor	541,620	7,164,525
LdS1	Lake Receptor	541,789	7,164,516
LDS-1	Lake Receptor	546,398	7,161,179
LdS10	Lake Receptor	544,254	7,166,873
LdS11	Lake Receptor	543,451	7,164,236
LdS2	Lake Receptor	541,241	7,164,233
LdS2	Lake Receptor	541,211	7,164,250
LDS-2	Lake Receptor	546,807	7,160,027
LdS3	Lake Receptor	542,070	7,165,905
LDS-3	Lake Receptor	547,191	7,160,256
LdS4	Lake Receptor	541,535	7,165,807
LdS5	Lake Receptor	542,789	7,165,666
LdS6	Lake Receptor	541,563	7,166,957
LdS7	Lake Receptor	543,465	7,165,961
LdS8	Lake Receptor	543,085	7,164,811

DOMINION DIAMOND

Table 7.4-1 Select Receptors Included in the Air Quality Assessment

Receptor	Receptor Type	Coordinates[a]	
		Northing (m)	Easting (m)
LdS9	Lake Receptor	541,436	7,167,616
Leslie	Lake Receptor	515,984	7,173,296
Lynx	Lake Receptor	537,336	7,158,230
MF1-1	Lake Receptor	535,008	7,154,699
MF1-3	Lake Receptor	532,236	7,156,276
MF1-5	Lake Receptor	528,432	7,157,066
MF2-1	Lake Receptor	538,033	7,154,371
MF2-3	Lake Receptor	540,365	7,156,045
MF3-1	Lake Receptor	537,645	7,152,432
MF3-2	Lake Receptor	536,816	7,151,126
MF3-3	Lake Receptor	536,094	7,148,215
MF3-4	Lake Receptor	532,545	7,147,011
MF3-5	Lake Receptor	528,956	7,146,972
MF3-6	Lake Receptor	525,427	7,148,765
MF3-7	Lake Receptor	521,859	7,150,039
Moose	Lake Receptor	516,642	7,172,796
Nanuq	Lake Receptor	534,194	7,199,310
Nema	Lake Receptor	513,580	7,171,127
NF1	Lake Receptor	535,740	7,153,854
NF2	Lake Receptor	536,095	7,153,784
NF3	Lake Receptor	536,369	7,154,092
NF4	Lake Receptor	536,512	7,154,240
NF5	Lake Receptor	536,600	7,153,864
Phantom	Lake Receptor	537,741	7,159,089
PL-05	Lake Receptor	525,859	7,171,047
PL-1	Lake Receptor	533,179	7,173,835
PL-2	Lake Receptor	531,655	7,174,122
PL-3	Lake Receptor	528,681	7,172,550
PL-4	Lake Receptor	527,145	7,171,895
S2	Lake Receptor	507,635	7,164,482
S3	Lake Receptor	505,898	7,164,448
Slipper	Lake Receptor	507,106	7,165,281
UL1	Lake Receptor	524,766	7,190,484
UL2	Lake Receptor	525,264	7,189,286
UL3	Lake Receptor	525,355	7,188,141
Vulture	Lake Receptor	521,183	7,180,886

a) Coordinates are in Universal Transverse Mercator (UTM) North American Datum (NAD) 83, Zone 12.
CAMS = continuous air monitoring station; m = metre.

7.4.1.6 *Approach for Nitrogen Dioxide Conversion*

Nitrogen oxides are composed of nitric oxide (NO) and NO_2. High-temperature combustion processes primarily produce NO that in turn can be converted to NO_2 in the atmosphere through reactions with tropospheric ozone:

$$NO + O_3 \rightarrow NO_2 + O_2$$

The CALPUFF dispersion model uses a modified version of the RIVAD/ARM3 SO_X and NO_X chemistry scheme that was adopted to allow NO_2 concentrations to be calculated from NO emissions within the model. However, the CALPUFF model chemistry scheme has been shown to overestimate ambient NO_2 concentrations, especially close to large area emission sources such as mine pits (Staniaszek and Davies 2006).

For that reason, the NO_X ground-level concentrations obtained from the modelling were converted to NO_2 ground-level concentrations using the Ozone Limited Method according to the Alberta Air Quality Model Guideline (ESRD 2013). The Ozone Limited Method assumes that the conversion of NO to NO_2 in the atmosphere is limited by the ambient ozone concentration in the atmosphere. If the ozone concentration is greater than 90% of the modelled NO_X ground-level concentration, the method assumes all NO_X is converted to NO_2. Otherwise, the NO_2 concentration is equal to the sum of the ozone available to oxidize NO_X and 10% of the modelled NO_X ground-level concentration:

$$NO_2 = O_3 + 0.1 \times NO_X$$

Hourly values for O_3 concentrations were developed for each month to be used in the conversion of NO_2 in the dispersion model. These values were determined from O_3 monitoring data collected at the Snare Rapids air quality monitoring station between 2010 through 2012 (Stevens 2014). Refer to Appendix 7C, Table 7C5-3 for a table of hourly concentrations of ozone used.

7.4.1.7 *Approach for Acid Deposition*

Acidifying emissions include oxides of sulphur and nitrogen, and ammonia and are modelled with the CALPUFF model. Deposition of acidifying emissions can occur via wet and dry processes. Wet deposition processes remove these atmospheric emissions by precipitation. Dry processes remove emissions by direct contact with surface features (e.g., vegetation, soils, and surface water).

Wet and dry depositions are expressed as a flux in units of kilograms per hectare per year (kg/ha/y). Where more than one chemical species is considered, the flux is often expressed in terms of keq/ha/yr where "keq" refers to hydrogen ion equivalents (1 kiloequivalent [keq] = 1 kilomole [kmol] hydrogen ions [H^+]), the common acidic ion associated with various negatively charged ions.

Potential acid input is used as a deposition measure of acidification and is defined as follows:

$$PAI = PAI_{sulphur} + PAI_{nitrogen} + PAI_{background}$$

Where:

$PAI_{sulphur}$ is the model predicted PAI contributed by sulphur compounds;

$PAI_{nitrogen}$ is the model predicted PAI contributed by nitrogen compounds; and,

$PAI_{background}$ is the background PAI.

Further details on the PAI calculations are provided in Appendix 7C.

7.4.1.8 *Approach for Nitrogen Deposition*

Deposition of nitrogen includes both wet (removal in precipitation) and dry (direct contact with surface features) processes. In the current approach, nitrate particulate is determined to be deposited by both wet and dry processes and is directly calculated by the dispersion model based on modelled annual average concentrations and an assumed deposition velocity.

The deposited nitrogen (expressed as a mass flux of nitrogen mass equivalent species) is scaled by the molecular weights of the deposited species as follows:

$$\begin{aligned} &Nitrogen\ Deposition \\ &= \frac{NO_{dry} \times 14}{30} + \frac{NO_{2,dry} \times 14}{46} + \frac{\left(NO_{3,dry}^{-} + NO_{3,wet}^{-}\right) \times 14}{62} + \frac{\left(HNO_{3,dry} + HNO_{3,wet}\right) \times 14}{63} \end{aligned}$$

Using this approach, nitrate deposition is accounted for in acidification and eutrophication calculations.

7.4.2 Effects on Air Quality

7.4.2.1 *Emissions*

The air quality modelling assessment included the following three emission scenarios:

- Base Case, which includes projected emissions from the Ekati Mine in 2015, the last year before Project construction activities begin, and the Diavik Mine emissions.
- Application Case, which includes the emissions from the Ekati Mine and Diavik Mine in combination with the maximum Project emissions during the operations phase of the Project. The mining of the Jay Pit will utilize the existing infrastructure at the Ekati Mine and will extend the life of the Ekati Mine by 10 or more years.
- Construction Case, which includes the emissions from the Ekati Mine and Diavik Mine in combination with the maximum Project emissions during the construction phase of the Project.

Criteria Air Contaminants (CAC) include sulphur dioxide gas (SO_2), nitrogen oxides (NO_X), carbon dioxide (CO), particulate matter with particle diameter less than 2.5 microns (µm; $PM_{2.5}$), particulate matter with particle diameter less than 10 µm (PM_{10}), and total suspended particles (TSP). Non-CAC emissions include VOCs, PAHs, trace metals, and dioxin and furan emissions.

The current Ekati Mine and Jay Project layout can be seen in Map 7.4-1. Emission source locations for the Base Case, Application Case, and Construction Case are presented in Maps 7.4-2 to 7.4-4.

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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

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

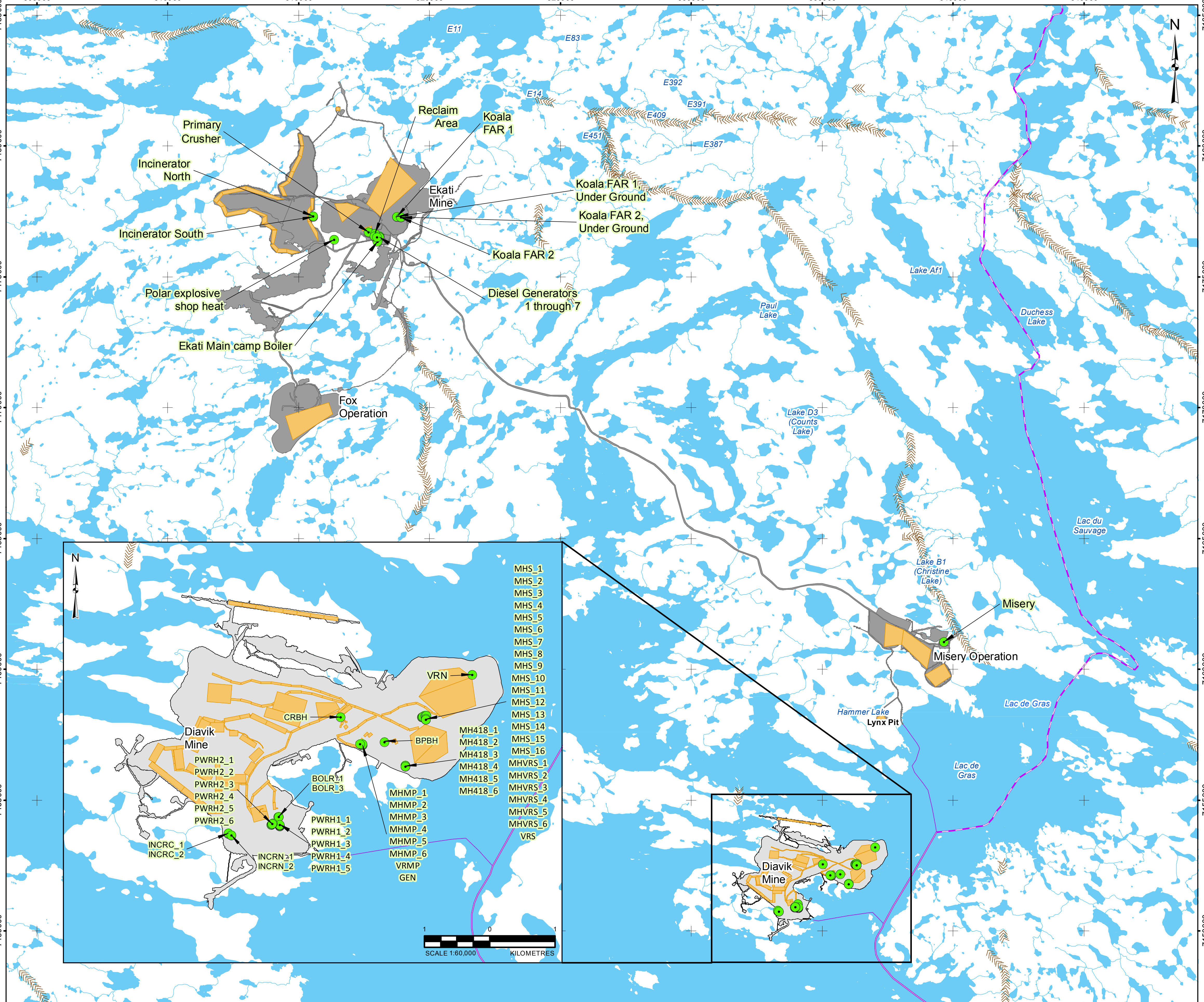
3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
EKATI MINE AND JAY PROJECT LAYOUT

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_021_GIS
DESIGN	SM	12/08/14	SCALE AS SHOWN REV 0
GIS	SM/JR	25/09/14	MAP 7.4-1
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- ESKER

EMISSION LOCATIONS

- EMISSION POINT SOURCE
- EMISSION AREA SOURCE

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
LIDAR AND BATHYMETRIC DATA OBTAINED FROM AURORA, 2013
WATER OBTAINED FROM CANVEC © NATURAL RESOURCES CANADA, 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

BASE CASE EMISSION SOURCE LOCATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_013_BL_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 0
GIS	SBM/JR	14/10/14		
CHECK	ACP	16/10/14	MAP 7.4-2	
REVIEW	CDM	16/10/14		

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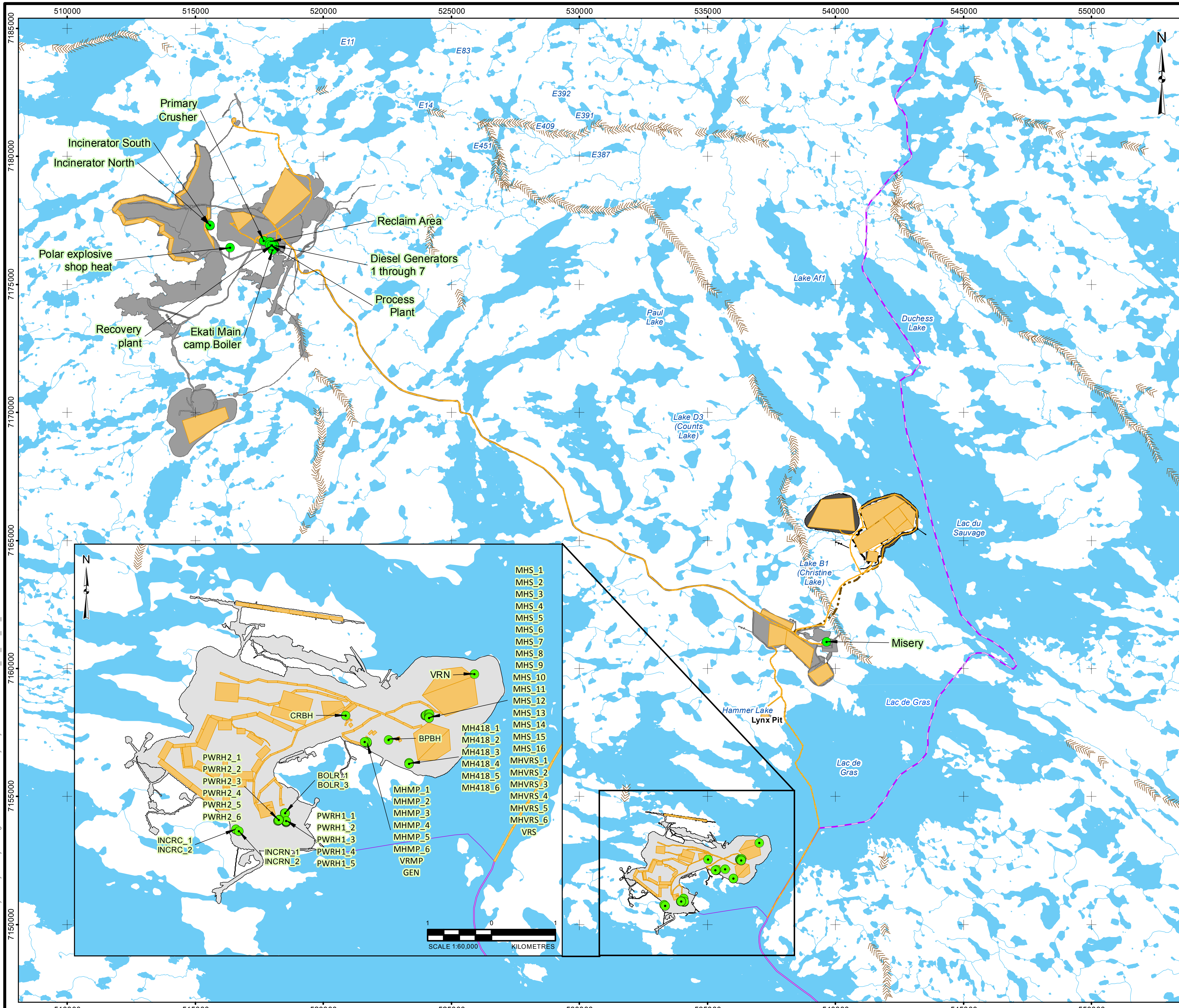


LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- ESKER

JAY PROJECT FOOTPRINT

- EXISTING SHORELINE OF DEWATERED AREA
- POWER LINE
- PROPOSED JAY PROJECT INFRASTRUCTURE

MODELED EMISSION LOCATIONS

- EMISSION POINT SOURCE
- EMISSION AREA SOURCE

NOTES

ROAD, PIPELINES, AND POWER LINE ARRANGEMENT TO BE DETAILED AS PART OF FURTHER PRE-FEASIBILITY DESIGN. APPROXIMATE CORRIDOR WIDTHS ARE SHOWN.

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
JAY PROJECT DESIGN BASIS MEMORANDUM FOR PRE-FEASIBILITY DESIGN OF PROJECT ROADS AND PIPELINE BENCHES, DOC#: 1313280041-E14031-TM-REVD-2020, DATED: AUGUST 1, 2014
LIDAR AND BATHYMETRIC DATA OBTAINED FROM AURORA, 2013
WATER OBTAINED FROM CANVEC © NATURAL RESOURCES CANADA, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

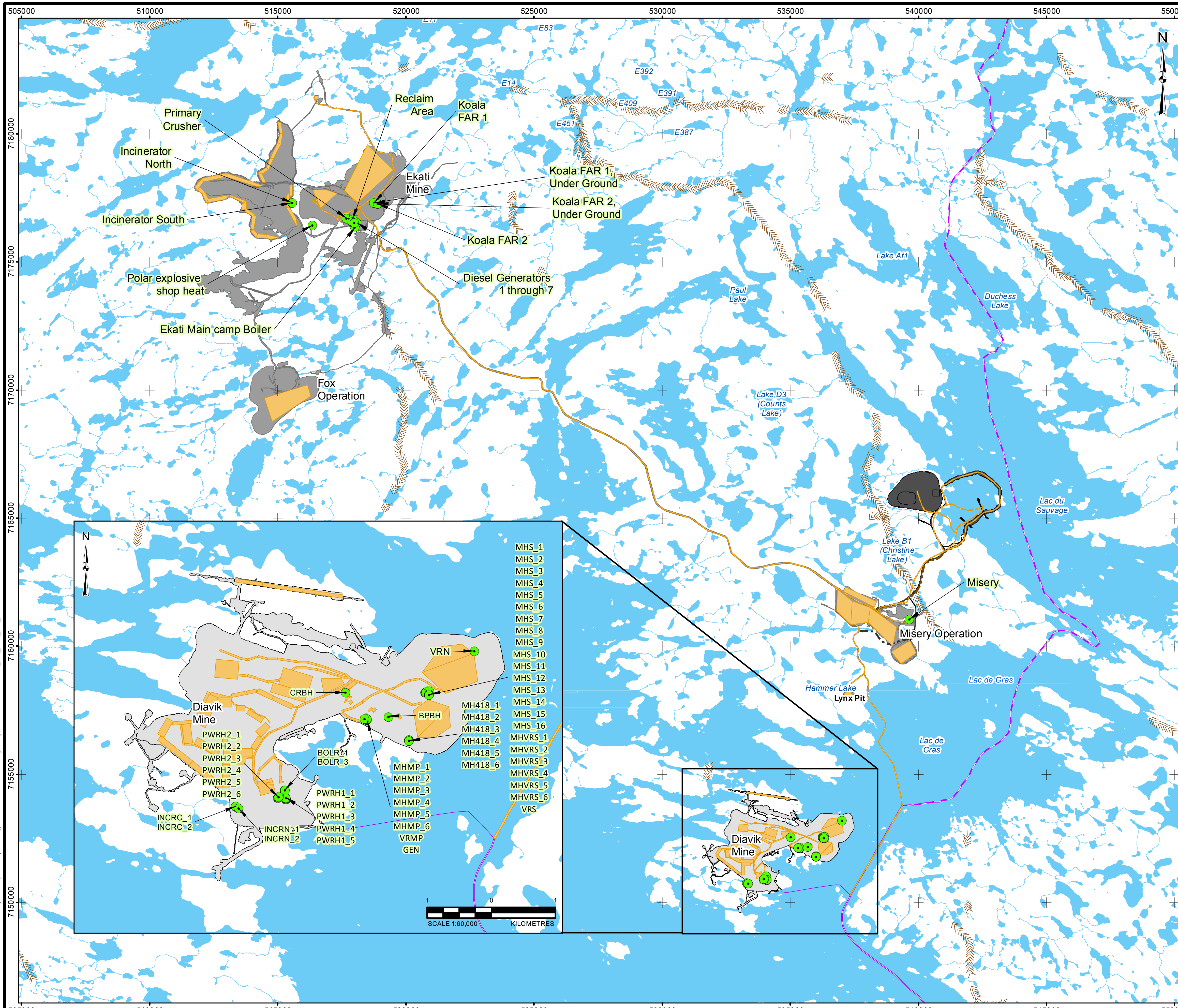
3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
APPLICATION CASE EMISSION SOURCE LOCATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_014_AP_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 1
GIS	SBM/JR	30/09/14	MAP 7.4-3	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		



LEGEND

EKATI MINE FOOTPRINT
DIAVIK MINE FOOTPRINT
WINTER ROAD
TIBBITT TO CONTWOYTO WINTER ROAD
NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
WATERCOURSE
WATERBODY
ESKER

JAY PROJECT FOOTPRINT

POWER LINE
PROPOSED JAY CONSTRUCTION INFRASTRUCTURE

EMISSION LOCATIONS

EMISSION POINT SOURCE
EMISSION AREA SOURCE

NOTES

ROAD, PIPELINES, AND POWER LINE ARRANGEMENT TO BE DETAILED AS PART OF PRE-FEASIBILITY DESIGN. APPROXIMATE CORRIDOR WIDTHS ARE SHOWN. POTENTIAL QUARRY MAY BE REQUIRED WITHIN THE FOOTPRINT OF THE PROPOSED JAY WASTE ROCK STORAGE AREA

REFERENCE

JAY PROJECT CONCEPTUAL ENGINEERING REPORT, EKATI MINE, DOC#: 1313280041-E14037-R-REV0-4060, DATED: MAY 13, 2014
JAY PROJECT DESIGN BASIS MEMORANDUM FOR PRE-FEASIBILITY DESIGN OF PROJECT ROADS AND PIPELINE BENCHES, DOC#: 1313280041-E14031-TM-REVD-2020, DATED: AUGUST 1, 2014
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DEVELOPER'S ASSESSMENT REPORT

3 0 3
SCALE 1:150,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

CONSTRUCTION CASE EMISSION SOURCE LOCATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_015_CS_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 0
GIS	SBM/JR	30/09/14	MAP 7.4-4	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Air\DAR\DAR_Air_015_CS_GIS.mxd

The Ekati Mine emissions in the Base Case represent the emissions associated with the mining activities projected in 2015, the last year before the construction of the Jay Project will begin. In 2015, there will be mining activities at the Misery Pit, Pigeon Pit, Lynx Pit, and Koala Underground Mine. Other sources of emissions include the following:

- stack emissions from power generators, diesel boilers and heaters, waste incinerators, and the fresh air raises;
- mine fleet exhaust emissions from the mobile and portable diesel combustion equipment at the Ekati Mine;
- fugitive particulate emissions from all mining and material handling activities that result in fugitive dust emissions;
- road dust emissions caused by vehicle travel on roads;
- wind erosion from the transportation and deposition of particulate matter including metals by the wind; and,
- vehicle emissions related to vehicle travel on the Tibbitt to Contwoyto Winter Road.

The Base Case CAC emissions are summarized in Table 7.4-2. The Base Case non-CAC emissions are summarized in Table 7.4-3. Details on the Base Case emissions are provided in Appendix 7B, Section 7B3.2.

