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10.0 SUBJECT OF NOTE: AIR QUALITY

10.1 Introduction

10.1.1 Context

This section of the Developer's Assessment Report (DAR) for the NICO Cobalt-Gold-Copper-Bismuth Project (NICO Project) consists solely of the Subject of Note (SON) for air quality. In the Terms of Reference (TOR) for the NICO Project DAR issued on 30 November 2009, the Mackenzie Valley Review Board (MVRB) identified air quality as 1 of 7 valued components (VCs) requiring consideration by the developer (MVRB 2009).

As identified within the TOR, the effects of the NICO Project on air quality are assessed in this SON; however, issues addressed in the following Key Lines of Inquiry (KLOI) and SON may overlap with this SON:

- KLOI: Water Quality (Section 7);
- KLOI: Caribou and Caribou Habitat (Section 8);
- SON: Fish and Aquatic Habitat (Section 12);
- SON: Terrain and Soils (Section 13);
- SON: Vegetation (Section 14);
- SON: Wildlife (Section 15);
- SON: Human Environment (Section 16); and
- Section 18: Biophysical Monitoring and Management Plans.

10.1.2 Purpose and Scope

The purpose of the SON for air quality is to assess the effects of the Project on air quality and meet the TOR issued by the MVRB. The TOR that apply to the SON for air quality are shown in Table 10.1-1. The TOR document is included in Appendix 1.I and the complete table of concordance for the DAR is in Appendix 1.II of Section 1, Introduction of the DAR.

Table 10.1-1: Subject of Note: Air Quality Concordance with the Terms of Reference

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
3.2.3	An overall environmental assessment study area and the rationale for its boundaries;	10.1.3.2, 10.1.3.3
	Fortune's chosen spatial boundaries for the assessment of potential impacts for each of the valued components considered; and	10.1.3.2, 10.1.3.3
	The temporal boundaries chosen for the assessment of impacts on each valued component.	10.4.1.1.1
3.2.4	**Description of the Existing Environment**	10.2
	The developer is encouraged to provide a description of the methods used to acquire the information used to describe baseline conditions.	10.2, Annex F

Table 10.1-1: Subject of Note: Air Quality Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
3.3.1	**Impact Assessment Steps and Significance Determination Factors** In assessing impacts on the biophysical environment, the *Developer's Assessment Report* will for each subsection:	
	• Identify any valued components used and how they were determined;	10.1.1
	• For each valued component, identify and provide a rationale for the criteria and indicators used;	10.1.1
	• Identify the sources, timelines and methods used for data collection;	10.2
	• Identify natural range of background conditions (where historic data are available), and current baseline conditions, and analyze for discernible trends over time in each valued component, where appropriate, in light of the natural variability for each;	10.2.1, 10.2.2
	• Identify any potential direct and indirect impacts on the valued components that may occur as a result of the proposed development, identifying all analytical assumptions;	10.3
	o Predict the likelihood of each impact occurring prior to mitigation measures being implemented, providing a rationale for the confidence held in the prediction;	10.3
	o Describe any plans, strategies or commitments to avoid, reduce or otherwise manage the identified potential adverse impacts, with consideration of best management practices in relation to the valued component or development component in question;	10.3
	o Describe techniques, such as models utilized in impact prediction including techniques used where any uncertainty in impact prediction was identified;	10.4
	• Assess and provide an opinion on the significance of any residual adverse impacts predicted to remain after mitigation measures; and	10.7
	• Identify any monitoring, evaluation and adaptive management plans required to ensure that predictions are accurate and if not, to proactively manage against adverse impacts when they are encountered.	18.0, 10.9
	The developer will characterize each predicted impact. These criteria will be used by the developer as a basis for its opinions on the significance of impacts on the biophysical environment.	10.6.2

Table 10.1-1: Subject of Note: Air Quality Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
3.3.9	**Air quality** The Developer's Assessment Report will evaluate the NICO Project's potential impacts on air quality due to project emissions. While considering impacts and mitigation on air quality, the developer is encouraged to enter dialogue with Environment Canada and the Government of the Northwest Territories about appropriate methods for modeling air quality and strategies for minimizing air quality impacts, and should consider the *Guideline for Ambient Air Quality Standards in the Northwest Territories* and Government of the Northwest Territories *Guideline for Dust Suppression*. The developer will:	
	• Describe and quantify existing conditions with respect to air quality and meteorological conditions.	10.2
	• Predict the emissions and potential impacts using an established air quality model, during all phases of the NICO Project and the components of its operations. The model shall predict both dispersion and deposition potential.	10.4
	• Describe proposed mitigations and any plans for air quality monitoring, evaluation and adaptive management.	10.9
3.6	**Cumulative Effects** Pursuant to paragraph 117(2)(a) of the *Mackenzie Valley Resource Management Act*, the Review Board considers cumulative effects in its determinations. Cumulative effects are the combined effects of the development in combination with other past, present or reasonably foreseeable future developments and human activities. In addressing cumulative effects, the developer is encouraged to refer to Appendix H of the Review Board's Environmental Impact Assessment Guidelines. The developer will:	
	• Describe and provide rationale for which past, present or reasonably foreseeable future developments and human activities are being considered in the cumulative effects assessment.	10.4.1.1.1
	• Identify which of the valued components may be affected by other past, present or reasonably foreseeable future developments and human activities.	10.4
	• Assess the likelihood, duration, and magnitude of the combined effect of these human activities on the identified valued components.	10.5
	• Describe any mitigation measures proposed to reduce or avoid the predicted effects, specifying if and how adaptive management will be used, and provide an assessment of any residual cumulative impacts.	10.3, 10,4, 18.0

Table 10.1-1: Subject of Note: Air Quality Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
Appendix A	**Existing Environment**	
	Biophysical environment Describe the biophysical environment within the relevant environmental assessment study areas. The following description should be at a level of detail sufficient to allow for a thorough assessment of NICO Project effects. Describe the following:	
	1) The physical location of the proposed development and identification of associated ecozones and ecoregions.	10.2
	2) Ambient air quality.	10.2
Appendix H	**Air Quality**	
	While assessing impacts on air, describe:	
	1) Pre-development conditions including:	10.2
	a. general climatology (typical temperatures, precipitation, air flows, etc.), terrain type and topography; and	10.2.1,
	b. baseline ambient concentrations of criteria air contaminants (total suspended particulates, particulate matter (PM_{10}, $PM_{2.5}$) nitrogen oxides, sulphur dioxide and carbon monoxide).	10.2.2
	2) Potential impacts from project emissions during construction, operation and closure phases:	
	a. estimate criteria air contaminant emissions from all project sources including fugitive dust;	10.4.1.2,10.4.2.1
	b. predict annual carbon emissions over the life of the mine and describe any offsets proposed to mitigate carbon emissions;	10.4.2.1
	c. predict local and regional dispersion of the project emissions and resulting ambient concentrations and deposition of pollutants using an established air quality model;	10.4.2.3
	d. compare predicted ambient concentrations and deposition rates to relevant ambient air quality guidelines and standards;	10.4.2
	e. discuss potential sources and quantities of contaminants from the handling and transport of ore and concentrate, and their expected deposition range; and	10.4.2
	f. discuss and quantify any potential links between predicted air quality impacts and other valued components such as water quality, fish, wildlife, and human health.	10.3.2
	3) Monitoring, mitigation and adaptive management strategies:	
	a. use predicted ambient air quality concentrations to design an appropriate monitoring program and to develop mitigation and adaptive management strategies to minimize emissions of criteria air contaminants;	10.9.1, 18.0

Table 10.1-1: Subject of Note: Air Quality Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
	b. describe specific mitigation, adaptive management strategies and monitoring methods, to minimize contamination by fugitive dust from the handling and transport of raw ore and concentrate and the processing operations; and	10.9.1.4, 10.9.1.5, 10.9.1.6, 10.9.1.7, 10.9.2, 10.9.3
	c. develop and describe an incineration management plan.	10.9.3

Valued components represent physical, biological, cultural, social, and economic properties of the environment that are considered to be important by society. The atmospheric environment is identified as a VC for this effects assessment. Air quality is a fundamental component of the natural ecosystem because of its biological importance to all living organisms, including vegetation and wildlife, and the potential for deposition of dust and contaminants on the landscape and waterbodies. Air quality also has an aesthetic value in terms of visibility and odour. Air contaminants can have the potential to adversely affect ecological and human health. In addition, air quality issues have the potential to extend to regional and global scales to include potential acidic deposition (acid rain) and climate effects (global warming).

The assessment endpoints represent the key features of the VCs that should be protected. Assessment endpoints for the ambient air quality and climate VCs are presented in Table 10.1-2. In addition, the measurement endpoints, used to evaluate the assessment endpoints, are presented.

Table 10.1-2: Summary of the Assessment and Measurement Endpoints for the Air Quality Valued Component

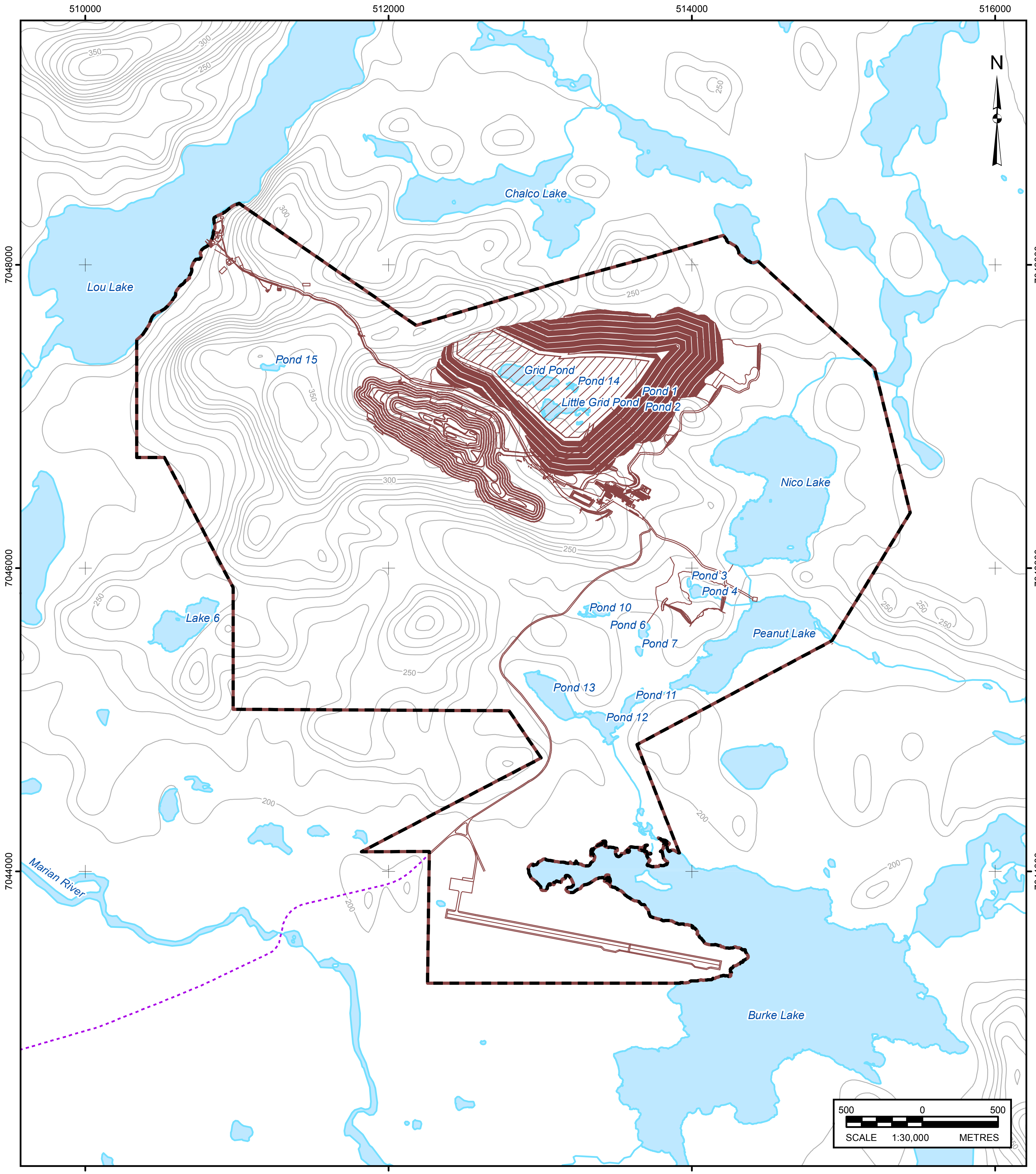
Valued Component	Assessment Endpoints	Measurement Endpoints
Atmospheric environment	• Compliance with regulatory ambient air quality guidelines or standards	• Total suspended particulates, course particulate matter, and fine particulate matter • Sulphur dioxide, nitrogen oxides, carbon monoxide • Metals (e.g., arsenic) • Deposition rates

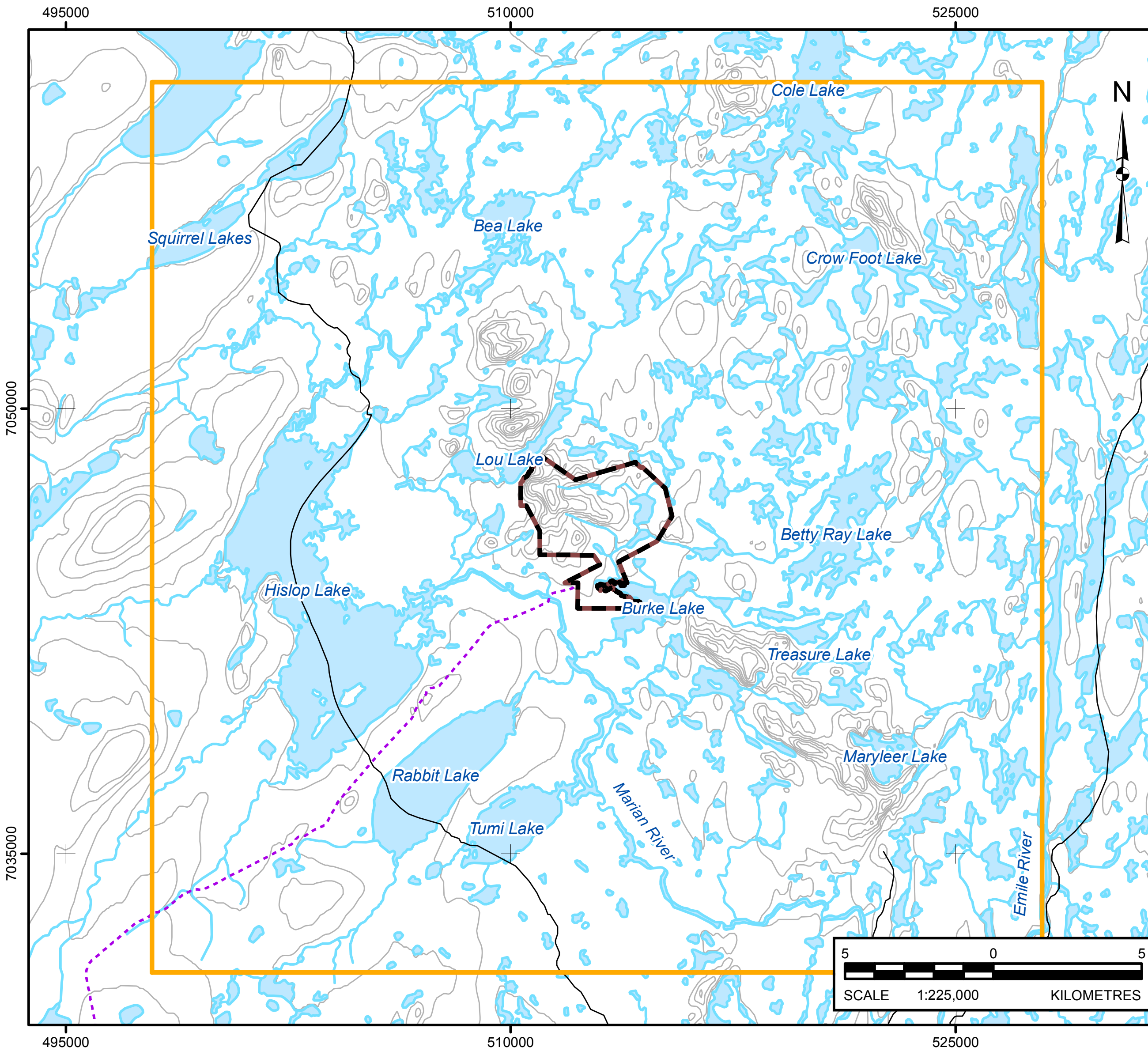
10.1.3 Study Areas

10.1.3.1 General Setting

The NICO Project is located approximately 160 kilometres (km) northwest of Yellowknife, Northwest Territories (NWT) in the Wek'èezhìi Settlement Area and is located within the Marian River drainage basin, approximately 10 km east of Hislop Lake at a latitude of 63°33' North and a longitude of 116°45' West.

The NICO Project is surrounded by elevated terrain, which is expected to influence the local meteorological conditions. Figure 10.1-1 shows contour plots of the surrounding topography at the NICO Project.





LEGEND

- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- CONTOUR (10 METRE INTERVAL)
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE
ELEVATION CONTOURS AT THE NICO PROJECT AND SURROUNDING AREA

Golder Associates
Edmonton, Alberta

FILE No. E-Air-002-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.1-1**	
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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10.1.3.2 Study Area Selection

Appropriate spatial boundaries require definition to assess the potential effects of the NICO Project on air quality. The study area for this SON was identified in the TOR (MVRB 2009) as follows:

> *"The geographic scope will include all areas that may be affected by activities within the NICO Project scope of development."*

The boundaries for the air quality study were selected based on the following factors:

- location and concentration of emission sources;
- potentially sensitive receptor locations; and
- the extent of the dispersing plume(s).

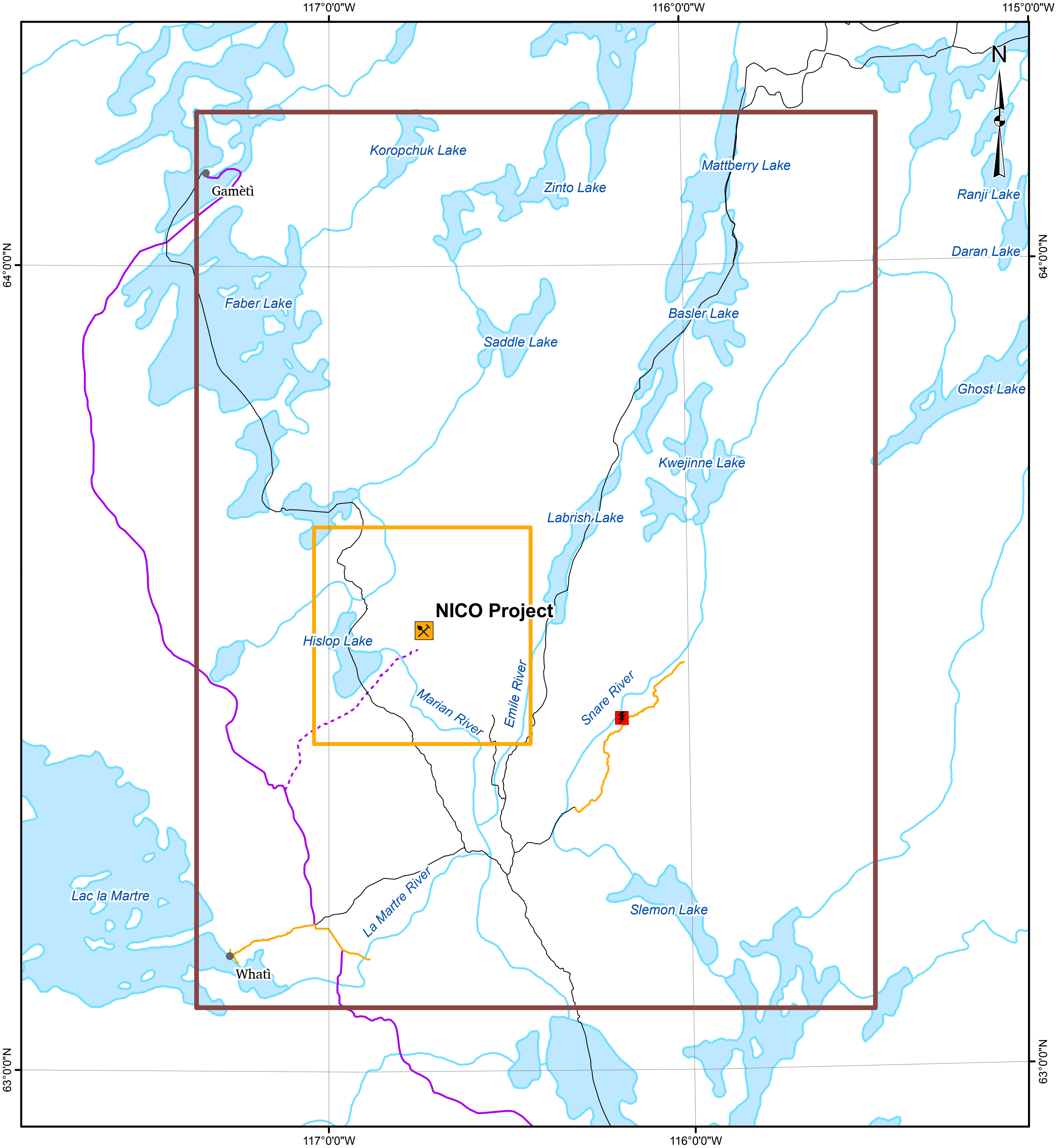
10.1.3.3 Air Quality Study Areas

The SON: Air Quality has the following 2 study areas, which are shown in Figure 10.1-2:

- Regional Study Area: The RSA defines the region over which modelling results are presented. The RSA for the NICO Project is defined by a 94 km by 124 km area. The RSA was selected to include air quality cumulative effects associated with emissions from existing and approved industrial sources within the region in combination with the NICO Project. It was designed to include the communities of Gamètì and Whatì but allow for the smallest grid spacing possible near the NICO Project for modelling.
- Local Study Area (LSA): The LSA defines an area in the immediate vicinity of the NICO Project where most of any air quality effects caused by the NICO Project are expected to occur. The LSA is a subset of the RSA and is subject to a more focussed assessment of the effects associated with the NICO Project. The air quality LSA is defined by a 30 by 30 km area centred on the NICO Project.

To meet the TOR and to address the factors listed in Section 10.1.3.2, the selected RSA captures the following:

- the NICO Project as a source of emissions;
- the Snare Rapids Hydro Project as a source of emissions;
- the traffic emissions from the potential realignment of the winter road through the Wek'èezhìi Settlement Area (i.e., Proposed Tłı̨chǫ Road Route) as well as the NICO Project Access Road (NPAR) from the Proposed Tłı̨chǫ Road Route to the NICO Project;
- the various fisheries and water quality lake receptor sites identified for an ecological risk assessment;
- the NICO Project camp site, camp sites on Hislop Lake and the towns of Gamètì and Whatì identified for a human health risk assessment;
- the former Rayrock Mine; and
- the 0.17 kilo-equivalent (hydrogen ion equivalent – 1 keq = 1 kmol H^+) per hectare per year (keq/ha/y) Potential Acid Input (PAI) isopleths.



LEGEND

- NICO PROJECT
- POPULATED PLACE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- SNARE HYDRO LOCATION
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

25 0 25

SCALE 1:750,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

AIR QUALITY LOCAL AND REGIONAL STUDY AREAS

FILE No. E-Air-001-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	
GIS	BS	08 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

Edmonton, Alberta

FIGURE: 10.1-2

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The NICO Project within the NICO Project Lease Boundary envelops all major on-site emission sources associated with the NICO Project and includes areas that will be physically disturbed due to the construction, operation, and closure and reclamation of the NICO Project. The area outside of this boundary is used to determine compliance with applicable ambient air quality standards.

Off-site emission sources due to traffic emissions from the Proposed Tłįchǫ Road Route and construction and use of the NPAR are not included in the RSA, LSA or NICO Project Lease Boundary because they are assessed separately using a different assessment approach as discussed in Section 10.4.1.

10.1.4 Content

Section 10 presents the impact assessment of the NICO Project on air quality. The headings in Section 10 are arranged according to the sequence of steps in the assessment. Table 10.1-3 summarizes the contents under each heading of this SON.

Table 10.1-3: Subject of Note: Air Quality Organization

Section	Content
Section 10.1	**Introduction** – Provides an introduction to the SON Air Quality section by defining the context, purpose, scope, and study areas, and providing an overview of this SON organization.
Section 10.2	**Existing Environment** – Summarizes existing conditions in the region of the NICO Project.
Section 10.3	**Pathway Analyses** – Identifies potential pathways by which the NICO Project could affect air quality and assesses the validity of each identified pathway; the sub-sections summarize the environmental design features that mitigate these pathways, and assess the validity of each identified pathway, linking potential NICO Project activities to specific potential impacts on air quality and downwind receptors.
Section 10.4	**Effects on Air Quality** – (1) Explains the scientific methods (i.e., the dispersion model, the modelling approaches, and emission calculations) that were used to predict changes to air quality as a result of the NICO Project, and (2) Identifies effects of the NICO Project including those of sulphur dioxide, oxides of nitrogen, carbon monoxide, particulate matter, and other emitted substances on air quality.
Section 10.5	**Residual Effects Summary** – Summarizes the effects on air quality that are expected to remain after measures to eliminate or reduce negative effects have been incorporated into the NICO Project design.
Section 10.6	**Residual Impact Classification** – Describes methods used to classify residual effects, summarizes the classification results, and assesses the environmental consequences of air quality modelling results.
Section 10.7	**Environmental Significance** – Provides a discussion of the environmental significance of the impacts identified in the environmental assessment.
Section 10.8	**Uncertainty** – Discusses sources of uncertainty surrounding the modelling and assessment of effects on air quality.
Section 10.9	**Monitoring and Follow-up** – Summarizes the objectives of the proposed monitoring and follow-up programs that will be implemented to evaluate the impacts of the NICO Project on air quality.

The following Appendices and Annex are included to provide additional information:

- Appendix 10.I: Dispersion Modelling Methodology
- Appendix 10.II: Regional Air Emission Sources
- Appendix 10.III: Results of Air Quality Modelling
- Annex F: Air Quality and Meteorology Baseline Report

10.2 Existing Environment

This sub-section documents the current air quality in the area surrounding the NICO Project, as well as meteorological data relevant to atmospheric dispersion. The information presented in this section was gathered from various sources, including meteorological and ambient air quality measurements collected by Fortune Minerals Limited (Fortune) at the proposed site of the NICO Project, ambient air quality measurements collected by the Government of the Northwest Territories (GNWT), as well as Environment Canada meteorological data collected from Yellowknife, NWT.

Baseline air quality data are analyzed to establish background air concentrations that are added to modelled concentrations of various substances. These background concentrations result from emissions from natural sources (e.g., wind-blown dust) and/or long-range transport from sources outside the RSA. Regional air quality information was collected at the NICO Project, as well as from the Daring Lake and Yellowknife stations (Annex F: Air Quality and Meteorology Baseline Report).

10.2.1 Climate

Fortune operates a meteorological station near the proposed NICO Project. It is located at the height of land north of the proposed mine at UTM 511931 East and 7047508 North (NAD 83). Meteorological data have been collected near the NICO Project since October 2004. Data were logged year-round on an hourly basis. Maximum, average, and total values were collected for wind, temperature, rainfall, relative humidity, and solar radiation. Data were fully recovered for the sampling period through to the spring of 2008. Battery failure caused data loss between May and August 2008. Instrument maintenance, including field calibration, was performed in June 2006 and in August 2008; however, at the time of writing the Air Quality and Meteorology Baseline Report, data from the station could not be retrieved from August 2009 until July 2010 when technical issues were addressed. Details on the equipment and methodology used to obtain the data, as well as the subsequent measurements, are presented in Annex F: Air Quality and Meteorology Baseline Report.

Thirty-year normals observed at the Environment Canada Yellowknife airport station between the years of 1971 and 2000 were also included for comparison (Environment Canada 2008).

10.2.1.1 Wind

A windrose for the October 2004 to April 2008 period shows frequent winds from the southeast and northwest, with approximately 25 percent (%) of the total winds from the southeast (Figure 10.2-1). The pattern of large-scale weather systems that move through the region influence annual winds and predominance from the southeast is consistent with the expected pattern in the region of the NICO Project. Sustained wind speeds in excess of 30 kilometres per hour (km/h) were common, and calm wind conditions were recorded 5% of the time.

Table 10.2-1 presents a summary of the winds observed at the Environment Canada Yellowknife airport station between the years of 1971 and 2000 (Environment Canada 2008). Similarities between the NICO Project and Yellowknife stations were not expected since the terrain is markedly different between the 2 locations.

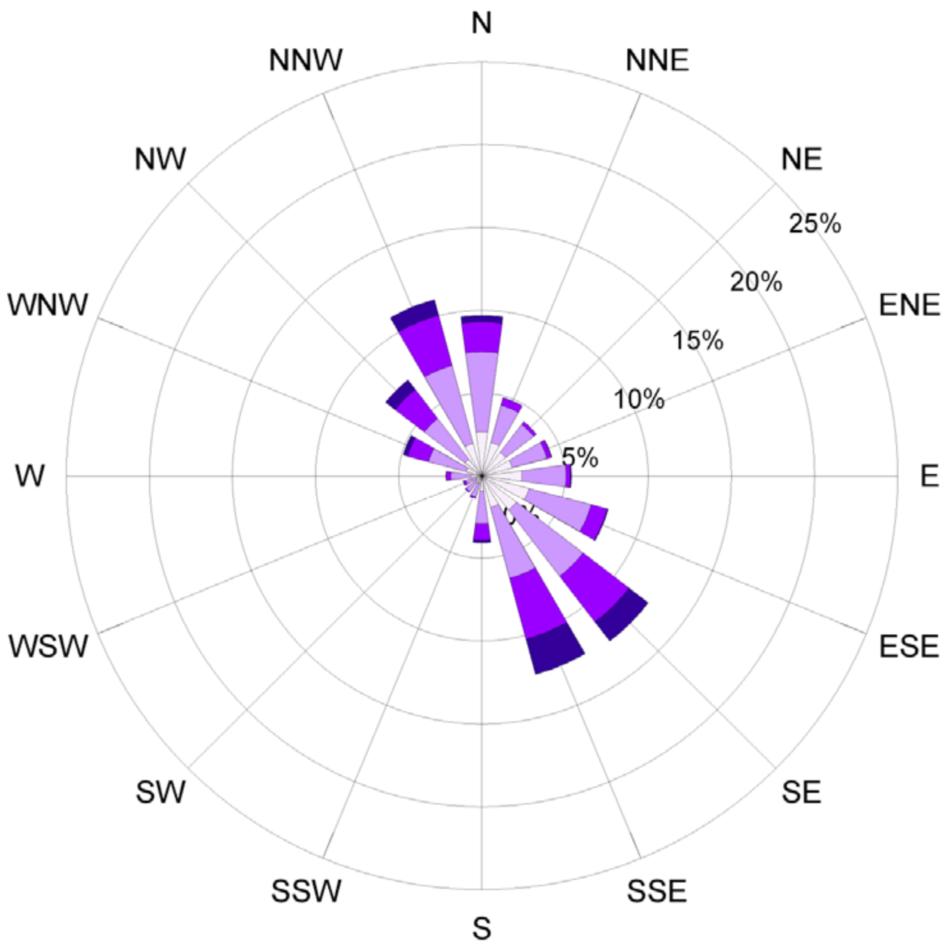


Figure 10.2-1: Windrose at the NICO Project (October 2004 to April 2008)

Table 10.2-1: Climate Normal Wind Statistics at Yellowknife Airport (1971 to 2000)

Wind	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Average speed (km/h)	12	13	14	15	16	15	14	14	15	16	14	12	14
Most frequent direction	NW	NW	NW	NE	SE	SE	SE	SE	SE	E	E	NW	E
Maximum hourly speed (km/h)	72	61	61	64	64	68	64	64	72	64	64	57	72
Maximum gust speed (km/h)	105	98	74	93	87	89	85	80	105	93	113	80	105

Source: Environment Canada (2008), internet site.

km/h = kilometre per hour; E = east; NE = northeast; NW = northwest; SE = southeast.

10.2.1.2 Temperature

The range of monthly mean temperatures at the NICO Project between 2004 and 2008 were as follows:

- -26.0 degrees Celsius (°C) in December to -7.4 °C in October 2004 (October to December 2004 data only);
- -25.8 °C in January to +14.5 °C in July 2005;
- -23.4 °C in January to +15.9 °C in June 2006;
- -25.2 °C in February to +17.5 °C in July 2007; and
- -26.7 °C in February to -3.7 °C in April 2008 (January to April data only).

The monthly temperatures observed at the NICO Project and Yellowknife airport are shown in Figure 10.2-2 for 2005 to 2007. The 1971 to 2000 long-term climate normals for Yellowknife are also presented for comparison.

10.2.1.3 Rainfall

The monthly rainfall measurements at the NICO Project are shown in Figure 10.2-3 for 2005 to 2007. The data were compared to the monthly rainfall for Yellowknife for the same years and were also compared to the 1971 to 2000 long-term climate normals for Yellowknife. The figure indicates that the majority of rainfall occurs between April and October.

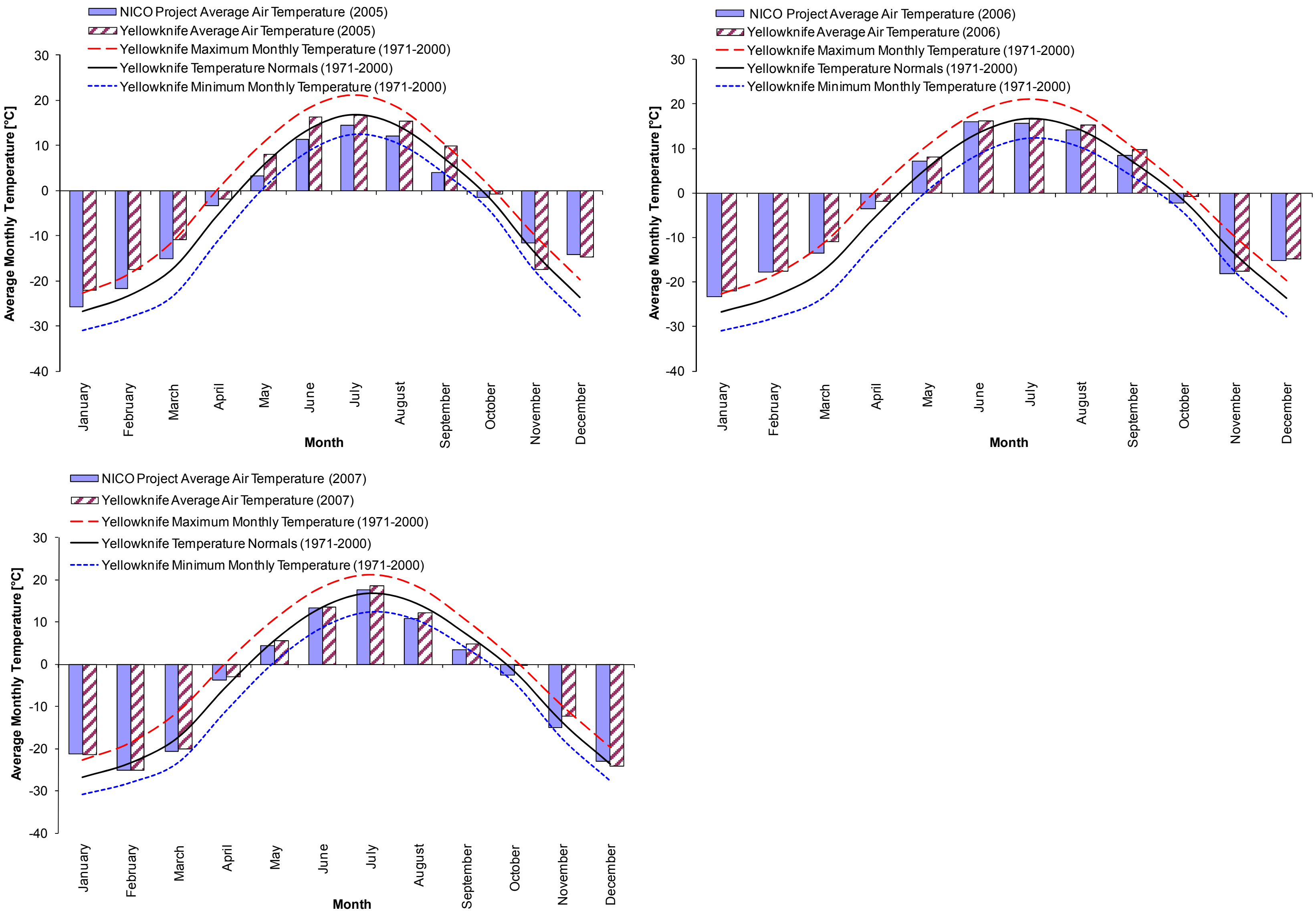


Figure 10.2-2: Monthly Temperature Summary (2005 to 2007)

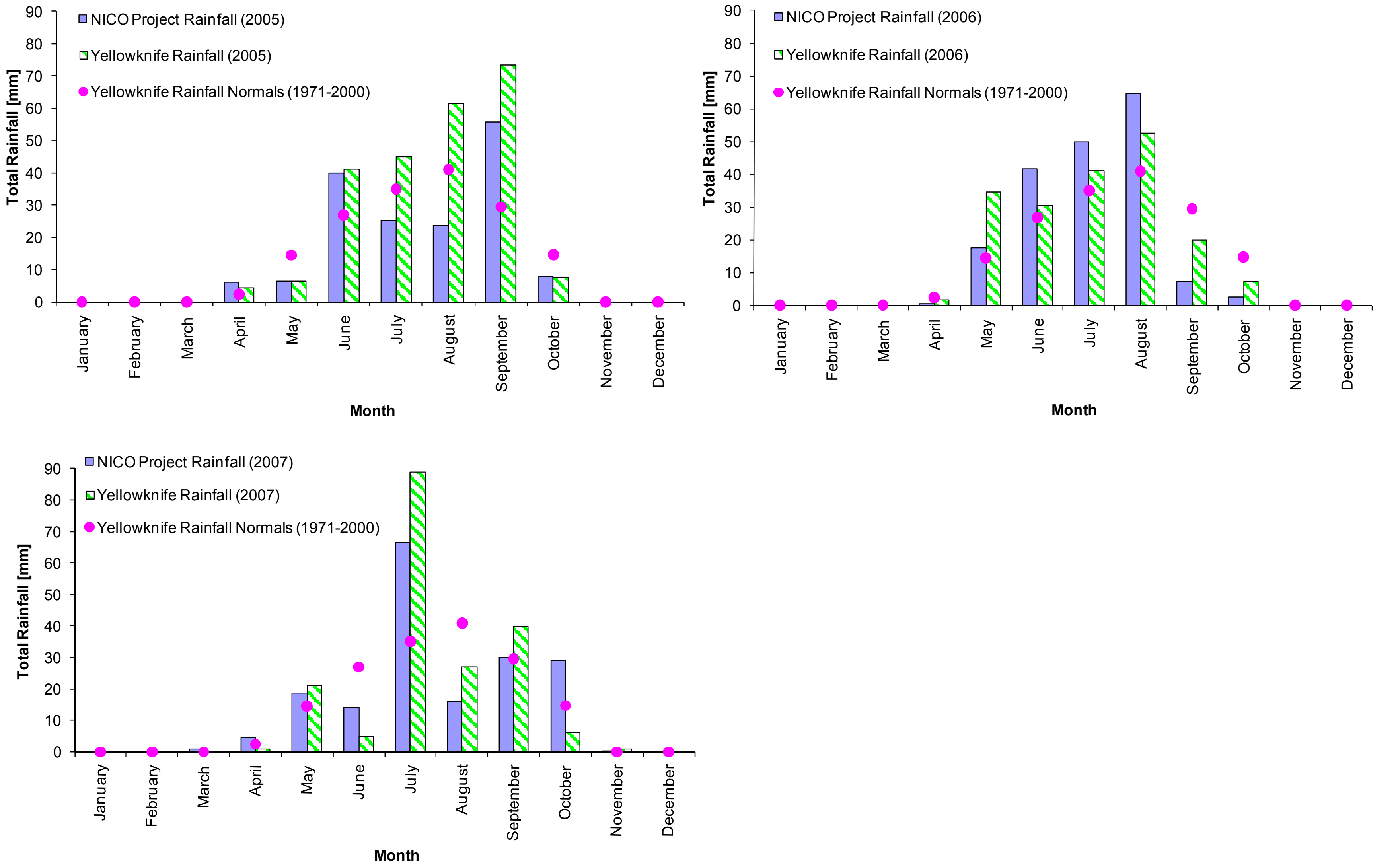


Figure 10.2-3: Monthly Rainfall Summary (2005 to 2007)

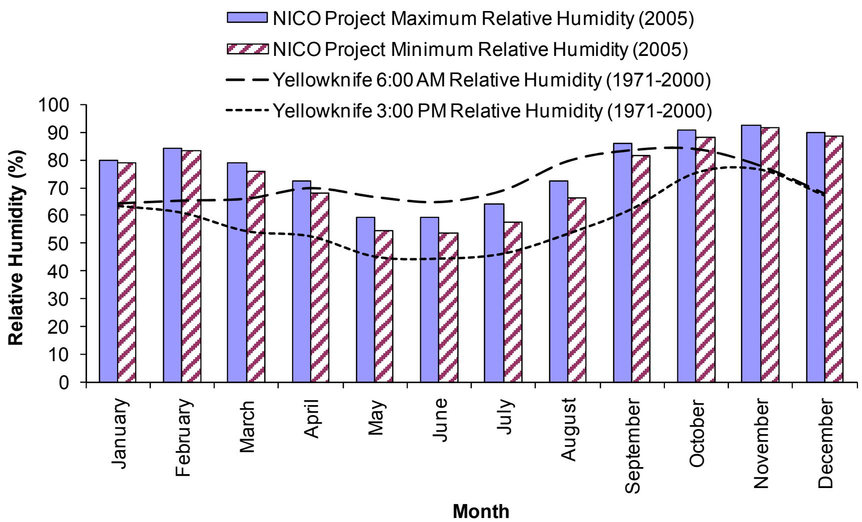
10.2.1.4 Relative Humidity

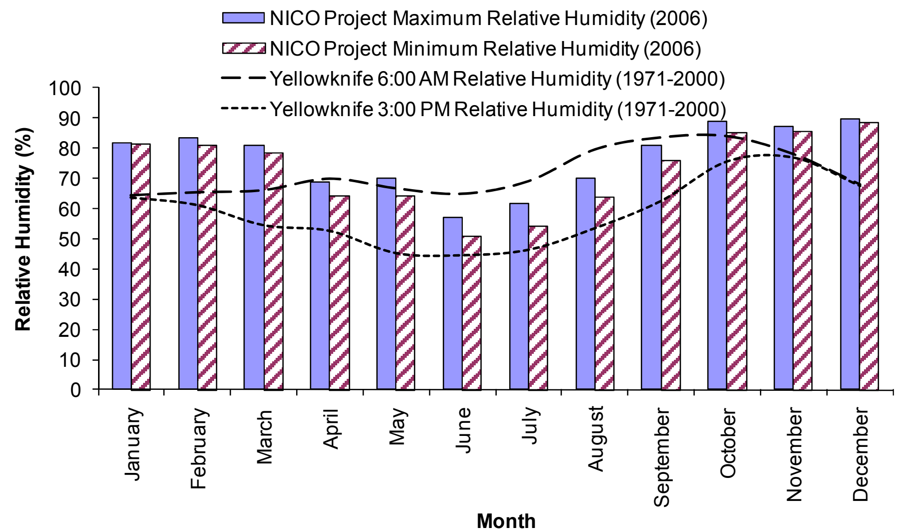
Average monthly relative humidity ranges at the NICO Project between 2004 and 2008 were as follows:

- 79.4% in December to 90.3% in October 2004 (October to December data only);
- 56.4% in June to 92.1% in November 2005;
- 54.0% in June to 89.2% in December 2006;
- 47.4% in June to 93.3% in October 2007; and
- 64.2% in April to 79.2% in January 2008 (January to April data only).

The monthly relative humidity mean values observed at the NICO Project and Yellowknife airport are shown in Figure 10.2-4 for 2005 to 2007. The 1971 to 2000 long-term climate normals for Yellowknife are also presented for comparison.

The relative humidity data for the NICO Project showed a pattern and range consistent with that of the Yellowknife data. The relative humidity data were higher on average at the NICO Project than in Yellowknife, which could be attributed to lower ambient temperatures at the NICO Project.





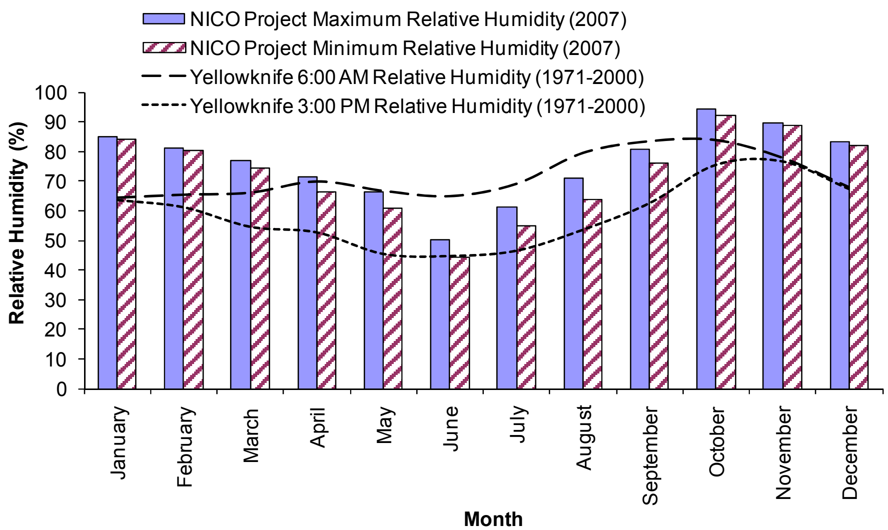


Figure 10.2-4: Monthly Relative Humidity Summary (2005 to 2007)

10.2.1.5 Solar Radiation

Figure 10.2-5 presents the monthly solar radiation summaries for 2004 to 2008. The annual ranges of solar radiation monthly averages at the NICO Project between 2004 and 2008 were as follows:

- 1.4 watt per square metre (W/m^2) in December to 26.4 W/m^2 in October 2004 (October to December data only);
- 0.5 W/m^2 in December to 247.7 W/m^2 in May 2005;
- 1.6 W/m^2 in December to 270.2 W/m^2 in June 2006;
- 2.0 W/m^2 in January to 290.2 W/m^2 in June 2007; and
- 2.0 W/m^2 in January to 160.1 W/m^2 in April 2008.

Changes in the weather variables may cause the annual peak in solar radiation to fluctuate from year to year. The peak occurred in May during 2005 and in June for both 2006 and 2007. Data were not collected in May and June of 2004.

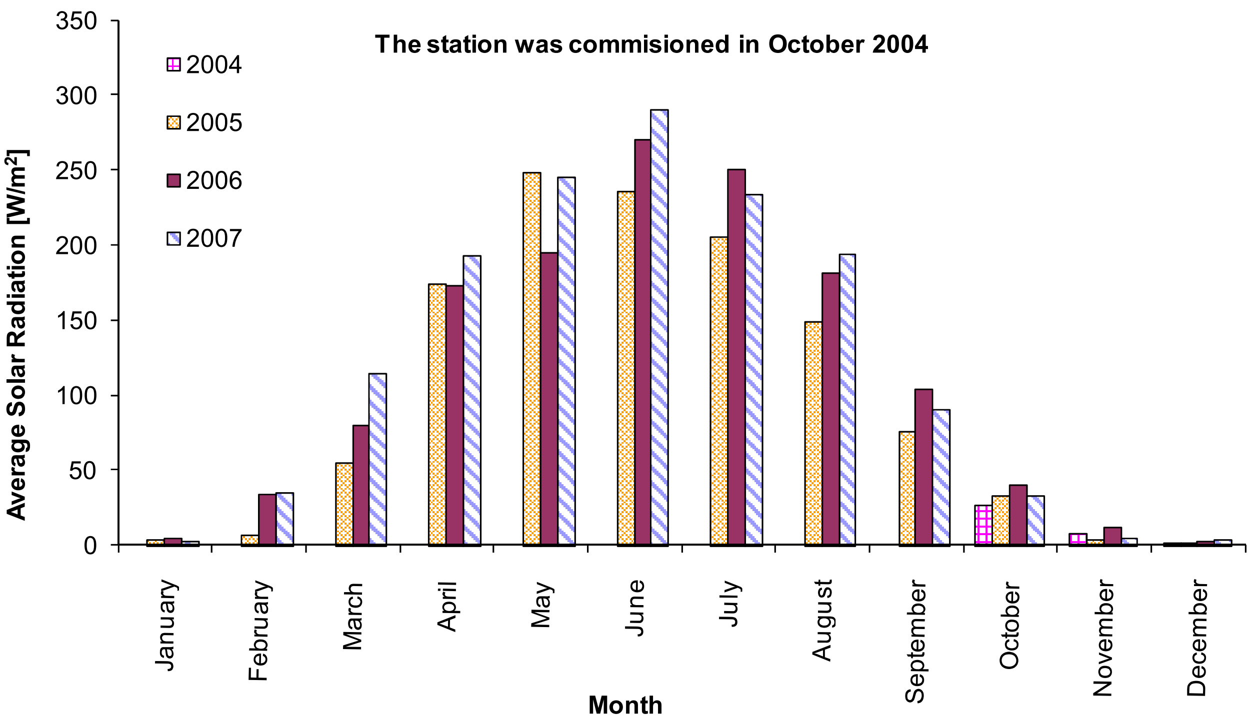


Figure 10.2-5: Solar Radiation Summary near the NICO Project (2004 to 2008)

10.2.1.6 Summary

A meteorological monitoring station at the NICO Project recorded ambient meteorological conditions from October 2004 to April 2008. The data collected were consistent with regional data and the data collection efficiency was close to 100% through to 15 April 2008. The data gaps were a result of station calibration, occasional wind sensor freeze-up during winter months, and a failed battery in the summer of 2008. The calibration of equipment was performed in June 2006 and August 2008.

10.2.2 Air Quality

Background air quality information based on locally collected, pre-development data is preferred to “proxy” (i.e., substitute) estimates from a distant location. In the absence of sufficient local data, values from other locations can be considered as long as the activity in the air-shed, terrain, land-use, and climate are similar. To this end, the existing air quality at the NICO Project was defined using data both from the monitoring station at the NICO Project and from the GNWT Air Quality Monitoring Network.

The ambient concentrations of the following compounds were included to characterize the existing environment:

- nitrogen dioxide (NO_2);
- sulphur dioxide (SO_2);
- particulate matter with mean aerodynamic diameter of 10 microns (µm) or smaller (PM_{10});
- particulate matter with mean aerodynamic diameter of 2.5 microns (µm) or smaller ($PM_{2.5}$); and
- ozone (O_3).

Carbon monoxide concentrations were not monitored at the NICO Project, because activities prior to the NICO Project are minimal and hence concentrations of carbon monoxide, which is a by-product of combustion, are negligible. The nearest source of combustion would be the existing winter road from Behchokǫ̀ to Gamètì.

10.2.2.1 Nitrogen Dioxide and Sulphur Dioxide

An ambient air quality monitoring program was undertaken at the NICO Project in the summers of 2006 and 2007 to monitor NO_2 and SO_2. Background air quality measurements were taken during a period of relatively low activity at the NICO Project. An underground bulk ore sampling program was in place, but the level of activity at the site was light relative to what would be expected during the construction and operation of the NICO Project.

Nitrogen dioxide and SO_2 concentrations were measured at 3 locations in the NICO Project area: the NICO Project meteorological station, at Peanut Lake approximately 3 km to the southeast, and at Lion Lake approximately 3.5 km to the northwest. The sampling duration ranged from 30 to 90 days, but the data are reported as prorated 30-day averages. The stations were frequently disturbed by wildlife activity, and hence the dataset is not complete; however, it still provides a reasonable estimate of ground-level concentrations of NO_2 and SO_2 in the area.

The monitoring data indicate that background concentrations of NO_2 and SO_2 were low in the NICO Project area. The maximum NO_2 concentration observed during the monitoring period was 2.6 micrograms per cubic metre (µg/m³), and the minimum concentration was 0.2 µg/m³ (Table 10.2-2). The maximum SO_2 concentration observed during the monitoring period was 0.5 µg/m³, and the minimum concentration was 0.3 µg/m³ (Table 10.2-3).

Table 10.2-2: Nitrogen Dioxide Observed Ground-Level Concentrations

Exposure Date	Collection Date	Sampling Duration (days)	Location	Concentration (ppb)	Concentration (μg/m³)
1 October 2006	1 November 2006	31	NICO Project Met Station	0.2	0.4
9 April 2007	1 June 2007	53	NICO Project Met Station	0.4	0.8
1 June 2007	1 July 2007	30	NICO Project Met Station	0.6	1.1
1 July 2007	31 July 2007	30	NICO Project Met Station	0.7	1.3
31 July 2007	1 September 2007	32	NICO Project Met Station	0.1	0.2
1 September 2007	29 September 2007	28	NICO Project Met Station	0.5	0.9
			NICO Project Meteorological Station Average	***0.4***	***0.8***
1 October 2006	29 October 2006	28	Lion Lake	1.4	2.6
9 April 2007	1 June 2007	53	Lion Lake	0.2	0.4
1 June 2007	1 July 2007	30	Lion Lake	0.6	1.1
1 July 2007	31 July 2007	30	Lion Lake	0.5	0.9
1 September 2007	29 September 2007	28	Lion Lake	0.6	1.1
			Lion Lake Station Average	***0.7***	***1.2***
1 October 2006	1 November 2006	31	Peanut Lake	0.2	0.4
1 October 2006	1 November 2006	31	Peanut Lake	0.6	1.1
9 April 2007	1 June 2007	53	Peanut Lake	0.4	0.8
1 June 2007	1 July 2007	30	Peanut Lake	0.8	1.5
1 July 2007	31 July 2007	30	Peanut Lake	0.6	1.1
1 July 2007	31 July 2007	30	Peanut Lake	0.3	0.6
31 July 2007	1 September 2007	32	Peanut Lake	0.4	0.8
31 July 2007	1 September 2007	32	Peanut Lake	0.4	0.8
1 September 2007	29 September 2007	28	Peanut Lake	0.7	1.3
1 September 2007	29 September 2007	28	Peanut Lake	0.6	1.1
			Peanut Lake Station Average	***0.5***	***0.9***
Overall Average				**0.5**	**1.0**

ppb = parts per billion; μg/m³ = microgram per cubic metre.

Based on the data observed at the site in October and November 2006 and April through September 2007, the overall baseline average NO_2 concentration was 1.0 μg/m³. The stations farthest from the NICO Project (i.e., Lion Lake and Peanut Lake stations) both indicated ambient NO_2 concentrations higher than the observed concentrations closer to the NICO Project; however, the average concentrations at all 3 stations were very low due to the undeveloped state of the local environment.

Table 10.2-3: Sulphur Dioxide Observed Ground-Level Concentrations

Exposure Date	Collection Date	Sampling Duration (days)	Location	Concentration (ppb)	Concentration (μg/m^3)
1 March 2007	1 June 2007	92	NICO Project Met Station	0.2	0.5
1 March 2007	1 June 2007	92	NICO Project Met Station	0.2	0.5
			NICO Project Meteorological Station Average	***0.2***	***0.5***
1 March 2007	1 June 2007	92	Lion Lake	0.2	0.5
Lion Lake Station Average				***0.2***	***0.5***
1 September 2006	1 December 2006	91	Peanut Lake	0.1	0.3
1 March 2007	1 June 2007	92	Peanut Lake	0.2	0.5
1 June 2007	1 September 2007	92	Peanut Lake	0.1	0.3
Peanut Lake Station Average				***0.1***	***0.5***
Overall Average				**0.2**	**0.5**

ppb = parts per billion; μg/m^3 = microgram per cubic metre.

Based on the ambient SO_2 observations at the site in September to December 2006 and March to September 2007, the overall baseline average SO_2 concentration was 0.5 μg/m³. The Lion Lake and Peanut Lake stations both indicated ambient SO_2 concentrations higher than the observed concentrations closer to the NICO Project; however, the average SO_2 concentrations at all 3 stations were very low because the local environment is undeveloped.

Although the concentrations observed at the off-site stations for both NO_2 and SO_2 were slightly higher than at the on-site station, the concentrations measured at each of the stations were just above detection limits and within the margin of error of the sampling method. As such, the differences in measured data between the stations were very small, and conclusions about these differences cannot be drawn.

10.2.2.2 Particulate Matter

The GNWT Air Quality Monitoring Network consists of 4 permanent monitoring stations located in Yellowknife, Inuvik, Fort Liard, and Norman Wells. All 4 stations monitor $PM_{2.5}$. PM_{10} is measured in Inuvik, Yellowknife, and Fort Liard; however, the data are not representative of the NICO Project since these stations are located within or near communities and measured concentrations are influenced by local emissions.

Short-term seasonal particulate monitoring occurs at the NWT Tundra Ecological Research Station located at Daring Lake. The Daring Lake Station monitored PM_{10} in the summer of 2002 and monitors $PM_{2.5}$ during the summer months, beginning in 2003. The $PM_{2.5}$ and PM_{10} data from Daring Lake were considered representative of conditions at the NICO Project, since the station is remote. None of the information from the other sites is presented here.

10.2.2.2.1 Daring Lake

The closest remote air quality station to the NICO Project is the NWT Tundra Ecological Research Station at Daring Lake. Particulate matter concentration data were collected during the summers of 2002 to 2008 using a Partisol sampler. PM_{10} was measured in 2002, and $PM_{2.5}$ was measured from 2003 to 2008. Data were not collected during the summer of 2009 because the sampler was not functional. The particulate concentrations recorded at the Daring Lake station are presented in Figures 10.2-6 and 10.2-7.

At Daring Lake, 19 of the PM_{10} samples were collected in 2002, with 12 passing quality checks (J. McKay, Environmental Natural Resources, 2010, pers. comm.). The maximum PM_{10} concentration was 3.3 µg/m^3.

From 2003 to 2008, 106 $PM_{2.5}$ samples were collected, and 86 samples passed quality checks (J. McKay, Environmental Natural Resources, 2010, pers. comm.). The annual average concentrations during 2003 to 2008 ranged from 0.9 to 7.1 µg/m^3. The average $PM_{2.5}$ concentration over the period was 3.1 µg/m^3, and the maximum $PM_{2.5}$ concentration was 41.5 µg/m^3 (29 July 2004). This reading was attributed to smoke from forest fires burning south of Great Slave Lake (GNWT 2008). The overall concentrations for 2007 and 2008 were similar, with a maximum $PM_{2.5}$ concentration of up to 7 µg/m^3. The 2007 and 2008 results were typical of background levels and were not influenced by forest fires as in previous years (GNWT 2007; 2008).