Table 7.4-2 Base Case Ekati Mine Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Power Generators	1.442	2,972.7	789.6	51.6	53.2	64.7
Boilers/Heaters	0.264	24.8	6.2	1.9	2.9	4.1
Waste Incinerators	0.529	0.5	1.6	1.1	1.1	1.1
Mine Fleet Exhaust	0.661	586.7	345.5	44.5	45.4	42.9
Drilling and Blasting	0.002	0.0	0.1	0.1	1.0	1.5
Loading and Unloading	—	—	—	2.8	18.0	33.6
Bulldozing	—	—	—	6.2	75.4	239.9
Grading	—	—	—	5.9	9.9	20.2
Crushing, Screening, Conveying	—	—	—	5.2	29.2	65.3
Road Dust	—	—	—	94.2	923.4	2,888.8
Wind Erosion	—	—	—	0.0	0.1	0.2
Exposed Lakebed	—	—	—	—	—	—
Winter Roads	0.002	0.9	0.4	0.0	0.0	0.0
Total	**2.900**	**3,585.6**	**1,143.4**	**213.5**	**1,159.6**	**3,362.3**

Note: The emission rates presented in the above table have been rounded. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; PM_{10} = particulate matter of mean aerodynamic diameter less than 10 microns; TSP = total suspended particulate; — = no emissions.

Table 7.4-3 Base Case Ekati Mine Non-Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans
Power Generators	76.1	0.197	0.2	—
Boilers/Heaters	0.2	0.001	0.0	—
Waste Incinerators	0.5	0.000	0.0	2.31×10^{-8}
Mine Fleet Exhaust	58.2	0.116	0.2	—
Drilling and Blasting	—	—	0.1	—
Loading and Unloading	—	—	2.5	—
Bulldozing	—	—	19.6	—
Grading	—	—	1.7	—
Crushing, Screening, Conveying	—	—	2.3	—
Road Dust	—	—	236.1	—
Wind Erosion	—	—	0.0	—
Exposed Lakebed	—	—	—	—
Winter Roads	0.1	—	0.0	—
Total	**135.1**	**0.314**	**262.7**	**2.31×10^{-8}**

Note: The emission rates presented in the above table have been rounded. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons; — = no emissions.

In the Application Case, the mining emissions associated with the Base Case were replaced with the maximum mine emissions for the Jay Pit operations. The emissions associated with the Ekati plant and utility operation in the Application Case were assumed to remain unchanged from those in the Base Case excluding the heating of the Koala underground mine which will no longer be in operation. The Application Case includes emissions from the exposed lake bed resulting from the dewatering of part of Lac du Sauvage. Application Case emissions are summarized in Tables 7.4-4 and 7.4-5. Details on the Application Case emissions are provided in Appendix 7B, Section 7B3.3.

Table 7.4-4 Application Case Ekati Mine and Jay Project Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Power Generators	1.442	2,972.7	789.6	51.6	53.2	64.7
Boilers/Heaters	0.081	7.6	1.9	0.6	0.9	1.3
Waste Incinerators	0.529	0.5	1.6	1.1	1.1	1.1
Mine Fleet Exhaust	2.189	1,725.5	1,029.3	131.3	132.8	118.4
Drilling and Blasting	0.003	0.0	0.1	0.2	1.7	2.4
Loading and Unloading	—	—	—	3.8	24.8	46.3
Bulldozing	—	—	—	9.3	114.1	363.8
Grading	—	—	—	5.9	9.9	20.2
Crushing, Screening, Conveying	—	—	—	5.2	29.2	65.3

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Table 7.4-4 Application Case Ekati Mine and Jay Project Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Road Dust	—	—	—	117.0	1,142.0	3,475.3
Wind Erosion	—	—	—	0.0	0.2	0.4
Exposed Lakebed	—	—	—	0.0	0.1	0.2
Winter Roads	0.002	0.9	0.4	0.0	0.0	0.0
Total	**4.246**	**4,707.2**	**1,822.9**	**326.0**	**1,510.0**	**4,159.4**

Note: The emission rates presented in the above table have been rounded to three decimal places. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; PM_{10} = particulate matter of mean aerodynamic diameter less than 10 microns; TSP = total suspended particulate; — = no emissions.

Table 7.4-5 Application Case Ekati Mine and Project Non-Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans
Power Generators	76.1	0.197	0.2	
Boilers/Heaters	0.1	0.000	0.0	—
Waste Incinerators	0.5	0.000	0.0	$2.31{\times}10^{-8}$
Mine Fleet Exhaust	170.5	0.383	0.4	—
Drilling and Blasting	—	—	0.2	—
Loading and Unloading	—	—	3.4	—
Bulldozing	—	—	29.7	—
Grading	—	—	1.7	—
Crushing, Screening, Conveying	—	—	2.3	—
Road Dust	—	—	284.0	—
Wind Erosion	—	—	0.0	—
Exposed Lakebed	—	—	0.0	—
Winter Roads	0.1	—	0.0	—
Total	**247.2**	**0.581**	**321.9**	$\mathbf{2.31{\times}10^{-8}}$

Note: The emission rates presented in the above table have been rounded to three decimal places. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons; — = no emissions.

The construction of the Project will occur over a period of three years, starting in 2016 and ending in 2019. The construction period will include installation of the Project infrastructure and dewatering part of Lac du Sauvage before production mining can begin. After the water has been drained, pre-stripping of the Jay Pit and initial mining will begin.

Sources of emissions during the construction phase of the Project will be similar to emission sources of the Base Case. New sources will include an emissions associated with the dike construction and an aggregate crushing plant, assumed to be located at the Misery Pit. The construction phase emissions are summarized in Tables 7.4-6 and 7.4-7. Details on the construction emissions are provided in Appendix 7B, Section 7B3.4.

Table 7.4-6 Construction Case Ekati Mine and Jay Project Criteria Air Contaminants Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Power Generators	1.442	2,972.7	789.6	51.7	53.2	64.7
Boilers/Heaters	0.264	24.8	6.20	1.9	2.9	4.1
Waste Incinerators	0.529	0.5	1.642	1.1	1.1	1.1
Mine Fleet Exhaust	0.775	647.2	369.43	48.1	49.1	46.6
Drilling and Blasting	0.002	0.0	0.1	0.1	1.0	1.5
Loading and Unloading	—	—	—	17.4	197.9	49.1
Bulldozing	—	—	—	20.1	250.8	872.9
Grading	—	—	—	5.9	9.9	20.2
Crushing, Screening, Conveying	—	—	—	8.0	32.0	71.5
Road Dust	—	—	—	193.2	1,912.8	5,311.4
Wind Erosion	—	—	—	0.0	0.1	0.2
Winter Roads	0.002	0.9	0.4	0.0	0.0	0.0
Total	**3.014**	**3,646.1**	**1,167.4**	**347.5**	**2,510.7**	**6,443.4**

Note: The emission rates presented in the above table have been rounded to three decimal places. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; PM_{10} = particulate matter of mean aerodynamic diameter less than 10 microns; TSP = total suspended particulate; — = no emissions.

Table 7.4-7 Construction Case Ekati Mine and Jay Project Non-Criteria Air Contaminants Emissions

Source Type	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans
Power Generators	76.1	0.197	0.2	—
Boilers/Heaters	0.2	0.001	0.0	—
Waste Incinerators	0.5	0.000	0.0	2.31×10^{-8}
Mine Fleet Exhaust	62.0	0.138	0.2	—
Drilling and Blasting	—	—	0.1	—
Loading and Unloading	—	—	3.6	—
Bulldozing	—	—	71.3	—
Grading	—	—	1.7	—
Crushing, Screening, Conveying	—	—	2.9	—

Table 7.4-7 Construction Case Ekati Mine and Jay Project Non-Criteria Air Contaminants Emissions

Source Type	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans
Road Dust	—	—	243.8	—
Wind Erosion	—	—	0.0	—
Winter Roads	0.1	—	0.0	—
Total	**138.9**	**0.337**	**323.9**	**2.31×10^{-8}**

Note: The emission rates presented in the above table have been rounded to three decimal places. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons; — = no emissions.

The annual emission rates from the proposed Project, the existing Ekati Mine operations, the construction phase of the Project, and the nearby Diavik Mine are summarized in Tables 7.4-8 and 7.4-9. Because the Project is an extension of the Ekati Mine, which also will alter the Ekati Mine emissions in the future, the Project emissions are presented as "Change Due to Project" in Tables 7.4-8 and 7.4-9.

Table 7.4-8 Summary of Project and Regional Annual Criteria Air Contaminants Emission Rates

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Base Case						
Ekati Mine	2.900	3,585.6	1,143.4	213.8	1,159.7	3,362.5
Diavik Mine	8.596	6,683.0	2,042.4	346.6	447.9	729.8
Total	**11.496**	**10,268.6**	**3,185.8**	**560.4**	**1607.6**	**4092.3**
Application Case						
Change Due to Project	1.346	1,121.6	679.6	112.4	350.3	796.8
Ekati Mine	2.900	3,585.6	1,143.4	213.8	1,159.7	3,362.5
Diavik Mine	8.596	6,683.0	2,042.4	346.6	447.9	729.8
Total	**12.842**	**11,390.2**	**3,865.4**	**672.8**	**1,957.9**	**4,889.1**
Construction Case						
Ekati Mine and Jay Project – Construction	3.014	3,646.1	1,167.4	347.5	2,510.7	6,443.4
Diavik Mine	8.596	6,683.0	2,042.4	346.6	447.9	729.8
Total	**11.61**	**10,329.1**	**3,209.8**	**694.1**	**2,958.6**	**7,173.2**

Note: The emission rates presented in the above table have been rounded. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; PM_{10} = particulate matter of mean aerodynamic diameter less than 10 microns; TSP = total suspended particulate.

Table 7.4-9 Summary of Project and Regional Annual Non-Criteria Air Contaminants Emission Rates

Source	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans
Base Case				
Ekati Mine	135.1	0.314	262.8	$2.31{\times}10^{-8}$
Diavik Mine	434.7	19.417	223.9	$2.31{\times}10^{-8}$
Total	**569.8**	**19.731**	**486.7**	$\mathbf{4.62{\times}10^{-8}}$
Application Case				
Change Due to Project	112.1	0.266	59.2	0
Ekati Mine	135.1	0.314	262.8	$2.31{\times}10^{-8}$
Diavik Mine	434.7	19.417	223.9	$2.31{\times}10^{-8}$
Total	**681.9**	**19.997**	**545.9**	$\mathbf{4.62{\times}10^{-8}}$
Construction Case				
Ekati Mine and Jay Project – Construction	138.9	0.337	323.9	$2.31{\times}10^{-8}$
Diavik Mine	434.7	19.417	223.9	$2.31{\times}10^{-8}$
Total	**573.6**	**19.754**	**547.8**	$\mathbf{4.62{\times}10^{-8}}$

Note: The emission rates presented in the above table have been rounded. Therefore, the totals may not appear to be sum of individual values.

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons.

7.4.2.1.1 Greenhouse Gas Emission Estimations

The dominant source of greenhouse gas emissions from the Ekati Mine and the Project is the exhaust from the diesel-fired power generators. The second substantial contributor to the total greenhouse gas emissions is the use of diesel vehicles and equipment. Greenhouse gas emissions associated with the use of fuel in vehicles, equipment, and power generators from the Project were estimated. Total annual greenhouse gas emissions during the operation phase are estimated to be 132 kilotonnes (kt) of carbon dioxide equivalent (CO_2E) per year in addition to projected Ekati Mine greenhouse gas emissions.

Although the activity level for each year may vary, annual and total greenhouse gas emissions from the Project are based on the assumption that the Project will be operating at the maximum capacity throughout the life of the Project. Therefore, the greenhouse gas emissions that are presented are conservative and expected to overestimate the actual emissions. Detailed emission calculations for greenhouse gas emissions during all Project phases are presented in Appendix 7B, along with the specific references used in each calculation.

Previously reported and projected greenhouse gas emissions for the Ekati Mine before and after the Project are shown in Table 7.4-6. As of 2013, global warming potentials from the Intergovernmental Panel on Climate Change's *Fourth Assessment Report* (IPCC 2007) are to be used to calculate greenhouse gas emissions. Emissions reported before 2013 used global warming potentials from the *Second Assessment Report* (IPCC 1995). Therefore, to facilitate comparison to current values, emissions before 2013 were recalculated using the global warming potentials from the *Fourth Assessment Report*. Values in parentheses represent values that were originally reported using global warming potentials from the *Second Assessment Report.*

The Base Case is represented by the year 2015, and the Application Case, which includes the Jay Project, is represented by 2022. The maximum greenhouse gas contribution from the Jay Project will be 132 kt CO2E (Table 7.4-10). The Project is estimated to increase the amount of greenhouse gas emissions over the Base Case Ekati Mine greenhouse gas emissions because a larger haul truck fleet and a longer haul distance is required for the Project compared to those required for the Base Case Ekati Mine. The Project's maximum annual greenhouse gas emissions represents 4.3% of total 2020 projected greenhouse gas emissions for the Northwest Territories, and 0.02% of the total 2020 projected greenhouse gas emissions in Canada (Table 7.4-11).

Table 7.4-10 A Comparison of Previous and Projected Ekati Mine Greenhouse Gas Emissions

Year	Annual Greenhouse Gas Emissions (kt CO_2E) [(b)]				
	CO_2	CH_4	N_2O	HFCs	Total
2008[(a)]	185.756 (185.756)	0.202 (0.170)	1.661 (1.728)	0.331 (0.260)	187.951 (187.914)
2009[(a)]	164.557 (164.557)	0.248 (0.208)	0.794 (0.826)	0.180 (0.141)	165.778 (165.732)
2010[(a)]	150.602 (150.602)	0.164 (0.138)	1.352 (1.406)	0.883 (0.693)	153.001 (152.840)
2011[(a)]	152.664 (152.664)	0.167 (0.140)	1.364 (1.419)	0.000 (0.000)	154.195 (154.223)
2012[(a)]	172.647 (172.647)	0.188 (0.158)	1.537 (1.599)	0.000 (0.000)	174.372 (174.404)
2015 (projected)	248.272	0.321	16.599	n/a	265.192
2022 (projected)	364.195	0.487	32.364	n/a	397.047
Change due to Project	115.923	0.166	15.766	n/a	131.855

a) Source: Environment Canada (2013b).

b) Emissions before 2013 were recalculated using the global warming potentials from the *Fourth Assessment Report,* and are not in parenthesis. Values in parentheses represent values that were originally reported using global warming potentials from the *Second Assessment Report.*

kt CO_2E = kilotonnes equivalent carbon dioxide; CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; HFCs = hydrofluorocarbons; n/a = Not applicable.

Table 7.4-11 A Comparison of Project, Northwest Territories, and Canadian Greenhouse Gas Emissions

	Annual Greenhouse Gas Emissions (kt CO_2E)		
	2012	2015 (Projected)	2020 (Projected)
Ekati Mine + Project	174	241	397[c]
Project Only	n/a	n/a	132 [c]
Northwest Territories[a]	1,778	2,292	3,089
Canada[b]	699,000	725,000	734,000
	Percent Contribution of Ekati Mine and Project to Total NWT and Canadian Greenhouse Gas Emissions		
	2012	2015 (Projected)	2020 (Projected)
Northwest Territories	9.695%	11.570%	12.854%
Canada	0.025%	0.037%	0.054%
	Percent Contribution of Project to Total NWT and Canadian Greenhouse Gas Emissions		
	2012	2015 (Projected)	2020 (Projected)
Northwest Territories	n/a	n/a	4.269%
Canada	n/a	n/a	0.018%

a) Source: MK Jaccard and Associates Inc. (2011).

b) Source: Environment Canada (2013a).

c) Project emissions in 2022 is assumed to be comparable to 2020 levels

kt CO_2E = kilotonnes equivalent carbon dioxide; n/a = not applicable;% = percent.

7.4.2.2 *Results*

The following subsections discuss the model-predicted concentrations and deposition rates. The results are compared to the applicable regulatory ambient air quality standards and presented in tables. The prediction contours are also presented graphically at 25%, 50%, 75%, and 100% of the applicable objectives.

7.4.2.2.1 Sulphur Dioxide

The maximum 1-hour, 24-hour, and annual SO_2 predictions in the Base Case and Application Case are summarized in Table 7.4-12. The predicted concentrations are all substantially below the NWT Ambient Air Quality Standards. The predictions are not shown graphically because the values are all below 25% of the NWT standards.

Table 7.4-12 Comparison of Regional Base Case and Application Case for SO_2

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)		
			Base Case	Application Case	Change
LSA	1-hour	450	15.6	15.6	0.0
	24-hour	150	5.9	5.9	0
	Annual	30	0.4	0.4	0
RSA	1-hour	450	15.6	15.6	0.0
	24-hour	150	5.9	5.9	0
	Annual	30	0.4	0.4	0

SO_2 = sulphur dioxide; NWT = Northwest Territories; µg/m^3 = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

7.4.2.2.2 Nitrogen Dioxides

The comparisons of predicted 1-hour, 24-hour, and annual NO_2 concentrations in the Base Case and Application Case are presented in Table 7.4-13. The maximum 1-hour, 24-hour, and annual NO_2 predictions are shown graphically in Maps 7.4-5 through 7.4-10. The prediction contours are all centred on the areas where mine fleet activities are most intensive at the Ekati Mine, the Jay Pit, and the Diavik Mine.

The maximum 1-hour and annual NO_2 concentrations are above the NWT standard in the Base Case and the 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 (Table 7.4-14) 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 predictions decrease sharply with distance from the edge of the mine sites.

Table 7.4-13 Comparison of Regional Base Case and Application Case for NO_2

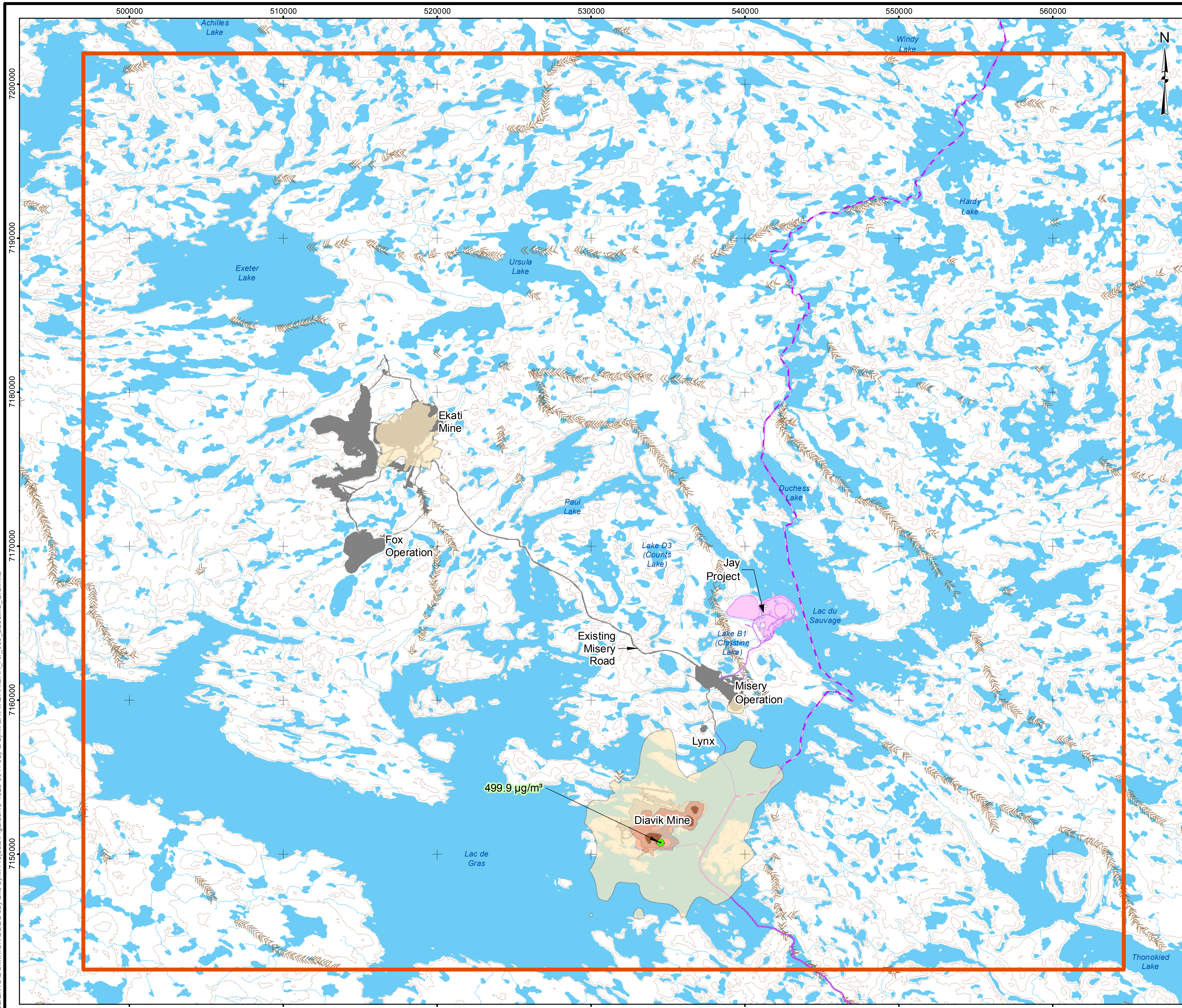
Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)		
			Base Case	Application Case	Change
LSA	1-hour	400	499.9	500.4	0.5
	24-hour	200	140.3	320.9	180.6
	Annual	60	42.1	77.8	35.7
RSA	1-hour	400	499.9	500.4	0.5
	24-hour	200	140.3	320.9	180.6
	Annual	60	42.1	77.8	35.7

NO_2 = nitrogen dioxide; NWT = Northwest Territories; µg/m^3 = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

Table 7.4-14 Frequency and Area of NO_2 Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Base Case	Application Case	Change
LSA	1-hour	Frequency (hour)	14	325	311
		Area (ha)	6	10	4
	24-hour	Frequency (day)	0	1	1
		Area (ha)	0	29	29
	Annual	Frequency (year)	0	1	1
		Area (ha)	0	0.5	0.5
RSA	1-hour	Frequency (hour)	14	325	311
		Area (ha)	6	10	4
	24-hour	Frequency (day)	0	1	1
		Area (ha)	0	29	29
	Annual	Frequency (year)	0	1	1
		Area (ha)	0	0.5	0.5

NO_2 = nitrogen dioxide; LSA = local study area; RSA = regional study area; ha = hectare.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 100 (BLANK)
- 100 to < 200
- 200 to < 400
- > 400
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM 1-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT	13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-5
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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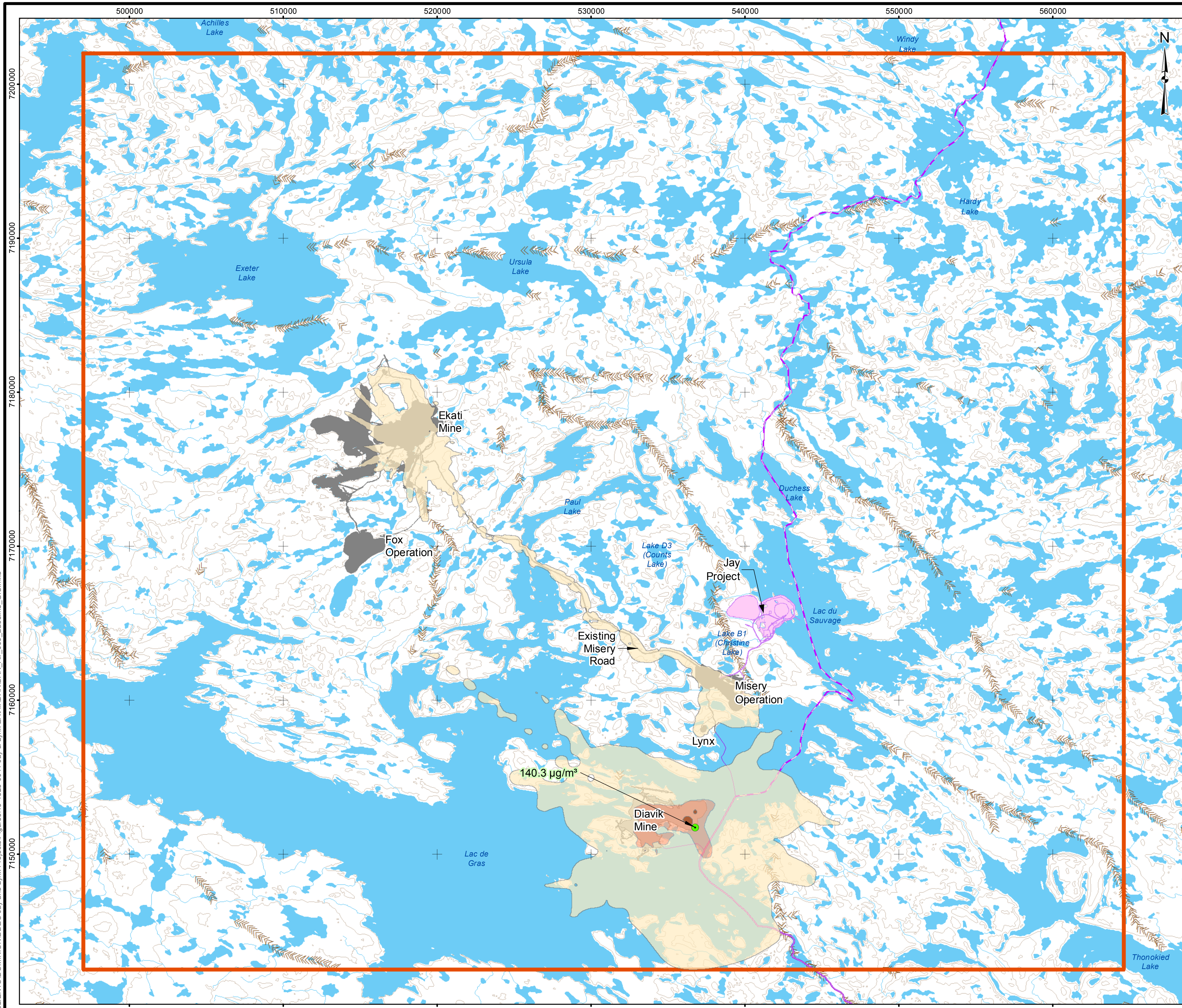

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- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
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- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

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- 50 to < 100
- 100 to < 200
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PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM 24-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-6
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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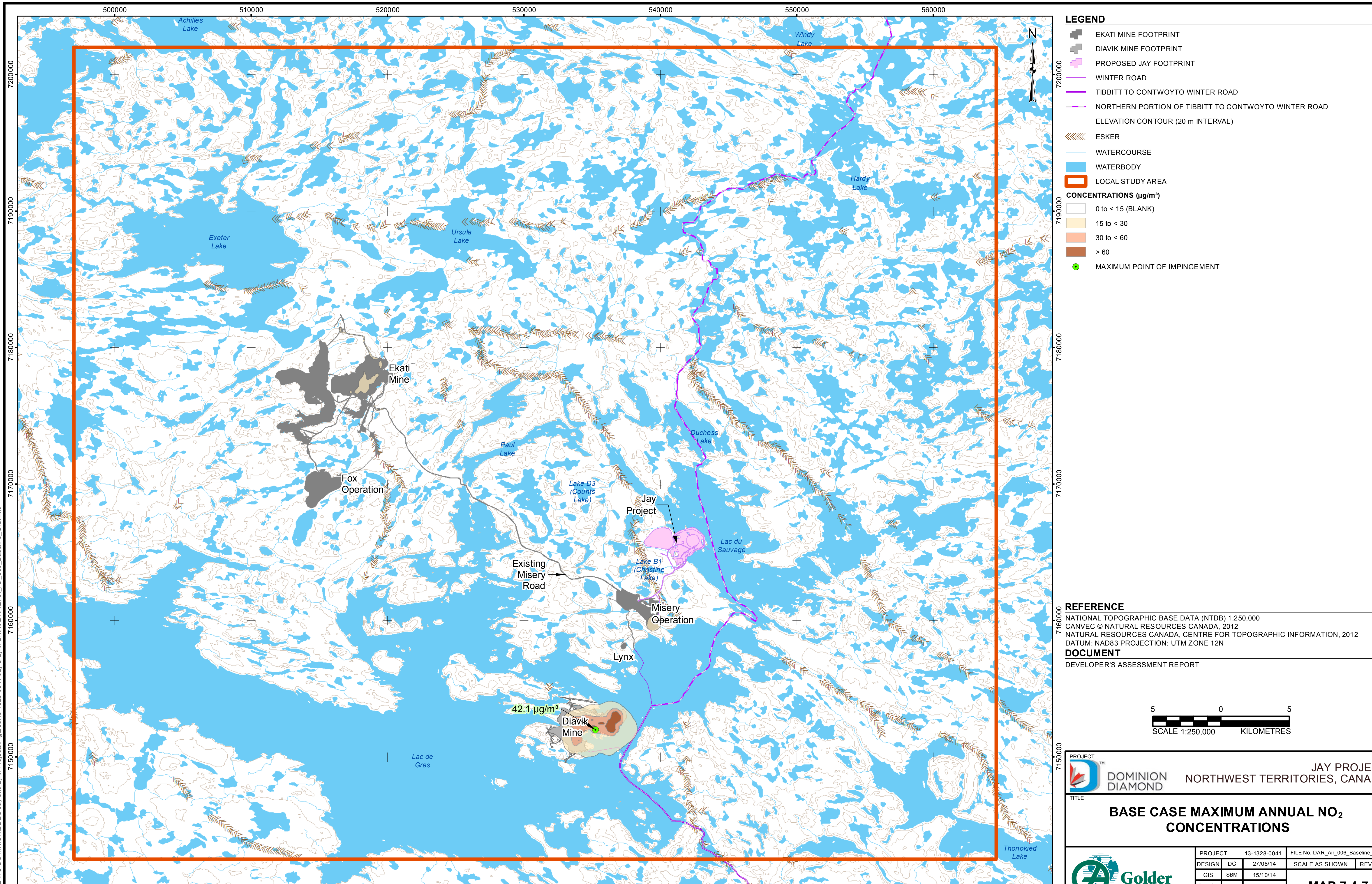

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PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM ANNUAL NO_2 CONCENTRATIONS

Golder Associates

PROJECT	13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-7
REVIEW	CDM	16/10/14	

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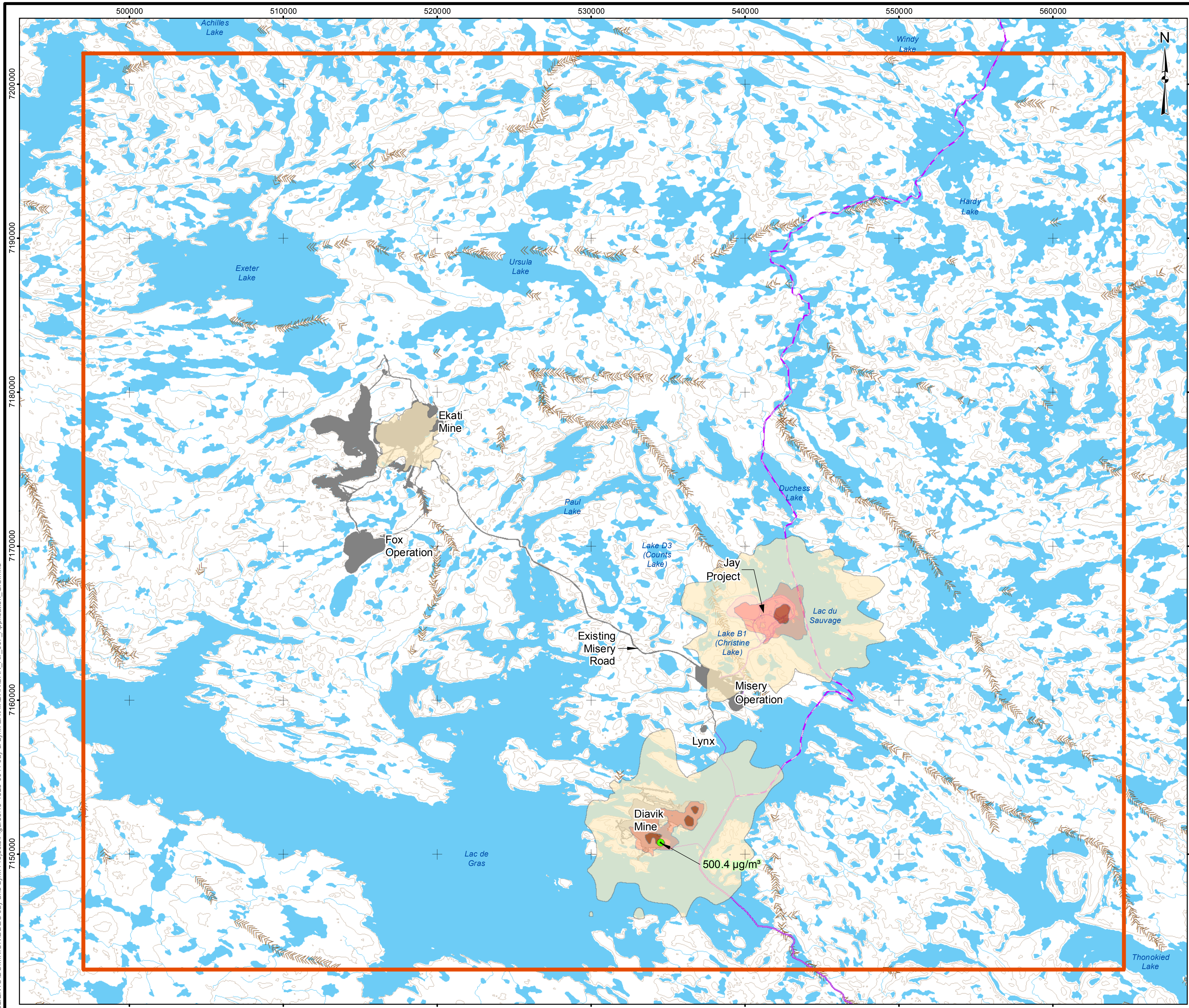

LEGEND

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- DIAVIK MINE FOOTPRINT
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- WINTER ROAD
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- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 100 (BLANK)
- 100 to < 200
- 200 to < 400
- > 400
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM 1-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	MAP 7.4-8	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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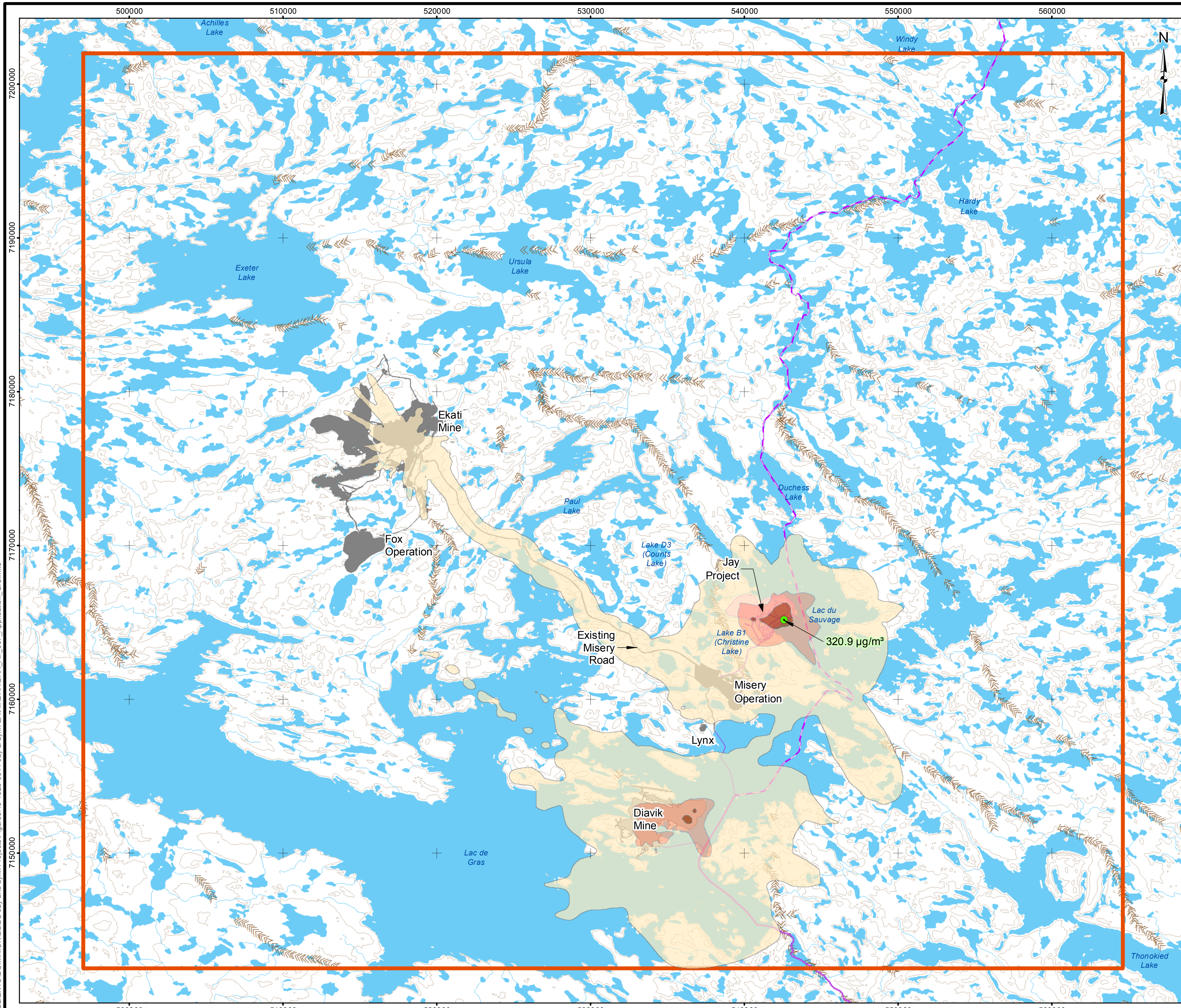

LEGEND

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- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (μg/m³)

- 0 to < 50 (BLANK)
- 50 to < 100
- 100 to < 200
- > 200
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM 24-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-9
REVIEW	CDM	16/10/14	

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LEGEND

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- WINTER ROAD
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- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 15 (BLANK)
- 15 to < 30
- 30 to < 60
- > 60
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
APPLICATION CASE MAXIMUM ANNUAL NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-10
REVIEW	CDM	16/10/14	

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7.4.2.2.3 Carbon Monoxide

The Base Case and Application Case predicted maximum 1-hour and 8-hour CO concentrations are compared in Table 7.4-15. The predicted concentrations in both assessment cases are substantially below the NWT Ambient Air Quality Standards. The predictions are not shown graphically because all values are below 25% of the NWT standards.

Table 7.4-15 Comparison of Regional Base Case and Application Case for CO

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (μg/m³)		
			Base Case	Application Case	Change
LSA	1-hour	15,000	1,418.8	2,407.2	988.4
	8-hour	6,000	981.9	1,949.4	967.5
RSA	1-hour	15,000	1,418.8	2,407.2	988.4
	8-hour	6,000	981.9	1,949.4	967.5

CO = carbon monoxide; NWT = Northwest Territories; μg/m^3 = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

7.4.2.2.4 $PM_{2.5}$

A comparison of the Base Case and Application Case predicted maximum 24-hour and annual $PM_{2.5}$ concentrations is provided in Table 7.4-16. The predicted 24-hour and annual $PM_{2.5}$ concentrations are shown in Maps 7.4-11 through 7.4-14. The $PM_{2.5}$ predictions are influenced by the diesel combustion sources (e.g., power generation and mine fleet) and the fugitive dust resulting from mining activities (e.g., road dust and blasting).

The maximum 24-hour and annual $PM_{2.5}$ in the Base Case and the Application Case exceed the NWT standards. The area and frequency of the exceedances of the NWT standards are summarized in Table 7.4-17. The areas over the NWT standards are confined to perimeters of the Ekati Mine, the Jay Pit, and the Diavik Mine. The number of days the area surrounding the Project may experience 24-hour $PM_{2.5}$ concentrations above the NWT standard for the Base Case is shown in Map 7.4-15, and for the Application Case in Map 7.4-16. The majority of the area with predicted concentrations above the standard may experience between 1 and 60 days of concentrations above the standard. Only the area immediately adjacent to the emission sources will experience more than 60 days of concentrations above the standard. No concentration above the NWT air quality standard is predicted beyond 5 km from the mine boundaries. The area above the annual standard extends no further than approximately 1 km beyond the mine boundaries (Maps 7.4-12 and 7.4-14).

Recent $PM_{2.5}$ concentrations measured at the Ekati Mine (BHP Billiton 2012) are generally below the NWT standard with approximately one measurement exceeding the NWT standard per year. Due to the conservative nature of the emission estimation for the Project as discussed in Section 7.5, it is expected that the actual $PM_{2.5}$ concentrations at the Project will be lower than predicted, closer to the concentrations measured currently at the Ekati Mine.

Dominion Diamond plans to develop an ambient air quality monitoring program that will be used to guide adaptive management strategies and the implementation of mitigation, if and as required, to maintain exposure to $PM_{2.5}$ levels below those that would be of concern.

Table 7.4-16 Comparison of Regional Base Case and Application Case for $PM_{2.5}$

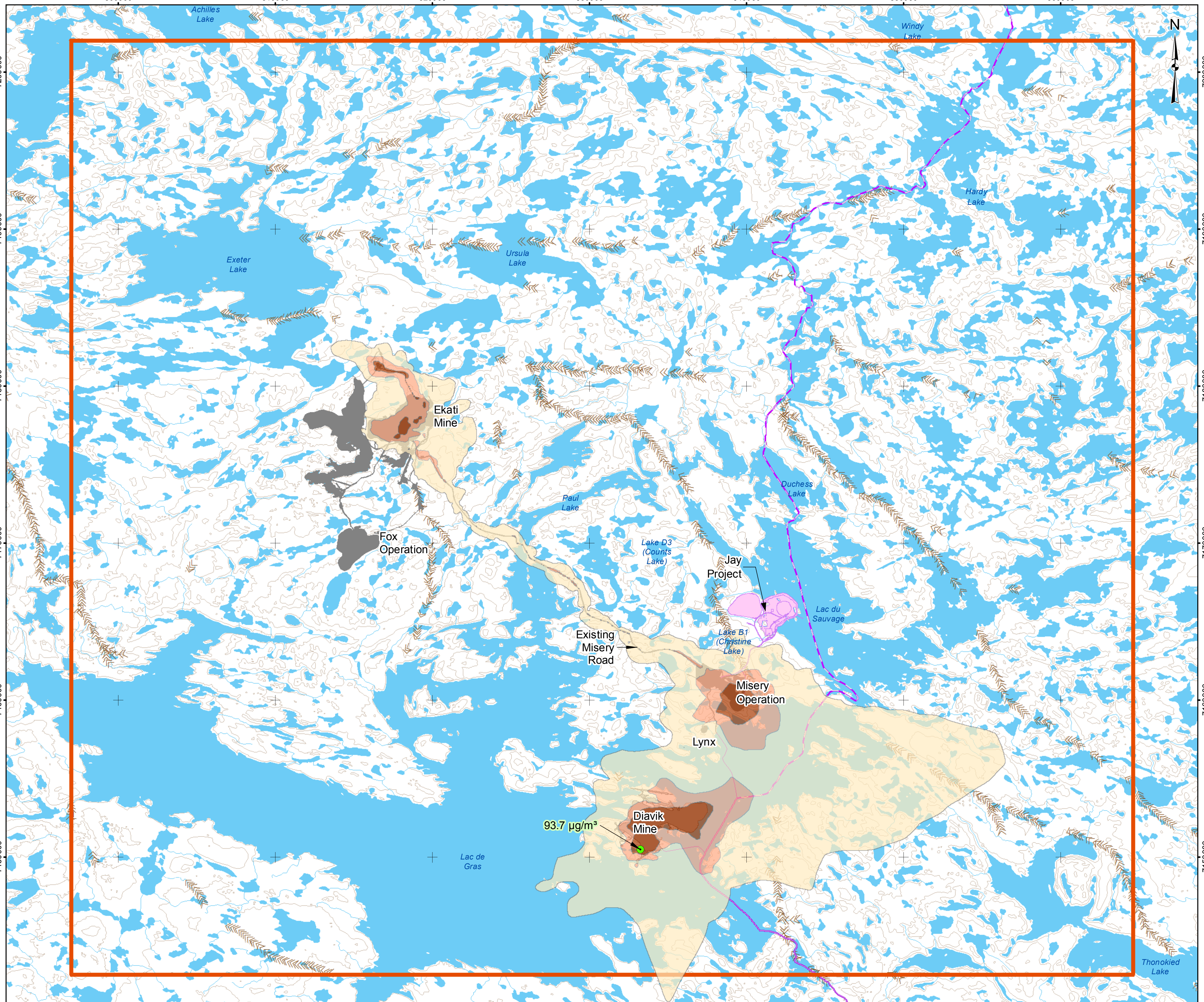
Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)		
			Base Case	Application Case	Change
LSA	24-hour	28	93.7	324.5	230.8
	Annual	10	14.0	39.4	25.4
RSA	24-hour	28	93.7	324.5	230.8
	Annual	10	14.0	39.4	25.4

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; NWT = Northwest Territories; µg/m³ = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

Table 7.4-17 Frequency and Area of $PM_{2.5}$ Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Base Case	Application Case	Change
LSA	24-hour	Frequency (hour)	44	155	111
		Area (ha)	374	3,996	3,622
	Annual	Area (ha)	58	169	111
RSA	24-hour	Frequency (hour)	44	155	111
		Area (ha)	374	3,996	3,622
	Annual	Area (ha)	58	169	111

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; LSA = local study area; RSA = regional study area; ha = hectare.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 7 (BLANK)
- 7 to < 14
- 14 to < 28
- > 28
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM 24-HOUR $PM_{2.5}$ CONCENTRATIONS

PROJECT		13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-11
REVIEW	CDM	16/10/14	

Golder Associates

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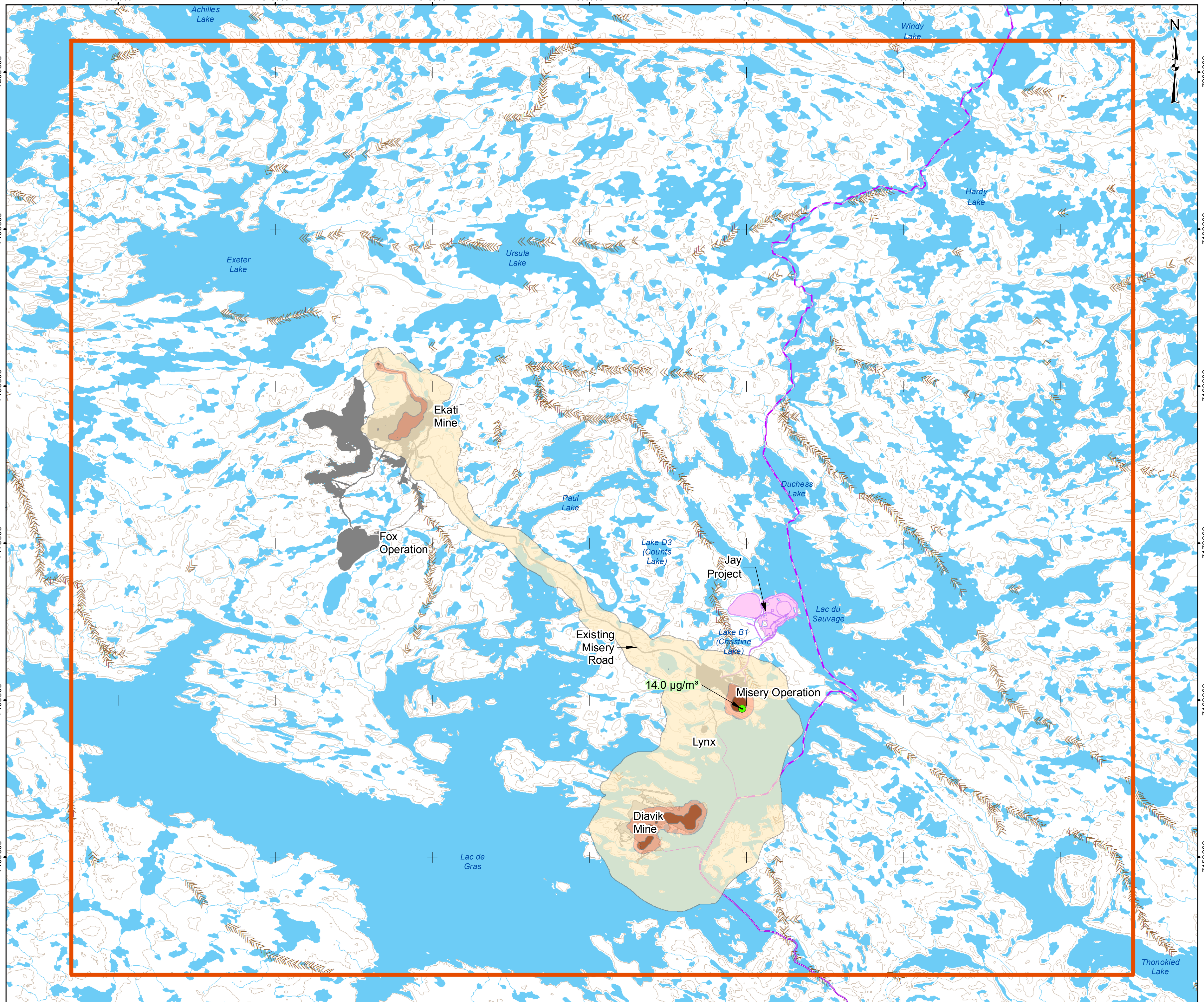