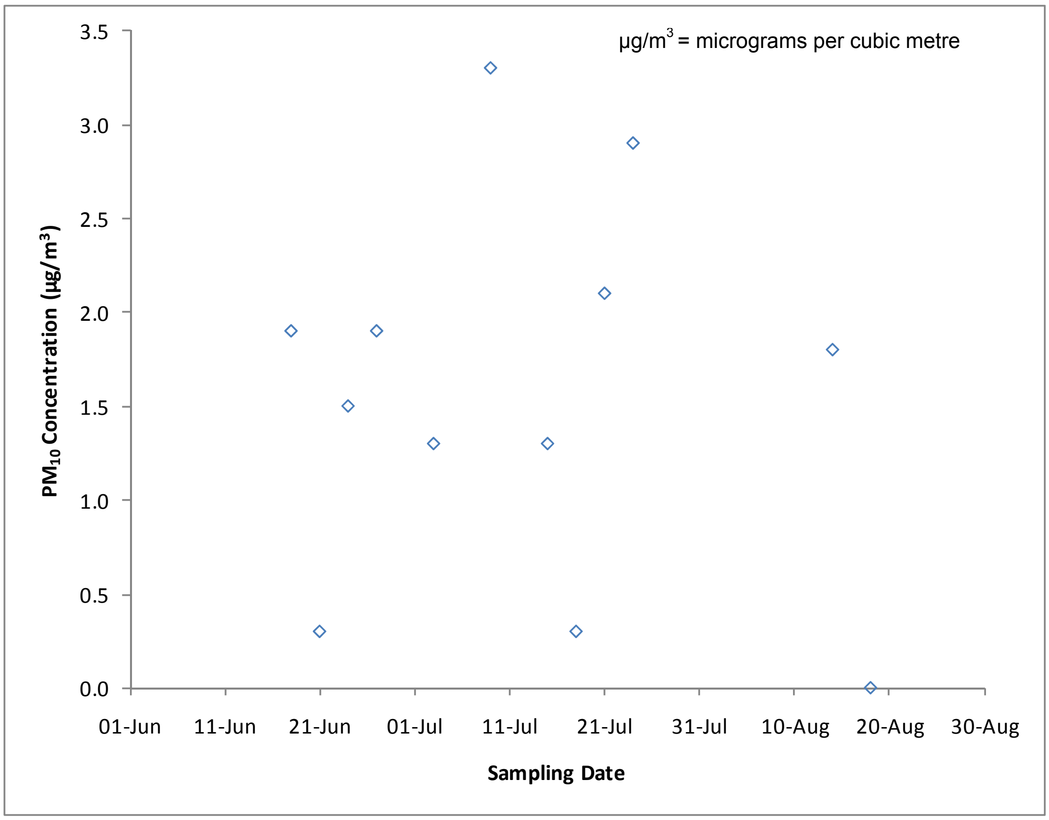


Figure 10.2-6: Daring Lake PM_{10} Concentrations (2002)

Source: J. McKay, Environmental Natural Resources, 2010, pers. comm.

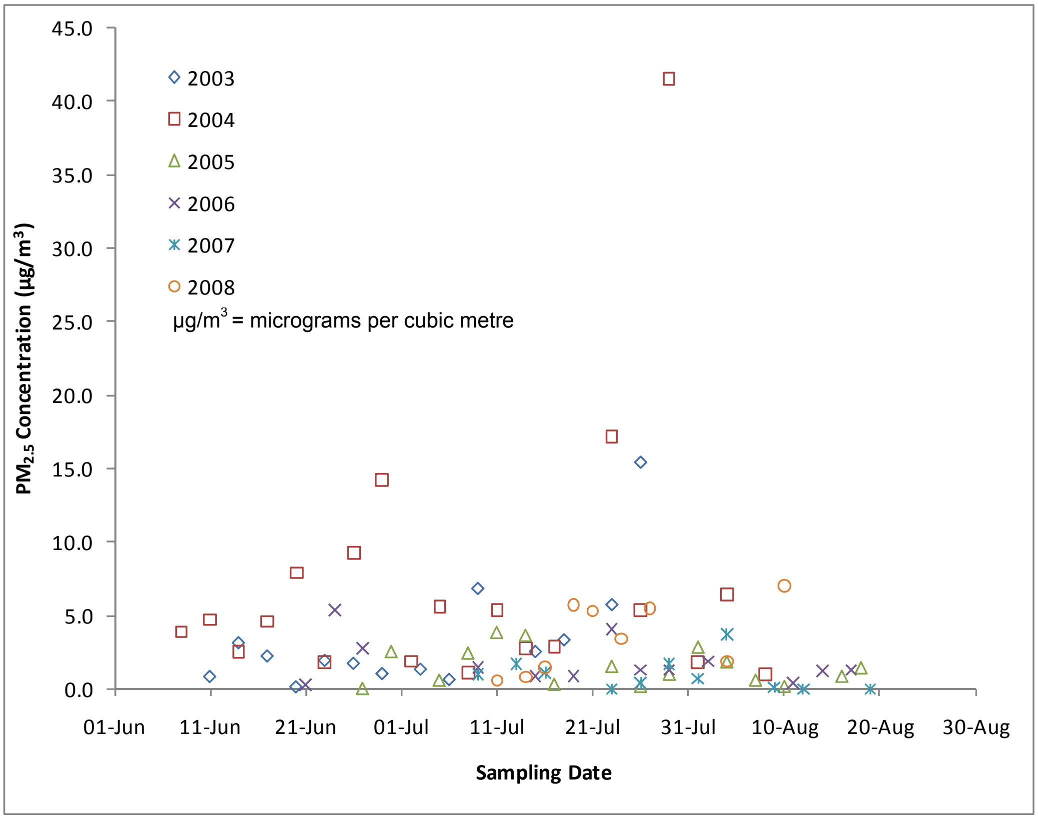


Figure 10.2-7: Daring Lake $PM_{2.5}$ Concentrations (2003 to 2008)

Source: J. McKay, Environmental Natural Resources, 2010, pers. comm.

10.2.2.3 Ozone

Ozone is monitored continuously at the Yellowknife, Inuvik, Fort Liard, and Norman Wells monitoring stations. Of the 4 stations, the station in Yellowknife is the closest to the NICO Project, and hence ozone concentrations are presented for the Yellowknife station only.

The hourly ozone concentrations monitored at the Yellowknife station are summarized in Table 10.2-4 for the 2007 to 2009 period. The maximum hourly concentration for the period was 63 parts per billion (ppb) (123 µg/m^3), indicating that the 8-hour ambient air quality guideline of 65 ppb (127 µg/m^3) was met. Typical monthly ozone concentrations at remote sites in Canada range between 40 and 80 µg/m^3, and Yellowknife concentrations for all 3 years fell below or within this range, indicating that most of the ozone detected is likely naturally occurring or background concentrations (GNWT 2008; 2010).

Table 10.2-4: Hourly Ozone Concentrations in Yellowknife (2007 to 2009)

Month	2007			2008			2009		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
January	3	35	25	2	35	22	14	35	27
February	1	38	25	1	36	25	0	38	24
March	1	43	23	1	40	24	1	42	26
April	1	50	34	1	48	32	6	49	29
May	6	48	28	4	56	38	2	44	24
June	10	41	28	8	46	27	2	40	25
July	7	40	24	9	40	24	2	34	20
August	1	37	21	0	42	18	1	33	18
September	0	63	21	0	31	17	0	28	15
October	1	35	19	0	30	18	0	35	20
November	5	36	27	2	31	23	4	35	23
December	1	41	23	2	29	20	2	34	24

Note: Values presented are in parts per billion (ppb).
Source: GNWT (2010).

10.3 Pathway Analyses

10.3.1 Methods

Pathway analysis identifies and assesses the linkages between the NICO Project components or activities and the potential residual effects on air quality. Potential pathways through which the NICO Project could affect air quality were identified from a number of sources including:

- the NICO Project Description;
- potential effects identified from the TOR for the NICO Project;
- scientific knowledge and experience with other mines in the NWT; and
- engagement with the regulatory bodies.

The first part of the analysis is to produce a list of all potential effects pathways for the NICO Project. Each pathway is initially considered to have a valid linkage to potential effects on air quality. This step is followed by the development of environmental design features that can be incorporated into the NICO Project to remove a pathway or limit (mitigate) the effects on air quality. Environmental design features include Project design elements, environmental best practices, and management policies and procedures.

Knowledge of the environmental design features is then applied to each of the pathways to determine the expected NICO Project-related changes to the environment and the associated residual effects (i.e., effects after mitigation) on air quality. For an effect to occur, there has to be a source (Project component or activity) that results in a measurable environmental change (pathway) and a correspondent effect on air quality.

Project activity → change in environment → effect on air quality

Pathway analysis is a screening step that is used to verify the existence of valid linkages from the initial list of potential effects pathways for the NICO 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. Pathways are determined to be primary, secondary (minor), or as having no linkage using scientific and traditional knowledge, logic, and experience with similar developments and environmental design features. Each potential pathway is assessed and described as follows:

- no linkage – pathway is removed by environmental design features so that the NICO Project results in no detectable environmental change and residual effects to air quality relative to baseline or guideline values;
- secondary – pathway could result in a minor environmental change, but would have a negligible residual effect on air quality relative to baseline or guideline values; or
- primary – pathway is likely to result in a measurable environmental change that could contribute to residual effects on air quality relative to baseline or guideline values.

Primary pathways require further effects analysis and impact classification to determine the environmental significance of the NICO Project on air quality. Pathways with no linkage to air quality or that are considered secondary are not analyzed further or classified in the DAR because environmental design features will remove the pathway (no linkage) or residual effects to air quality can be deemed negligible through a simple qualitative evaluation of the pathway (secondary). Pathways with no linkage to air quality or those that are secondary are not expected to have environmentally significant effects resulting in excursions from NWT air quality guidelines. All primary pathways are assessed in the DAR

10.3.2 Results

Potential pathways through which the NICO Project could affect air quality are presented in Table 10.3-1. Air quality effects from the NICO Project will be compared to regulatory air quality guidelines (i.e., NWT Air Quality Standards, Canada-Wide Standards, and National Ambient Air Quality Objectives) and changes in air quality will be included in the assessment of water quality, vegetation, wildlife, aquatic, and human health. Environmental design features and mitigation incorporated into the Project Description 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. The following section discusses the potential pathways relevant to effects on air quality.

All pathways were considered primary pathways for effects to the atmospheric environment and will be carried through the effects assessment (Table 10.3-1). They are as follows:

- exhaust from stationary equipment and the fleet; and
- fugitive emissions (e.g., dust).

Table 10.3-1: Potential Pathways for Effects on Air Quality

NICO Project Component/ Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Construction of mine and supporting infrastructure	Fugitive emissions (e.g., dust), and construction equipment and fleet exhaust. Waste incinerator exhaust	Compliance with regulatory emission requirements. Implementation of best management practices plan for controlling fugitive and exhaust emissions, and improving energy efficiencies, including the following: • Watering of roads and enforcing speed limits to suppress dust production. • Use of upswept exhausts on construction equipment. • Equipment and fleet equipped with industry-standard emission control systems. • NICO Project Access Road will be as narrow as possible, while maintaining safe construction practices.	Primary
Mining Operation	Air emissions including exhaust and fugitive emissions from the following: • Mining and material storage. • Mining equipment including fleet and material conveyance systems • Milling • On-site facilities (e.g., power generation and heat recovery systems, waste incinerator)	Compliance with regulatory emission requirements. Implementation of best management practices plan for controlling fugitive and exhaust emissions, and improving energy efficiencies including the following: • Watering of roads and enforcing speed limits to suppress dust production. • NICO Project Access Road will be as narrow as possible, while maintaining safe construction and operation practices. • Use of upswept exhausts on construction equipment. • Equipment and fleet equipped with industry-standard emission control systems. • Enclosing conveyance systems and processing facilities. • Processing equipment with high efficiency bag houses to reduce emissions of particulate matter.	Primary
Closure and Reclamation	Fugitive emissions (e.g., dust), and equipment and fleet exhaust	Compliance with regulatory emission requirements. Implementation of best management practices plan for controlling fugitive and exhaust emissions, and improving energy efficiencies during active closure including the following: • Watering of roads and enforcing speed limits to suppress dust production. • Use of upswept exhausts on construction equipment. • Equipment and fleet equipped with industry-standard emission control systems.	Primary

10.3.2.1 Good Practices to Mitigate and Reduce Emissions

In keeping with its focus on responsible and sustainable development, Fortune has identified a series of good practices that will be employed to minimize air quality changes. Continuous improvement and emission reduction are key management approaches that support the principle of keeping clean areas clean and encompass the Fortune goal of using best available technology economically achievable. Fortune will develop emission reduction action plans that will consider pollution prevention and best management practices. For example, NICO Project facilities and activities will consider and incorporate the best available technology economically achievable (BATEA).

Fortune is committed to the following general management approaches for air emissions from the NICO 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 surfaces will be regularly maintained for operational efficiencies and to minimize fuel consumption.
- NICO Project waste will be screened. Material containing metal and chlorinated organic waste will be segregated, and shipped off-site. The remainder will be combusted in an approved incinerator. The waste incinerator will be engineered and operated to meet the Canadian Council of Ministers of the Environment (CCME) emission standards for dioxins and furans (CCME 2001).

Fortune will minimize nitrogen oxide (NO_X) emissions through the following measures:

- use corporate fleet vehicles that meet applicable emission standards at the time of purchase, and encouraging contractors to do the same with their vehicles;
- consider NO_X emissions as a criterion in future engine and boiler upgrades;
- consider energy conservation initiatives, such as maintaining site road surfaces, to improve the energy efficiency of the fleet; and
- consider the use of catalytic converters to reduce NO_X emissions from the mobile fleet.

Fortune will manage transport-related dust and particulate emissions by adopting the following management practices:

- apply a water spray to control dust emissions on haul roads during the summer;
- consider the use of covered conveyors and limiting the height from which material is dropped; and
- manage vehicle speed to limit wind-blown dust from vehicle wheel entrainment.

Fortune plans to incorporate the results of its ambient air quality monitoring program into its emission management plans as part of its response to the principle of continuous improvement for the NICO Project.

10.3.2.1.1 Regulatory Emission Requirements

Fortune will design the NICO Project facility to meet CCME emission requirements for boilers and heaters, fuel storage tanks, and waste incinerators. These requirements are summarized as follows:

- National Emission Guidelines for Commercial/Industrial Boilers and Heaters (CCME 1998a): This documents sets out the emission limits from boilers and heaters. The limits are frequently referenced by regulatory agencies as targets that need to be achieved for approval and permit compliance.
- Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks (CCME 1995): This document is intended to provide consistency in controlling volatile organic compound emissions from fuel storage tanks.
- Canada-Wide Standards for Dioxins and Furans (CCME 2001): This documents sets out the emission limits from incinerators. Emission limits are expressed as a concentration in the exhaust gas exiting the stack of the facility and will be met using generally available incineration and emission control technology and waste diversion. An emission concentration limit of 80 pico-grams of International Toxic Equivalency Quotients per cubic metre (pg I-TEQ/m^3) is applicable to the NICO Project for hazardous waste and sewage sludge incineration.

10.3.2.1.2 Canadian Regulatory Air Quality Guidelines

Air emissions from industrial activities can have direct and indirect effects on humans, wildlife, aquatic life, vegetation, soil, and water quality. For these reasons, environmental regulatory agencies have established ambient air concentration thresholds. Table 10.3-2 presents the NWT Air Quality Standards, the Canada-Wide Standards, and the National Ambient Air Quality Objectives for the following criteria air pollutants:

- SO_2;
- NO_2;
- carbon monoxide (CO);
- total suspended particulate (TSP); and
- $PM_{2.5}$.

The listed standards and objectives refer to averaging periods ranging from 1 hour to 1 year.

Table 10.3-2: Canadian Regulatory Air Quality Guidelines

Substance	NWT Air Quality Standards[a]	Canada-Wide Standards[b]	National Ambient Air Quality Objectives[c]		
			Desirable	Acceptable	Tolerable
SO_2 (µg/m^3)					
1-Hour	450	–	450	900	–
24-Hour	150	–	150	300	800
Annual	30	–	30	60	–
NO_2 (µg/m^3)					
1-Hour	400	–	–	400	1 000
24-Hour	200	–	–	200	300

Table 10.3-2: Canadian Regulatory Air Quality Guidelines (continued)

Substance	NWT Air Quality Standards[a]	Canada-Wide Standards[b]	National Ambient Air Quality Objectives[c]		
			Desirable	Acceptable	Tolerable
Annual	60	–	60	100	–
CO (μg/m^3)					
1-Hour	15 000	–	15 000	35 000	–
8-Hour	6 000	–	6 000	15 000	20 000
TSP (μg/m^3)					
24-Hour	120	–	–	120	400
Annual	60	–	60	70	–
$PM_{2.5}$ (μg/m^3)					
24-Hour	30[d]	30[d]	–	–	–
Annual	–	–	–	–	–

[a] GNWT (2011b).

[b] CCME (2000).

[c] Environment Canada (1981).

[d] compliance with the GNWT 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 3 years of measurements.

– = No guideline available; μg/m^3 = micrograms per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; TSP = total suspended particulates; PM = particular matter; CO = carbon monoxide; GNWT = Government of the Northwest Territories.

10.3.2.1.2.1 Northwest Territories Air Quality Standards

The NWT Air Quality Standards (GNWT 2011b) are used in air quality assessments of proposed and existing developments, and in the reporting of 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 standards, the size of the affected area, availability of control options, and environmental, human health, and socio-economic impacts.

10.3.2.1.2.2 Canada-Wide Standards

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

The Canada-Wide Standards are intended to be achievable standards that are based on sound science, and which take into consideration social implications and technical feasibility. The Canada-Wide Standards do not have legal force under federal legislation; however, each provincial/territorial jurisdiction participating in the Harmonization Accord has committed to implementing the standards under existing provincial/territorial legislation, or through the drafting of new legislation.

10.3.2.1.2.3 National Ambient Air Quality Objectives

The Canadian Federal Government has established the following 3 levels of National Ambient Air Quality Objectives (Environment Canada 1981):

- 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) without delay 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 air quality assessment for the NICO Project because they represent the highest allowable concentrations, which are higher than corresponding NWT guidelines and inconsistent with Fortune's approach to use of good practice.

10.4 Effects on Air Quality

10.4.1 Methods

10.4.1.1 General Approach

The approach used to assess effects on air quality was based on the requirements specified in the TOR (MVRB 2009) and the approach agreed upon with Environment Canada and presented to the GNWT (D. Fox, Environment Canada, 2010, pers. comm.). Environment Canada will be providing comments to the MVRB on air quality issues. The approach includes the following steps:

- Identification and evaluation of pre-development conditions of the NICO Project relevant to air quality.
- Evaluation of potential air quality impacts from the NICO Project, including the following:
  - estimating the air emissions from the NICO Project, including greenhouse gas emissions, for the construction, operation, and closure and reclamation phases (i.e., the emissions inventory);
  - estimating the ambient concentrations and deposition rates of air contaminants released from the NICO Project during the operation phase using dispersion modelling;
  - comparing the predicted ambient concentrations to available criteria and standards; and
  - completing a pathway analysis.
- Preparing monitoring, mitigation, and adaptive management strategies that reflect the nature of the NICO Project, the area where the NICO Project is situated, and the predicted air impacts.

Air dispersion models were used to estimate the ambient ground-level concentrations and deposition rates of air emissions released from the NICO Project during operation. There is no air modelling guideline for the NWT; therefore, the dispersion modelling approach for this assessment is based on the Air Quality Model Guideline developed by Alberta Environment (AENV 2009). Specifically, the NICO Project was assessed using the following dispersion models:

- the concentrations resulting from on-site emissions (i.e., activities within the NICO Project Lease Boundary) were evaluated using the California puff plume dispersion model (CALPUFF) (U.S. EPA 1999); and
- the concentrations resulting from off-site emissions (i.e., activities of the proposed NPAR and Proposed Tłįchǫ Road Route) have been evaluated using the SCREEN3 dispersion model (U.S. EPA 1999).

10.4.1.1.1 Scenarios Modelled

Air quality was assessed considering the following assessment cases:

- CALPUFF Modelling – On-site Emissions
  - The Baseline Case includes an assessment of air quality from existing emission sources such as the communities of Whatì and Gamètì, and Snare Rapids Hydro. The predicted concentrations and deposition were added to the estimated background levels described in Appendix 10.1, Section 10.I.4.
  - The Application Case includes on-site emission sources from the NICO Project in addition to the Baseline Case sources (i.e., Application Case = Baseline Case + NICO Project).
- SCREEN3 Modelling – Off-site Emissions
  - The Baseline Case assesses the air quality resulting from existing vehicular traffic on the current winter road.
  - The Application Case includes emission sources from Fortune's use of the Proposed Tłı̨chǫ Road Route to the NPAR as well as the construction and use of the NPAR from the Proposed Tłı̨chǫ Road Route to the NICO Project.

With the exception of the proposed re-alignment of the winter road to an all-season road, which was assessed as part of the Application Case, the Future Case was not assessed for air quality, as there are no foreseeable projects with air emission sources within 100 km of the NICO Project. The only foreseeable project within 100 km is the Nailii Hydro Project. The emission source from the Nailii Hydro Project during operations would be from a waste incinerator. However, it is expected that waste from the hydro project will be transported to Whatì for disposal so these emissions were not included in the Future Case Assessments.

10.4.1.2 Emission Inventory

The identification of emission sources has been based on the list of NICO Project activities presented in the TOR, on information provided by Fortune, and on previous emission inventories developed by Golder Associates Ltd. Air emissions from the NICO Project have been calculated using emission factors, activity data, and other information according to the following primary documents and sources (see Appendix 10.II for details regarding the calculation of emissions):

- U.S. EPA AP-42 Sections (U.S. EPA 2010a);
- U.S. EPA NONROAD Model documents (U.S. EPA 2010b);
- information provided by equipment suppliers; and
- information provided by Fortune.

Emissions have been estimated for TSP, PM_{10}, $PM_{2.5}$, NO_X, SO_2, CO, and metals. Metals such as cobalt, bismuth, copper, and arsenic are compared to applicable standards in this section. Additional metals relevant to the NICO Project are provided in Appendices 10.II and 10.III.

10.4.1.3 Dispersion Models

10.4.1.3.1 CALPUFF Model

Due the complex nature of the local terrain (Figure 10.1-1), the dispersion of the NICO Project on-site emissions is represented using the full capabilities of the CALPUFF dispersion model (i.e., run in dynamic, 3-dimensional mode with a fine resolution meteorological data set). When run in this manner, CALPUFF allows locally induced meso- and micro-meteorology, such as terrain induced flow, valley and mountain breezes, or heat fluxes from snow covered ground, to be modelled.

The CALPUFF model is one of the refined dispersion models recommended by Alberta Environment (AENV 2009). Key advantages of the modelling system over others are as follows:

- applicability to spatial scales ranging from a few kilometres to more than 100 km;
- simulation of wet and dry atmospheric substance removal processes (i.e., substance deposition);
- simulation of both SO_2 and NO_X chemistry that is required to model PAI;
- simulation of wind speed and wind direction in 3 spatial dimensions and time providing for representative plume movement. To emulate the plume movement, the initial source substance emissions are represented by a series of puffs;
- acceptance by the GNWT for environmental assessments;
- sound, openly documented physical principles that have undergone independent review; and
- incorporation of the Plume Rise Model Enhancement downwash algorithms to determine the aerodynamic effects of buildings on the plume rise from stacks.

A detailed review of the CALPUFF model, as applied in this air quality assessment, is provided in Appendix 10.I, Section 10.I.2.

10.4.1.3.2 SCREEN3

The SCREEN3 model was used to model off-site exhaust and fugitive emissions from the construction and use of the NPAR, and the use of the Proposed Tłı̨chǫ Road Route. Off-site emissions resulting from the NICO Project will consist primarily of emissions along the NPAR and Proposed Tłı̨chǫ Road Route, and are expected to occur with much lower intensity than the on-site emissions. This results in local effects. In addition, these emissions will be spread out over the length of the NPAR (i.e., over a length of 27 km) and Proposed Tłı̨chǫ Road Route. The SCREEN3 dispersion model is well suited in the analysis of such local air effects. Due to built-in conservative parameters and values, SCREEN3 modelling results are usually higher than those of refined models such as CALPUFF.

The following SCREEN3 model scenarios were assessed:

- NICO Project traffic on the NPAR;
- construction of the NPAR; and
- NICO Project traffic on the Proposed Tłı̨chǫ Road Route.

The modelling of vehicular traffic on both the NPAR and Proposed Tłı̨chǫ Road Route was based on the assumption that 2 B-train transport trucks would travel in convoy. The emissions from 2 B-train trucks in convoy was modelled assuming that each truck was the maximum allowable vehicle length of 25 m, and the width of the road plus an additional 6 m accounted for the air turbulence cause by each vehicle (Oklahoma Department of Environmental Quality 2006). In addition, emissions from 4 adjacent road segments with the same dimensions as above (2 adjacent road segments on each side) were included in the model to account for the cumulative effects of vehicles in motion (Oklahoma Department of Environmental Quality 2006) (i.e., emissions from the B-train convoy travelling on 5 road segments were modelled).

For the construction of the NPAR, it was assumed that heavy equipment (e.g., bulldozer) would be working for at least 10 minutes on each road segment per day. This assumption is conservative based on the number of equipment, construction period, and length of the NPAR.

Fugitive emissions resulting from vehicular travel along both the NPAR and Proposed Tłı̨chǫ Road Route were derived using U.S. EPA, AP-42 Section 13.2.2 - Unpaved Roads (U.S. EPA 2010b). No controls (e.g., watering) were assumed. No precipitation or snow/ice coverage was accounted for in deriving the emission factors, although precipitation and snow accumulation on the road surface will provide some degree of mitigation of the road dust emissions during the winter.

SCREEN3 was executed with rural and simple terrain options and the full built-in meteorology (i.e., all stability classes modelled).

10.4.1.4 CALMET Meteorological Data

The 3-dimensional wind fields used in the CALPUFF dispersion modelling were created using the CALMET model preprocessor (CALMET) developed specifically for use with the CALPUFF model (U.S. EPA 1999). One year of meteorological data covering 1 January 2005 to 31 December 2005 was generated using output from a mesoscale meteorological model in combination with local meteorological observations. The meteorological data required in CALMET includes the following:

- **Upper air parameters**: The upper air parameters for use in the CALMET modelling were simulated using the Fifth generation NCAR/Penn State Mesoscale Model.
- **Hourly surface meteorological parameters**: Meteorological observations from the on-site meteorological station and the Lac La Martre Environment Canada station located in Whatì were included in CALMET. Since precipitation observations were not complete or available from the on-site station or the Lac La Martre station, data from the NCAR/Penn State Mesoscale Model I were used.
- **Geophysical parameters**: The CALMET model requires a physical description of the ground surface to determine meteorological parameters in the boundary layer. The geophysical parameters included in the assessment were land use, terrain elevation, roughness length, albedo, Bowen ratio, soil heat flux parameter, anthropogenic heat flux, and leaf area index.

The CALMET modelling domain size is 102 km in the east-west direction and 132 km in the north-south direction. A detailed description of the NCAR/Penn State Mesoscale Model and CALMET model and inputs used in the air quality assessment are provided in Appendix 10.I, Section 10.I.3.

10.4.1.5 CALPUFF 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 based primarily on AENV modelling guidance (AENV 2009), which recommends the following receptor placement:

- spacing of 20 m in the general area of maximum impact and the property boundary;
- spacing of 50 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; and
- spacing of 1000 m between 5 and 10 km from the sources of interest.

In addition to the receptors placed near the NICO Project operations, the air quality assessment included additional receptors distributed across the modelling domain. These receptors were spaced at 5 km intervals.

One of the objectives of this air quality assessment is to put the potential air concentrations into perspective for other regional people interested in the NICO Project and regulatory authorities. To facilitate this, maximum air quality concentrations were also predicted at sensitive receptor locations which are shown in Table 10.4-1. The list includes 2 communities (Whatì and Gamètì), the on-site work camp, 18 local points of interest, and along the NICO Project Lease Boundary where persons could experience prolonged exposure to emissions. In addition, the potential impacts to the air quality at other communities (i.e., Behchokǫ̀, Wekweetì, and Yellowknife) that are outside of the RSA were evaluated by using the predictions at the surrogate regional receptors within the RSA that are closest to these communities. Appendix 10.I, Section 10.I.4 shows the placement of all receptors, including the surrogate receptors for Behchokǫ̀, Wekweetì, and Yellowknife.

Table 10.4-1: Sensitive Receptors Included in the Air Assessment

Receptors	Location[a]	
	Distance (km)	Distance
Communities		
Gamètì	71	north-northwest
Whatì	53	south-southwest
Behchokǫ̀	57	south-southeast
Wekweetì	73	east-northeast
Yellowknife	74	southeast
Others		
Worker Camp	0.2	east
Marian River Receptor 1	5	west-southwest
Marian River Receptor 2	4	southwest
Marian River Receptor 3	4	southwest
Marian River Receptor 4	4	south-southwest
Marian River Receptor 5	4	south-southwest
Marian River Receptor 6	5	south-southwest

Table 10.4-1: Sensitive Receptors Included in the Air Assessment (continued)

Receptors	Location[a]	
	Distance (km)	Distance
Bea Lake Receptor	9	north-northwest
Hislop Lake Receptor 1	10	southwest
Hislop Lake Receptor 2	7	west-southwest
Hislop Lake Receptor 3	8	west-southwest
Hislop Lake Receptor 4	10	west-southwest
Hislop Lake Receptor 5	10	west
Hislop Lake Receptor 6	12	west
Hislop Lake Receptor 7	10	west-northwest
Hislop Lake Receptor 8	12	west-northwest
Hislop Lake Receptor 9	11	west-northwest
Hislop Lake Receptor 10	10	west-northwest
Hislop Lake Receptor 11	9	northwest
Maximum Prediction outside of NICO Project Lease Boundary	—	—

[a] distance and direction are relative to the centre of the NICO Project Lease Boundary.