LEGEND

- EKATI MINE FOOTPRINT
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- PROPOSED JAY FOOTPRINT
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- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 2.5 (BLANK)
- 2.5 to < 5
- 5 to < 10
- > 10
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
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SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM ANNUAL $PM_{2.5}$ CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	**MAP 7.4-12**	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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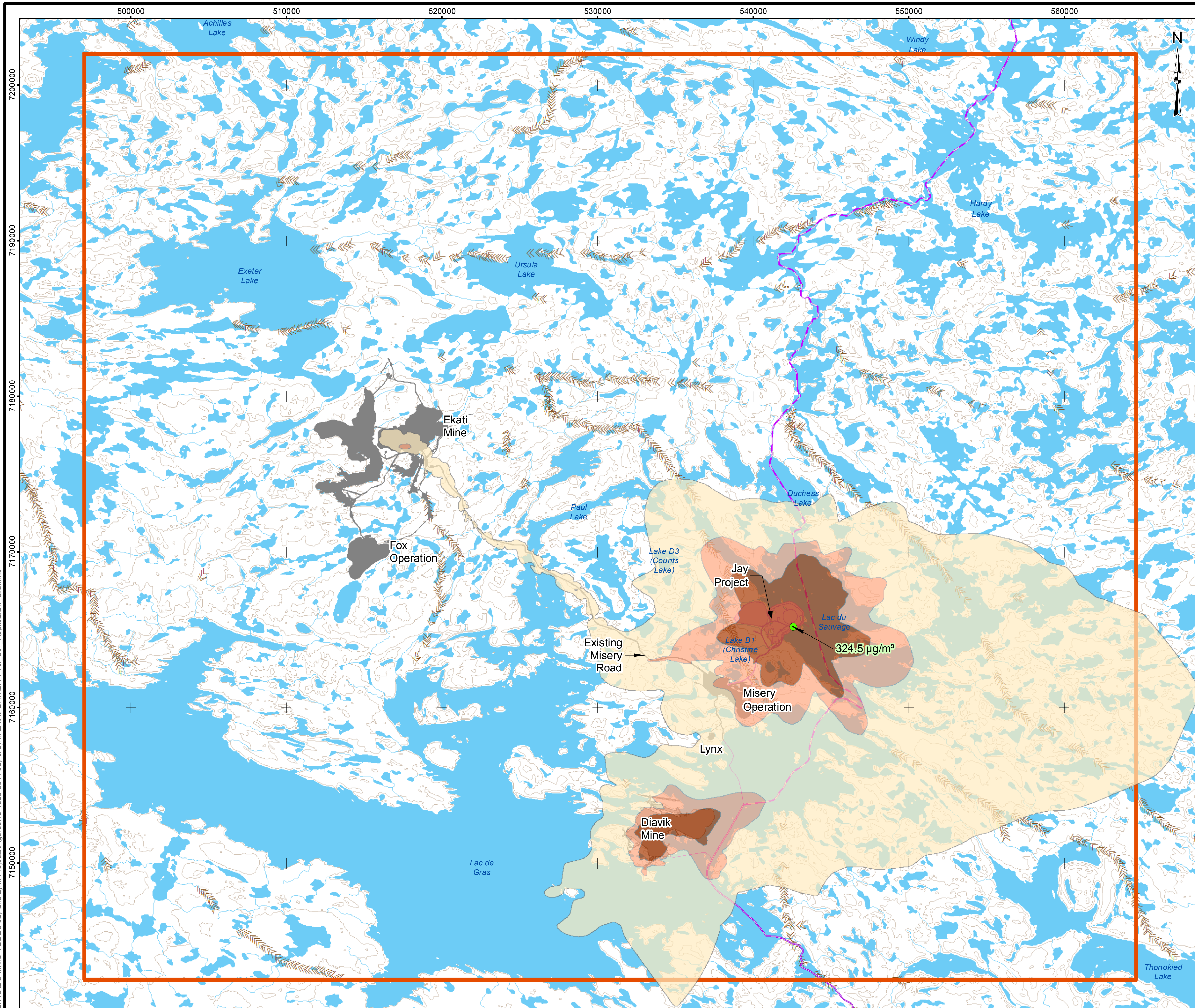

LEGEND

EKATI MINE FOOTPRINT
DIAVIK MINE FOOTPRINT
PROPOSED JAY FOOTPRINT
WINTER ROAD
TIBBITT TO CONTWOYTO WINTER ROAD
NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
ELEVATION CONTOUR (20 m INTERVAL)
ESKER
WATERCOURSE
WATERBODY
LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

0 to < 7 (BLANK)
7 to < 14
14 to < 28
> 28
MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM 24-HOUR $PM_{2.5}$ CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-13
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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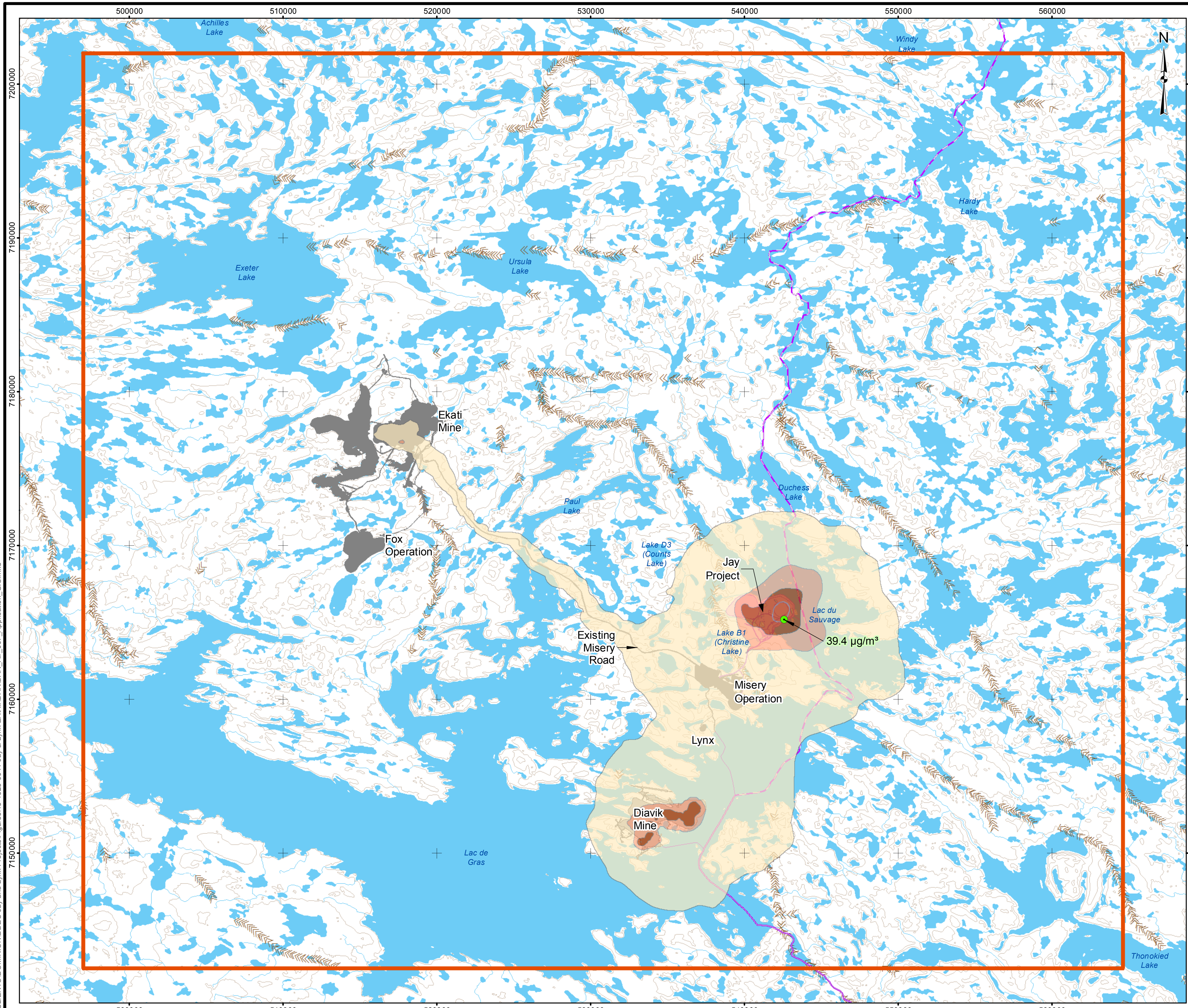

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CONCENTRATIONS (µg/m³)

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- 2.5 to < 5
- 5 to < 10
- > 10
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

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PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM ANNUAL $PM_{2.5}$ CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	**MAP 7.4-14**	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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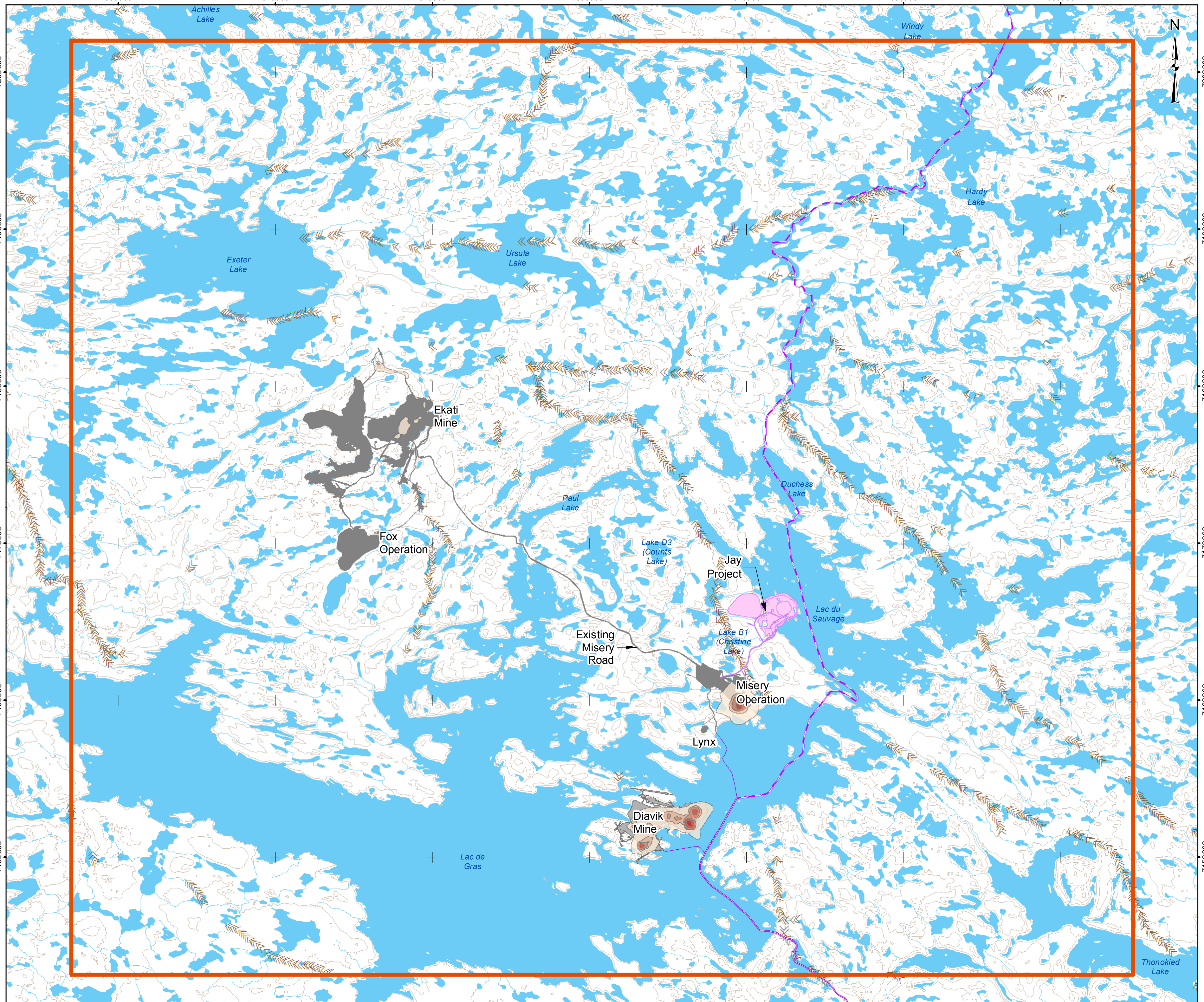

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- WATERBODY
- LOCAL STUDY AREA

NUMBER OF DAYS OF EXCEEDANCE

- 1 to 14
- 15 to 30
- 31 to 60
- 61 to 120
- 121 to 180

REFERENCE

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
BASE CASE NUMBER OF DAYS EXCEEDING 24-HOUR $PM_{2.5}$ AIR QUALITY STANDARDS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_016_BL_XC_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 1
GIS	SBM	25/09/14	**MAP 7.4-15**
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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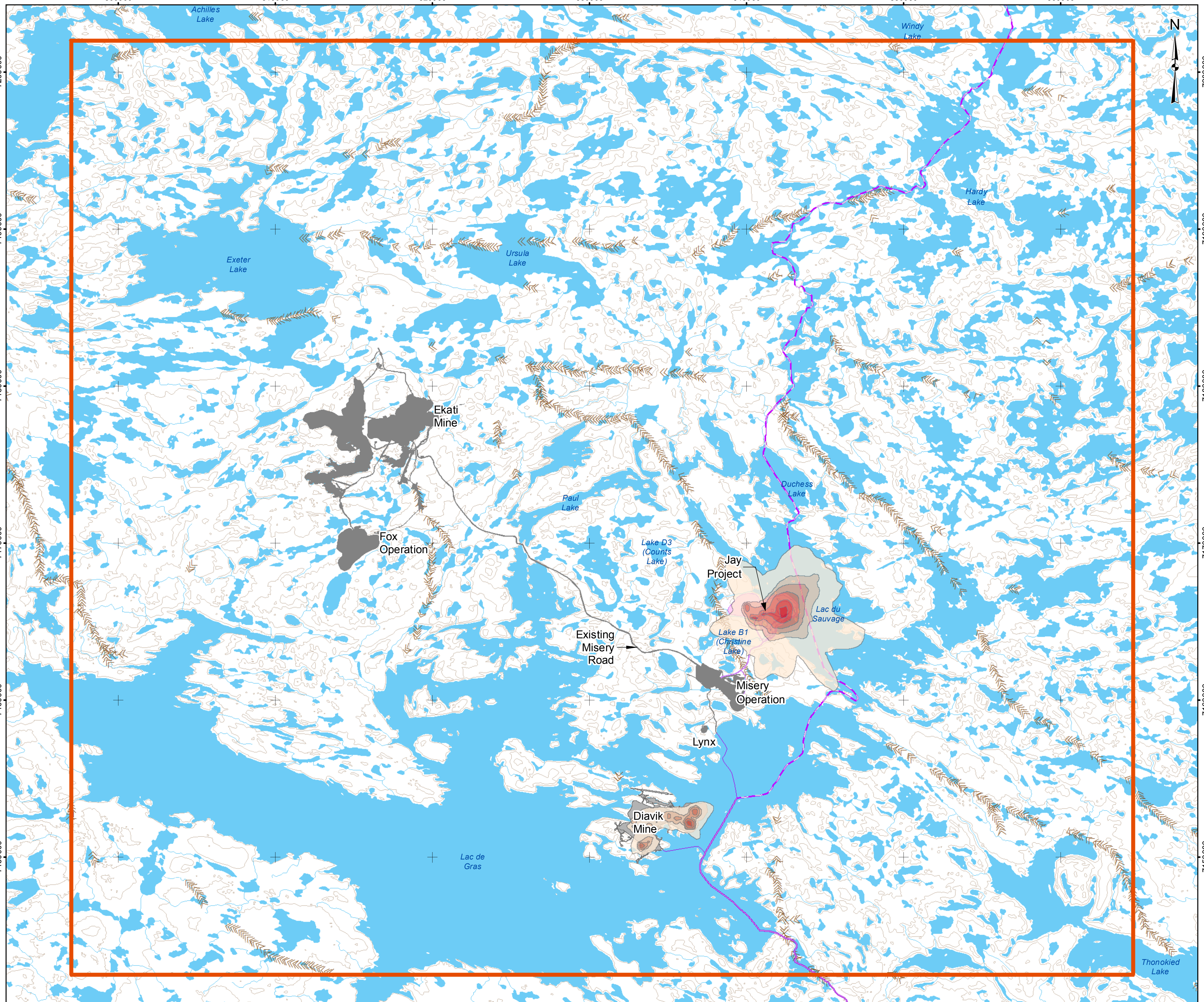

LEGEND

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- 15 to 30
- 31 to 60
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REFERENCE

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DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE NUMBER OF DAYS EXCEEDING 24-HOUR $PM_{2.5}$ AIR QUALITY STANDARDS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_017_AP_XC_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 1
GIS	SBM	25/09/14	
CHECK	ACP	16/10/14	MAP 7.4-16
REVIEW	CDM	16/10/14	

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7.4.2.2.5 Total Suspended Particulate

A comparison of the Base Case and Application Case predicted 24-hour and annual TSP concentrations is provided in Table 7.4-18. The predicted 24-hour and annual TSP concentrations are shown in Maps 7.4-17 through 7.4-20. The TSP predictions are primarily influenced by fugitive particulates resulting from road dust emissions.

The maximum 24-hour and annual TSP Base Case and Application Case predictions exceed the NWT standards. The area and frequency of the NWT standards are summarized in Table 7.4-19. The areas over the NWT standards are confined to perimeters of the Ekati Mine, the Jay Pit, and the Diavik Mine. The number of days the area surrounding the Project will experience 24-hour TSP concentrations above the NWT standard for the Base Case and the Application Case are shown in Map 7.4-21 and 7.4-22, respectively. The majority of the area with predicted concentrations above the standard will experience 1 to 60 days of concentrations above the standards. Only the area adjacent to the emission sources will experience more than 60 days of concentrations above the standard. No concentration above the NWT air quality standard is predicted beyond 3 km from the mine boundaries. The area above the annual standard extends no further than approximately 1 km beyond the mine boundaries (Maps 7.4-18 and 7.4-20). This result is to be expected, because in general the majority of TSP tends to settle out within a hundred metres of ground-level sources (USEPA 1995), which are the primary sources of TSP at the Project.

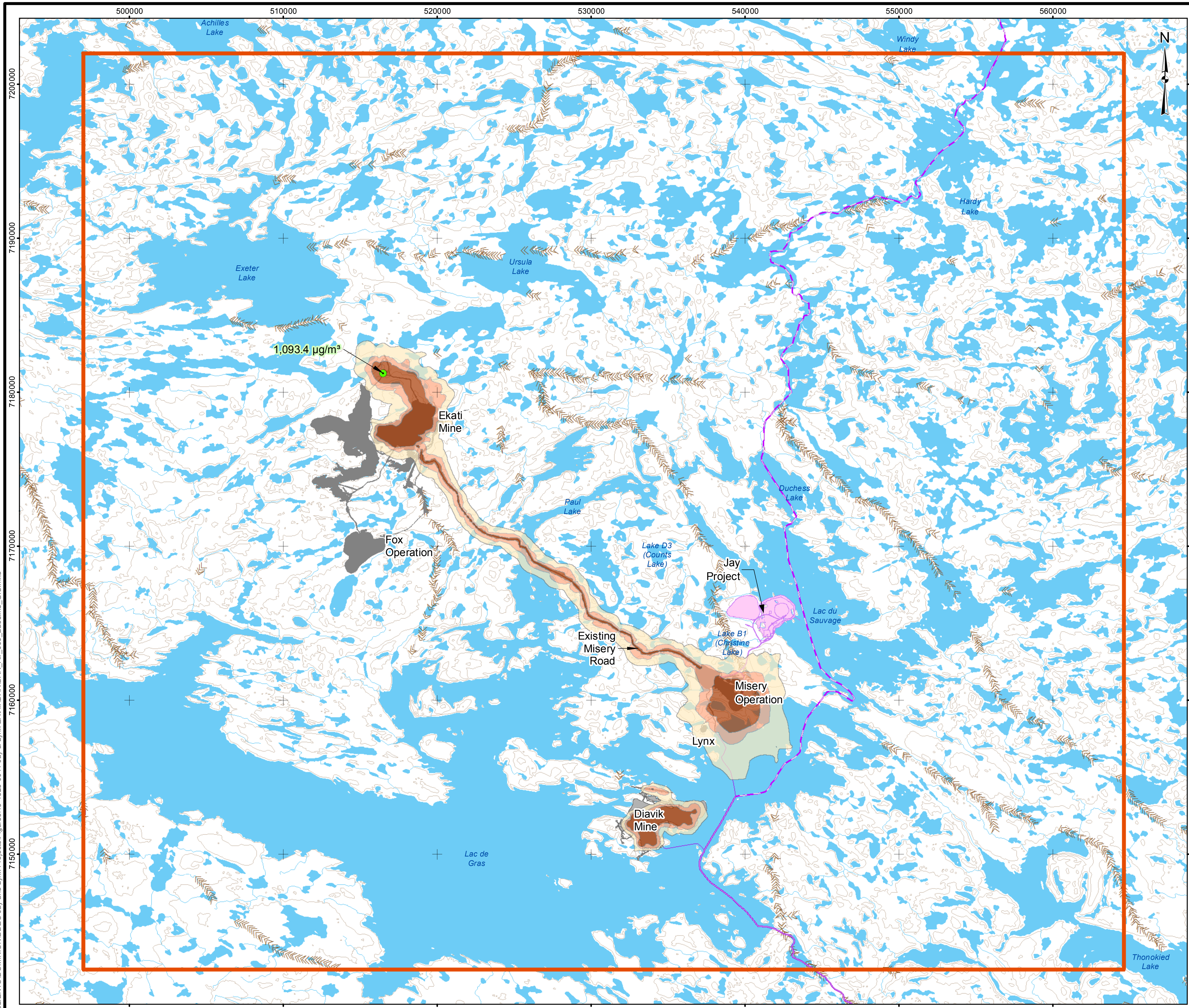
Recent TSP concentrations measured at the Ekati Mine (BHP Billiton 2012) are generally below the NWT standard with approximately two measurements exceeding the NWT standard per year. Due to the conservative nature of the emission estimation for the Project as discussed in Section 7.5, it is expected that the actual TSP concentrations at the Project will be lower than predicted, closer to the concentrations measured currently at the Ekati Mine.

Dominion Diamond plans to develop an ambient air quality monitoring program that will be used to guide adaptive management strategies and the implementation of mitigation, if and as required, to maintain exposure to TSP levels below those that would be of concern.

Table 7.4-18 Comparison of Regional Base Case and Application Case for Total Suspended Particulate

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)		
			Base Case	Application Case	Change
LSA	24-hour	120	1,093.4	5,152.2	4,058.8
	Annual	60	191.0	607.6	416.6
RSA	24-hour	120	1,093.4	5,152.2	4,058.8
	Annual	60	191.0	607.6	416.6

NWT = Northwest Territories; µg/m³ = micrograms per cubic metre; LSA = local study area; RSA = regional study area.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 30 (BLANK)
- 30 to < 60
- 60 to < 120
- > 120
- MAXIMUM POINT OF IMPINGEMENT

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

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
BASE CASE MAXIMUM 24-HOUR TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_Air_006_Baseline_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

MAP 7.4-17

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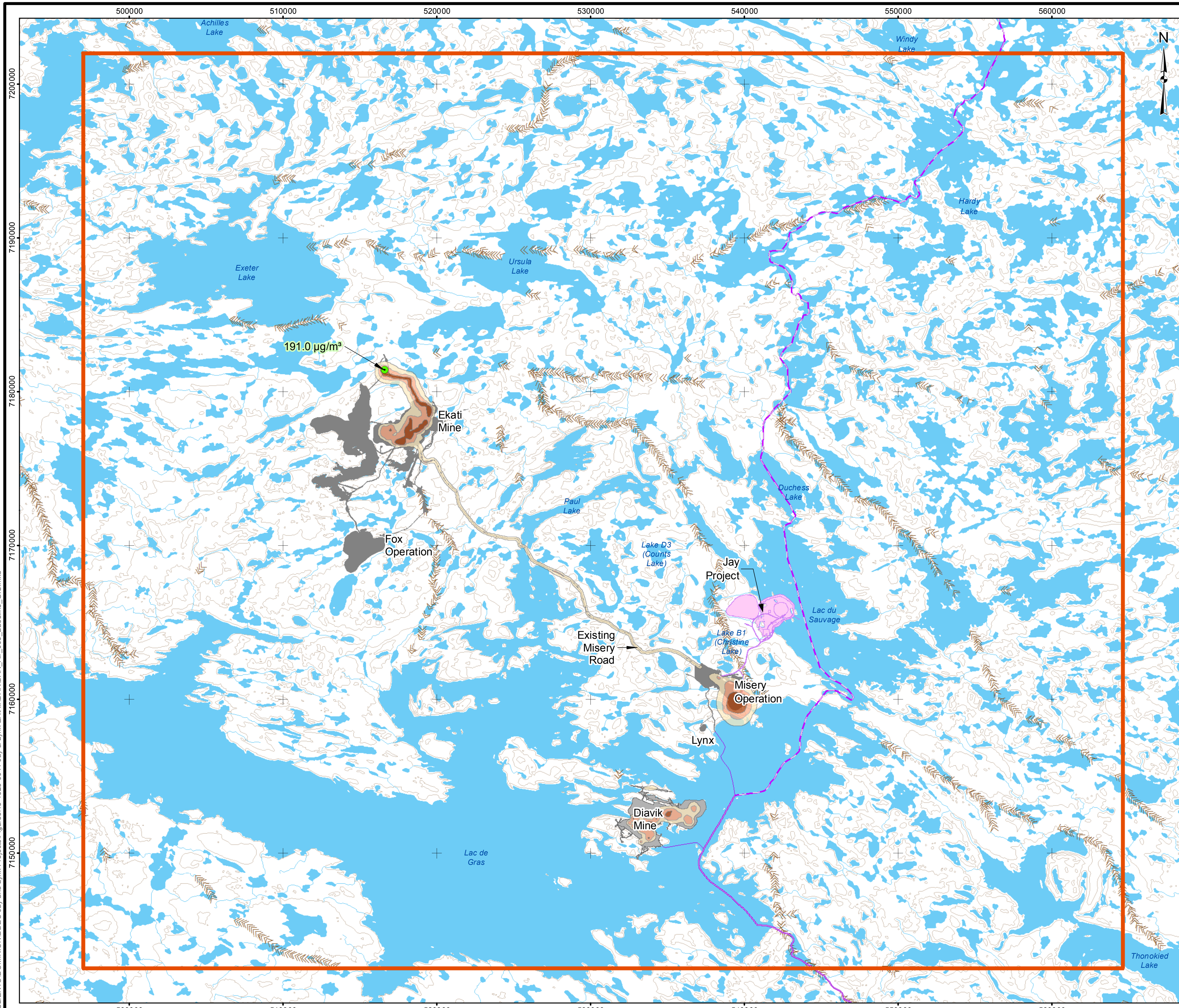

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 15 (BLANK)
- 15 to < 30
- 30 to < 60
- > 60
- MAXIMUM POINT OF IMPINGEMENT

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

5 0 5

SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM ANNUAL TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_006_Baseline_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-18
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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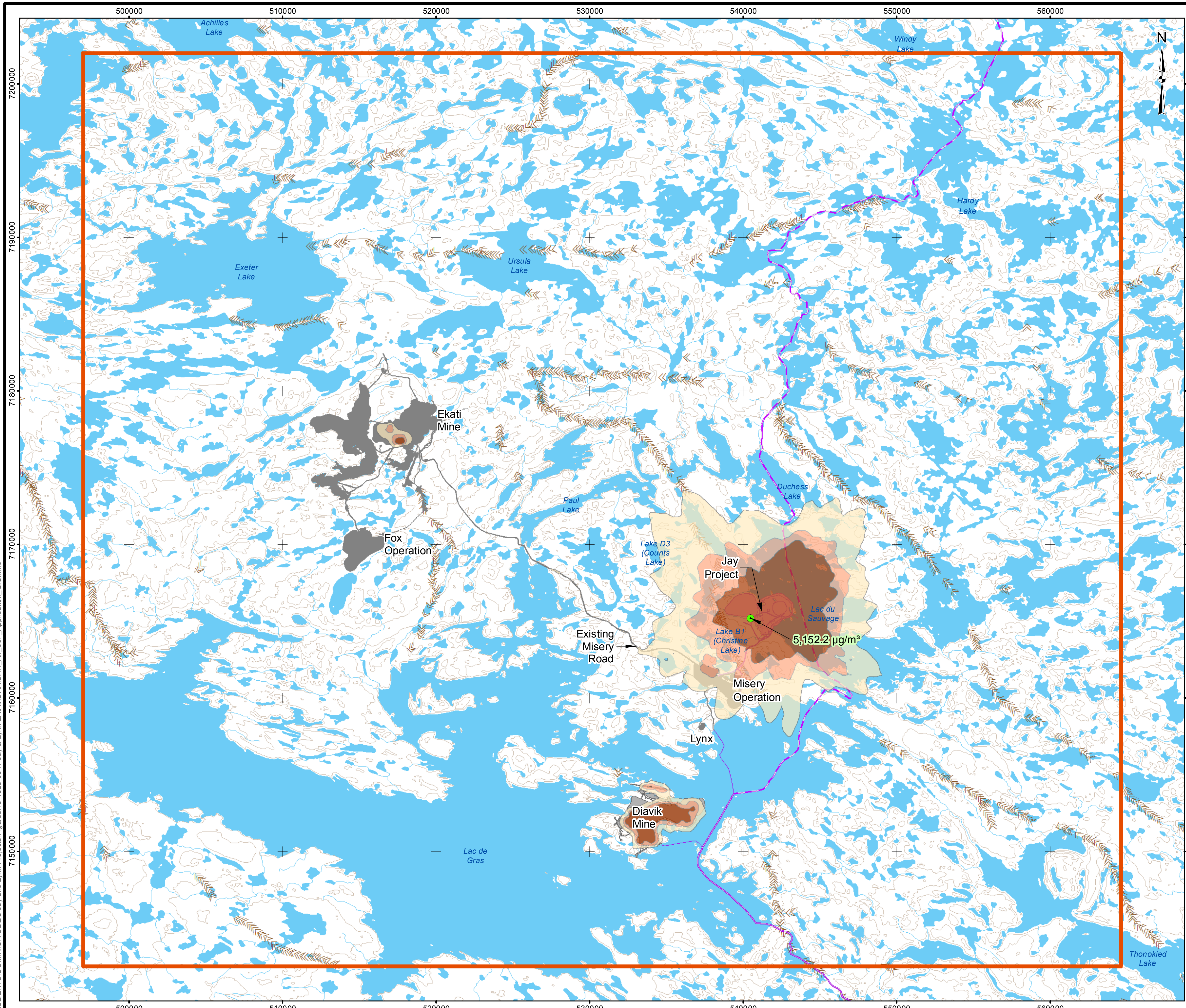

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 30 (BLANK)
- 30 to < 60
- 60 to < 120
- > 120
- MAXIMUM POINT OF IMPINGEMENT

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

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5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
APPLICATION CASE MAXIMUM 24-HOUR TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_007_Application_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	MAP 7.4-19	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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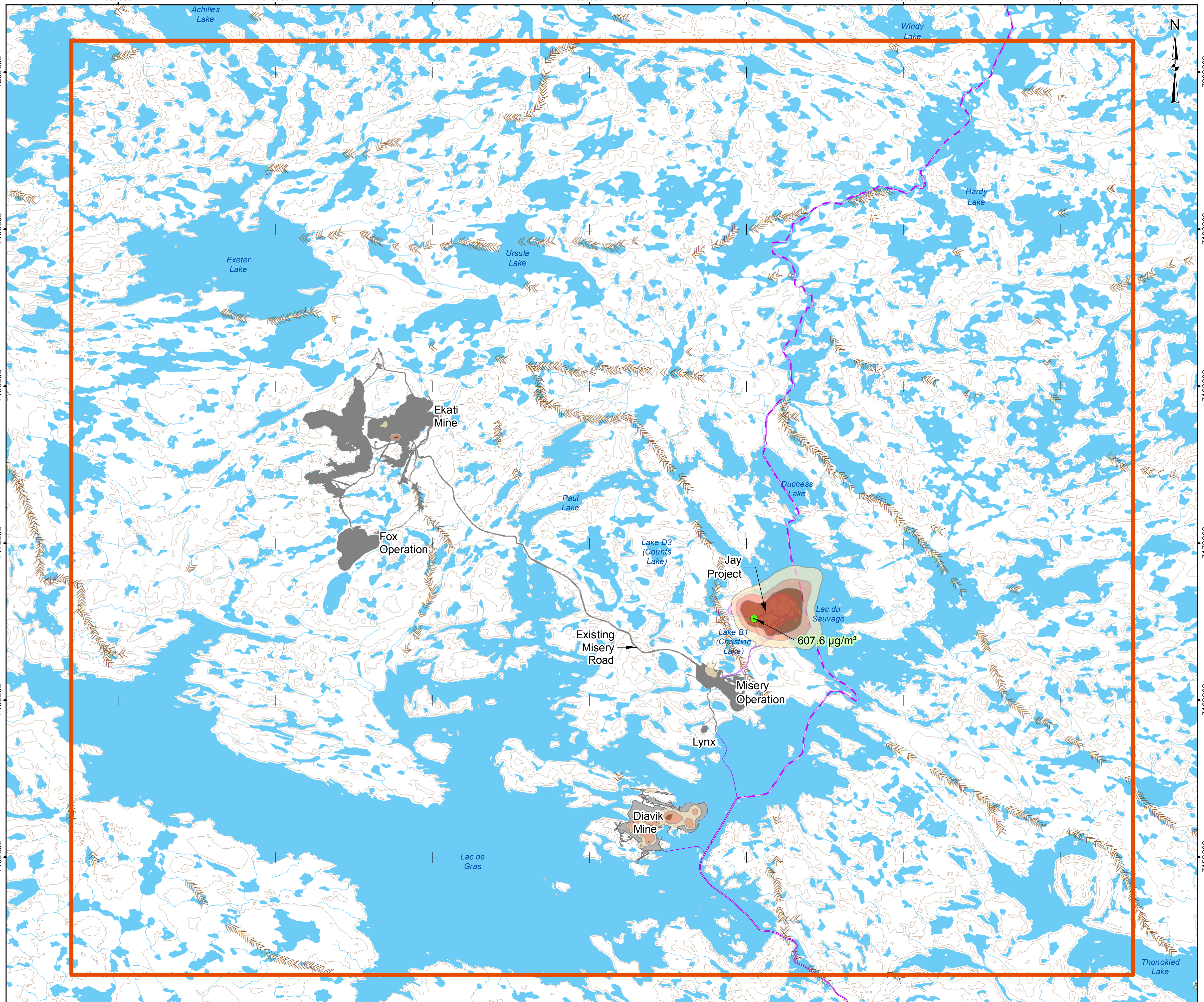

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 15 (BLANK)
- 15 to < 30
- 30 to < 60
- > 60
- MAXIMUM POINT OF IMPINGEMENT

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

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PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM ANNUAL TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT	13-1328-0041		FILE No. DAR_Air_007_Application_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-20
REVIEW	CDM	16/10/14	

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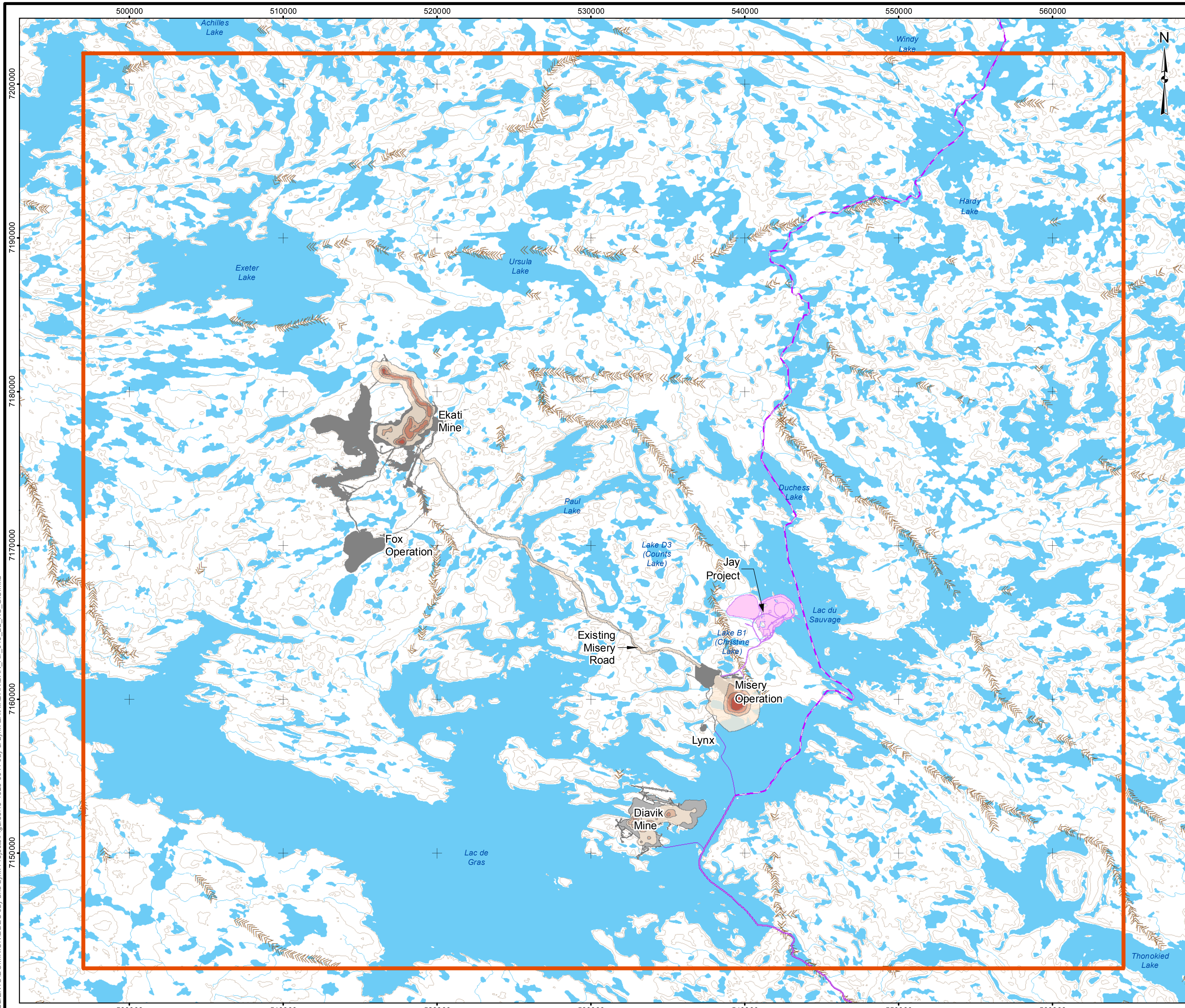

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LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

NUMBER OF DAYS OF EXCEEDANCE

- 1 to 30
- 31 to 60
- 61 to 120
- 121 to 240

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

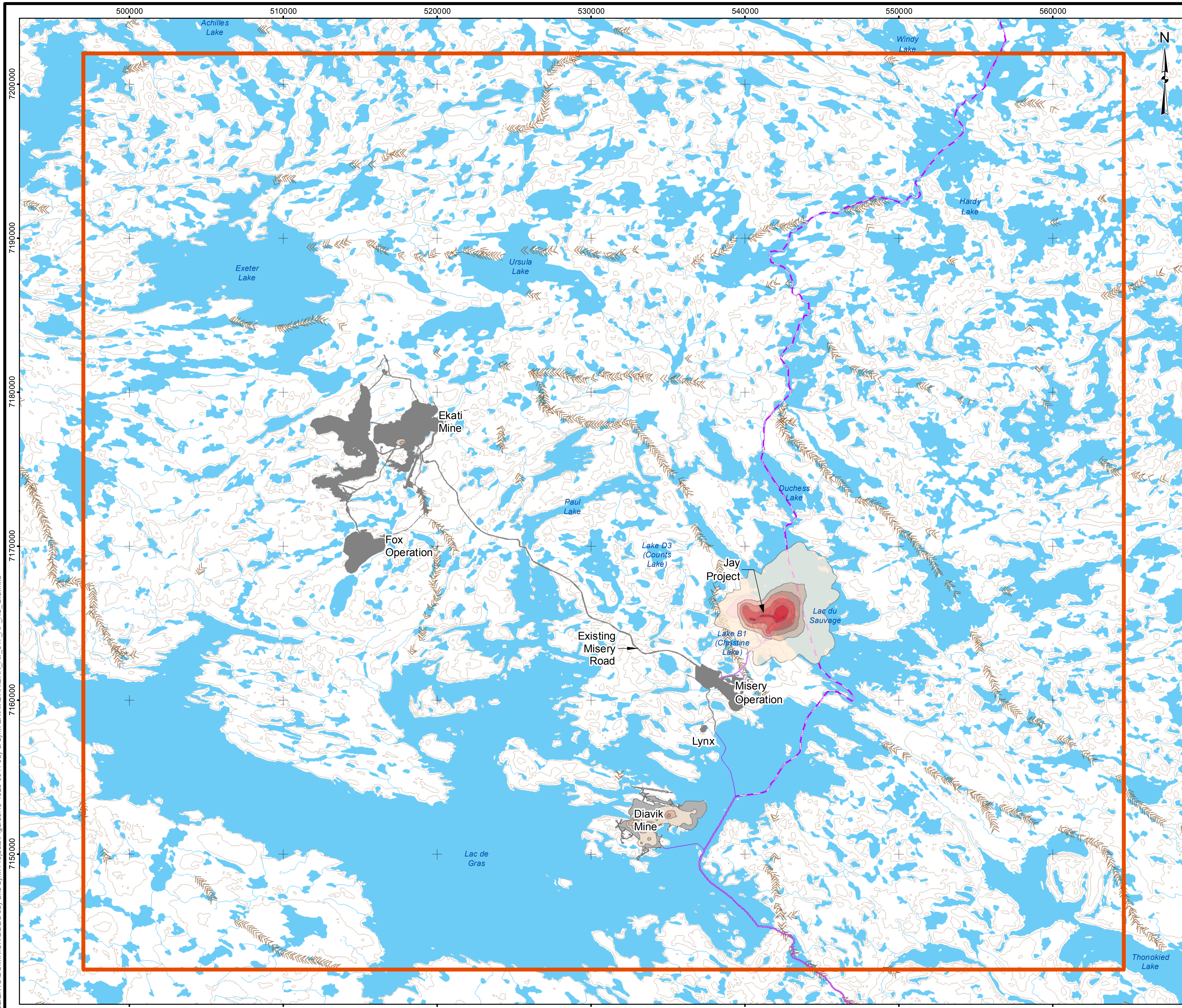
5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
BASE CASE NUMBER OF DAYS EXCEEDING 24-HOUR TOTAL SUSPENDED PARTICULATE AIR QUALITY STANDARDS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_016_BL_XC_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 1
GIS	SBM	25/09/14	
CHECK	ACP	16/10/14	MAP 7.4-21
REVIEW	CDM	16/10/14	



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

NUMBER OF DAYS OF EXCEEDANCE

- 1 to 30
- 31 to 60
- 61 to 120
- 121 to 240
- > 240

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

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
APPLICATION CASE NUMBER OF DAYS EXCEEDING 24-HOUR TOTAL SUSPENDED PARTICULATE AIR QUALITY STANDARDS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_017_AP_XC_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 1
GIS	SBM	25/09/14	MAP 7.4-22
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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Table 7.4-19 Frequency and Area of $PM_{2.5}$ Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Base Case	Application Case	Change
LSA	24-hour	Frequency (hour)	194	324	130
		Area (ha)	1,039	3,417	2,378
	Annual	Area (ha)	71	222	151
RSA	24-hour	Frequency (hour)	194	324	130
		Area (ha)	1,039	3,417	2,378
	Annual	Area (ha)	71	222	151

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; LSA = local study area; RSA = regional study area; ha = hectare.

7.4.2.2.6 Potential Acid Input Deposition

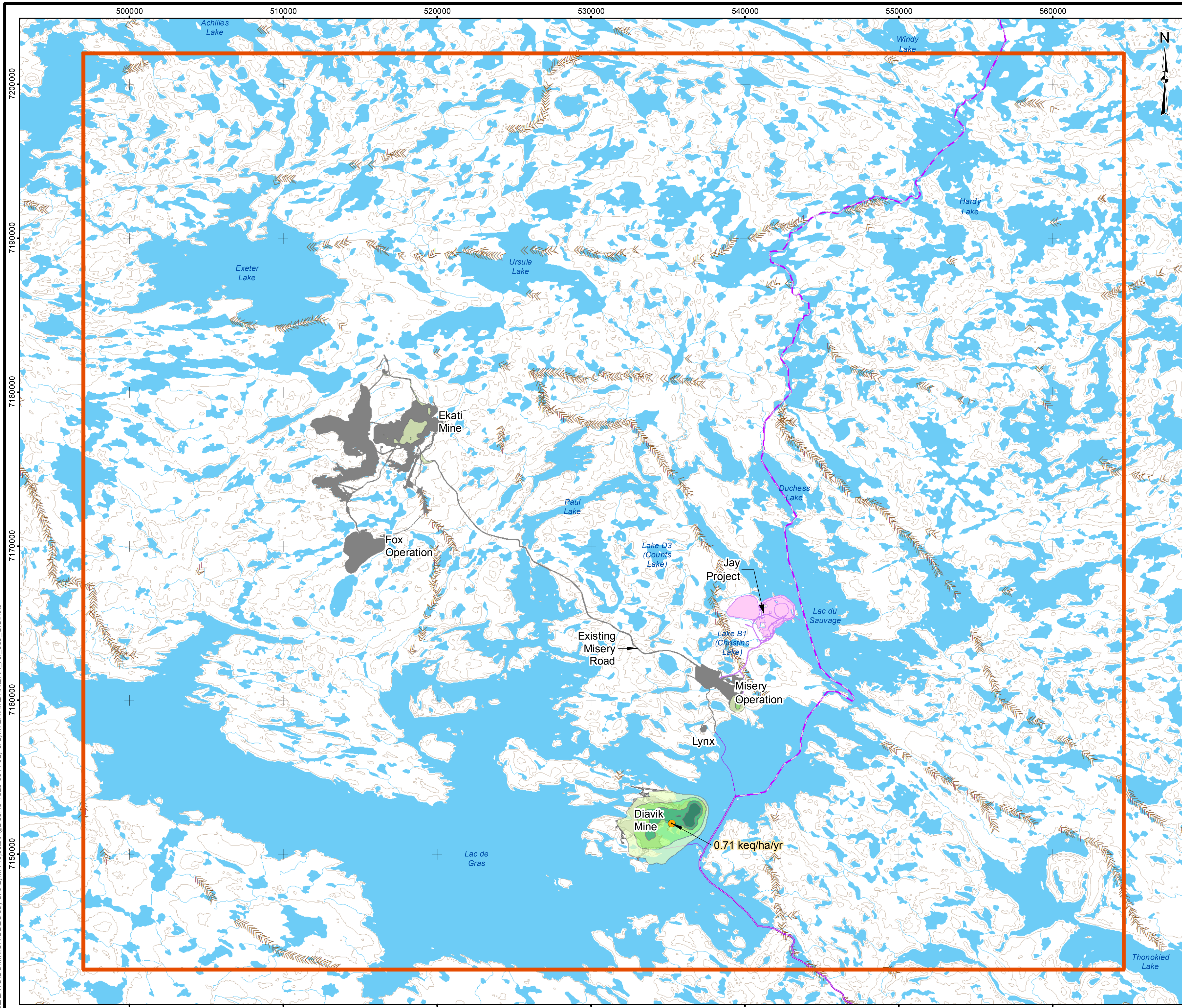
A comparison of the potential acid input (PAI) between the Base Case and the Application Case is provided in Table 7.4-20. The Base Case and Application Case PAI deposition rates are presented graphically in Maps 7.4-23 and 7.4-24, respectively. In the Application Case, the maximum PAI deposition outside the development area is 1.46 keq/ha/yr. The predicted PAI, sulphate, and nitrate deposition raw data on the regional waterbodies were provided as inputs to the water quality assessment (Section 8).

Table 7.4-20 Comparison of Predicted Base Case and Application Case Acid Deposition Results

Parameters	Base Case[(a)]	Application Case[(a)]	Change Due to Project[(a)]
LSA			
Maximum PAI (keq/ha/yr)	0.71	1.46	0.75
Area >0.17 keq/ha/yr (ha)	875	1,440	565
Area >0.25 keq/ha/yr (ha)	284	346	62
Area >0.5 keq/ha/yr (ha)	6	12	6
Area >1 keq/ha/yr (ha)	0	1	1
RSA			
Maximum PAI (keq/ha/yr)	0.71	1.46	0.75
Area >0.17 keq/ha/yr (ha)	875	1,440	565
Area >0.25 keq/ha/yr (ha)	284	346	62
Area >0.5 keq/ha/yr (ha)	6	12	6
Area >1 keq/ha/yr (ha)	0	1	1

a) Excludes predictions inside development areas.