— = implies distances and directions vary depending on the compound of interest; km = kilometre.

10.4.1.6 Approach for Nitrogen Dioxide Conversion

Nitrogen oxides are comprised 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 AENV (2009). 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:

$$NO_2 = O_3 + 0.1 \text{ X } NO_X$$

The hourly, daily, and annual ozone concentrations used in the Ozone Limited Method calculations assessment are 34.7, 33.3, and 23.9 ppb, respectively. These values were determined based on hourly ozone monitoring data collected in Yellowknife between 2007 through 2009 (GNWT 2010).

10.4.1.7 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 results remove these atmospheric emissions by precipitation. Dry processes remove emissions by direct contact with surface features (e.g., vegetation, soils, and surface water).

Both 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/y where 'keq' refers to hydrogen ion equivalents (1 keq = 1 kmol 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 10.I, Section 10.I.4.

10.4.1.8 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:

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

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

10.4.2 Results

10.4.2.1 Emission Estimation

10.4.2.1.1 Identification of Sources

The first step in preparing the NICO Project emission inventory was to identify the activities that are likely to result in air emissions. Table 10.4-2 presents the activities listed in the TOR, and an indication as to whether they are potential sources of air emissions. This table also identifies during which phase of the NICO Project each activity will take place. A list of air emission sources associated with activities within each phase of the NICO Project is shown in Table 10.4-3.

Table 10.4-2: Summary of the Project Activities According to the Terms of Reference

Terms of Reference Activities (Section 2.1 of Terms of Reference)	Potential Source of Air Emissions	Project Phase (Construction, Operation, Closure)
Mining and Materials Storage		
Development of underground workings and Open Pit, including use of the existing decline and crosscut and drift development	Yes	Construction and Operation
Extraction and crushing of ore-bearing rock	Yes	Operation
Transport, storage, and use of explosives	Yes	Operation
Mine dewatering	No	N/A
Construction and transportation of materials to the Co-Disposal Facility	Yes	Construction and Operation
Construction and management of a waste disposal facility within the tailings management area	Yes	Construction and Operation
Management of initial separation and concentration reject materials, ore stockpiles on surface, including construction of any associated foundations, buildings, and water treatment and management systems	Yes	Construction and Operation
Mining equipment operation, including vehicles and materials conveyance systems	Yes	Operation
Milling		
Construction and use of conventional concentrator with ball mills	Yes	Construction and Operation
Initial flotation, secondary flotation of bulk rougher concentrate, bulk cleaner flotation, and any other processing	Yes	Operation
Extraction, transportation, consumption, recycling, treatment, and discharge to the environment of treated effluent	No	N/A
Storage, handling, use and disposal of milling process additives and chemicals	No	N/A
Thickening, filtration and packaging of concentrate for transportation	Yes	Operation
Other On-Site Facilities and Activities		
Power generation and heat recovery facilities	Yes	Construction and Operation
Construction and use of the Effluent Treatment Facility that will treat effluent from the Mineral Process Plant and other sources	Yes	Construction
Construction and use of drainage control structures, process pipelines and waste water pipelines from mine to surface, on surface at the NICO Project mine site, runoff collection trenches, and Surge Pond	Yes	Construction

Table 10.4-2: Summary of the Project Activities According to the Terms of Reference (continued)

Terms of Reference Activities (Section 2.1 of Terms of Reference)	Potential Source of Air Emissions	Project Phase (Construction, Operation, Closure)
Construction and use of all roads at the NICO mine site	Yes	Construction and Operation
Construction and use of the Water Treatment Plant	Yes	Construction
Construction and use during mine operations of the pump house and water intake, water discharge system (including seasonal water storage areas, all drainage ditches and discharge point) and potable water supplies for camps	Yes	Construction
Construction and use of fuel storage facilities on-site	Yes	Construction
Use of the pioneer camp at Lou Lake and permanent camp west of Nico Lake	Yes	Construction (Pioneer camp and permanent camp), Operation (permanent camp)
Construction and use of Sewage Treatment Facility	Yes	Construction
Construction and use of service complex and mine equipment management building	Yes	Construction
Use of vehicles and all other emissions sources at the NICO mine site	Yes	Construction, Operation and Closure
Installation and use of waste incinerator	Yes	Construction and Operation
Support/Ancillary Facilities and Activities		
Transportation activities by air and road (including the NPAR and the Proposed Tłı̨chǫ Road Route that support the NICO Project's operation, including transportation of goods, fuel, contractors, and employees in to and out of the mine	Yes	Construction, Operation and Closure
Removal and disposal of wastes or other materials	Yes	Construction and Operation
Construction and use of the airstrip at the mine site	Yes	Construction and Operation
Development and use of borrow sources for aggregate production at the mine site or along the NPAR	Yes	Construction
Closure and Reclamation		
Removal or stabilization of all structures and equipment	Yes	Closure
Reclamation of the Co-Disposal Facility and site water management facilities	Yes	Closure
Reclamation of the NPAR, and all roads on the NICO Project mine site	Yes	Closure
Reclamation of infrastructure foundations, piping, and all built structures at the mine site	Yes	Closure

Table 10.4-2: Summary of the Project Activities According to the Terms of Reference (continued)

Terms of Reference Activities (Section 2.1 of Terms of Reference)	Potential Source of Air Emissions	Project Phase (Construction, Operation, Closure)
Reclamation of any stockpiles and materials storage locations	Yes	Closure
Re-vegetation of areas affected by mining, NPAR, or support activities	Yes	Closure
Bulkhead installation and close portal to the underground mine	Yes	Operation and Closure
Long-term mine water outflow monitoring and water management around the mine site	No	N/A

N/A = not applicable.

Table 10.4-3: Summary of Emission Sources Associated with the NICO Mine Project

Phase	Activity		Air Emissions
Construction	I – Land Clearing and Debris Removal	I.1 General land clearing	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		I.2 Loading of land cleared debris into trucks	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		I.3 Truck transport of debris	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		I.4 Dumping material onto Growth Media Stockpile	Fugitive Emissions (PM)
		I.5 Wind erosion from Growth Media Stockpile	Fugitive Emissions (PM)
	II – Site Preparation	II.1 Drilling	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.2 Blasting	Fugitive Emissions (PM)
		II.3 Bulldozing	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.4 Material handling	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.5 Compacting	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.6 Grading	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.7 Loading of aggregate material into trucks	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.8 Hauling material	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.9 Jaw crusher	Fugitive Emissions (PM)
		II.10 Material screening	Fugitive Emissions (PM)

Table 10.4-3: Summary of Emission Sources Associated with the NICO Mine Project (continued)

Phase	Activity		Air Emissions
Construction (continued)	III - General Construction	III.1 Vehicular traffic	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		III.2 Air transport	Fugitive Emissions (PM)
		III.3 Off-site transport, NPAR use	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		III.4 Off-site transport, Proposed Tłı̨chǫ Road Route use	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		III.5 Power generation	Combustion Emissions (stack)
		III.6 Incineration	Combustion Emissions (stack)
	IV – NICO Project Access Road Construction	IV.1 General land clearing	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.2 Drilling	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.3 Bulldozing	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.4 Material handling	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.5 Compacting	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.6 Grading	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.7 Loading of aggregate into trucks	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.8 Hauling aggregate material along the road	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		IV.9 Vehicular traffic	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)

Table 10.4-3: Summary of Emission Sources Associated with the NICO Mine Project (continued)

Phase	Activity		Air Emissions
Construction (continued)		IV.10 Jaw crusher	Fugitive Emissions (PM)
		IV.11 Material screening	Fugitive Emissions (PM)
		IV.12 Blasting	Fugitive Emissions (PM)
Operation	I – Open Pit Extraction	I.1 Drilling	Fugitive Emissions (PM with Metals)
			Combustion Emissions (tail-pipe exhaust)
		I.2 Blasting	Fugitive Emissions (PM with Metals)
		I.3 Ore transport (haul truck transport)	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	II – Ore Management	II.1 Transfer (dump) to stockpile 1	Fugitive Emissions (PM with Metals)
		II.2 Transfer to primary crusher by front end loader/maintenance, stockpile 1	Fugitive Emissions (PM with Metals)
			Combustion Emissions (tail-pipe exhaust)
		II.3 Wind erosion from stockpile 1	Fugitive Emissions (PM with Metals)
		II.4 Transfer (dump) to stockpile 2	Fugitive Emissions (PM with Metals)
		II.5 Transfer to primary crusher by front end loader/maintenance, stockpile 2	Fugitive Emissions (PM with Metals)
			Combustion Emissions (tail-pipe exhaust)
		II.6 Wind erosion from stockpile 2	Fugitive Emissions (PM with Metals)
	III – Ore Processing	III.1 Ore Drop into primary crusher	Process Emissions (PM with Metals)
		III.2 Primary crushing	Process Emissions (PM with Metals)
		III.3 Conveyor transport (1200-CV-003)	Process Emissions (PM with Metals)
		III.4 Ore drop into secondary crusher	Process Emissions (PM with Metals)
		III.5 Secondary crushing	Process Emissions (PM with Metals)
		III.6 Conveyer transport (2150-CV-005)	Process Emissions (PM with Metals)
		III.7 Ore drop in transfer tower	Process Emissions (PM with Metals)
		III.8 Conveyer transport (2150-CV-007)	Process Emissions (PM with metals)
		III.9 Ore drop into material screen	Process Emissions (PM with Metals)
		III.10 Material screening	Process Emissions (PM with metals)
		III.11 Tertiary crushing	Process Emissions (PM with Metals)

Table 10.4-3: Summary of Emission Sources Associated with the NICO Mine Project (continued)

Phase	Activity		Air Emissions
Operation (continued)		III.12 Grinding	N/A
		III.13 Ore concentration using flotation and recovery	N/A
		III.14 Tailing slurry transfer to CDF	N/A
	IV – Co-Disposal Facility	IV.1 Mine Rock dumping in CDF	Fugitive Emissions (PM with Metals)
		IV.2 Co-Disposal Facility management	Fugitive Emissions (PM with Metals)
			Combustion Emissions (tail-pipe exhaust)
		IV.3 Transport of rock to Co-Disposal Facility	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	V – Concentrate Storage	V.1 Dumping into Fine Ore Bin	Process Emissions (PM with Metals)
		V.2 Storage	N/A
	VI – Concentrate Transport	VI.1 B-Train - NPAR use (road from NICO mine to Proposed Tłįchǫ Road Route)	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		VI.2 B-Train Proposed Tłįchǫ Road Route use	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	VII – Other Off-site Transport (people, equipment, supplies)	VII.1 Air transport	Fugitive Emissions (PM)
		VII.2 Off-site transport - mine access road use (NPAR to Proposed Tłįchǫ Road Route)	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		VII.3 Off-site transport Proposed Tłįchǫ Road Route use	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	VIII – Support Activities	VIII.1 Power generation	Combustion emission (stacks)
		VIII.2 Incineration	Combustion emission (stacks)
		VIII.3 Heating	N/A
		VIII.4 On-site use of support equipment and vehicles	Combustion Emissions (tail-pipe exhaust)
		VIII.5 Fuel storage	Fugitive Emissions (VOCs)

Table 10.4-3: Summary of Emission Sources Associated with the NICO Mine Project (continued)

Phase	Activity		Air Emissions
Closure	I – Land Contouring and Debris Removal	I.1 General land contouring	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		I.2 Loading of land cleared debris	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	II – Co-Disposal Facility Cover	II.1 Bulldozer	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.2 Material handling (burrows)	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.3 Loading of material onto trucks	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.4 Hauling material from burrow areas to Co-Disposal Facility	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
		II.5 Material handling (Co-Disposal Facility)	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)
	III – General Closure	III.1 Vehicular traffic	Fugitive Emissions (PM)
			Combustion Emissions (tail-pipe exhaust)

PM = particulate matter; VOCs = volatile organic compound; N/A = not applicable.

In addition to grouping the sources in terms of the phase of the NICO Project, Table 10.4-3 also characterizes the activity according to the nature of the emissions. These include the following:

- Fugitive emissions: This category includes the fugitive particulate emissions associated with the disturbance of granular material, including transport activities on unpaved roads. This category also includes any fugitive emissions of volatile organic compounds from fuel storage. This category does not apply to activities that involve the handling or processing of ore, which are expected to contribute to the airborne release of metals.
- Fugitive emissions (Particulate Matter with metals): This category includes the fugitive particulate emissions associated with the disturbance of ore, including handling and transport activities. Because the ore is rich in metals such as cobalt, arsenic, and copper, fugitive emissions associated with the ore are expected to include airborne metals.
- Process emissions: This category includes emissions associated with the ore processing activities. As such, these activities are also expected to result in emissions of airborne metals.
- Combustion emissions (fleet exhaust): This category includes the exhaust emissions from the fleet (i.e., vehicles and equipment).
- Combustion emission (stacks): This category includes the emissions from the stationary combustion sources, namely the power generators and incinerator.

The following comments apply to the information presented in Table 10.4-3:

- **Construction:** Construction of the NICO Project will occur in 1 year. NICO Project Access Road construction will occur at the same time as mine site construction.
- **Construction/General Construction Air Transport:** During construction, air traffic will be used for emergency transportation and for bringing employees to and from remote locations approximately twice per week for the first 6 months and 4 times per week for the following 6 months. Due to the infrequent air traffic schedule, aircraft exhaust emissions have been considered as a marginal contribution to the overall emissions from the NICO Project and were not included in the emission calculation. Fugitive emissions as wind blown dust from the airstrip have been included in the emission calculation.
- **Construction/NPAR Construction:** The NPAR is expected to be constructed with granular material from borrow areas; therefore, fugitive particulate emissions are expected from this activity.
- **Operation/Extraction/Drilling, Blasting, and Ore Transport:** Extraction of ore at the NICO mine will commence using underground and open pit mining techniques. Underground mining is planned to be completed within the first 2 years, open pit mining is expected to be completed over 18 years. The emission sources were quantified for the year with the expected highest emissions, which has been assumed to correspond to the year in which the highest volume of ore and rock is mined. This corresponds to a year when only open pit extraction is occurring.
- **Operation/Ore Management/Transfer to Stockpile, Transfer to Primary Crusher, Wind Erosion from Stockpile:** Ore from extraction activities will be stockpiled in 2 piles adjacent to the primary crusher.

Fugitive emissions associated with the stockpiles are considered a potential source of particulate and metal emissions.

- **Operation/Ore Processing/Grinding, Ore Concentration Using Flotation:** Grinding will be a wet process undertaken using hydrocyclones. Flotation and recovery will be a wet process.
- **Operation/Ore Processing/Tailing Slurry Transfer to Co-Disposal Facility:** The tailings will be dewatered prior to disposal in the Co-Disposal Facility to a target solids concentration of 75% (by weight) solids. Due to a moisture content of approximately 25% (by weight), tailings dewatering and transfer by pipeline are not considered potential sources of particulate or metal emissions.
- **Operation/Concentrate Storage/Storage:** All concentrate produced in the NICO Project will be bagged and sealed suitable for storage and transport off-site; therefore, concentrate storage is not considered a potential source of particulate or metal emissions.
- **Operation/Concentrate Transport/Road Transport – NPAR, Proposed Tłįchǫ Road Route Use:** Concentrate will be transported from the site along the NPAR and Proposed Tłįchǫ Road Route. Given the nature of the operations and the road surfaces, this activity is expected to result in the following:
  - Fugitive particulate emissions (i.e., road dust): The transport of concentrate from and/or supplies to the NICO Project will be on the NPAR and the Proposed Tłįchǫ Road Route, both of which will ultimately be all weather roads; therefore, this activity is expected to generate road surface fugitive particulate emissions.
  - Concentrate emissions: The concentrate will be transported in sealed bags; leaks caused by damage to the bags or poor bag containment (e.g., excess material in the bags, bags not properly sealed) could cause spillage onto the road surface, resulting in airborne metal emissions. To minimize the potential for this happening, the bags will undergo inspection and will be promptly replaced upon detection of damages. In addition, the bagging process will promote proper bag containment. Specific monitoring and mitigation strategies and inspection procedures will be developed and applied to ensure that if a spill occurs, it will be promptly cleaned up; therefore, it is assumed that there is little chance for the concentrate to be spilled onto and remain on the road surface, and thus there is no potential for fugitive particulate and metal emissions.
- **Operation/Other Off-site Transport/Road Transport NPAR, Proposed Tłįchǫ Road Route Use:** As discussed for concentrate transport activity, no metals emissions are expected from the use of the NPAR and Proposed Tłįchǫ Road Route, but there will be general fugitive particulate from the road surface.
- **Operation/Other Off-site Transport/Air Transport:** During the operation phase, air traffic will be used for emergency transportation and for bringing employees to and from remote locations approximately once every 4 days. Due to the infrequent air traffic schedule, aircraft exhaust emissions have been considered as a marginal contribution to the overall emissions from the NICO Project and were not included in the emission calculation. Fugitive emissions as wind blown dust from the airstrip have been included in the emission calculation.

- **Operation/Support Activities/Heating:** A glycol-based heat recovery system connected to the power generation units will be used to provide heated ventilation when necessary; therefore, no direct emissions from the mine and building heating system are expected.
- **Operation/Support Activities/Fuel Storage:** Fugitive volatile organic compound emissions from fuel storage have been considered as a marginal contribution to the overall emissions from the NICO Project and were not included in the emission calculation.
- **Closure/Co-Disposal Facility Cover:** A cover on top of the Co-Disposal Facility will be applied during the closure phase using material from borrow areas. This is expected to result in fugitive and combustion emissions and has been included in the emission calculation.
- **Use of the pioneer camp at Lou Lake and permanent camp west of Nico Lake:** The pioneer camp will be decommissioned once the permanent camp is built, and hence will not contribute to emissions during the operations phase of the NICO Project.

10.4.2.1.2 Emission Calculations

Tables 10.4-4 to 10.4-7 present emission summaries for the construction, operation, and closure phases, respectively, during winter months when no dust control measures are undertaken. During the winter months, no emissions management activities have been assumed, which results in higher daily particulate and metals emissions. Although precipitation and snow accumulation on surfaces will provide some degree of mitigation of dust emissions during winter months, fugitive emissions were estimated based on the conservative assumption of no natural mitigation. Due to the generally conservative nature of fugitive and wind-blown emission estimates, there is a high degree of confidence that actual emission rates will be less than calculated. The calculated fugitive emission rates, therefore, should be considered conservative. During the summer, emission management activities will include watering ore stockpiles, the primary crusher, and on-site roads for the operation phase. A chemical dust suppressant will be applied to the airstrip. Daily emission rates will be lower for summer months when dust control measures are implemented.

Table 10.4-8 provides a summary that compares the overall emissions during the construction, operation, and closure phases. The operation phase will likely cause the greatest effect to local air quality based on the higher emission rates and longer duration of this phase than the other 2 phases; therefore, the evaluation of potential impacts on air quality due to the NICO Project focuses on air emissions during the operation phase.

Detailed emission calculations are presented in Appendix 10.II, along with the specific references used in each calculation.

Table 10.4-4: Emissions Summary – On-site Construction

Activities	Emission Rate (kg/day)						
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Dioxins/ Furans
I - Land Clearing	290.96	108.45	25.48	24.16	0.056	8.26	N/A
II - Site Preparation	724.33	240.85	27.56	119.20	4.18	192.20	N/A
III - General Construction	871.50	247.52	89.55	3636.07	3.44	986.98	8.50E-10
Total	**1886.79**	**596.82**	**142.59**	**3779.43**	**7.68**	**1187.44**	**8.50E-10**

TSP = total suspended particulates; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; N/A = No applicable emission.

Table 10.4-5: Emissions Summary – NICO Project Access Road Construction

Activities	Emission Rate (kg/day)						
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Dioxins/ Furans
IV - NPAR Construction	1166.98	313.78	75.65	372.12	0.67	113.40	N/A

NPAR = NICO Project Access Road; TSP = total suspended particulates; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; N/A = No applicable emission.

Table 10.4-6: Emissions Summary – Operation

Activities	Emission Rate (kg/day)						
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Dioxins/ Furans
I - Extraction	782.97	165.28	20.96	285.72	10.19	461.96	N/A
II - Ore management	24.35	8.10	2.32	5.31	0.014	2.02	N/A
III - Ore Processing	69.08	28.47	1.31	N/A	N/A	N/A	N/A
IV - CDF	2656.51	657.68	128.76	139.93	0.30	46.09	N/A
V - Concentrate Storage	8.31E-05	3.93E-05	5.95E-06	N/A	N/A	N/A	N/A
VI - Concentrate Transport	490.01	100.30	10.08	2.60	0.0047	1.19	N/A
VII - Other Off-site Transport	928.64	203.84	21.63	4.67	0.0085	2.14	N/A
VIII - Support Activities	70.25	65.14	65.03	3518.29	3.28	940.61	8.50E-10
Total	**5021.81**	**1228.81**	**250.09**	**3956.52**	**13.80**	**1454.01**	**8.50E-10**

CDF = Co-Disposal Facility; TSP = total suspended particulates; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; N/A = No applicable emission; kg/day = kilogram per day.

Table 10.4-7: Emissions Summary – Closure

Activities	Emission Rate (kg/day)						
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Dioxins/ Furans
I - Land Contouring and Debris Removal	161.58	55.58	17.78	19.11	0.046	6.53	N/A
II - CDF Cover	484.70	200.08	26.30	49.04	0.11	17.32	N/A
III - General Closure	370.87	159.33	23.15	167.99	0.27	63.89	N/A
Total	**1017.15**	**415.00**	**67.22**	**236.14**	**0.42**	**87.75**	**N/A**

CDF = Co-Disposal Facility; TSP = total suspended particulates; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; N/A = No applicable emission; kg/day = kilogram per day.

Table 10.4-8: Emissions Summary – All NICO Project Phases

Activities		Emission Rate (kg/day)						
		TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Dioxins/ Furans
I - Construction	Mine Site	1886.78	596.82	142.59	3779.43	7.68	1187.44	8.50E-10
	NPAR	1166.98	313.78	75.65	372.12	0.67	113.40	N/A
II - Operation		5021.81	1228.81	250.09	3956.52	13.80	1454.01	8.50E-10
III - Closure		1017.15	415.00	67.22	236.14	0.42	87.75	N/A
Total		**9092.73**	**2554.41**	**535.55**	**8344.21**	**22.57**	**2842.60**	**1.70E-09**

NPAR = NICO Project Access Road; TSP = total suspended particulates; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; N/A = No applicable emission; kg/day = kilogram per day.

10.4.2.1.3 Greenhouse Gas Emission Estimations

Greenhouse Gas emissions associated with the use of fuel in vehicles, equipment, and power generators from the NICO Project were calculated. Total daily greenhouse gas emissions during the operations phase of the NICO Project are estimated to be 276.46 tonnes of carbon dioxide equivalent per day. Total annual greenhouse gas emissions during the operations phase are estimated to be 100.23 thousand tonnes of carbon dioxide equivalent per year.

The major source of greenhouse gas emissions from the NICO Project is the use of diesel power generators. Eight 1450 kilowatts (kW) power generators are expected to operate 24 hours per day during the operations phase, accounting for approximately 68% of the total annual greenhouse gas emissions. The second major contributor to the total greenhouse gas emissions is the use of diesel vehicles and equipments. The waste incinerator is expected to contribute approximately 1% of the total annual greenhouse gas emissions from the NICO Project.

Detailed emission calculations for greenhouse gas emissions during all NICO Project phases are presented in Appendix 10.II, along with the specific references used in each calculation.

10.4.2.2 CALMET Modelling Results

The meteorological parameters generated by CALMET, including wind, temperature, mixing height, and stability class, are provided in Appendix 10.1, Section 10.I.3.2 and summarized below.

10.4.2.2.1 Wind

The dispersion and transport of atmospheric emissions are driven primarily by the 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, and the direction from which the wind blows is illustrated by the orientation of the bar in 1 of 16 directions.

Figure 10.4-1 presents a comparison of the observed and CALMET-derived winds for the NICO Project. The predominant winds at the NICO Project are from the south-southeast and north. The CALMET winds for the 2 by 2 km grid cell containing the NICO Project also indicate a south-southeast predominance, although to a lesser degree.

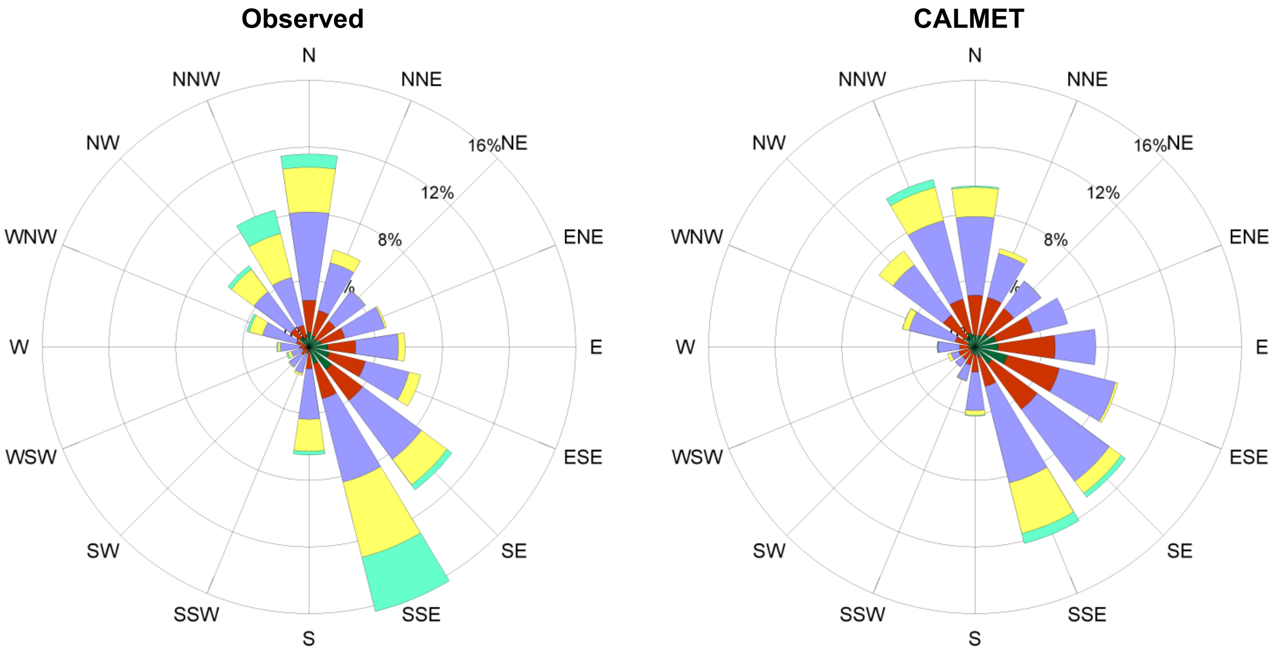


Figure 10.4-1: Observed and CALMET-Derived Windroses for the NICO Project

10.4.2.2.2 Temperature

Figure 10.4-2 shows the comparison of observed and CALMET-derived temperatures for the NICO Project. The figure includes a box-whisker plot that shows the minimum and maximum temperatures, the 25th and 75th percentiles, and the median temperature. The frequency distribution of temperatures is also shown. This comparison indicates that the CALMET-derived temperatures are similar to the observed temperatures.

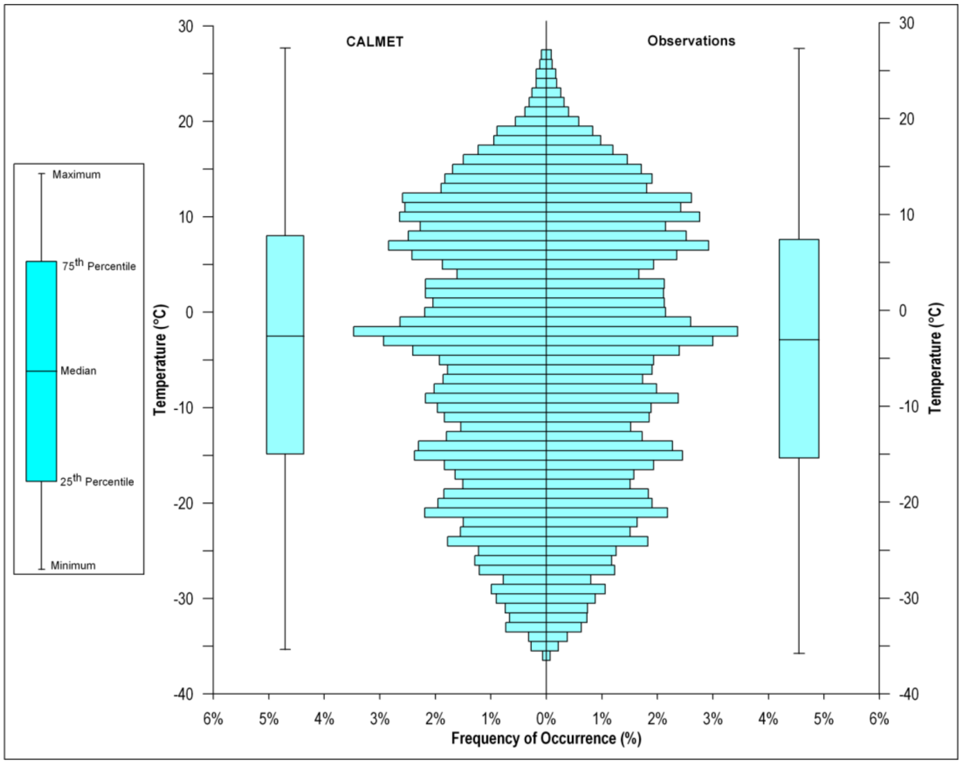


Figure 10.4-2: Comparison of Observed and CALMET-Derived Temperatures for the NICO Project

10.4.2.2.3 Mixing Height

Mixing height is a measure of the depth of the atmosphere through which mixing of emissions can occur. Mixing heights often exhibit a strong diurnal and seasonal variation: they are lower during the night and higher during the day. Seasonally, mixing heights are typically lower in the winter and higher in the late spring and early summer.