LSA = local study area; RSA = regional study area; keq/ha/yr = kiloequivalents per hectare per year; >= greater than; PAI = potential acid input; ha = hectare.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

DEPOSITION (keq/ha/yr)

- 0 to < 0.17 (BLANK)
- 0.17 to < 0.25
- 0.25 to < 0.5
- 0.5 to < 1
- ≥ 1
- MAXIMUM POINT OF IMPINGEMENT

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

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

BASE CASE MAXIMUM ANNUAL POTENTIAL ACID INPUT PREDICTIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_009_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-23
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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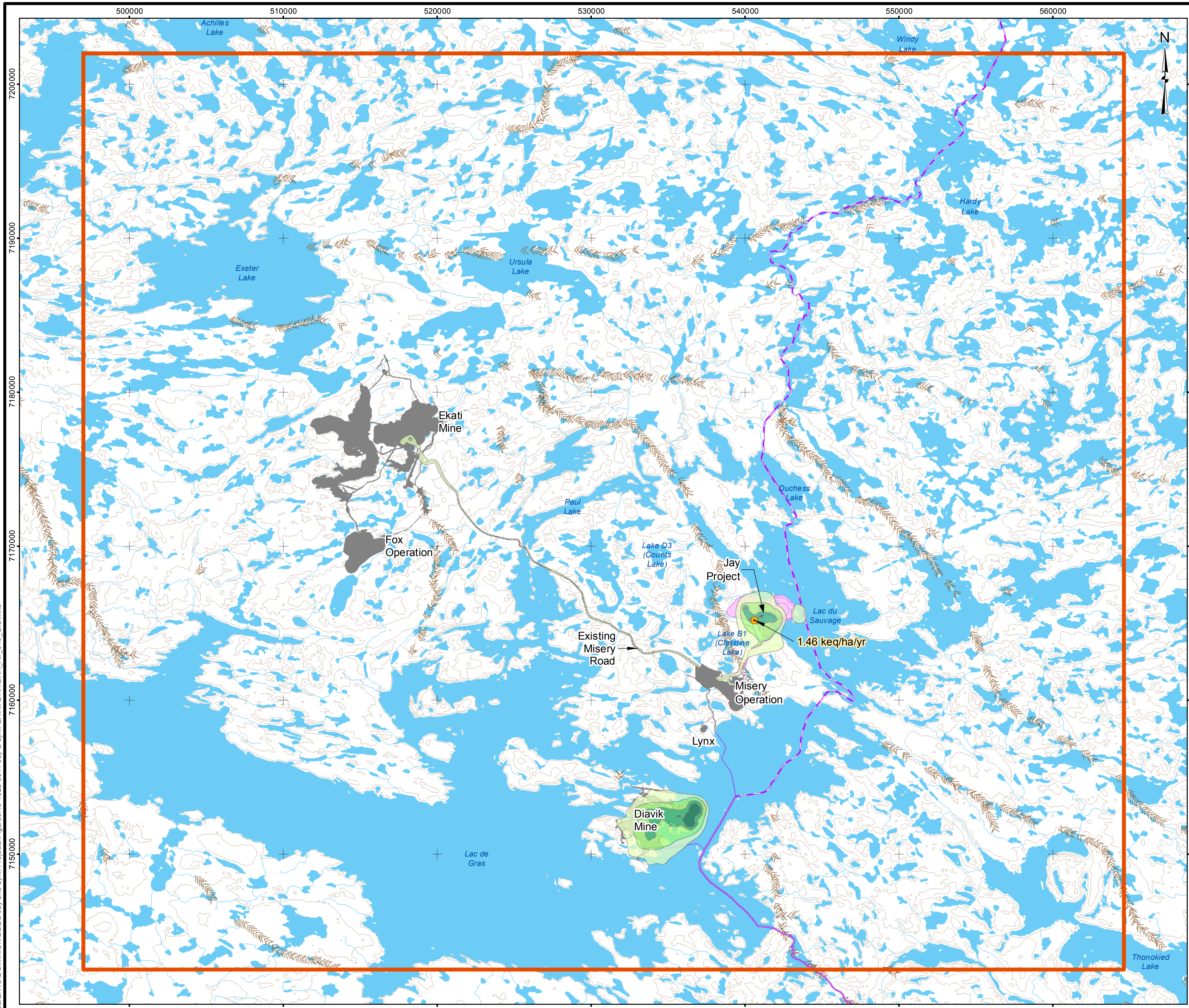

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

DEPOSITION (keq/ha/yr)

- 0 to < 0.17 (BLANK)
- 0.17 to < 0.25
- 0.25 to < 0.5
- 0.5 to < 1
- ≥ 1
- MAXIMUM POINT OF IMPINGEMENT

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

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SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

APPLICATION CASE MAXIMUM ANNUAL POTENTIAL ACID INPUT PREDICTIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_010_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	
CHECK	ACP	16/10/14	MAP 7.4-24
REVIEW	CDM	16/10/14	

7.4.2.2.7 Volatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

The Project sources emit trace gaseous substances, such as volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAH), from stacks and the mine fleet (Appendix 7B). The substances addressed in this section have been identified as those that may potentially have a negative effect on human health or health of ecological receptors if present in air in sufficient concentrations. These substances were modelled to determine the maximum hourly, daily, and annual ground-level concentrations and deposition rates near the proposed Project. The results were presented for use in the assessment of the risk to the health of humans and ecological receptors in Sections 11.3.2.2, 12.3.2.2, 13.3.2.2, and 14.6. The predicted ground-level concentrations and deposition rates at various health receptors are detailed in Appendix 7A.

7.4.2.2.8 Metals

There are no applicable metals air quality guidelines that apply in the NWT. The metal compounds addressed in this section have been identified as those that may potentially have a negative effect on human health or health of ecological receptors. These substances were modelled to determine the maximum hourly, daily, and annual concentrations and deposition rates near the proposed Project. The results were presented for use in the assessment of the risk to the health of humans and ecological receptors in Sections 11.3.2.2, 12.3.2.2, 13.3.2.2, and 14.6. Predicted ground-level concentrations and deposition rates at various health receptors are detailed in Appendix 7A.

The maximum concentrations of the various metal species are located near active mine areas, haul roads, and the plant, and they are associated with the dispersion pattern resulting from wind-blown dust emissions. Deposition was determined assuming that metals were associated with the TSP fraction from combustion, wind-blown dust, and mechanically generated (fugitive) sources.

7.4.2.2.9 Dioxins and Furans

There are no applicable air quality criteria in the NWT for dioxins and furans. The results were presented for use in the assessment of the risk to the health of humans and ecological receptors in Sections 11.3.2.2, 12.3.2.2, 13.3.2.2, and 14.6. Details of predicted ground-level concentrations at various health receptors are presented in Appendix 7A. The Ekati Mine utilizes modern incineration equipment to achieve dioxin and furan concentrations below the federal emission guideline (Dominion Diamond 2014b) and will continue this practice for the Project. Stack tests in 2013 done at the Ekati Mine incinerators passed the CCME CWS for dioxins and furans, and mercury (Dominion Diamond 2014c).

7.4.2.2.10 Construction Case

Construction activities associated with the Project are expected to occur two to three years before production from the Jay Pit. Predicted SO_2 concentrations for the Construction Case are presented in Table 7.4-21. The Construction Case predictions are lower than the Application Case predictions. The predicted maximum concentrations outside of the development area are all below the applicable NWT air quality standards for all averaging periods.

7.4.2.2.11 Summary of Human Health Assessment

A human health risk assessment will be completed to evaluate how the predicted changes to air quality outlined herein could potentially affect human health. No impacts are expected for human health. However, if the risk assessment determines there are unacceptable risks. Dominion Diamond will incorporate mitigation as required to prevent negative effects to human health.

Table 7.4-21 Construction Case Predicted SO_2 Concentrations

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)
LSA	1-hour	450	15.6
	24-hour	150	5.9
	Annual	30	0.4
RSA	1-hour	450	15.6
	24-hour	150	5.9
	Annual	30	0.4

SO_2 = sulphur dioxide; NWT = Northwest Territories; µg/m^3 = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

The Construction Case predicted NO_2 concentrations are summarized in Table 7.4-22. Overall, the Construction Case predictions are lower than the Application Case predictions, as anticipated. The Construction Case predicted frequency and area above the Northwest Territories Ambient Air Quality Standards for NO_2 are summarized in Table 7.4-23. The predicted maximum concentrations outside of the development area are all below the NWT standards for all averaging periods except for the 1-hour period. Similar to the Application Case predictions, the areas with predictions exceeding the NWT standards are confined to areas close to the mines. The predicted 1-hour, 24-hour, and annual concentrations are shown graphically in Maps 7.4-25 to 7.4-27, respectively.

Table 7.4-22 Construction Case Predicted NO_2 Concentrations

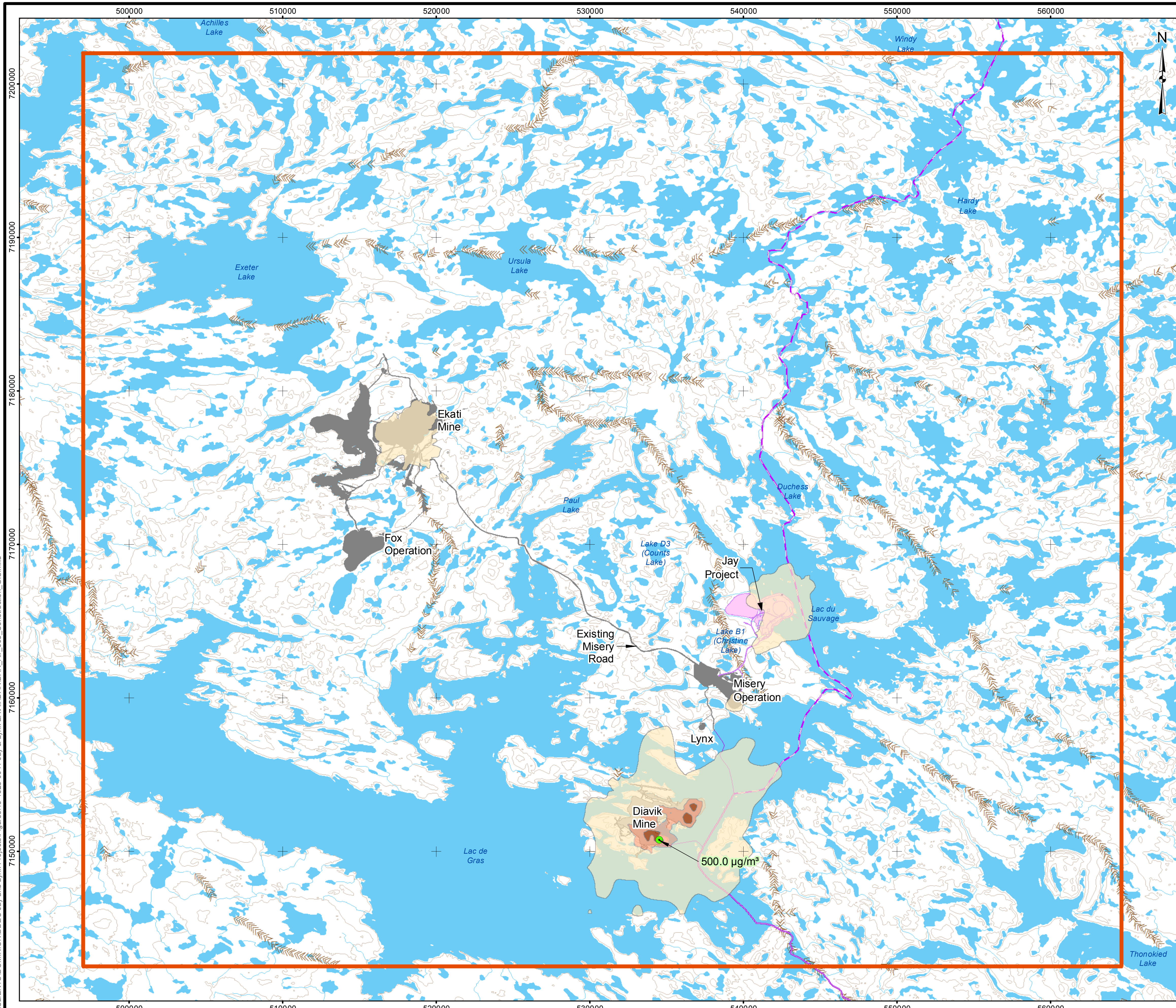
Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)
LSA	1-hour	400	500.0
	24-hour	200	146.8
	Annual	60	51.8
RSA	1-hour	400	500.0
	24-hour	200	146.8
	Annual	60	51.8

NO_2 = nitrogen dioxide; NWT = Northwest Territories; µg/m^3 = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

Table 7.4-23 Frequency and Area of Construction Case NO_2 Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Construction Case
LSA	1-hour	Frequency (hour)	14
		Area (ha)	6
	24-hour	Frequency (day)	0
		Area (ha)	0
	Annual	Frequency (year)	0
		Area (ha)	0
RSA	1-hour	Frequency (hour)	14
		Area (ha)	6
	24-hour	Frequency (day)	0
		Area (ha)	0
	annual	Frequency (year)	0
		Area (ha)	0

NO_2 = nitrogen dioxide; LSA = local study area; RSA = regional study area; ha = hectare.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 100 (BLANK)
- 100 to < 200
- 200 to < 400
- > 400
- MAXIMUM POINT OF IMPINGEMENT

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

5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

CONSTRUCTION CASE MAXIMUM 1-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	MAP 7.4-25	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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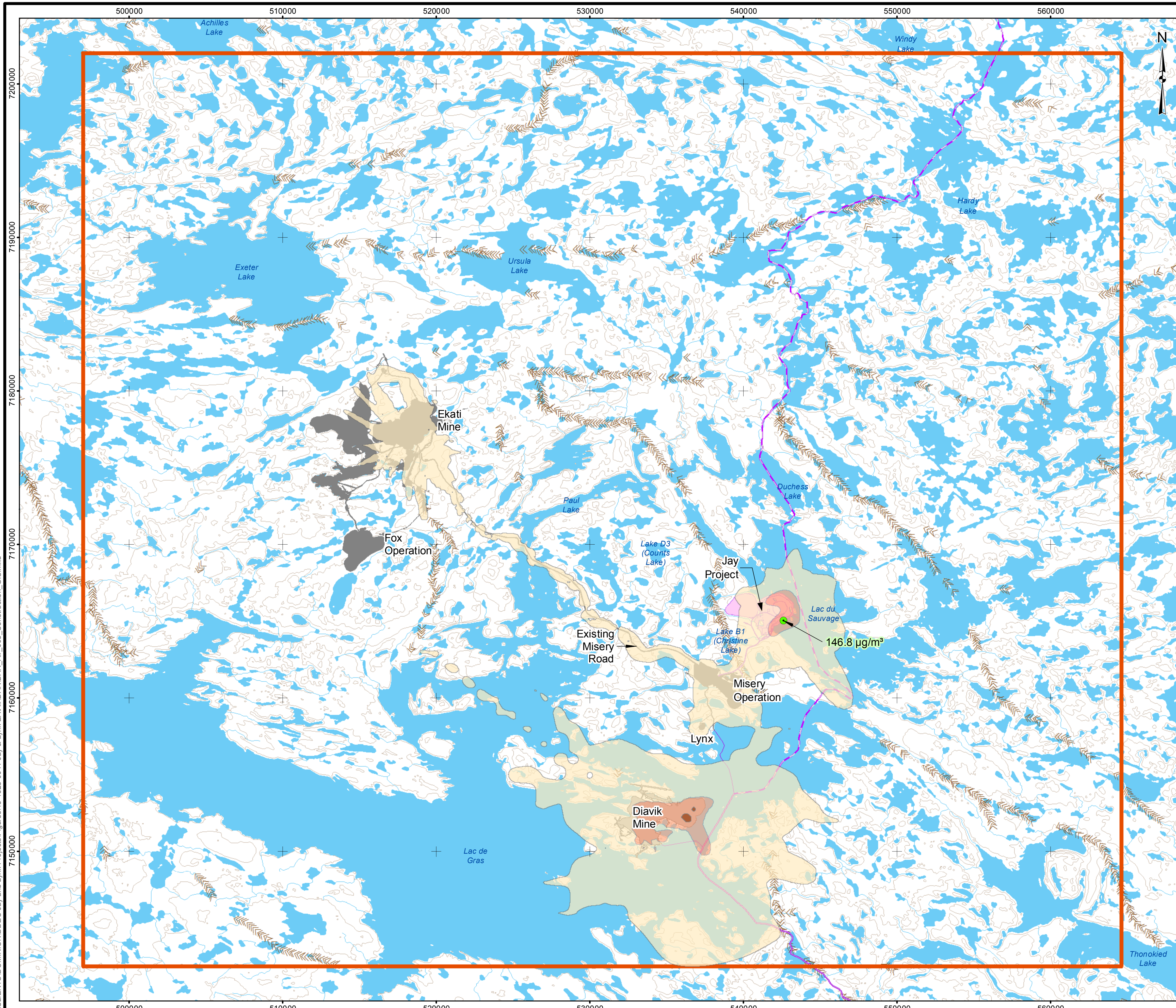


LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 50 (BLANK)
- 50 to < 100
- 100 to < 200
- > 200
- MAXIMUM POINT OF IMPINGEMENT

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

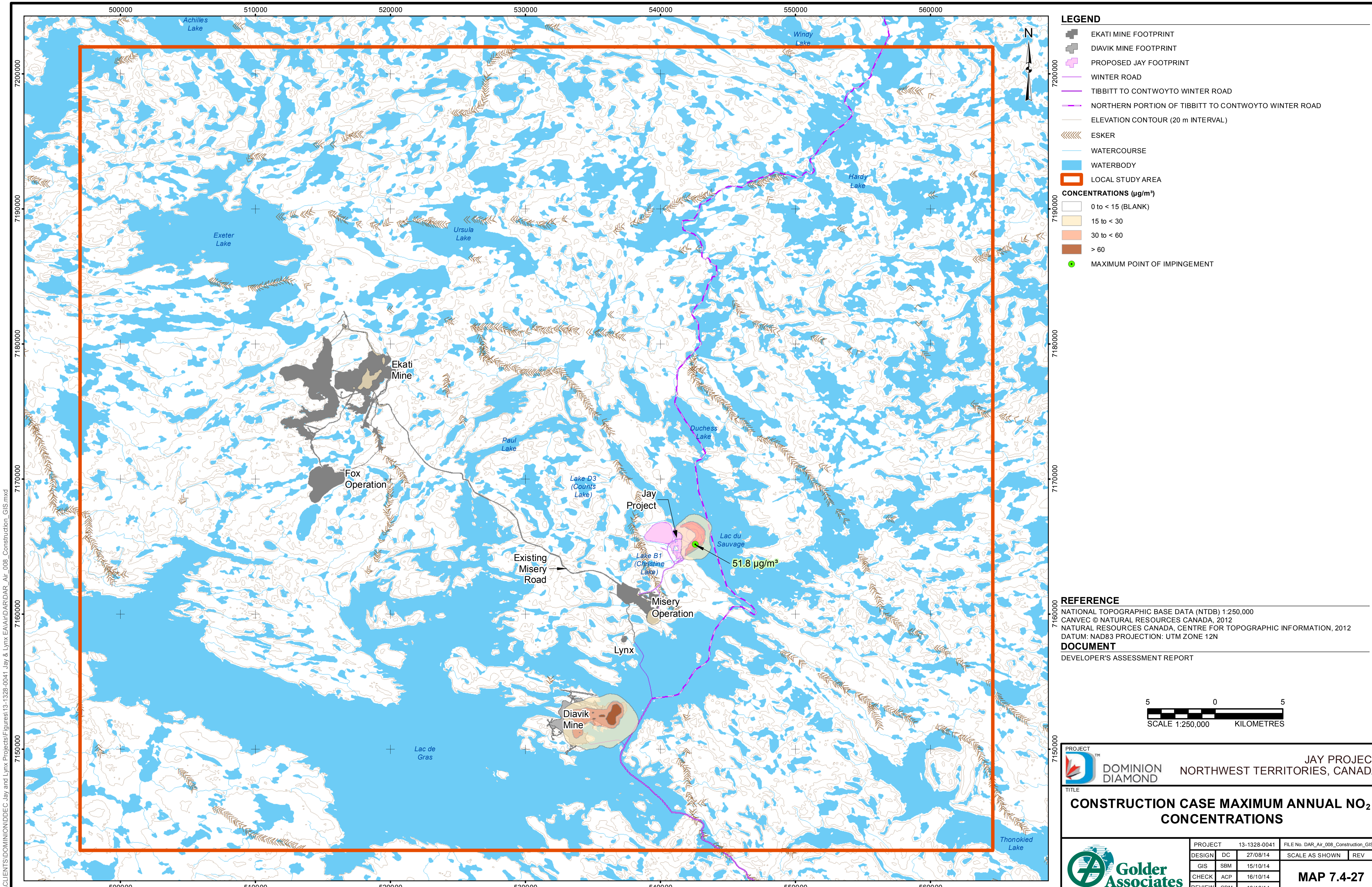
5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
CONSTRUCTION CASE MAXIMUM 24-HOUR NO_2 CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14		
CHECK	ACP	16/10/14	MAP 7.4-26	
REVIEW	CDM	16/10/14		



500000
510000
520000
530000
540000
550000
560000
7200000
7190000
7180000
7170000
7160000
7150000
N
Achilles Lake
Windy Lake
Hardy Lake
Exeter Lake
Ursula Lake
Ekati Mine
Fox Operation
Paul Lake
Duchess Lake
Lake D3 (Counts Lake)
Jay Project
Lac du Sauvage
Lake B1 (Christine Lake)
51.8 µg/m³
Existing Misery Road
Misery Operation
Lynx
Diavik Mine
Lac de Gras
Thonokied Lake
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
ELEVATION CONTOUR (20 m INTERVAL)
ESKER
WATERCOURSE
WATERBODY
LOCAL STUDY AREA
CONCENTRATIONS (µg/m³)
0 to < 15 (BLANK)
15 to < 30
30 to < 60
> 60
MAXIMUM POINT OF IMPINGEMENT
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
5 0 5
SCALE 1:250,000 KILOMETRES
PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA
TITLE
CONSTRUCTION CASE MAXIMUM ANNUAL NO₂ CONCENTRATIONS
Golder Associates
PROJECT 13-1328-0041 FILE No. DAR_Air_008_Construction_GIS
DESIGN DC 27/08/14 SCALE AS SHOWN REV 3
GIS SBM 15/10/14
CHECK ACP 16/10/14
REVIEW CDM 16/10/14
MAP 7.4-27
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The Construction Case predicted CO concentrations are summarized in Table 7.4-24. The predicted maximum concentrations outside of the development area are all below the NWT standards for both 1-hour and 8-hour averaging periods.

Table 7.4-24 Construction Case Predicted CO Concentrations

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)
LSA	1-hour	15,000	1,419.9
	24-hour	6,000	983.4
RSA	1-hour	15,000	1,419.9
	24-hour	6,000	983.4

CO = carbon monoxide; NWT = Northwest Territories; µg/m³ = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

The Construction Case predicted 24-hour and annual $PM_{2.5}$ concentrations are summarized in Table 7.4-25. The predicted maximum 24-hour concentration outside the development area is 302.6 µg/m³, above the NWT air quality standard of 28 µg/m³. The Construction Case predicted frequency and area above the Northwest Territories Ambient Air Quality Standards for $PM_{2.5}$ are summarized in Table 7.4-26. The NWT air quality standard may be exceeded for up to 166 days per year. The predicted 24-hour and annual concentrations are shown graphically in Maps 7.4-28 and 7.4-29, respectively. The predicted maximum concentrations outside the development area are associated with fugitive dust emissions from the construction activities surrounding the Jay Pit and haul roads.

Table 7.4-25 Construction Case Predicted $PM_{2.5}$ Concentrations

Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)
LSA	24-hour	28	302.6
	Annual	10	47.9
RSA	24-hour	28	302.6
	Annual	10	47.9

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; NWT = Northwest Territories; µg/m³ = micrograms per cubic metre; LSA = local study area; RSA = regional study area.

Table 7.4-26 Frequency and Area of Construction Case $PM_{2.5}$ Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Construction Case
LSA	24-hour	Frequency (day)	166
		Area (ha)	2,820
	Annual	Area (ha)	234
RSA	24-hour	Frequency (day)	166
		Area (ha)	2,820
	Annual	Area (ha)	234

$PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; LSA = local study area; RSA = regional study area; ha = hectare.

The construction phase predicted 24-hour and annual TSP concentrations are summarized in Table 7.4-27. The Construction Case predicted frequency and area above the NWT Ambient Air Quality Standards for TSP are summarized in Table 7.4-28.The predicted maximum 24-hour concentrations outside the development area may exceed the NWT air quality standard for 316 days per year. The predicted 24-hour and annual concentrations are shown graphically in Maps 7.4-30 and 7.4-31, respectively. The predicted maximum concentrations outside the development area are associated with fugitive dust emissions from the construction activities surrounding the Jay Pit and haul roads.

Table 7.4-27 Construction Case Predicted Total Suspended Particulate Concentrations

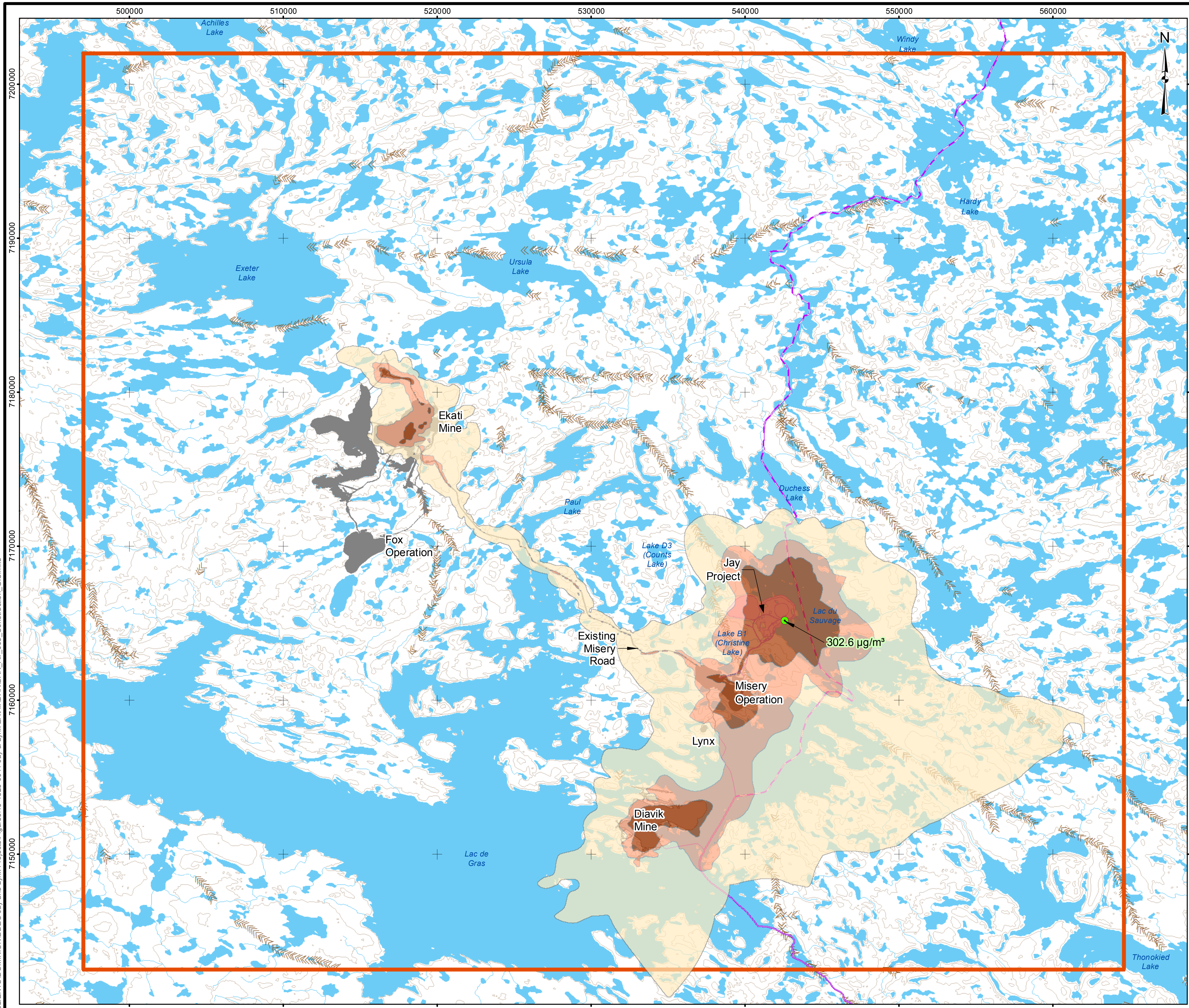
Study Area	Averaging Period	Criteria (NWT Ambient Air Quality Standards)	Maximum Predicted Concentrations Excluding Development Area (µg/m³)
LSA	24-hour	120	3,043.4
	Annual	60	556.6
RSA	24-hour	120	3,043.4
	Annual	60	556.6

NWT = Northwest Territories; $\mu g/m^3$ = microgram per cubic metre; LSA = local study area; RSA = regional study area.

Table 7.4-28 Frequency and Area of Construction Case Total Suspended Particulate Predictions Above the Northwest Territories Ambient Air Quality Standards

Study Area	Averaging Period	Parameter	Construction Case
LSA	24-hour	Frequency (day)	316
		Area (ha)	2,735
	Annual	Area (ha)	387
RSA	24-hour	Frequency (day)	316
		Area (ha)	2,735
	Annual	Area (ha)	387

LSA = local study area; RSA = regional study area; ha = hectare.



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
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 7 (BLANK)
- 7 to < 14
- 14 to < 28
- > 28
- MAXIMUM POINT OF IMPINGEMENT

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

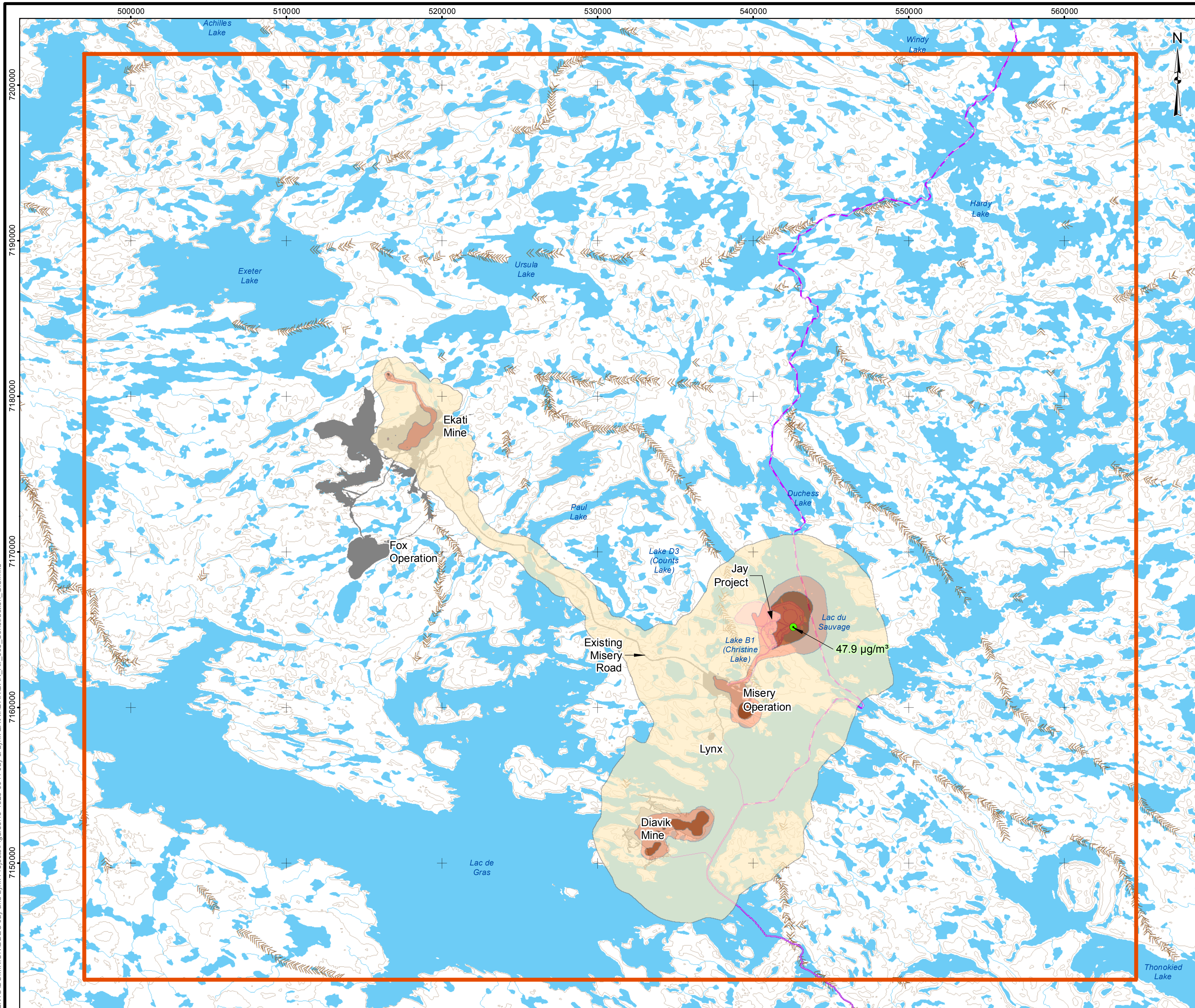
5 0 5
SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
CONSTRUCTION CASE MAXIMUM 24-HOUR $PM_{2.5}$ CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN REV 3
GIS	SBM	15/10/14	MAP 7.4-28
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	



LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
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- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 2.5 (BLANK)
- 2.5 to < 5
- 5 to < 10
- > 10
- MAXIMUM POINT OF IMPINGEMENT

REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
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DATUM: NAD83 PROJECTION: UTM ZONE 12N

DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND™

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

CONSTRUCTION CASE MAXIMUM ANNUAL $PM_{2.5}$ CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	MAP 7.4-29	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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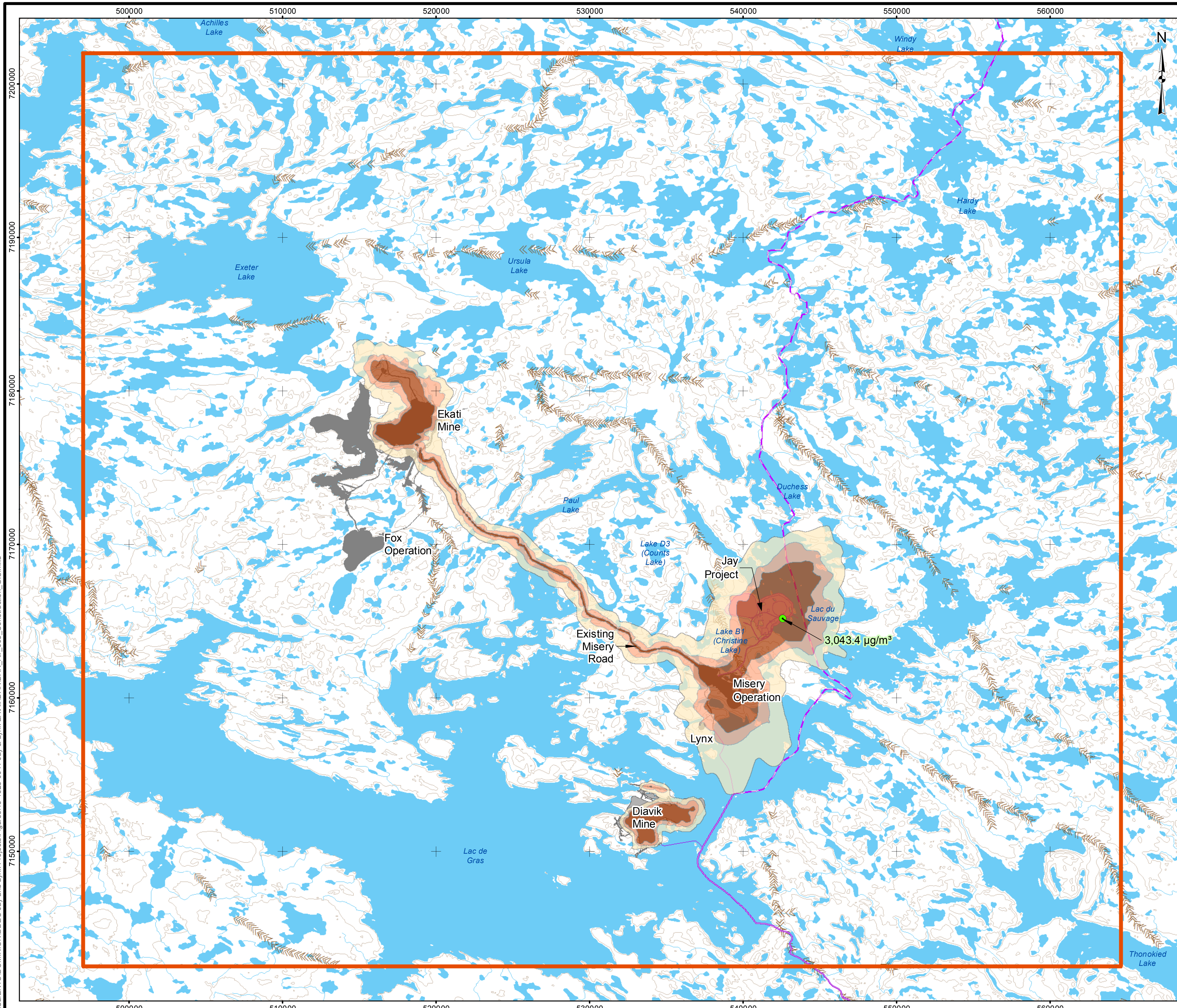

LEGEND

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- WINTER ROAD
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- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 30 (BLANK)
- 30 to < 60
- 60 to < 120
- > 120
- MAXIMUM POINT OF IMPINGEMENT

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

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
CONSTRUCTION CASE MAXIMUM 24-HOUR TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS
DESIGN	DC	27/08/14	SCALE AS SHOWN / REV 3
GIS	SBM	15/10/14	MAP 7.4-30
CHECK	ACP	16/10/14	
REVIEW	CDM	16/10/14	

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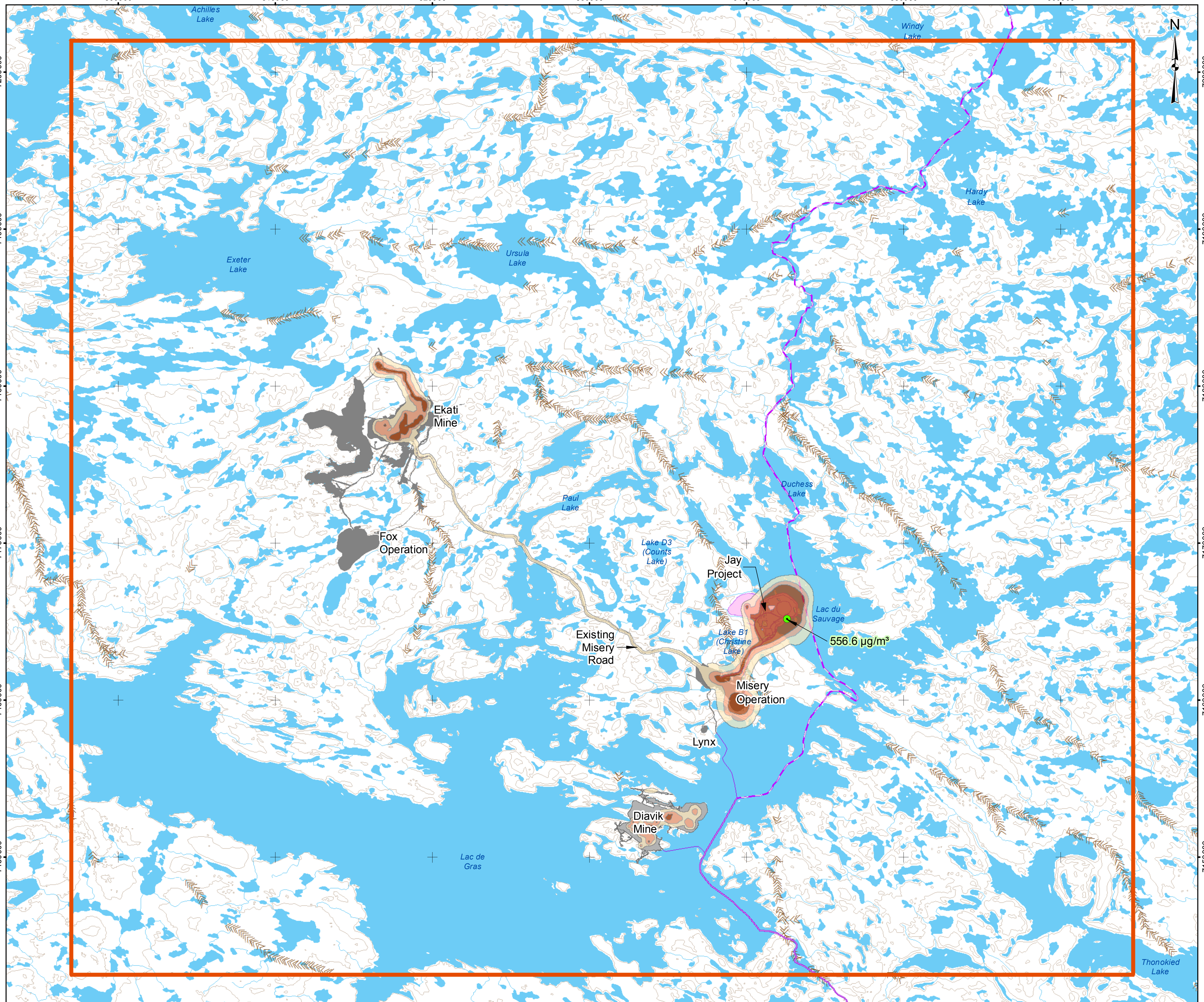

LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

CONCENTRATIONS (µg/m³)

- 0 to < 15 (BLANK)
- 15 to < 30
- 30 to < 60
- > 60
- MAXIMUM POINT OF IMPINGEMENT

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

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SCALE 1:250,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
CONSTRUCTION CASE MAXIMUM ANNUAL TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates

PROJECT		13-1328-0041	FILE No. DAR_Air_008_Construction_GIS	
DESIGN	DC	27/08/14	SCALE AS SHOWN	REV 3
GIS	SBM	15/10/14	MAP 7.4-31	
CHECK	ACP	16/10/14		
REVIEW	CDM	16/10/14		

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7.4.3 Residual Effects Summary

Residual effects on air quality for the Application Case were evaluated by comparing maximum predicted ground-level concentrations to NWT Ambient Air Quality Standards. Concentrations and deposition rates of other organic and inorganic substances were also modelled for the purpose of assessing the effects on ecological and human receptors as part of the effects assessments for other sections in the DAR. Residual effects of these other substances are not summarized and their impacts were not classified in this section because there are no regulatory ambient air quality guidelines that are applicable in the NWT.

A summary of the predicted maximum concentrations outside the Project-developed areas within the LSA is presented in Table 7.4-29 for all substances with regulatory ambient air quality guidelines. The modelling results for the Application Case indicate the following:

- **SO_2 and CO**: Predicted maximum concentrations of SO_2 and CO are in compliance with and well below the applicable ambient air quality standards and guidelines for all averaging periods.
- **NO_2**: The maximum predicted 1-hour, 24-hour, and annual concentrations outside the development area are predicted to exceed the applicable NWT Ambient Air Quality Standards. However, the areas exceeding the NWT standards are small (less than 30 hectares [ha]) and confined to a few hundred metres from the edge of the development area.
- **$PM_{2.5}$**: The maximum predicted 24-hour $PM_{2.5}$ concentration outside the development area is predicted to exceed the NWT standard for as many as 155 days in a year. The maximum predicted annual $PM_{2.5}$ concentration outside the development area also exceeds the applicable NWT standard.
- **TSP**: The maximum predicted 24-hour TSP concentration outside the development area is predicted to exceed the NWT standard for as many as 324 days in a year. The maximum predicted annual concentration outside the development area also exceeds the NWT standard.

Table 7.4-29 Summary of Key Modelled Air Quality Concentrations in the Local Study Area

Compound	Averaging Period	NWT Ambient Air Quality Standards[a] (μg/m^3)	Maximum Ground-level Concentration Outside the Project Lease Boundary (μg/m^3)	
			Baseline	Application
SO_2	1-hour	450	15.6	15.6
	24-hour	150	5.9	5.9
	Annual	30	0.4	0.4
NO_2	1-hour	400	499.9	500.4
	24-hour	200	140.3	320.9
	Annual	60	42.1	77.8
CO	1-hour	15,000	1,418.8	2,407.2
	8-hour	6,000	981.9	1949.4
$PM_{2.5}$	24-hour	30	93.7	324.5
	Annual	10	14.0	39.4

Table 7.4-29 Summary of Key Modelled Air Quality Concentrations in the Local Study Area

Compound	Averaging Period	NWT Ambient Air Quality Standards[(a)] (μg/m³)	Maximum Ground-level Concentration Outside the Project Lease Boundary (μg/m³)	
			Baseline	Application
TSP	24-hour	120	1,093.4	5,152.2
	Annual	60	191.0	607.6

Note: A predicted concentration that exceeds a criterion is accentuated in bold.
a) Source = ENR (2014).
NWT = Northwest Territories; μg/m³ = micrograms per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; TSP = total suspended particulates.

7.5 Prediction Confidence and Uncertainty

Dispersion models simplify the atmospheric processes associated with air mass movement and turbulence. This simplification limits the capability of a model to replicate discrete events and therefore introduces uncertainty. As a result of the uncertainty, dispersion models are coupled with model inputs that are generally designed to conservatively model concentration and deposition values. In doing so, practitioners can apply model results with the understanding that effects are likely overestimated.

The model as applied to the Project and described in detail in Appendix 7C has a number of limitations that result in model uncertainty. These include the following:

- The model's capability to predict concentrations accurately is not a perfect representation of a real world scenario, but accepted air dispersion models have been considered appropriate in predicting concentrations from industrial emission sources. An accepted dispersion model (i.e., CALPUFF) was selected for the analysis to minimize these uncertainties.
- The air dispersion model relies upon using existing meteorological data to model the dispersion of emissions in a future context. The assumption is that the future meteorology in the Project domain during the years of operation of the Project will be similar to the meteorological data used in the dispersion model. While the meteorology from the 2002 MM5 meteorological data with input from local meteorological stations will not be identical to future meteorology in the Project domain, data were appropriate for use in preparing the three-dimensional (3D) meteorological dataset, and were corroborated by comparing with local meteorological station data.
- All years of the construction and operation lifecycle of the Project were not assessed in the dispersion model. Rather, scenarios were assessed which accounted for expected peak emissions for specified cases, namely: a Base Case, Construction Case, and Application Case. These cases were each developed with conservative estimations to account for the uncertainty of emissions in each scenario.
- Emissions associated with industrial activities from the Project, the Ekati Mine, and the Diavik Mine were either developed with input from Dominion Diamond or taken from recent applications such as the NWT Diamonds Project Environmental Impact Statement (BHP 1995), 2006 air dispersion model (Rescan 2006), and Diavik Mine air dispersion model (Golder 2012). Some emission sources were reasonably well defined, such as point sources, but emissions from area sources are difficult to estimate and simulate in dispersion models. The Project area emission sources include pits, roads, dykes, mine rock piles, processed kimberlite storage areas, and dried lake bed.

- Characterization of emissions near pits and other sources of mechanically generated particulate are uncertain. Most estimates of particulate emissions for mining activities were based on United States Environmental Protection Agency (USEPA) emission factors. Many of these factors have limited applicability outside of the area in which they were developed (typically southwestern United States coal mines).
- Emission sources that are mitigated, such as for the application of dust suppression on haul roads, have mitigation factors applied to the modelled emission rate. Mitigation factors are chosen as accurately as possible, but in general, a conservative estimate of the mitigation is chosen so that higher emissions likely result in the model from the mitigated source than in reality.
- The time frame of concentration averages are also affected by uncertainties in the release of emissions from sources, which do not continually emit substances into the airshed. For example, certain processes modelled in the Project may emit at peak rate intermittently, such as generators, but they are conservatively modelled as emitting continually at peak rate due to the uncertainty in actual operations. This will likely lead to higher predictions over 24-hour or annual concentration periods than would be expected if the source was not emitting at peak continually.
- In cold weather conditions, such as those experienced at the Project, the conversion of NO concentrations to NO_2 will occur at a slower rate than in warmer conditions. Models assume the conversion is instantaneous, introducing uncertainty into the location and magnitude of predicted NO_2 concentrations.