CALMET calculates an hourly convective mixing height for each grid cell from hourly surface heat fluxes and vertical temperature profiles from twice-daily soundings. Mechanical mixing heights are calculated using an empirical relationship that is a function of friction velocity. To incorporate adjective effects, mixing height fields are smoothed by incorporating values from upwind grid cells. The higher of the 2 mixing heights (convective or mechanical) in a given hour is used. A more detailed description of this method is given in the CALMET User’s Manual Version 5.0 (Earth Tech 2000).

Figure 10.4-3 shows the frequency of diurnal mixing heights derived by CALMET for the NICO Project for the assessment period. Mixing heights are typically lower at night than during the day. The average nighttime mixing height is 74 m and the average daytime mixing height is 539 m. The minimum and maximum mixing heights were set to 50 m and 3000 m, respectively. The high frequency of low mixing heights is likely due to the very stable conditions associated with little to no incoming solar radiation during the winter months.

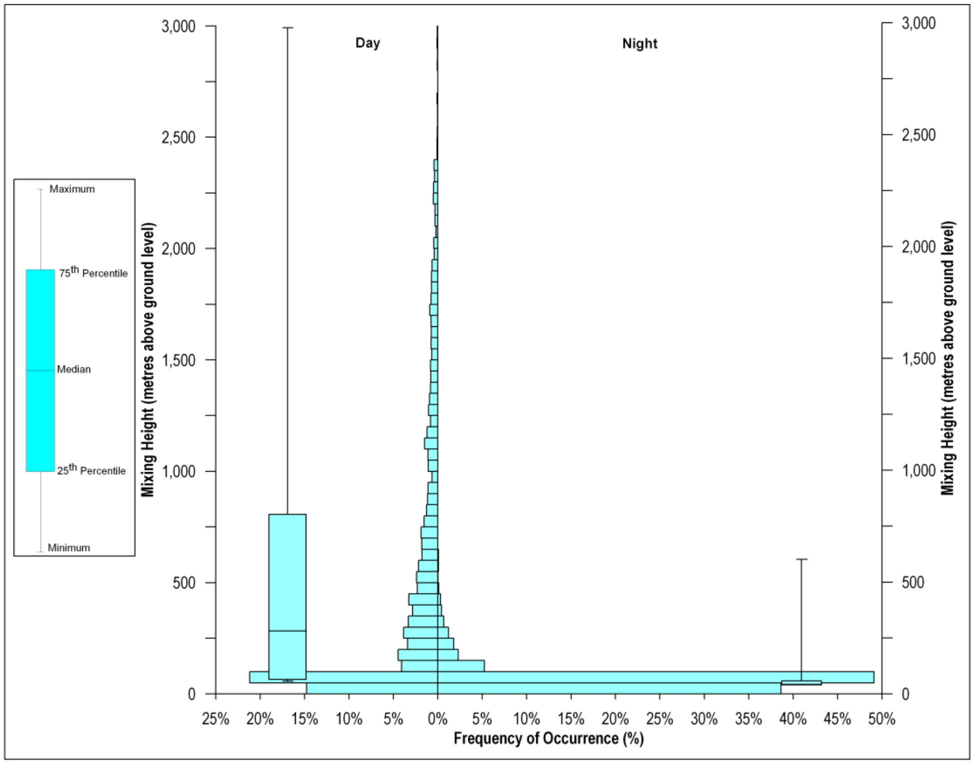


Figure 10.4-3: CALMET-Derived Mixing Heights for the NICO Project

10.4.2.2.4 Stability Class

Atmospheric stability can be viewed as a measure of the atmosphere's capability to disperse emissions. The amount of turbulence plays an important role in the dilution of a plume as it is transported by the wind. Turbulence can be generated by either thermal or mechanical mechanisms. Surface heating or cooling by radiation contributes to the generation or suppression of thermal turbulence, whereas high wind speeds contribute to the generation of mechanical turbulence.

The Pasquill-Gifford stability classification scheme is one classification of the atmosphere. The classification ranges from Unstable (Stability Classes A, B, and C), Neutral (Stability Class D) to Stable (Stability Classes E and F). Unstable conditions are primarily associated with daytime heating conditions, which result in enhanced turbulence levels (enhanced dispersion). Stable conditions are associated primarily with night-time cooling conditions, which result in suppressed turbulence levels (poorer dispersion). Neutral conditions are primarily associated with higher wind speeds or overcast conditions.

Figure 10.4-4 provides a comparison between the stability conditions derived by CALMET for the NICO Project for the assessment period. The following can be observed from the comparison:

- the CALMET model estimated that unstable (A, B, and C) conditions would occur 18% of the time;
- neutral conditions were estimated to occur 46% of the time; and
- stable (E and F) conditions were estimated to occur 36% of the time.

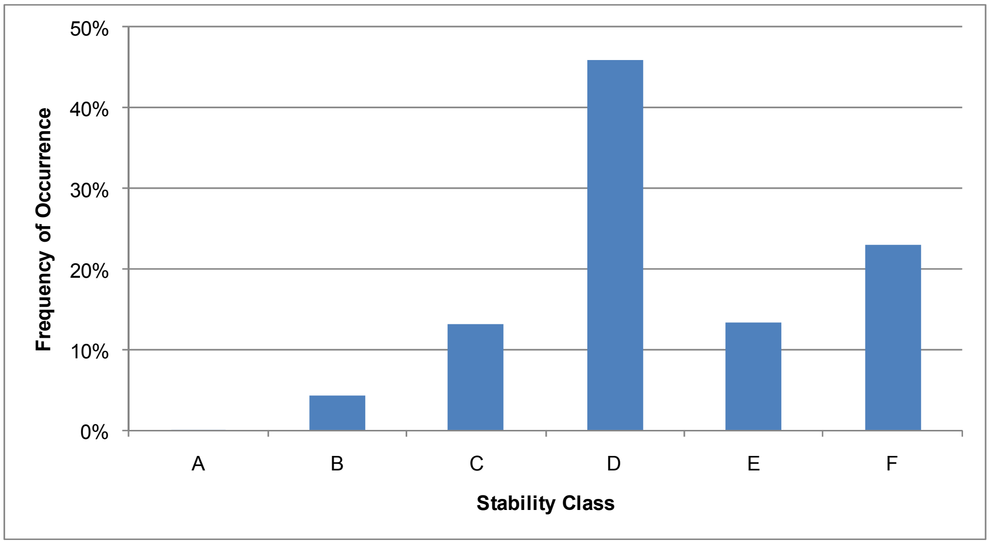


Figure 10.4-4: CALMET-Derived Pasquill-Gifford Stability Classes for the NICO Project

10.4.2.3 CALPUFF Modelling Results

10.4.2.3.1 Ambient Concentrations

Modelling was conducted using the operating year (Year 4) with the maximum emission rates from the NICO Project. Other operating years are expected to have emission rates that are a fraction of Year 4. Therefore, the modelling results shown in this DAR are the maximum concentration and deposition values that are estimated to result from the NICO Project.

Table 10.4-9 presents the maximum predicted concentrations for averaging periods, along with applicable air quality standards that were presented in Section 10.3.2.3. The model results shown in the table are based on the on-site emissions of the NICO Project. Ambient air concentrations resulting from off-site emissions from the NICO Project are presented in Section 10.4.2.7.

The modelling results for the Baseline Case indicate that the maximum predicted concentrations for all compounds modelled are below the applicable air quality guidelines. For the Application Case, the modelling results in Table 10.4-9 indicate the following:

- **SO_2**: The predicted maximum 1-hour, 24-hour, and annual ground-level SO_2 concentrations are well below the applicable air quality standards for all of the receptors in the receptor grid, including areas within the NICO Project Lease Boundary.
- **NO_2**: The predicted maximum 1-hour and 24-hour ground-level NO_2 concentrations are below the applicable air quality standards outside the NICO Project Lease Boundary (Figures 10.4-5 and 10.4-6, respectively); however, the predicted annual average NO_2 concentration of 68 μg/m^3 exceeds the annual NO_2 standard of 60 μg/m^3 (Figure 10.4-7). Approximately an area of 4 hectares (ha) outside of the NICO Project Lease Boundary exceeds the annual standard. These areas are limited to the north side of the NICO Project Lease Boundary, near the mine site and Co-Disposal Facility. The NO_2 concentrations decrease rapidly with distance from the NICO Project. The predicted concentrations at Hislop Lake and Marian River are below the air quality objectives.

Table 10.4-9: Predicted Maximum Ambient Air Concentrations Based on CALPUFF Modelling

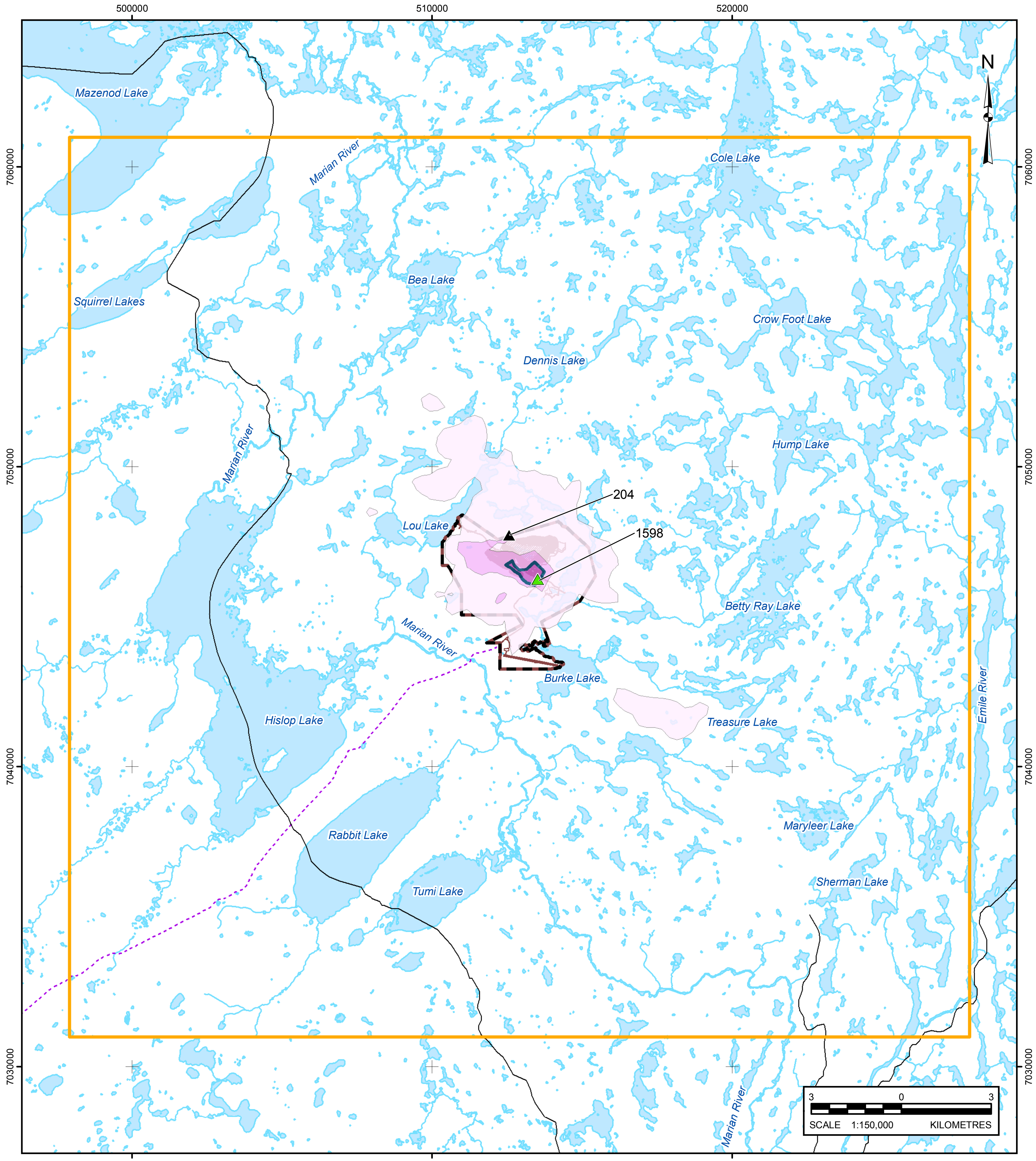
Compound	Averaging Period	NWT Air Quality Standards ($\mu g/m^3$)	Maximum Ground-level Concentration ($\mu g/m^3$)				
			Baseline Case[a]	Application Case			
				Local Study Area		Regional Study Area	
				Overall[b]	Excluding Developed Area[c]	Overall[b]	Excluding Developed Area[c]
SO_2	1-hour	450	<1	19	10	19	10
	24-hour	150	<1	9	4	9	4
	Annual	30	<1	2	1	4	1
NO_2	1-hour	400	74	1 598	204	1 598	204
	24-hour	200	28	626	129	626	129
	Annual	60	2	128	68	128	68
CO	1-hour	15 000	366	4 433	965	4 433	965
	8-hour	6 000	358	3 017	694	3 017	694
$PM_{2.5}$	24-hour	30	3	198	80	198	80
TSP	24-hour	120	3	7 770	1 669	7 770	1 669
	Annual	60	2	1 179	166	1 179	166

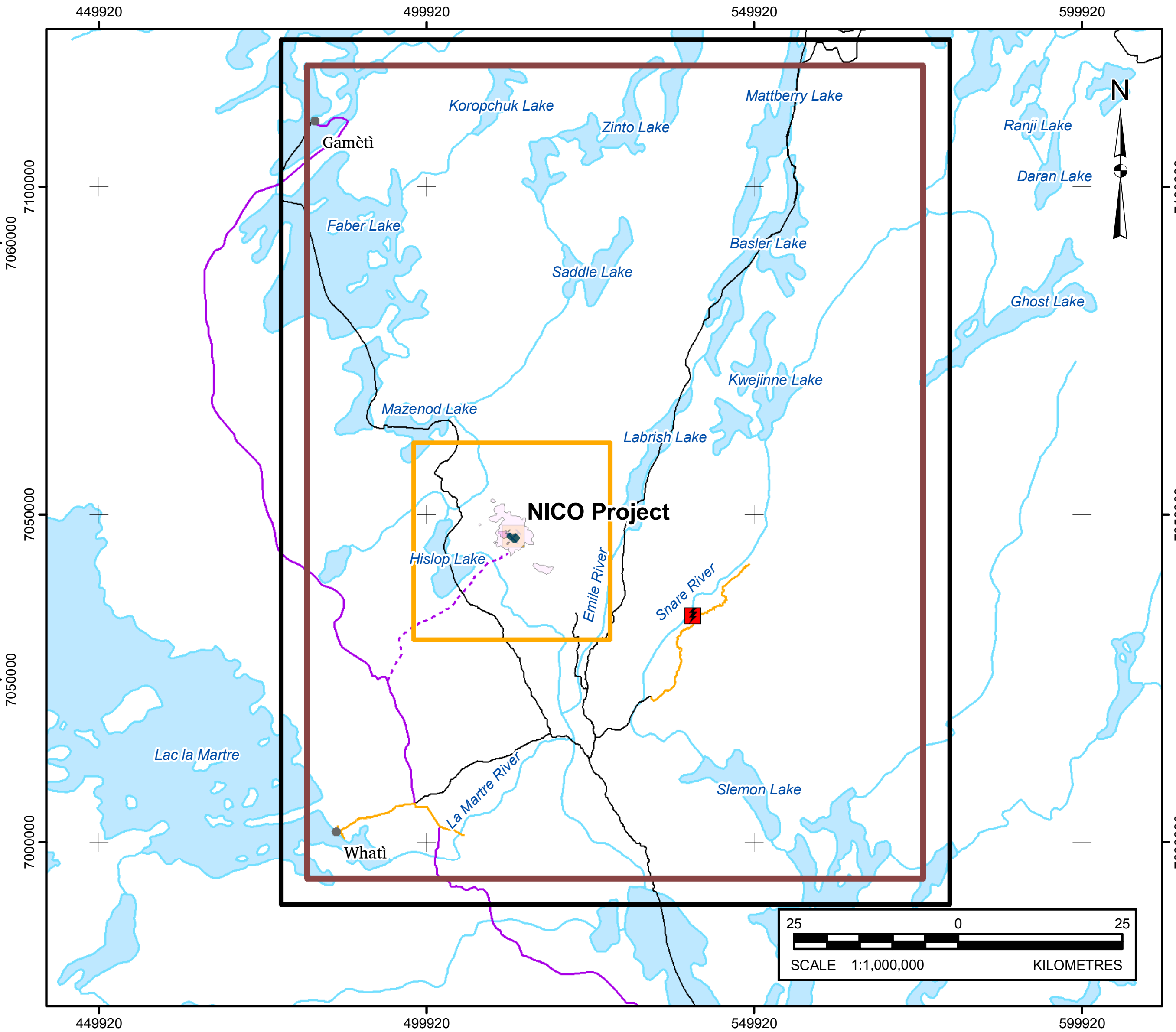
[a] within the RSA (including the area within the NICO Project Lease Boundary).

[b] within the NICO Project Lease Boundary.

[c] outside the NICO Project Lease Boundary.

$\mu g/m^3$ = microgram per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; PM = particulate matter; TSP = total suspended particulates.





LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION ($\mu g/m^3$)

- >= 400
- 200 to < 400
- 100 to < 200
- 0 to < 100

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE MAXIMUM 1-HOUR NITROGEN DIOXIDE CONCENTRATIONS

Golder Associates
Edmonton, Alberta

FILE No. E-Air-003-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.4-5**	
GIS	BS	07 Mar. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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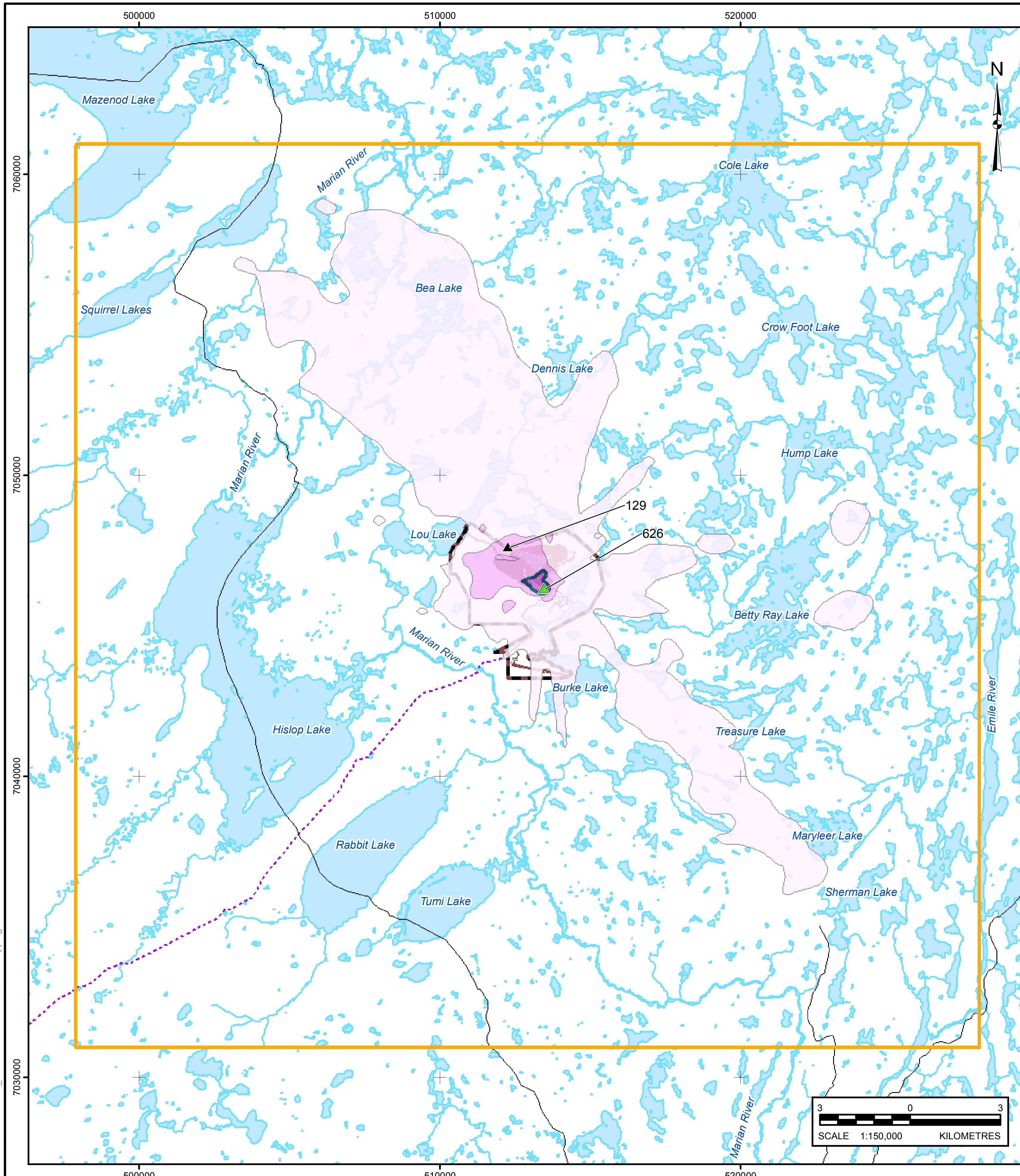

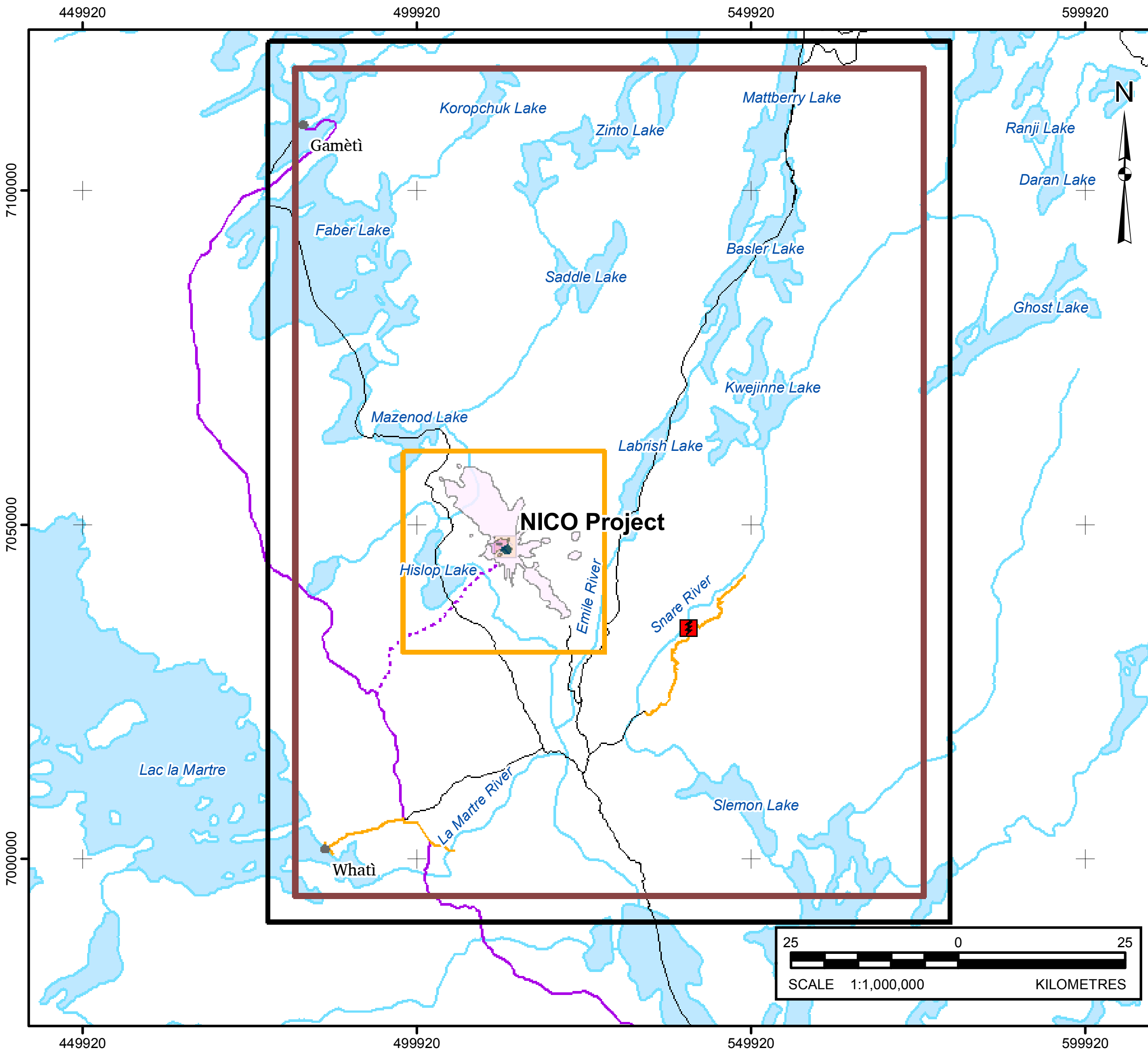

LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION (µg/m³)

- >= 200
- 100 to < 200
- 50 to < 100
- 0 to < 50

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE MAXIMUM 24-HOUR NITROGEN DIOXIDE CONCENTRATIONS

Golder Associates
Edmonton, Alberta

FILE No. E-Air-004-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011		
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

FIGURE: 10.4-6

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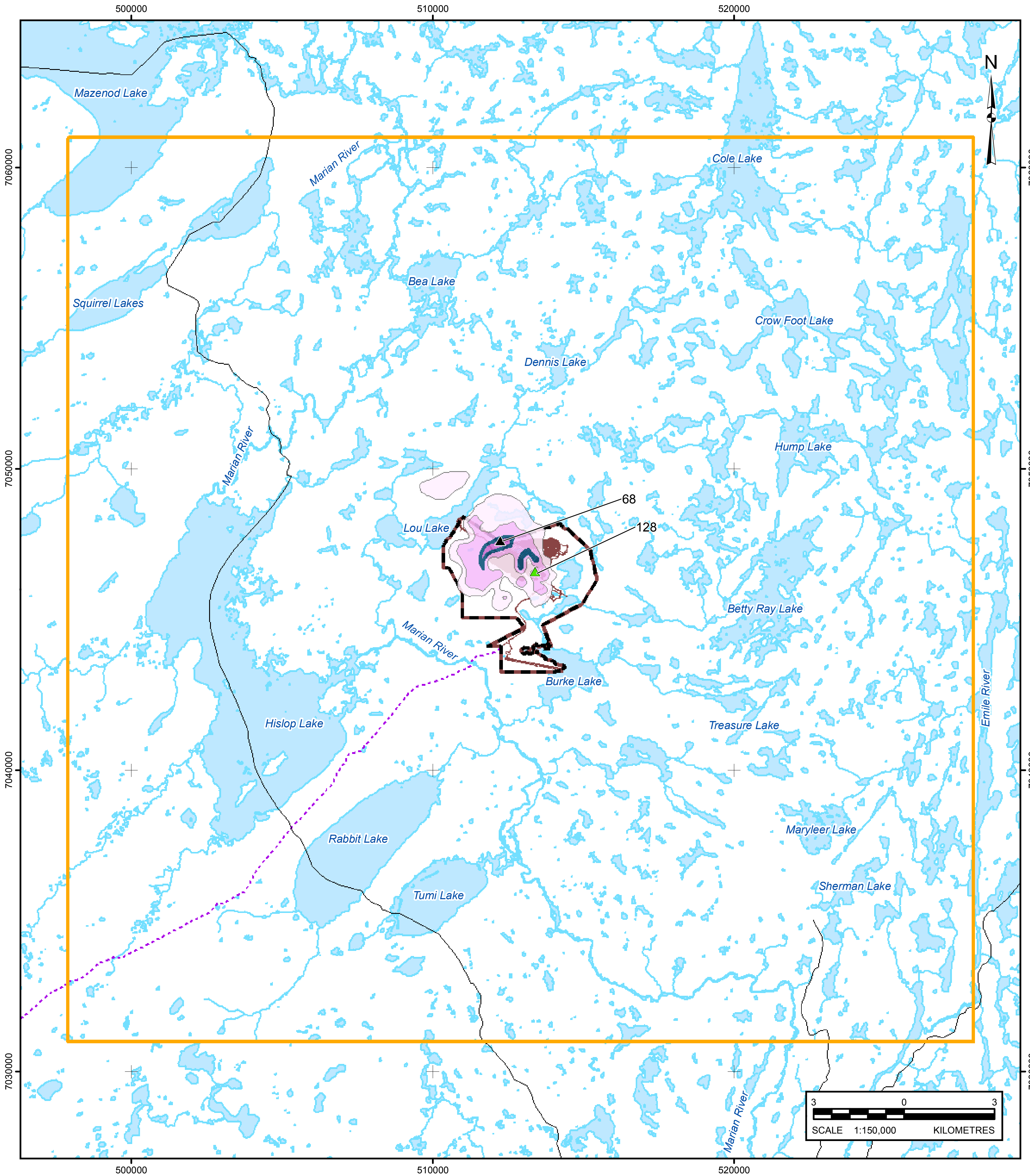

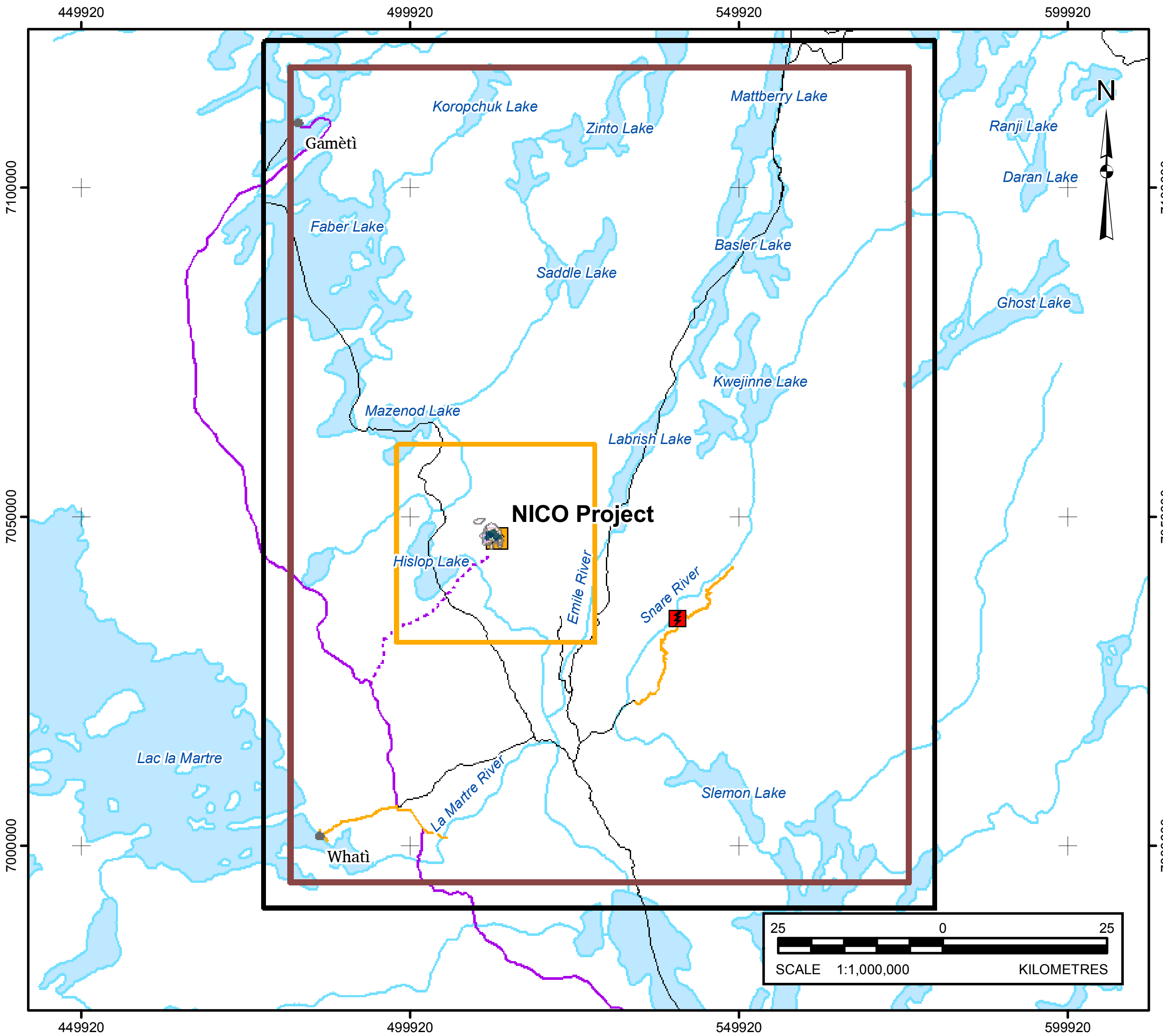

LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION (µg/m^3)

- >= 60
- 30 to < 60
- 15 to < 30
- 0 to < 15

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE ANNUAL AVERAGE NITROGEN DIOXIDE CONCENTRATIONS

Golder Associates
Edmonton, Alberta

FILE No. E-Air-005-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	
GIS	AB	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 10.4-7

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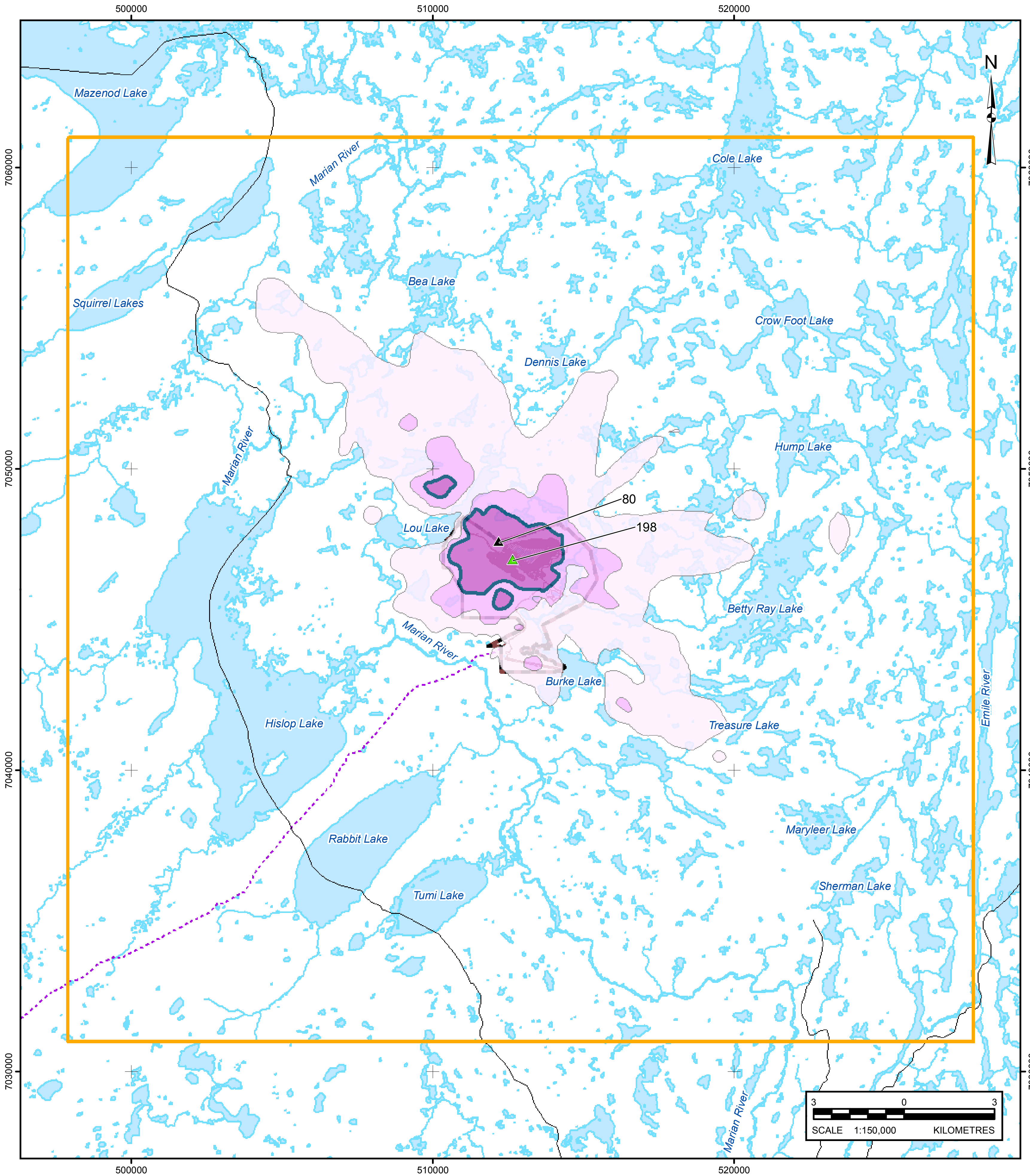
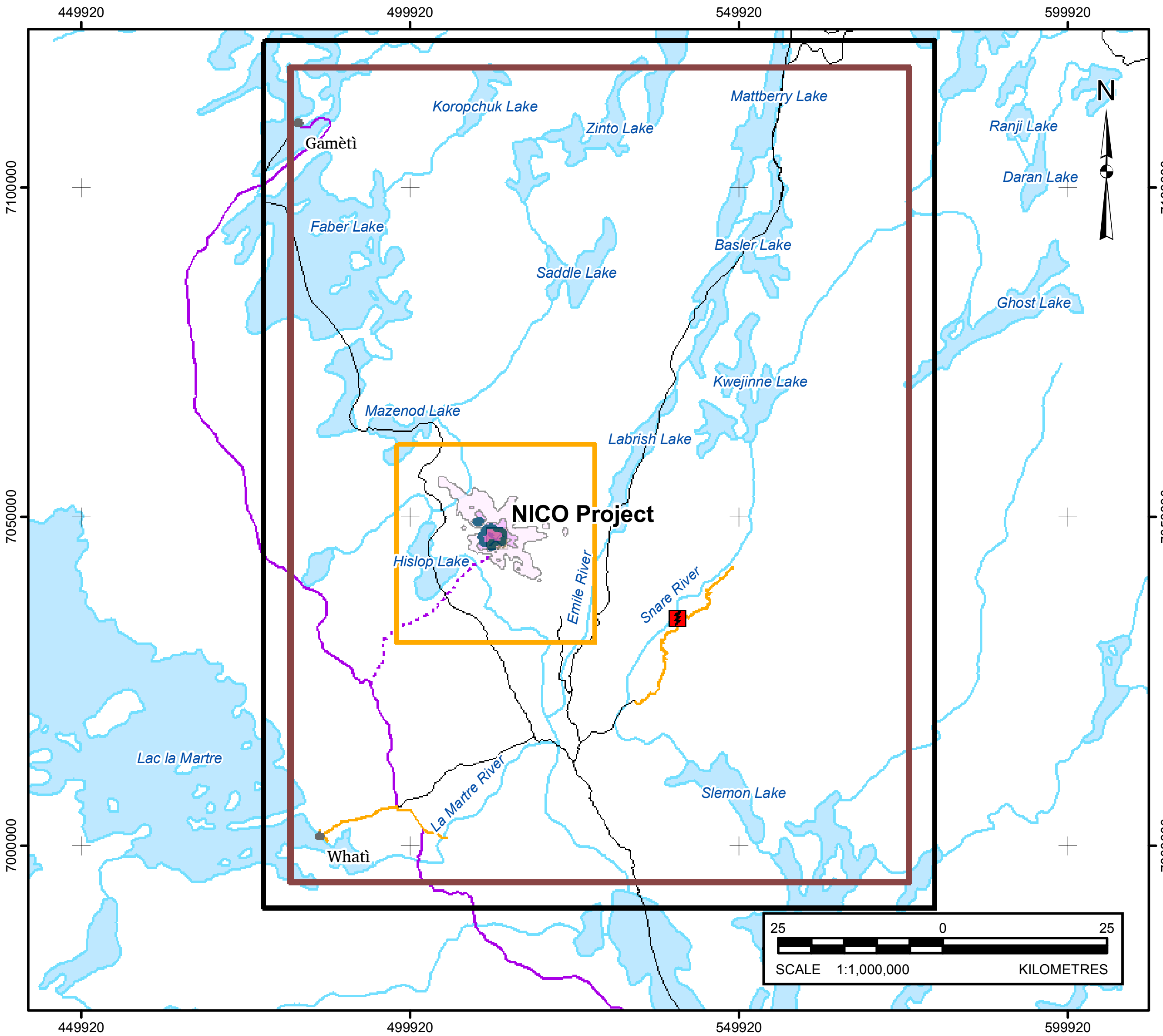
- **CO**: The predicted maximum 1-hour and 8-hour ground-level CO concentrations are below the applicable air quality standards for all of the receptors in the receptor grid, including areas within the NICO Project Lease Boundary.

- **$PM_{2.5}$**: The predicted maximum 24-hour concentrations outside the NICO Project Lease Boundary exceed the air quality standard of 30 µg/m³ for a maximum of 39 days per year, or 11% of the time. Approximately an area of 189 ha outside of the NICO Project Lease Boundary exceeds the standard. These areas are Open Pit, Co-Disposal Facility, and haul roads, on the northern boundary of the developed area, as well as northwest of the NICO Project at the hill across Lou Lake (Figure 10.4-8). Concentrations above the air quality standard are limited to within 2 km of the NICO Project Lease Boundary. The excursion is the result of fugitive road dust emissions during winter months when there will be no road watering. Although precipitation and snow accumulation on the haul road surface will provide some degree of mitigation of the road dust emissions during the winter, the winter road dust emissions modelled in the Application Case were based on the conservative assumption of no mitigation. Due to the generally conservative nature of fugitive and wind-blown emission estimates, there is a high degree of confidence that actual concentrations will be less than modelled results. The predicted concentrations, therefore, should be considered conservative. A detailed description of the assumptions and the methodology for estimating road dust emissions is provided in Appendix 10.II.

  Figure 10.4-9 illustrates the number of days the area surrounding the NICO Project is predicted to exceed the NWT $PM_{2.5}$ standard. The figure shows that, for the majority of the area outside the NICO Project Lease Boundary, predicted concentrations above the standard occur between 1 and 13 days.





LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION ($\mu g/m^3$)

- >= 30
- 15 to < 30
- 7.5 to < 15
- 0 to < 7.5

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

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

Golder Associates
Edmonton, Alberta

FILE No. E-Air-006-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011		
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

FIGURE: 10.4-8

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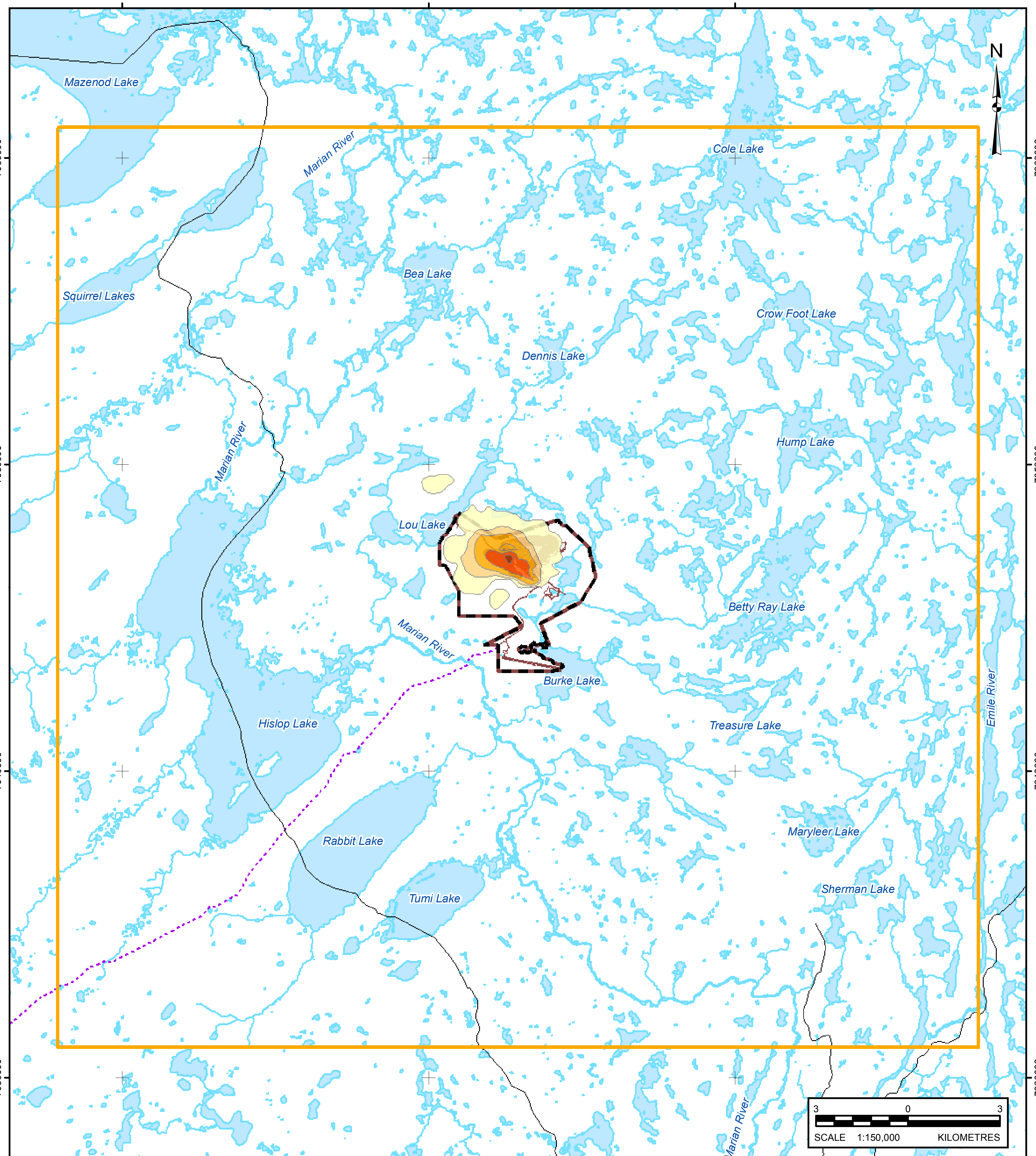

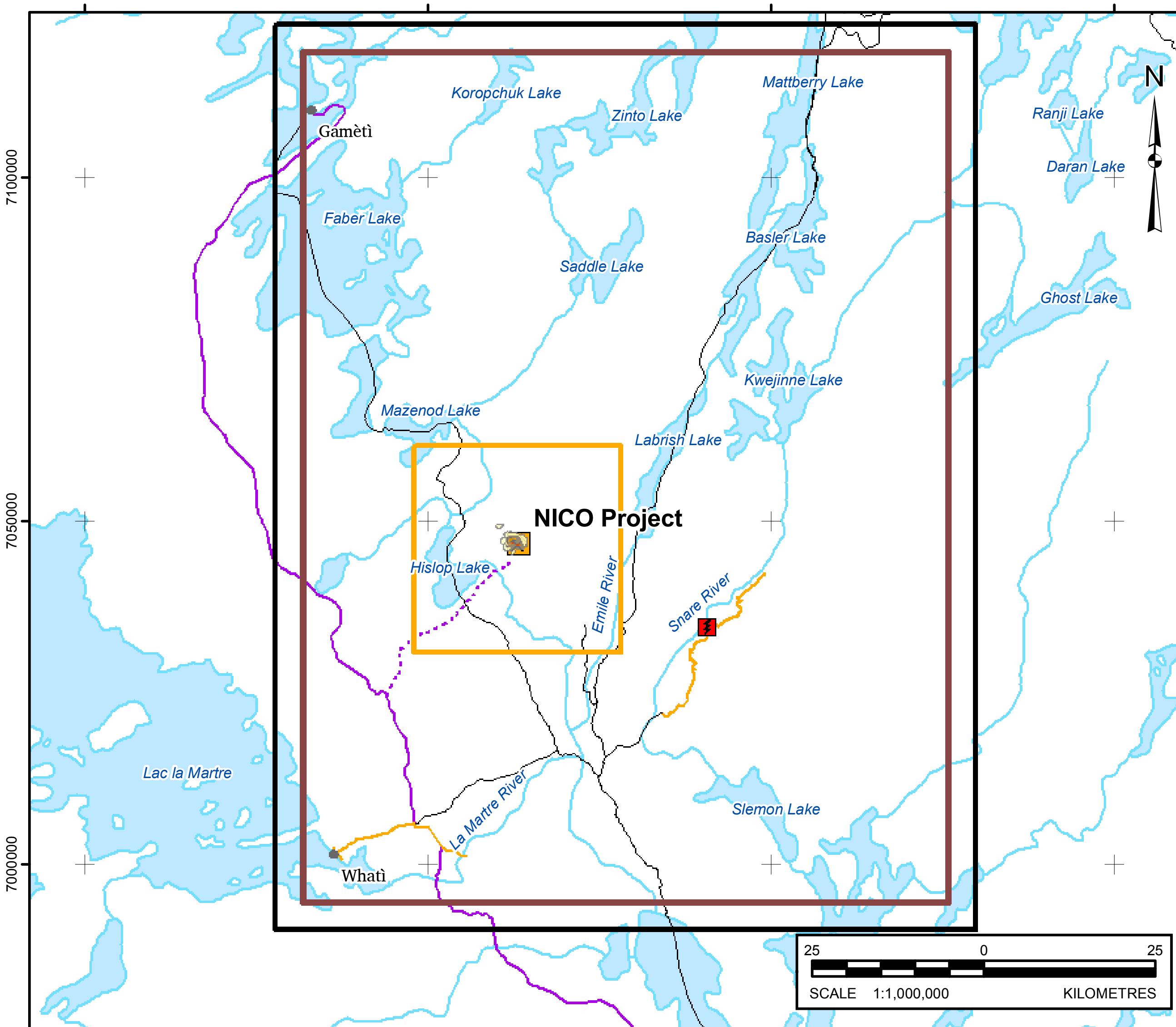

LEGEND

NICO PROJECT	SNARE HYDRO LOCATION
PROJECT LEASE BOUNDARY	CALPUFF MODELLING DOMAIN
PROPOSED NICO MINE SITE	LOCAL STUDY AREA
EXISTING ALL-WEATHER ROAD	REGIONAL STUDY AREA
EXISTING WINTER ROAD	
PROPOSED NICO PROJECT ACCESS ROAD	
PROPOSED TŁĮCHǪ ROAD ROUTE	
WATERCOURSE	
WATERBODY	

NUMBER OF DAYS EXCEEDING AIR QUALITY STANDARD

- >= 120
- 60 to 119
- 30 to 59
- 14 to 29
- 1 to 13

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

NUMBER OF DAYS EXCEEDING 24-HOUR $PM_{2.5}$ AIR QUALITY STANDARD

Golder Associates
Edmonton, Alberta

FILE No. E-Air-007-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	FIGURE: 10.4-9	
GIS	BS	08 Mar. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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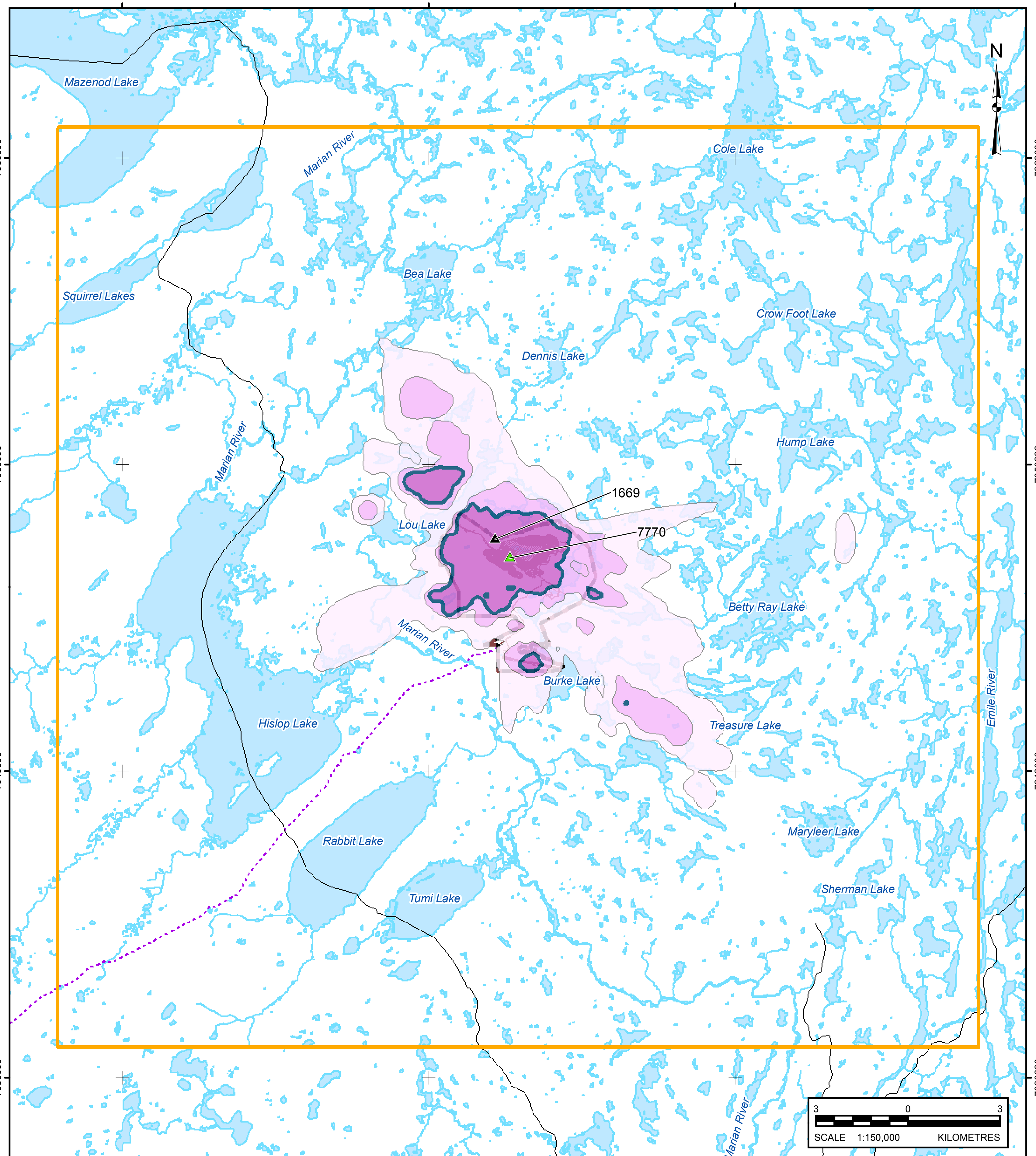
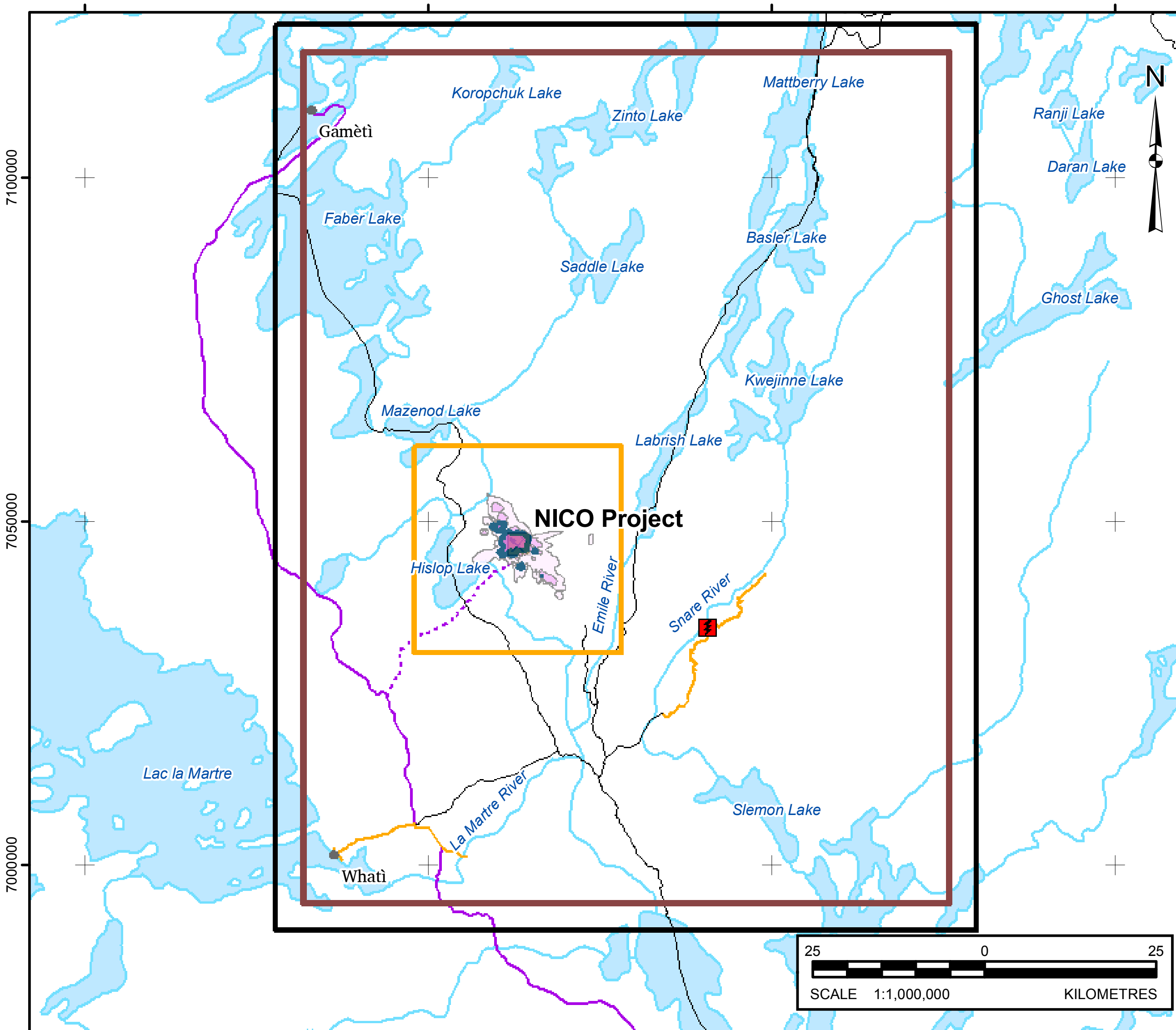
- **TSP**: The predicted maximum 24-hour and annual average concentrations exceed the air quality standard of 120 µg/m³ and 60 µg/m³, respectively. Figure 10.4-10 shows that the area outside the NICO Project Lease Boundary above the 24-hour standards is adjacent to the boundary and northwest of the NICO Project at the hill across Lou Lake. Concentrations above the air quality standard are limited to within 2 km of the NICO Project Lease Boundary. Figure 10.4-11 shows that the area outside the NICO Project Lease Boundary above the annual standard is adjacent to the northern portion of boundary. The predicted concentrations at Hislop Lake and Marian River are below the air quality standards for both averaging periods. Elevated predicted maximum concentrations are primarily the result of winter fugitive road dust emissions discussed above. The conservative nature of the winter road dust emissions are explained in Appendix 10.II.