These uncertainties were mitigated with the following methods and assumptions:

- Modelling was conducted using the 2022 operating year, which was expected to have the maximum emission rates from the Project. Other operating years are expected to have emission rates that are less than 2022. Therefore, the modelling results shown in this DAR are the maximum concentration and deposition values that are estimated to result from the Project.
- The modelling was based on the assumption that most equipment will be operating continuously at maximum capacity. This assumption can lead to an overestimation of the potential Project impacts for the longer averaging periods (24-hour and annual averaging periods).
- Emission rates can be determined in various ways for industrial sources. In general, if a less conservative emission rate was not known or could not be adequately justified for a source, a more conservative emission rate was chosen. For instance, if manufacturing data were not available for an equipment source, a more conservative rate such as from the USEPA AP-42 (USEPA 1995) may have been used.
- Conservative mitigation factors were applied to mitigated sources if accurate rates were not known for the mitigation process.
- Lower tier vehicle ratings were modelled than will likely exist in the current Ekati Mine vehicle fleet or that will be acquired for the Project fleet. Dominion Diamond will develop and execute air emissions management and ambient air quality monitoring programs as appropriate to validate that the predicted concentrations from the Project are conservative and to assist in managing that the Project emissions are kept to a reasonable level.

7.5.1 Level of Confidence

The level of confidence of predicted residual effects is provided in Table 7.5-1. The prediction confidence of the assessment on each VC is based on scientific information and statistical analysis, professional judgement, and effectiveness of mitigation (rated as High: greater than 80% confidence; Medium: 40% to 80% confidence; and Low: less than 40% confidence).

Conservatism was built into the various aspects of the air quality assessment as detailed in Section 7.6.3.

Based on the conservatism of the emission inventory, the emission modelling, and the addition of the background concentrations, it is unlikely that Project emissions and Project effects were underestimated. Therefore, the level of confidence is High.

Table 7.5-1 Level of Confidence in Potential Residual Effect Predictions: Air Quality

<table>
<tr><th>Residual Effect</th><th>Level of Confidence in Residual Effect Prediction</th><th>Level of Confidence Rationale</th></tr>
<tr><td colspan="3">Construction</td></tr>
<tr><td>Compliance with NWT Ambient Air Quality Standards, Canada-Wide Standards, and National Ambient Air Quality Objectives</td><td colspan="2">Effects will be bounded by operational effects.</td></tr>
<tr><td colspan="3">Operations</td></tr>
<tr><td>SO_2 Concentration – 1-Hour Averaging Period</td><td rowspan="12">High</td><td rowspan="12">Conservatism built into emission rate estimation (refer to Appendix 7A Summary Results of Air Quality Modelling)) and modelling methods consistent with standard modelling methods and best practices.

Quantification of emission rates based on conservative emission factors and assumptions (e.g., equipment is operating at maximum capacity).

The conservatism and the combination of Project effects and background concentrations lends certainty to residual effect predictions.</td></tr>
<tr><td>SO_2 Concentration – 24-Hour Averaging Period</td></tr>
<tr><td>SO_2 Concentration – Annual Averaging Period</td></tr>
<tr><td>NO_2 Concentration – 1-Hour Averaging Period</td></tr>
<tr><td>NO_2 Concentration – 24-Hour Averaging Period</td></tr>
<tr><td>NO_2 Concentration – Annual Averaging Period</td></tr>
<tr><td>CO Concentration – 1-Hour Averaging Period</td></tr>
<tr><td>CO Concentration – 8-Hour Averaging Period</td></tr>
<tr><td>$PM_{2.5}$ Concentration – 24-Hour Averaging Period</td></tr>
<tr><td>$PM_{2.5}$ Concentration – Annual Averaging Period</td></tr>
<tr><td>TSP Concentration – 24-Hour Averaging Period</td></tr>
<tr><td>TSP Concentration – Annual Averaging Period</td></tr>
<tr><td colspan="3">Closure</td></tr>
<tr><td>Compliance with NWT Ambient Air Quality Standards, Canada-Wide Standards, and National Ambient Air Quality Objectives</td><td colspan="2">Effects will be bounded by operational effects.</td></tr>
</table>

NWT = Northwest Territories; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; TSP = total suspended particulates.

7.6 Residual Impact Classification and Significance

7.6.1 Methods

7.6.1.1 *Residual Impact Classification*

The purpose of the residual impact classification is to describe the incremental and cumulative effects from approved developments and the Project (Application Case) on air quality 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 of the Project and other developments on the assessment endpoint for air quality. Effects are described using the criteria defined in Table 7.6-1, 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 air quality. 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 or to cause public concern. Therefore, positive effects are not assessed for significance.

Magnitude is a measure of the degree of change in an analysis endpoint caused by the Project and is classified into scales of negligible to low, moderate, and high. It is often described as the amount of change in a measurable parameter or variable relative to the baseline conditions, guidelines, or established threshold values. For this assessment, the amount of change is measured relative to the Base Case, and also compared to the NWT Ambient Air Quality Standards. The air quality compounds evaluated and the magnitude criteria used to evaluate the residual effects are outlined in Table 7.6-2.

Table 7.6-1 Definitions of Residual Impact Criteria Used to Evaluate Significance for Air Quality

Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood
Negligible: • The predicted change in concentration is less than or equal to 1% of the NWT AAQS; and the maximum predicted concentration is below 25% of the NWT AAQS **Low:** • The predicted change in concentration is less than or equal to 1% of the NWT AAQS; and the maximum predicted concentration is between 25% and 50% of the NWT AAQS; or, • The predicted change in concentration is greater than 1% of the NWT AAQS; and the maximum predicted concentration is below 25% of the NWT AAQS **Moderate:** • The predicted change in concentration is less than or equal to 1% of the NWT AAQS; and the maximum concentration is between 50% and 100% of the NWT AAQS; or, • The predicted change in concentration is greater than 1% of the NWT AAQS; and the maximum concentration is between 25% and 100% of the NWT AAQS **High:** • The predicted maximum concentration is at or above the NWT AAQS	**Local:** Project effect is confined to the LSA **Regional:** Project effect extends beyond the LSA but is restricted to within the RSA **Beyond Regional:** Project effect extends beyond the RSA	**Short-term:** Project effect is short-term and evident during the construction, decommissioning and closure phases **Medium-term:** Project effect is evident for an extended period, and lasts throughout the operations phase **Long-term:** Project effect extends beyond the life of the Project	**Infrequent:** Project effect is confined to a specific discrete period **Frequent:** Project effect occurs intermittently but repeatedly over the assessment period **Continuous:** Project effect occurs continuously over the assessment period.	**Reversible:** Project effect is readily reversible once the project activities cease **Irreversible:** Project effect cannot be reversed, or will take an extended time after project activities cease for the effects to be reversed	**Unlikely:** Predicted maximum concentration is possible but unlikely due to conservatism in methodology, model limitations, and/or rare emission scenarios or meteorological conditions that cause the predictions **Likely:** Predicted maximum predicted concentration is possible, but is not certain due to conservatism in methodology or model limitations **Highly Likely:** Predicted maximum concentration is likely to occur or is certain

% = percent; NWT AAQS = Northwest Territories Ambient Air Quality Standards; LSA = local study area; RSA = regional study area.

Table 7.6-2 Magnitude Classifications for Criteria Air Quality

Parameter	Magnitude if Prediction is:			
	Negligible (µg/m³)	**Low (µg/m³)**	**Moderate (µg/m³)**	**High (µg/m³)**
1-hour SO_2	<112.5 and change ≤4.5	<112.5 and change >4.5 or 112.5 ≤ Prediction <225 and change ≤ 4.5	225 ≤ Prediction <450 and change ≤4.5 or 112.5 ≤Prediction <450 and change >4.5	≥450
24-hour SO_2	<37.5 and change ≤1.5	<37.5 and change >1.5 or 37.5 ≤Prediction <75 and change ≤1.5	75 ≤Prediction <150 and change ≤1.5 or 37.5≤Prediction <150 and change >1.5	≥150
annual SO_2	<7.5 and change ≤0.3	<7.5 and change >0.3 or 7.5 ≤Prediction <15 and change ≤0.3	15 ≤ Prediction <30 and change ≤0.3 or 7.5 ≤Prediction <30 and change >0.3	≥30
1-hour NO_2	<100 and change ≤4	<100 and change >4 or 100 ≤Prediction <200 and change ≤4	200 ≤ Prediction <400 and change ≤4 or 100 ≤Prediction <400 and change >4	≥400
24-hour NO_2	<50 and change ≤2	<50 and change >2 or 50 ≤ Prediction <100 and change ≤ 2	100 ≤ Prediction <200 and change ≤2 or 50 ≤ Prediction <200 and change >2	≥200
annual NO_2	<15 and change ≤0.6	<15 and change >0.6 or 15 ≤ Prediction <30 and change ≤0.6	30 ≤ Prediction <60 and change ≤0.6 or 15 ≤ Prediction <60 and change >0.6	≥60
1-hour CO	<3,750 and change ≤150	<3,750 and change >150 or 3,750 ≤ Prediction <7,500 and change ≤150	7,500 ≤ Prediction <15,000 and change ≤150 or 3,750 ≤ Prediction <15,000 and change >150	≥15,000
8-hour CO	<1,500 and change ≤60	<1,500 and change >60 or 1,500 ≤ Prediction <3,000 and change ≤60	3,000 ≤ Prediction <6,000 and change ≤60 or 1,500 ≤ Prediction <6,000 and change >60	≥6,000
24-hour $PM_{2.5}$	<7 and change ≤0.28	<7 and change >0.3 or 7 ≤ Prediction <14 and change ≤0.28	14 ≤ Prediction <28 and change ≤0.28 or 7 ≤ Prediction <28 and change >0.28	≥28
Annual $PM_{2.5}$	<2.5 and change ≤0.1	<2.5 and change >0.1 or 2.5 ≤ Prediction <5 and change ≤0.1	5 ≤ Prediction <10 and change ≤0.1 or 2.5 ≤ Prediction <10 and change >0.1	≥10
24-hour TSP	<30 and change ≤1.2	<30 and change >1.2 or 30 ≤ Prediction <60 and change ≤1.2	60 ≤ Prediction <120 and change ≤1.2 or 30 ≤ Prediction <120 and change >1.2	≥120
annual TSP	<15 and change ≤0.6	<15 and change >0.6 or 15 ≤ Prediction <30 and change ≤0.6	30 ≤ Prediction <60 and change ≤0.6 or 15 ≤ Prediction <60 and change >0.6	≥60

µg/m³ = micrograms per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; TSP = total suspended particulates; <= less than; >= greater than; ≤ = less than or equal to; ≥ = greater than or equal to.

Generally, the magnitude was classified as negligible if there was no predicted increase, or the predicted increase due to the Project emissions was less than 1% of the NWT Ambient Air Quality Standard. Predicted increases of this magnitude should not be measurable. A low or moderate magnitude was assigned when an increase was predicted but the maximum predicted value outside of the development areas from the dispersion modelling was below the applicable NWT Ambient Air Quality Standard. The NWT Ambient Air Quality Standard has been established to provide protection against adverse effects on the environment and human health, which means environmental or health impacts would be low below these levels. A high magnitude was assigned if the prediction is above the NWT standard.

Geographic extent refers to the area impacted by the effect, and is different from the spatial boundary (i.e., effects study area) for the effects analysis. Geographic extent is categorized into three scales of local, regional, and beyond regional. For air quality, effects are largest nearest to the sources (local effects) and decrease rapidly with distance away from the sources. 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.

The duration of individual events, timing (i.e., frequency), and the overall period during which the residual effect may occur are considered. Duration refers to the overall time frame during which the impact may occur. Frequency refers to how often the effect will occur within a given time period.

Reversibility indicates the potential for recovery of the resource from an environmental effect. The effect of the Project on air quality is reversible because emissions will not affect air quality after the Project is complete and has been decommissioned.

Likelihood is the probability of an impact occurring and is described in parallel with uncertainty. In the case of air quality, likelihood depends on several factors, including the certainty in the emission estimates, the representativeness of meteorology and surface features, and confidence in model results.

7.6.1.2 *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 air quality. The significance of the contribution of incremental effects from the Project on air quality is provided, but the evaluation is focused on determining the significance of cumulative effects on air quality.

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 context for classifying the magnitude of effects to air quality assessment endpoints. Frequency and likelihood are also considered as modifiers when determining significance, where applicable.

The evaluation of significance for air quality considers the entire set of primary pathways that influence the assessment endpoint; thus, significance is not explicitly assigned to each pathway. Rather, the relative contribution of each pathway is used to determine the significance of the Project and other developments on the assessment endpoint, which represents a weight of evidence approach (i.e., evaluating the persuasiveness of evidence indicating that an effect is significant or not significant). For example, a pathway with a high magnitude, a large geographic extent, and a long-term duration is given more weight in determining significance relative to pathways with smaller-scale effects. The relative effect from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to the assessment endpoint are assumed to contribute the most to the determination of environmental significance.

The determination of environmental significance on air quality considered the following key factors:

- Results from the residual impact classification of primary pathways 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.
- The level of confidence in predicted effects, established guidelines and standards, and experienced opinion are also included in the evaluation of determining environmental significance.

For the air quality assessment endpoint "compliance with applicable ambient air quality criteria," the definition of environmental significance is limited to the air quality VC. Although each of the ambient air quality criteria were developed to be protective of human health or other ecological endpoints, such as vegetation or wildlife, the ultimate determination of the environmental significance of the Project as it pertains to air quality on human health and other VCs is analyzed by each discipline (e.g., human health, wildlife) and presented in other Key Lines of Inquiry or SONs within the DAR.

A key consideration when determining significance of predicted ground-level concentrations to air quality is the implicit value attributed to the quality of the air by humans and other ecological receptors. This could apply to aesthetic qualities, including taste, smell, and visual appeal. The air quality significance ratings, therefore, can be considered an intermediate step towards an overall determination of significance to the health and well-being of various VCs.

For the purpose of this assessment, a significant impact was considered to be one where irreversible and long-term changes in air quality would be expected after mitigation and other design features are implemented. Due to an implied linkage between the value placed on clean air and the regulatory air quality standards in place, the significance ratings are related to the potential for excursions from the established standards; therefore, if a prediction is reversible and short-term or medium-term in duration, but it is above the established threshold at times, it would receive a not significant rating. Conversely, if a compound is expected to result in an irreversible and long-term change in air quality but it is below the established guideline, it would receive a rating of significant.

This method is used to identify predicted residual adverse effects that have sufficient magnitude, duration, and geographic extent to cause fundamental changes to air quality, and therefore, result in significant impacts. The following definitions are used for predicting the significance of effects to compliance with regulatory air emission standards and guidelines.

Not significant – Predicted concentrations may be either above or below the AAQS for the NWT, but where exceedances of the relevant criteria are consistently confined to the area immediately adjacent to the Project activities, and/or where the changes to air quality that result in exceedances of the AAQS are reversible upon cessation of the Project activities. There is also an understanding that the limitations of simulating air quality compel the use of conservative assumptions in the modelling.

Significant – Predicted concentrations are above the AAQS for the NWT and exceedances of the relevant criteria are widespread, continuous, and occur well-beyond the Project area. Significant effects are defined by a prognosis for long-term reversibility or irreversibility, and a high degree of confidence that the effects are likely.

7.6.2 Results

A summary of the impact classification and prediction of significance on the air quality endpoints are provided in Table 7.6-3. All of the effects were classified as local in geographic extent and of medium duration because emissions and effects cease when Project activities are completed. Magnitude classifications ranged from negligible to high within the LSA. Consequently, effects to air quality were classified as not significant.

Table 7.6-3 Summary of Residual Impact Classification of Primary Pathways and Predicted Significance of Cumulative Effects on Air Quality

Pathway	Effects Statement	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Likelihood	Significance for Assessment Endpoint[(a)]
Mine equipment, processing, and fleet exhaust emissions during construction, operations, and closure.	SO_2 Concentration – 1-Hour Averaging Period	Negligible	Local	Medium-term	Frequent	Reversible	Likely	Not Significant
	SO_2 Concentration – 24-Hour Averaging Period	Negligible	Local	Medium-term	Frequent	Reversible	Likely	
	SO_2 Concentration – Annual Averaging Period	Negligible	Local	Medium-term	Infrequent	Reversible	Likely	
	NO_2 Concentration – 1-Hour Averaging Period	High	Local	Medium-term	Frequent	Reversible	Likely	
	NO_2 Concentration – 24-Hour Averaging Period	High	Local	Medium-term	Frequent	Reversible	Likely	
	NO_2 Concentration – Annual Averaging Period	High	Local	Medium-term	Infrequent	Reversible	Likely	
	CO Concentration – 1-Hour Averaging Period	Low	Local	Medium-term	Frequent	Reversible	Likely	
	CO Concentration – 8-Hour Averaging Period	Moderate	Local	Medium-term	Frequent	Reversible	Likely	
	$PM_{2.5}$ Concentration – 24-Hour Averaging Period	High	Local	Medium-term	Frequent	Reversible	Unlikely	
	$PM_{2.5}$ Concentration – Annual Averaging Period	High	Local	Medium-term	Infrequent	Reversible	Unlikely	
Fugitive emissions (e.g., dust), and equipment and fleet exhaust.	TSP Concentration – 24-Hour Averaging Period	High	Local	Medium-term	Frequent	Reversible	Unlikely	
	TSP Concentration – Annual Averaging Period	High	Local	Medium-term	Infrequent	Reversible	Unlikely	

a) Compliance with the NWT ambient air quality standards.

SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; $PM_{2.5}$ = particulate matter of mean aerodynamic diameter less than 2.5 microns; TSP = total suspended particulates.

7.7 Follow-Up and Monitoring

In the DAR, monitoring programs are proposed to deal with the uncertainties associated with the effect predictions and the performance of environmental design features and mitigation. In general, monitoring is used to verify the effects predictions. Monitoring also is used to identify any unanticipated effects and provide for the implementation of adaptive management to limit these effects. Typically, monitoring includes one or more of the following categories, which may be applied during the development of the Project:

- **Compliance inspections** – 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 of a silt fence).
- **Environmental monitoring** – monitoring to track conditions or issues during the development lifespan of the Project, and subsequently provide for the implementation of adaptive management (e.g., monitoring of minewater discharge quality and volumes).
- **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 detects effects that are different from predicted effects, or the need for improved or modified design features and mitigation, then adaptive management will be implemented. This may include increased monitoring, changes in monitoring plans, or additional mitigation. The existing Ekati Mine Air Quality Management and Monitoring Plan can be expanded to encompass the Project.

7.8 References

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7.9 Glossary

Term	Definition
Acidification	The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic processes. Acidification is exhibited as the lowering of pH.
Ambient air	Outdoor or open air beyond the developed industrial footprint.
Ammonia (NH_3)	A pungent, colourless, gaseous, alkaline compound of nitrogen and hydrogen that is soluble in water, lighter than air, and can easily be condensed to a liquid by cold and pressure.
Anthropogenic	Human-related, often referring to an activity, development or disturbance on the landscape.
Background concentration	The concentration of a chemical in a defined control area during a fixed period before, during or after data gathering.
Barrenland	The area of the Northwest Territories east of the Mackenzie River valley and north and east of the tree line characterized by a low rolling tundra landscape, continuous permafrost, and low densities of human settlement.
Base Case	Describes the existing environment before the application of the Project to provide an understanding of the current physical, biological, and social conditions that may be influenced by the Project. Existing conditions include the cumulative effects from all previous and existing developments and activities that are approved, and are either under construction or not yet initiated in the ESA of a VC.
Carbon monoxide (CO)	A colourless, odourless, toxic gas at standard conditions that is a product of incomplete combustion of fossil fuels.
Climate normal	The arithmetic mean of climatological elements over 30 years used to describe the average climate conditions at a location.
Daily average	The arithmetic mean based on a dataset of 24 1-hour averages for each day. Daily averages are only calculated for days with eighteen or more valid hours of data in the day.
Developer's Assessment Report	The Developer's Assessment Report is a document submitted by the developer of a proposed project that addresses the issues that are identified in the Terms of Reference. This document provides regulatory agencies and the general public the information they will require to make informed decisions regarding the project.
Diurnal	Daily.
Emission	The act of releasing or discharging air contaminants into the ambient air from any source.
Eutrophication	The over fertilization of a body of water, which generally results in increased plant growth and decay. This ultimately leads to an increase in simple algae and plankton over more complex plant species, resulting in a decrease in water quality. Causes of eutrophication can be anthropogenic or natural.
Greenhouse Gases	Gases such as carbon dioxide (CO_2), water vapour, methane (CH_4), nitrous oxide (N_2O), and other trace gases, which trap heat in the atmosphere, producing the greenhouse effect.
Key Line of Inquiry	Areas of the greatest concern that require the most attention during the environmental impact review and the most rigorous analysis and detail in the Developer's Assessment Report. Their purpose is to ensure a comprehensive analysis of the issues that resulted in significant public concern about the proposed development.
Local Study Area	Defines the spatial extent directly or indirectly affected by the project.
Mean	Arithmetic average value in a distribution.
Median	A single statistical value used to characterize a series of data values. Half of the data values are larger than the median value, and half of the data values are less than the median value.
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.

Term	Definition
Nitrogen dioxide (NO_2)	One of the component gases of oxides of nitrogen, which also includes nitric oxide. In burning natural gas, coal, oil and gasoline, atmospheric nitrogen may combine with molecular oxygen to form nitric oxide, an ingredient in the brown haze observed near large cities. Nitric oxide is converted to nitrogen dioxide in the atmosphere. Cars, trucks, trains and planes are a major source of oxides of nitrogen. Other major sources include oil and gas industries and power plants.
Nitrogen oxides (NO_X)	Consist of nitric oxide (NO) and nitrogen dioxide (NO_2) and are reported as equivalent NO_2.
Parameter	A particular physical, chemical, or biological property that is being measured.
Ozone (O_3)	A gas that occurs both in the Earth's upper atmosphere and at ground level. Ozone in the upper atmosphere protects living organisms by preventing damaging ultraviolet light from reaching the Earth's surface. Ground-level ozone is an air pollutant with harmful effects on the respiratory systems of animals.
Particulate matter	Any aerosol that is released to the atmosphere in either solid or liquid form.
$PM_{2.5}$	Particulate matter with particle diameter nominally smaller than 2.5 micrometres (µm).
PM_{10}	Particulate matter with particle diameter nominally smaller than 10 micrometres (µm).
Polycyclic Aromatic Hydrocarbons	A large group of organic compounds comprised of two or more aromatic rings and by-products of combustion. They are found in crude oil and a variety of products such as bitumen, asphalt, coal tar pitch volatiles, and unrefined or mildly refined mineral oils. Polycyclic aromatic hydrocarbons (PAHs) are emitted into the Canadian environment from both natural and anthropogenic sources. Forest fires, which release approximately 2,000 tonnes of PAHs per year, are the single most important natural source of PAHs in Canada. However, since releases from that source are generally widely separated in time and space across the country, they do not result in continuous exposure in any specific area. Anthropogenic sources are numerous and result in emissions of PAHs into all environmental compartments.
Potential Acid Input	A composite measure of acidification determined from the relative quantities of deposition from background and industrial emissions of sulphur, nitrogen and base cations.
Reasonably Foreseeable Development Case	Application Case plus reasonably foreseeable developments. includes the Application Case plus the cumulative effects of future projects.
Receptor	The person or organism subjected to exposure to chemicals or physical agents.
Regional study area	Represents the area of study for the assessment of cumulative (combined) effects of the Project and other past, existing or planned developments.
Relative humidity	The ratio of the amount of water vapour in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and measures the percentage of saturation.
Solar radiation	The principal portion of the solar spectrum that spans from approximately 300 nanometres (nm) to 4,000 nm in the electromagnetic spectrum. It is measured in watts per square metre (W/m^2), which is radiation energy per second per unit area.
Subject of Note	Areas of the concern that require attention during the environmental assessment. Are of lower priority than the key lines of inquiry, but still require a sufficient analysis to demonstrate whether the development is likely to cause significant adverse impacts.
Sulphur dioxide (SO_2)	A colourless gas with a pungent odour.
Total suspended particulate (TSP)	A term used to collectively describe tiny airborne particles or aerosols that are less than 100 micrometres in size.
Tundra	An area between the polar ice cap and taiga that is characterized by a lack of trees and permanently frozen subsoil.
Valued Component	Represents physical, biological, cultural, and economic properties of the social-ecological system that is considered to be important by society.

Term	Definition
Volatile Organic Compounds	A group of organic chemical compounds with high vapour pressures and low boiling points that evaporate readily.
Wildlife	A term to describe all undomesticated animals living in the wild.
Windrose	Graphic pie-type representation of frequencies of wind directions and speeds over a period of time (e.g., one year) for a meteorological station.
Winter road	Roads which are built over frozen lakes and tundra. Compacted snow and/or ice is used for embankment construction.