  Figure 10.4-12 shows the number of days the area surrounding the NICO Project is predicted to exceed the applicable standard. The 24-hour concentration is above the standard for a maximum of 121 days per year or 33% of the time. The figure shows that predicted concentrations above the standard for the majority of the area outside the NICO Project Lease Boundary occur less than 30 days. Only the area adjacent to the NICO Project Lease Boundary is estimated to experience 60 to 120 days of concentrations above the standard.





LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁJCHO ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION ($\mu g/m^3$)

- >= 120
- 60 to < 120
- 30 to < 60
- 0 to < 30

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE
APPLICATION CASE MAXIMUM 24-HOUR TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates
Edmonton, Alberta

FILE No. E-Air-008-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.4-10**	
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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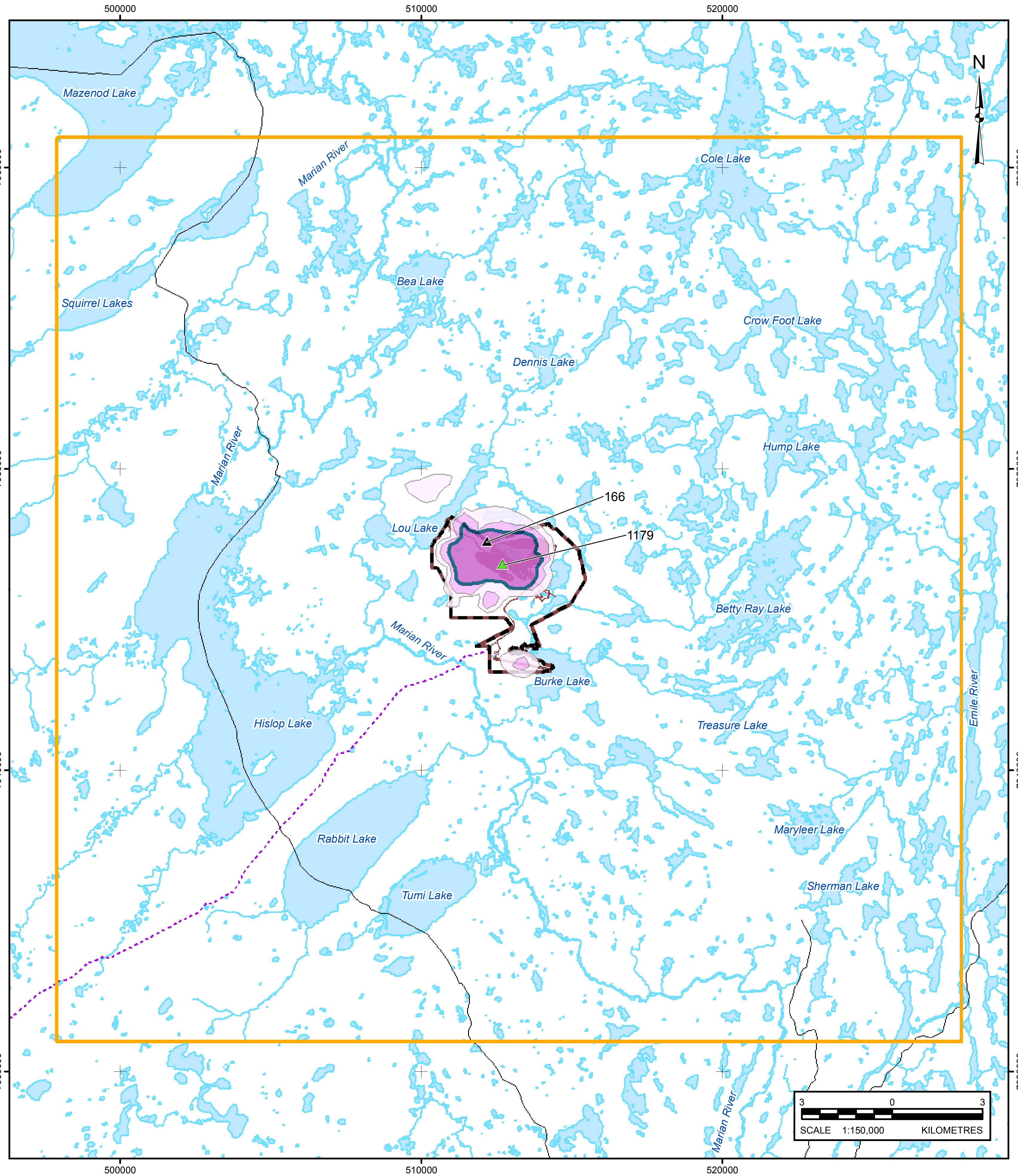
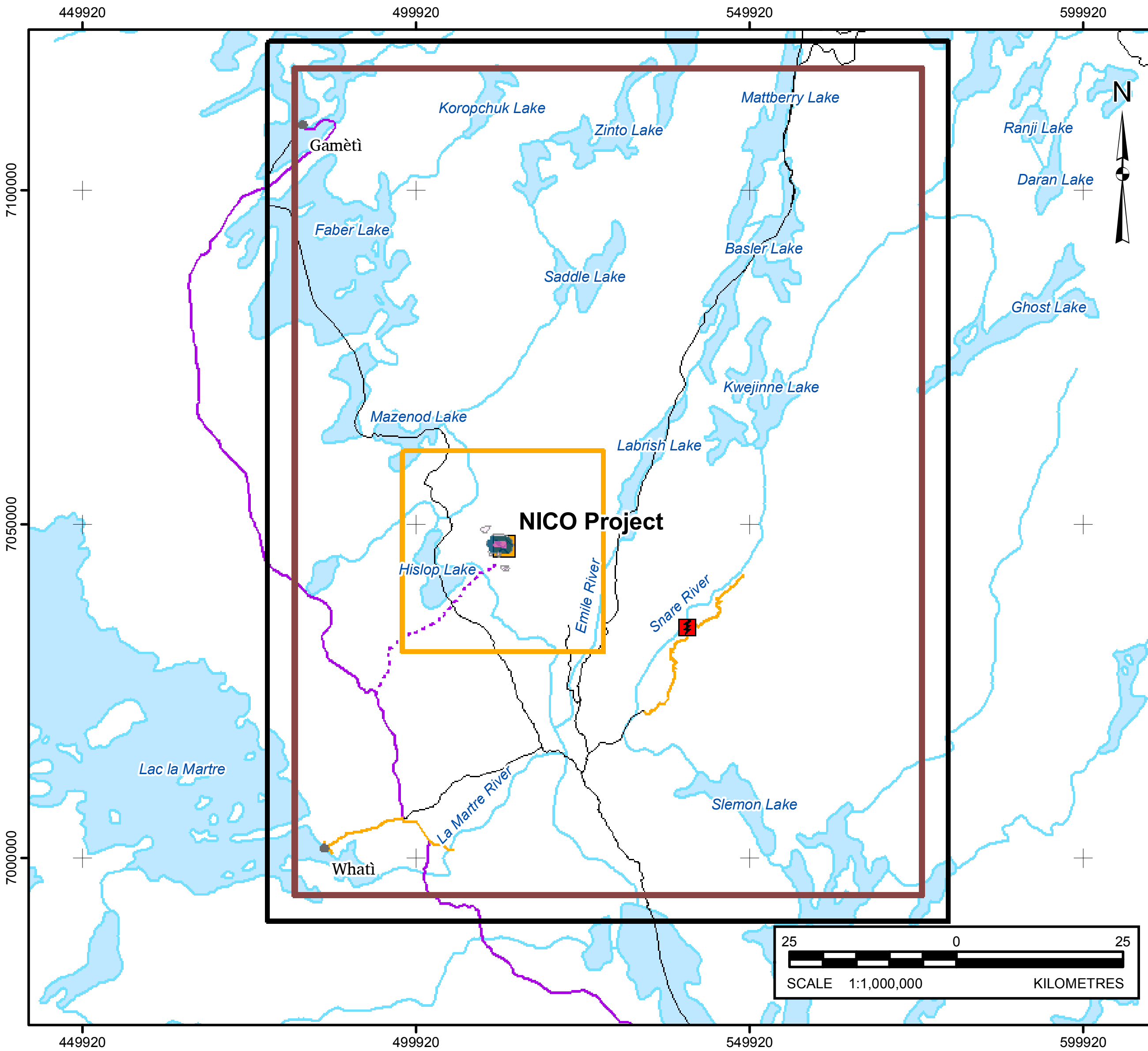




LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

CONCENTRATION (μg/m³)

- >= 60
- 30 to < 60
- 15 to < 30
- 0 to < 15

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

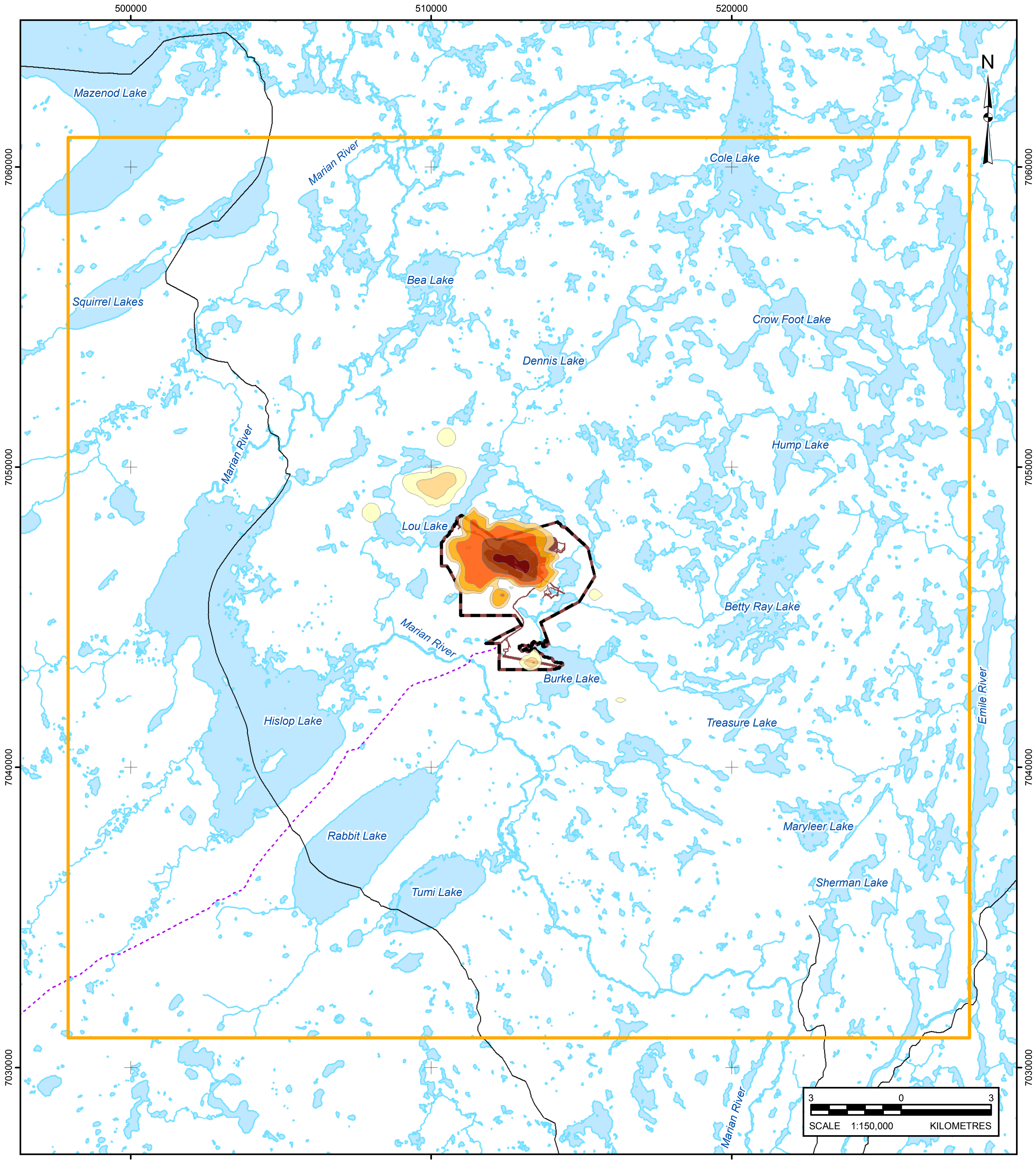
TITLE

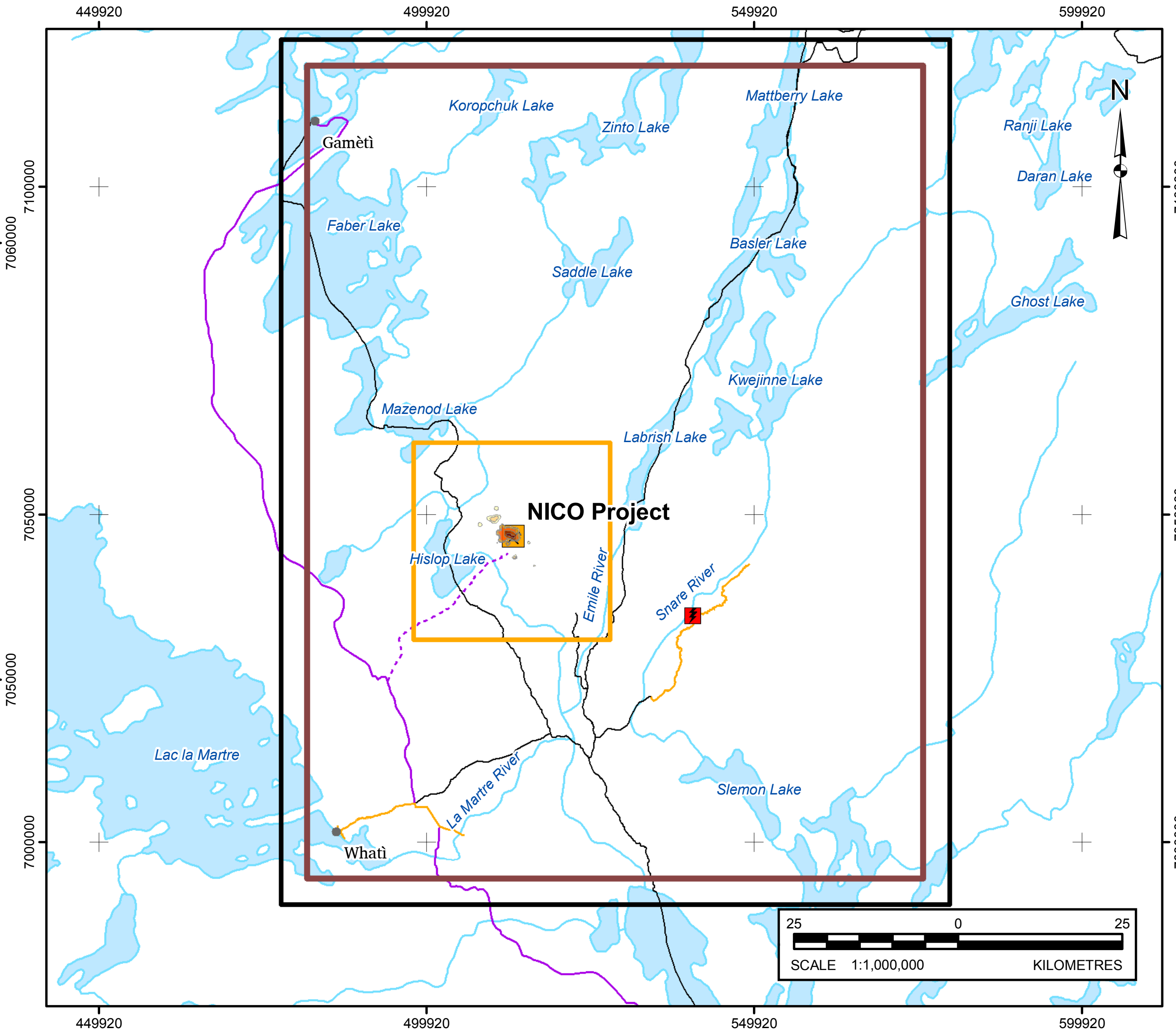
APPLICATION CASE ANNUAL AVERAGE TOTAL SUSPENDED PARTICULATE CONCENTRATIONS

Golder Associates
Edmonton, Alberta

FILE No. E-Air-010-GIS

PROJECT NO. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.4-11**	
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		





LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

NUMBER OF DAYS EXCEEDING AIR QUALITY STANDARD

- >= 240
- 120 to 239
- 60 to 119
- 30 to 59
- 14 to 29
- 1 to 13

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE
NUMBER OF DAYS EXCEEDING 24-HOUR TOTAL SUSPENDED PARTICULATE AIR QUALITY STANDARD

Golder Associates
Edmonton, Alberta

FILE No. E-Air-009-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	
GIS	BS	08 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 10.4-12

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10.4.2.3.2 Deposition Rates

Table 10.4-10 presents the Baseline Case and Application Case predicted deposition rates outside the NICO Project Lease Boundary. The predicted deposition values for the Baseline Case are small in comparison to those for the Application Case. The modelling results for the Application Case indicate the following:

- **TSP Deposition**: The predicted maximum TSP deposition rate outside the NICO Project Lease Boundary is 0.15 kg/m^2/y, and the overall TSP deposition rate including the area within the NICO Project Lease Boundary is 1.08 kg/m^2/y. Figure 10.4-13 shows the pattern of annual TSP deposition for the Application Case. The areas with the highest deposition rates are located near the mine site and the haul roads towards the northern side of the Project Lease.

- **PAI Deposition**: The predicted maximum PAI deposition outside the NICO Project Lease Boundary is 0.34 keq/ha/y, and the overall PAI deposition rate including the area within the NICO Project Lease Boundary is 2.29 keq/ha/y. Figure 10.4-14 shows the PAI deposition rates for the Application Case. The maximum deposition rates occurs in the middle of the Project Lease in the vicinity of the plant, Open Pit, and haul roads.

- **Nitrogen Deposition**: The maximum predicted nitrogen deposition outside of the NICO Project Lease Boundary is 4.14 kg/ha/y. Figure 10.4-15 shows the nitrogen deposition rates for the Application Case. The maximum deposition rates occur in the middle of the Project Lease in the vicinity of the plant, Open Pit, and haul roads.

The deposition results are presented in detail in Appendix 10.III. There are no NWT Air Quality Standards for deposition; however, the potential effects of TSP, PAI, nitrate, sulphate, and nitrogen deposition on the receiving environment are assessed in the following Sections of the DAR:

- KLOI: Water Quality (Section 7);
- KLOI: Caribou (Section 8);
- SON: Fish and Aquatic Habitat (Section 12); and
- SON: Wildlife (Section 15).

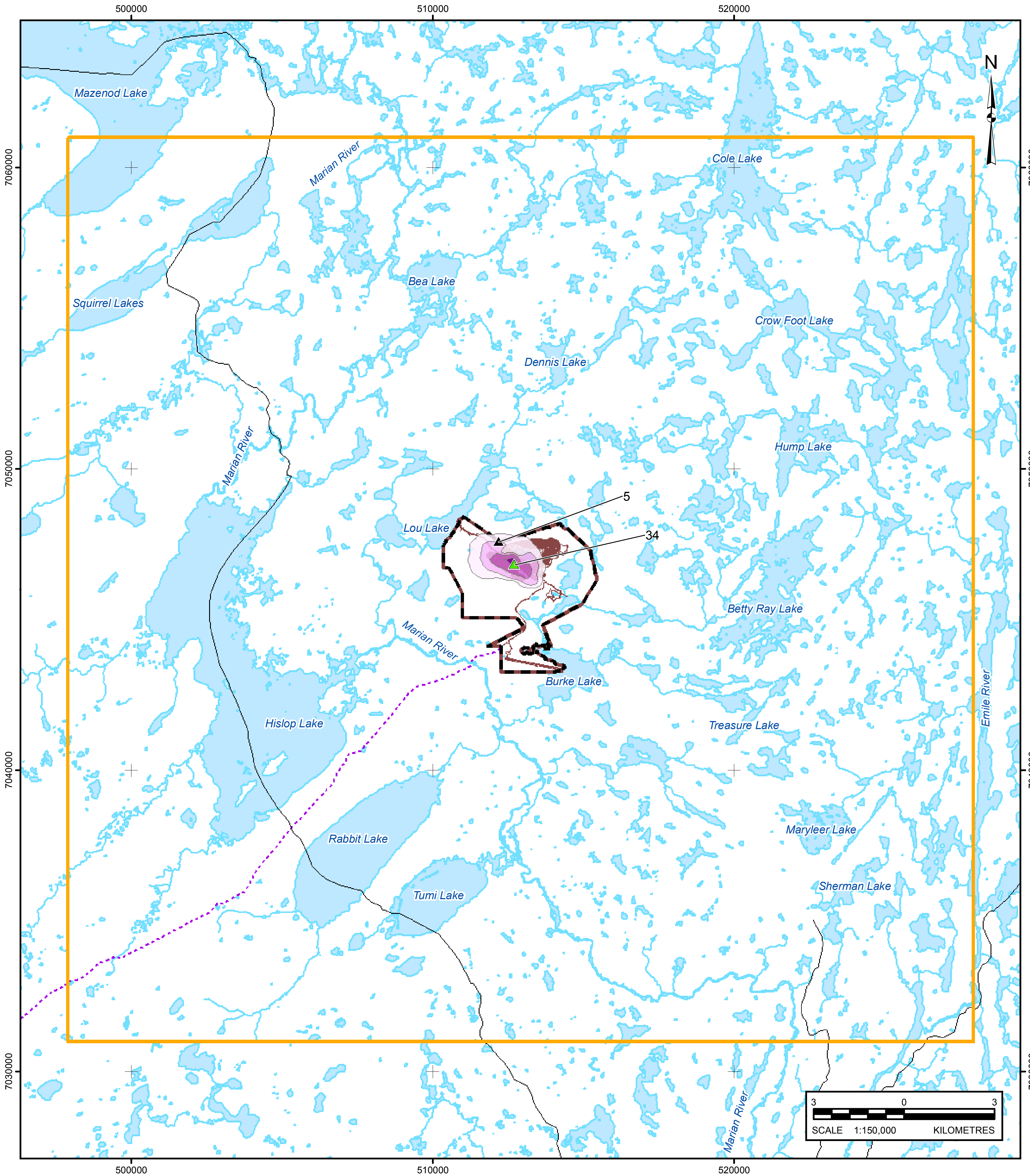
Table 10.4-10: Predicted Annual Deposition Rates Based on CALPUFF Modelling

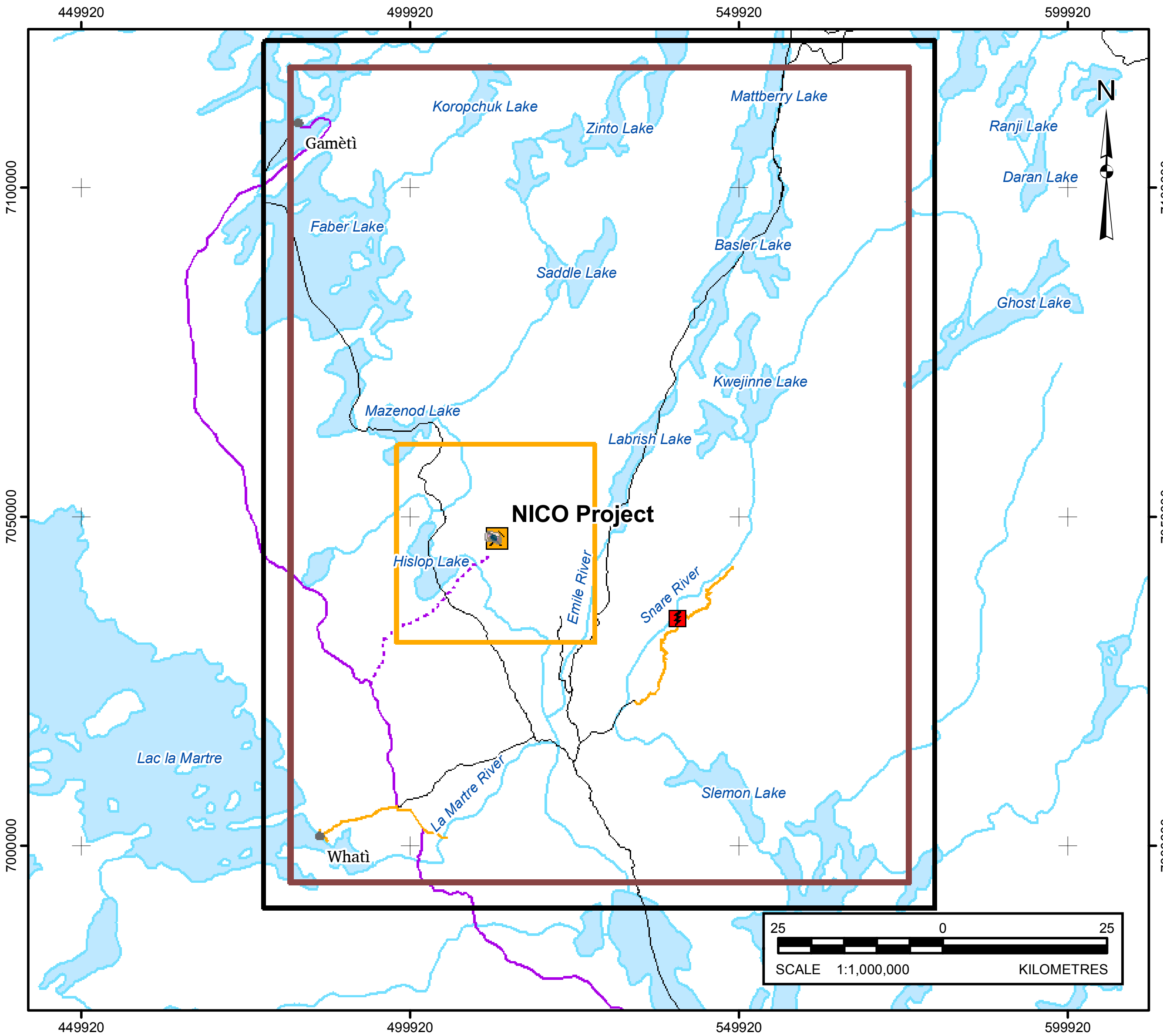
Compound	Baseline Case[a]	Application Case Excluding Developed Areas[b]	
		Local Study Area	Regional Study Area
TSP (kg/m^2/y)	0.00	0.15	0.15
PAI (keq/ha/y)	0.06	0.34	0.34
Nitrate (keq/ha/y)	0.03	0.30	0.30
Sulphate (keq/ha/y)	0.04	0.04	0.04
Nitrogen (kg/ha/y)	0.39	4.14	4.14

[a] within the RSA (including the area within the NICO Project Lease Boundary).

[b] outside the NICO Project Lease Boundary.

kg/m^2/y = kilogram per square metre per year; TSP = total suspended particulate; keq/ha/y = kiloequivalent per hectare per year; PAI = potential acid input; kg/ha/y = kilogram per hectare per year.





LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

DEPOSITION (µg/m²/s)

- >= 20
- 10 to < 20
- 5 to < 10
- 2.5 to < 5
- 0 to < 2.5

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE
TOTAL SUSPENDED PARTICULATE DEPOSITION

Golder Associates
Edmonton, Alberta

FILE No. E-Air-011-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.4-13**	
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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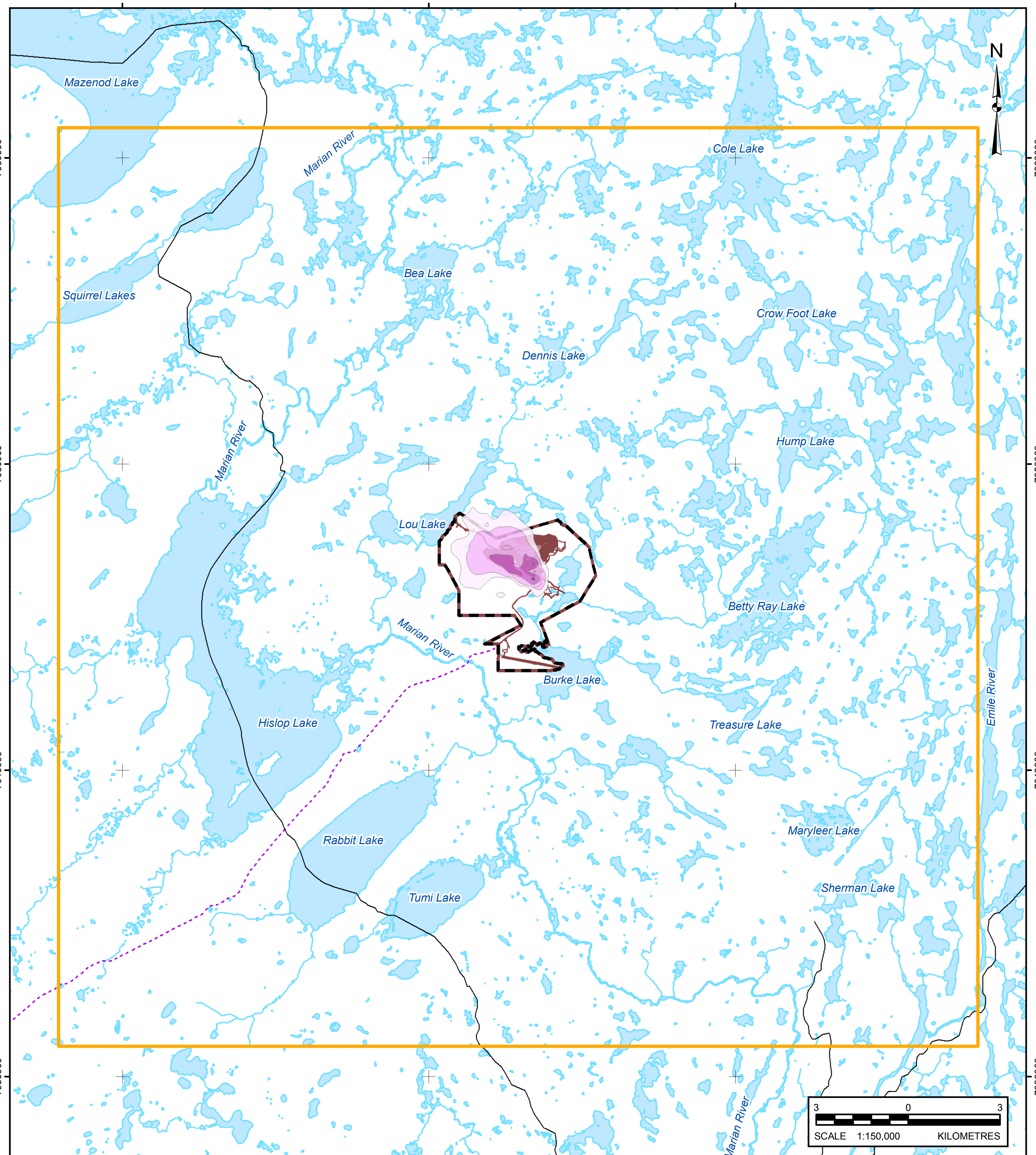

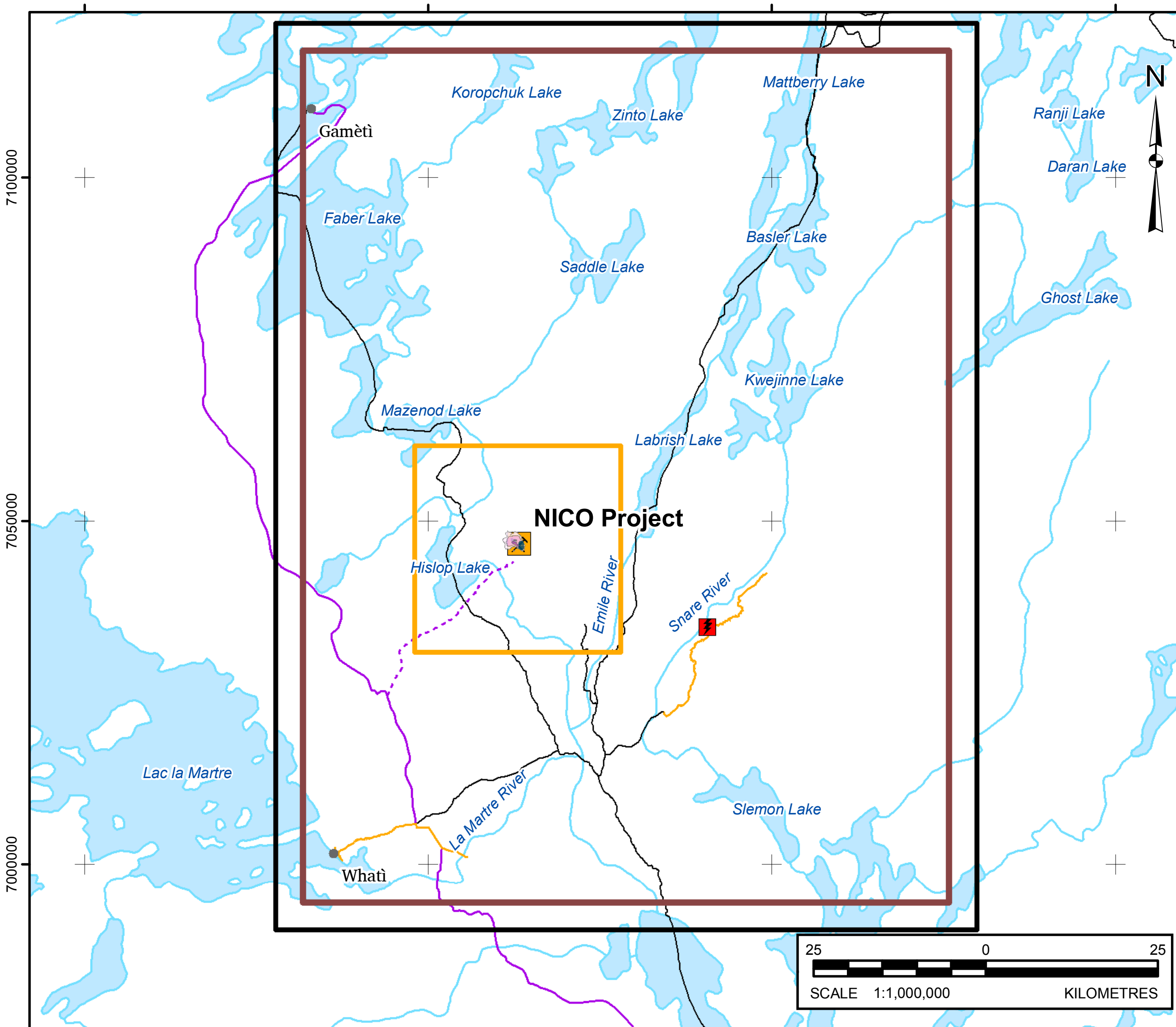

LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

DEPOSITION (keq/ha/y)

- >= 1
- 0.5 to < 1
- 0.25 to < 0.5
- 0.17 to < 0.25
- 0 to < 0.17

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE
POTENTIAL ACID INPUT

Golder Associates
Edmonton, Alberta

FILE No. E-Air-012-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	03 Feb. 2011	**FIGURE: 10.4-14**	
GIS	BS	08 Mar. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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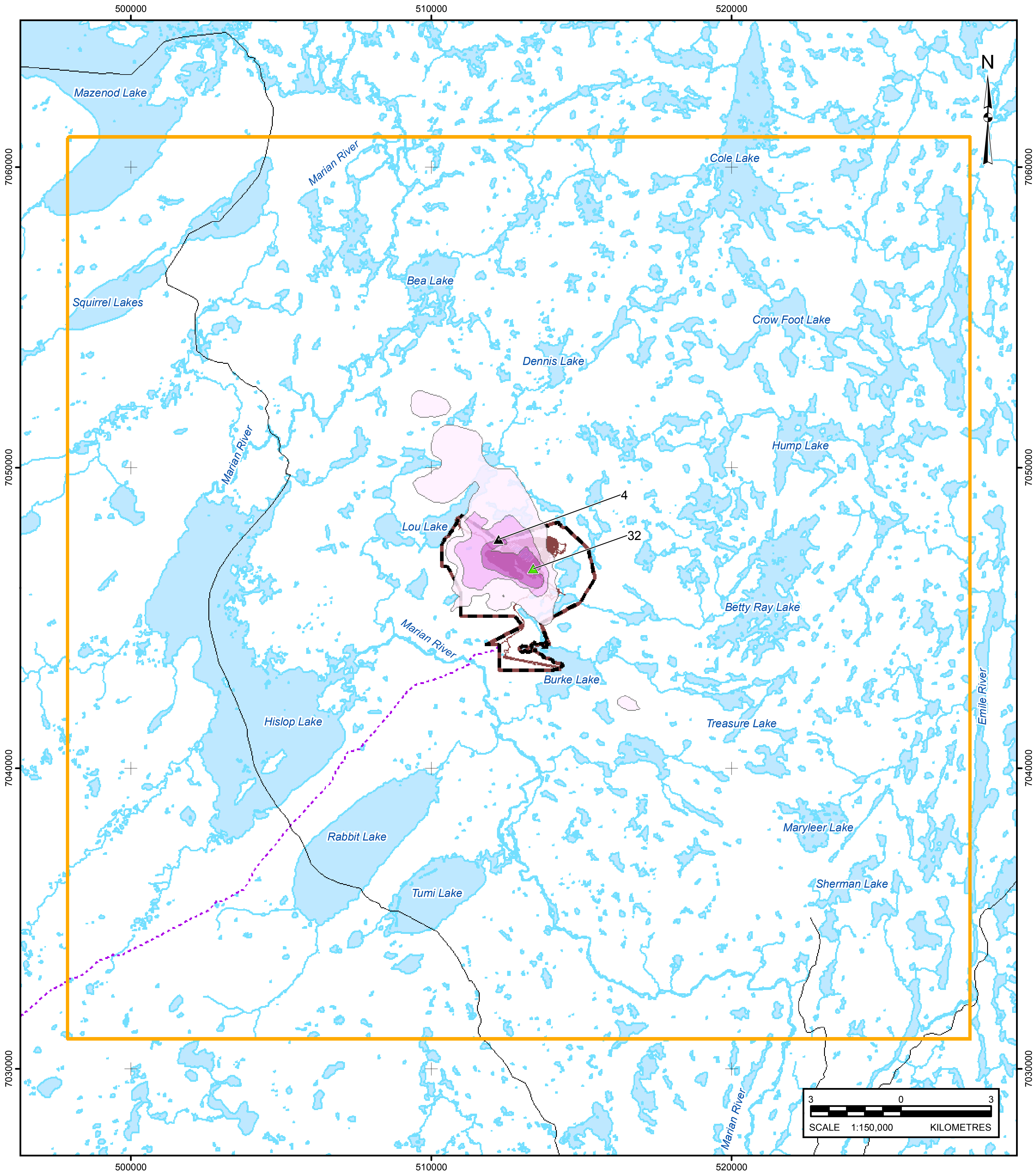

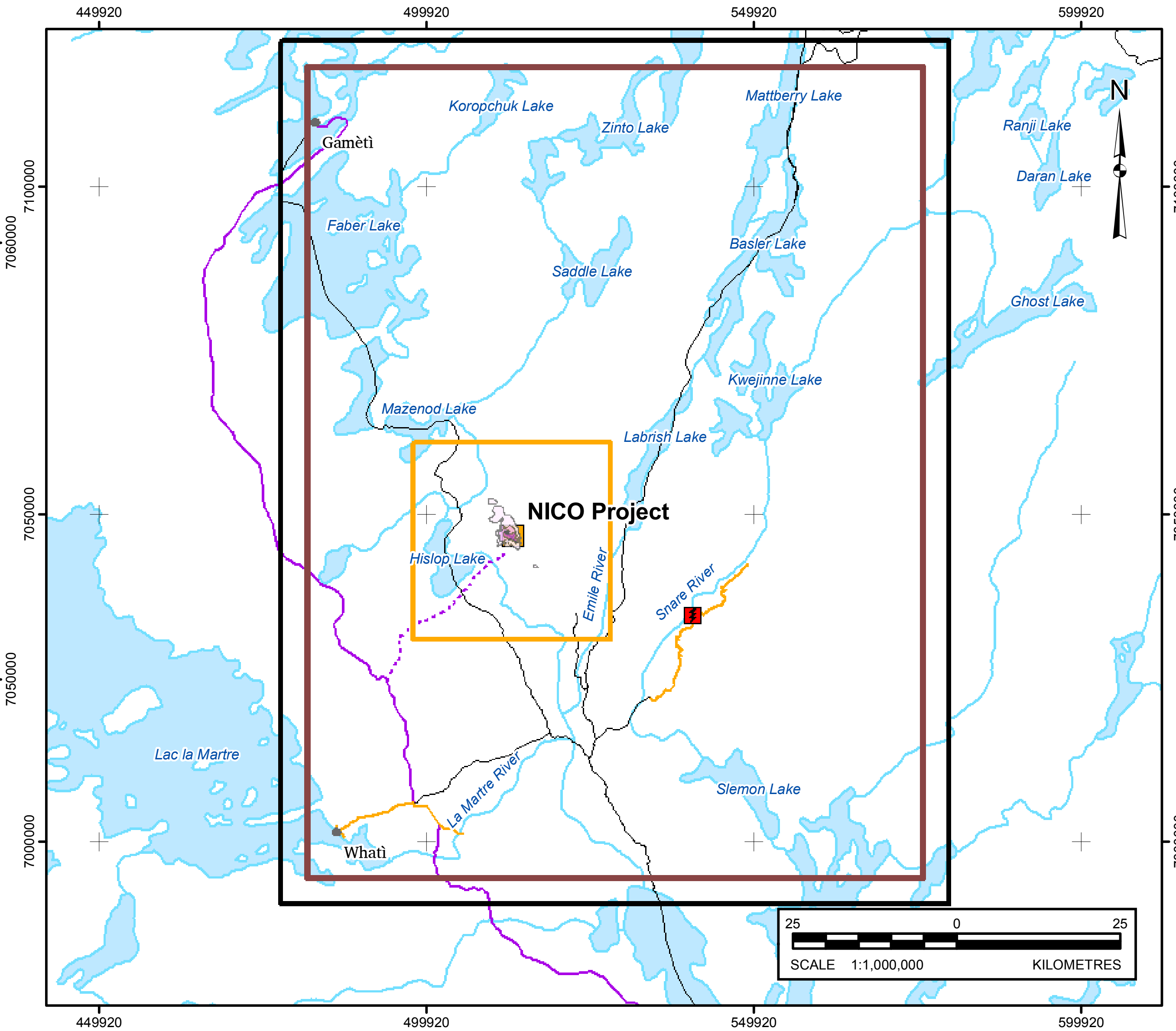

LEGEND

- NICO PROJECT
- PROJECT LEASE BOUNDARY
- PROPOSED NICO MINE SITE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA OUTSIDE PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA
- SNARE HYDRO LOCATION
- CALPUFF MODELLING DOMAIN
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

DEPOSITION (kg/ha/yr)

- > 4
- 2 to < 4
- 1 to < 2
- 0 to < 1

REFERENCE

Base data obtained from GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

APPLICATION CASE NITROGEN DEPOSITION

Golder Associates
Edmonton, Alberta

FILE No. E-Air-019-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	DC	15 Feb. 2011	**FIGURE: 10.4-15**	
GIS	AB	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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10.4.2.4 Volatile Organic Compounds and Polycyclic Aromatic Hydrocarbons

The NICO Project sources emit trace gaseous substances, such as volatile organic compounds and polycyclic aromatic hydrocarbons, from stacks and the mine fleet (Section 10.4.2.1). 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 NICO Project. The results were presented for use in the assessment of the risk to the health of humans and ecological receptors in Sections 7.9, 8.5.5, and 12.6.4. Details of the predicted ground-level concentrations and deposition rates at various health receptors are presented in Appendix 10.III.

10.4.2.5 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 NICO Project. The results were presented for use in the assessment of the risk to the health of humans and ecological receptors in Sections 7.9, 8.5.5, and 12.6.4. Details of predicted ground-level concentrations and deposition rates at various health receptors are presented in Appendix 10.III.

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.

10.4.2.6 Dioxins and Furans

There are no applicable air quality guidelines 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 7.9, 8.5.5, and 12.6.4. Details of predicted ground-level concentrations at various health receptors are presented in Appendix 10.III.

10.4.2.7 SCREEN3 Modelling Results

Tables 10.4-11 to 10.4-13 show the ambient ground-level concentrations resulting from emissions on the proposed NPAR and Proposed Tłı̨chǫ Road Route as a function of the distance from the emission source (i.e., road segment). The applicable standards are also presented for comparison. Predicted air concentrations using SCREEN3 correspond to 1-hour results. For compounds included in this assessment that do not have 1-hour air quality guidelines, 24-hour standards and conversion factors specified by the Ontario Ministry of the Environment (MOE 2009) have been used to derive 1-hour standards. For particulate emissions (TSP, PM_{10}, and $PM_{2.5}$), the predicted concentrations for exhaust and fugitive emissions (excluding background) have been provided separately, as well as the combined total predicted concentration.

The modelling results indicate that 1-hour concentrations of SO_2, CO, and NO_2 are lower than the standards during the construction and operation of the NPAR and the use of the Proposed Tłı̨chǫ Road Route. Concentrations of TSP are predicted to be higher than the standards during the construction and operation of the NPAR and the use of the Proposed Tłı̨chǫ Road Route. Concentrations of $PM_{2.5}$ are predicted to be higher than the standards during the construction of the NPAR. Tables 10.4-12 and 10.4-13 indicate that the fugitive emissions associated with vehicular transport along unpaved roads contribute in excess of 94% to the total ambient concentrations, with a relatively small portion attributable to vehicle exhaust emissions. The emissions used in the SCREEN3 modelling for fugitive emissions are considered to be conservative, since they assume no watering, or reduction in emissions due to rainfall or snow and ice coverage on the roads. In addition, the emissions were derived based on 2 B-train transport trucks in convoy; smaller vehicles that will also travel along the access road and Proposed Tłı̨chǫ Road Route would be expected to result in lower predicted ambient concentrations. Fortune is committed to implementing an air emissions management plan (Section 10.9) that will include mitigating fugitive emissions associated with the construction and use of the NPAR.

Table 10.4-11: Predicted Ambient Concentrations – Construction of the NICO Project Access Road

Distance from the Centre of the Source (m)	Maximum 1-hour Concentrations (µg/m^3)												
	TSP			PM_{10}			$PM_{2.5}$			NO_x[a]	SO_2[a]	CO[a]	NO_2[a]
	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]				
20	1.9	10 668.2	10 672.3	1.9	2 182.6	2 186.7	1.7	218.3	222.2	85.8	0.7	385.4	74.8
30	1.9	10 682.1	10 686.2	1.9	2 185.4	2 189.6	1.7	218.5	222.5	85.9	0.7	385.4	74.8
40	1.8	10 199.4	10 203.4	1.8	2 086.7	2 090.7	1.7	208.7	212.6	82.1	0.6	383.7	74.5
50	1.7	9 485.6	9 489.5	1.7	1 940.6	1 944.6	1.5	194.1	197.8	76.3	0.6	381.0	73.9
60	1.5	8 724.5	8 728.3	1.5	1 784.9	1 788.7	1.4	178.5	182.1	70.2	0.6	378.2	71.2
70	1.4	7 992.9	7 996.6	1.4	1 635.3	1 638.9	1.3	163.5	167.1	64.3	0.6	375.5	65.3
80	1.3	7 319.3	7 322.8	1.3	1 497.5	1 501.0	1.2	149.7	153.2	58.9	0.6	373.0	59.9
90	1.2	6 711.3	6 714.7	1.2	1 373.1	1 376.5	1.1	137.3	140.6	54.0	0.6	370.8	55.0
100	1.1	6 168.4	6 171.7	1.1	1 262.0	1 265.3	1.0	126.2	129.4	49.6	0.6	368.8	50.6
200	0.5	3 086.6	3 089.4	0.5	631.5	634.3	0.5	63.1	65.9	24.8	0.5	357.4	25.8
300	0.3	1 877.7	1 880.3	0.3	384.2	386.7	0.3	38.4	41.0	15.1	0.5	352.9	16.1
400	0.2	1 277.4	1 279.9	0.2	261.4	263.8	0.2	26.1	28.6	10.3	0.5	350.7	11.3
500	0.2	933.2	935.6	0.2	190.9	193.3	0.2	19.1	21.5	7.5	0.5	349.4	8.5
600	0.1	716.2	718.6	0.1	146.5	148.9	0.1	14.7	17.0	5.8	0.5	348.6	6.8
700	0.1	576.0	578.4	0.1	117.9	120.2	0.1	11.8	14.1	4.6	0.5	348.1	5.6
800	0.1	476.4	478.8	0.1	97.5	99.8	0.1	9.7	12.1	3.8	0.5	347.8	4.8
900	0.1	402.2	404.5	0.1	82.3	84.6	0.1	8.2	10.5	3.2	0.5	347.5	4.2
1000	0.1	346.1	348.4	0.1	70.8	73.1	0.1	7.1	9.4	2.8	0.5	347.3	3.8
Maximum Concentrations (16 m)	1.9	10 799.2	10 803.3	1.9	2 209.4	2 213.5	1.8	220.9	224.9	86.9	0.7	385.9	87.9
Standard 1-h[b]	-			-			-			-	450[c]	15 000[c]	400[c]
Standard Derived 1-h[d]	292[e]			-			73[e]			-	—	—	—

[a] The values include background levels.
[b] Air quality standards described in Section 10.3.2.3.
[c] GNWT Standard.
[d] Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE 2009).
[e] Derived from the GNWT standard.
TSP = total suspended particulate; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; NO_2 =nitrogen dioxide; µg/m^3 = micrograms per cubic metre; m = metre.

Table 10.4-12: Predicted Ambient Concentrations – Use of the NICO Project Access Road

Distance from the Centre of the Source (m)		Maximum 1-hour Concentrations (µg/m³)												
		TSP			PM_{10}			$PM_{2.5}$			NO_x[a]	SO_2[a]	CO[a]	NO_2[a]
		Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]				
20		0.1	1 742.5	1 744.9	0.1	356.5	358.9	0.1	35.6	38.0	6.4	0.5	349.0	7.4
30		0.1	1 744.8	1 747.1	0.1	357.0	359.3	0.1	35.7	38.1	6.4	0.5	349.0	7.4
40		0.1	1 665.9	1 668.3	0.1	340.8	343.2	0.1	34.1	36.4	6.2	0.5	348.8	7.2
50		0.1	1 549.3	1 551.7	0.1	317.0	319.3	0.1	31.7	34.0	5.7	0.5	348.6	6.7
60		0.1	1 425.0	1 427.4	0.1	291.5	293.9	0.1	29.2	31.5	5.3	0.5	348.4	6.3
70		0.1	1 305.5	1 307.9	0.1	267.1	269.4	0.1	26.7	29.0	4.8	0.5	348.2	5.8
80		0.1	1 195.5	1 197.8	0.1	244.6	246.9	0.1	24.5	26.8	4.4	0.5	348.0	5.4
90		0.1	1 096.2	1 098.5	0.1	224.3	226.6	0.1	22.4	24.7	4.0	0.5	347.9	5.0
100		0.1	1 007.5	1 009.8	0.1	206.1	208.4	0.1	20.6	22.9	3.7	0.5	347.7	4.7
200		0.0	504.1	506.4	0.0	103.1	105.4	0.0	10.3	12.6	1.9	0.5	346.9	2.9
300		0.0	306.7	309.0	0.0	62.7	65.0	0.0	6.3	8.5	1.1	0.5	346.5	2.1
400		0.0	208.7	210.9	0.0	42.7	44.9	0.0	4.3	6.5	0.8	0.5	346.4	1.8
500		0.0	152.4	154.7	0.0	31.2	33.4	0.0	3.1	5.4	0.6	0.5	346.3	1.6
600		0.0	117.0	119.2	0.0	23.9	26.2	0.0	2.4	4.6	0.4	0.5	346.2	1.4
700		0.0	94.1	96.3	0.0	19.2	21.5	0.0	1.9	4.2	0.3	0.5	346.2	1.3
800		0.0	77.8	80.1	0.0	15.9	18.2	0.0	1.6	3.8	0.3	0.5	346.1	1.3
900		0.0	65.7	67.9	0.0	13.4	15.7	0.0	1.3	3.6	0.2	0.5	346.1	1.2
1000		0.0	56.5	58.8	0.0	11.6	13.8	0.0	1.2	3.4	0.2	0.5	346.1	1.2
Maximum Concentrations (16 m)		0.1	1 763.9	1 766.2	0.1	360.9	363.2	0.1	36.1	38.5	6.5	0.5	349.0	7.5
Standard	1-h[b]	-			-			-			-	450[c]	15 000[c]	400[c]
	Derived 1-h[d]	292[e]			-			73[e]			-	—	—	—

[a] The values include background levels.
[b] Air quality standards described in Section 10.3.2.3.
[c] GNWT Standard.
[d] Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE 2009).
[e] Derived from the GNWT standard.
TSP = total suspended particulate; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; NO_2 =nitrogen dioxide; µg/m³ = micrograms per cubic metre; m = metre

Table 10.4-13: Predicted Ambient Concentrations – Use of the Proposed Tłı̨chǫ Road Route

Distance from the Centre of the Source (m)	Maximum 1-hour Concentrations ($\mu g/m^3$)												
	TSP			PM_{10}			$PM_{2.5}$			NO_X[(a)]	SO_2[(a)]	CO[(a)]	NO_2[(a)]
	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]	Exhaust	Fugitive	Total (Exhaust+ Fugitive+ Background)[a]				
20	0.1	1 742.5	1 744.9	0.1	356.5	358.9	0.1	35.6	38.0	6.4	0.5	349.0	7.4
30	0.1	1 744.8	1 747.1	0.1	357.0	359.3	0.1	35.7	38.1	6.4	0.5	349.0	7.4
40	0.1	1 665.9	1 668.3	0.1	340.8	343.2	0.1	34.1	36.4	6.2	0.5	348.8	7.2
50	0.1	1 549.3	1 551.7	0.1	317.0	319.3	0.1	31.7	34.0	5.7	0.5	348.6	6.7
60	0.1	1 425.0	1 427.4	0.1	291.5	293.9	0.1	29.2	31.5	5.3	0.5	348.4	6.3
70	0.1	1 305.5	1 307.9	0.1	267.1	269.4	0.1	26.7	29.0	4.8	0.5	348.2	5.8
80	0.1	1 195.5	1 197.8	0.1	244.6	246.9	0.1	24.5	26.8	4.4	0.5	348.0	5.4
90	0.1	1 096.2	1 098.5	0.1	224.3	226.6	0.1	22.4	24.7	4.0	0.5	347.9	5.0
100	0.1	1 007.5	1 009.8	0.1	206.1	208.4	0.1	20.6	22.9	3.7	0.5	347.7	4.7
200	0.0	504.1	506.4	0.0	103.1	105.4	0.0	10.3	12.6	1.9	0.5	346.9	2.9
300	0.0	306.7	309.0	0.0	62.7	65.0	0.0	6.3	8.5	1.1	0.5	346.5	2.1
400	0.0	208.7	210.9	0.0	42.7	44.9	0.0	4.3	6.5	0.8	0.5	346.4	1.8
500	0.0	152.4	154.7	0.0	31.2	33.4	0.0	3.1	5.4	0.6	0.5	346.3	1.6
600	0.0	117.0	119.2	0.0	23.9	26.2	0.0	2.4	4.6	0.4	0.5	346.2	1.4
700	0.0	94.1	96.3	0.0	19.2	21.5	0.0	1.9	4.2	0.3	0.5	346.2	1.3
800	0.0	77.8	80.1	0.0	15.9	18.2	0.0	1.6	3.8	0.3	0.5	346.1	1.3
900	0.0	65.7	67.9	0.0	13.4	15.7	0.0	1.3	3.6	0.2	0.5	346.1	1.2
1000	0.0	56.5	58.8	0.0	11.6	13.8	0.0	1.2	3.4	0.2	0.5	346.1	1.2
Maximum Concentrations (16 m)	0.1	1 766.1	1 766.2	0.1	363.1	363.2	0.1	38.3	38.5	6.5	0.5	349.0	7.5
Standard: 1-h[b]	-			-			-			-	450[c]	15 000[c]	400[c]
Standard: Derived 1-h[d]	292[(e)]			-			73[(e)]			-	—	—	—

[a] The values include background levels
[b] Air quality standards described in Section 10.3.2.3.
[c] GNWT Standard.
[d] Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE 2009).
[e] Derived from the GNWT standard.
TSP = total suspended particulate; PM = particulate matter; NO_x = nitrogen oxides; SO_2 = sulphur dioxide; CO = carbon monoxide; NO_2 =nitrogen dioxide; $\mu g/m^3$ = micrograms per cubic metre; m = metre

10.5 Residual Effects Summary

Residual effects on air quality for the Application Case were evaluated by comparing maximum predicted ground-level concentrations to ambient air quality guidelines that include NWT Air Quality Standards and National Ambient Air Quality Objectives. 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 NICO Project Lease Boundary within the RSA is presented in Table 10.5-1 for all substances with regulatory ambient air quality guidelines. The modelling results for on-site NICO Project emissions indicate the following:

- **SO_2 and CO**: Predicted maximum concentrations of SO_2 and CO are in compliance with the applicable ambient air quality guidelines for all averaging periods.
- **NO_2**: The maximum predicted 1-hour and 24-hour concentrations outside the NICO Project Lease Boundary are in compliance with the applicable ambient air quality guidelines. The predicted annual average NO_2 concentration exceeds the applicable standard.
- **$PM_{2.5}$**: The maximum predicted 24-hour $PM_{2.5}$ concentration exceeds the applicable standard outside the NICO Project Lease Boundary for as many as 39 days in a year.
- **TSP**: The predicted maximum 24-hour and annual average concentrations outside the NICO Project Lease Boundary exceed the applicable air quality standard. The 24-hour concentration is above the standard for a maximum of 121 days per year.

Table 10.5-1: Summary of Key Modelled Air Quality Concentrations in the Regional Study Area (On-site Emissions)

Compound	Averaging Period	NWT Air Quality Standards (µg/m³)	Maximum Ground-level Concentration Outside the NICO Project Lease Boundary (µg/m³)	
			Baseline	Application
SO_2	1-hour	450	<1	10
	24-hour	150	<1	4
	Annual	30	<1	1
NO_2	1-hour	400	74	204
	24-hour	200	28	129
	Annual	60	2	**68**
CO	1-hour	15 000	366	965
	8-hour	6 000	358	694
$PM_{2.5}$	24-hour	30	3	**80**
TSP	24-hour	120	3	**1669**
	Annual	60	2	**166**

Note: A predicted concentration that exceeds a criterion is accentuated in bold.
[a] GNWT (2011b).
µg/m³ = microgram per cubic metre; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; PM = particulate matter; TSP = total suspended particulates.

The modelling results for off-site NICO Project emissions (i.e., construction and use of the NPAR and use of the Proposed Tłįchǫ Road Route) indicate the following:

- **SO_2, CO, and NO_2**: Concentrations of SO_2, CO, and NO_2 are lower than the standards during the construction and operation of the NPAR and the use of the Proposed Tłįchǫ Road Route.
- **$PM_{2.5}$**: Concentrations of $PM_{2.5}$ are predicted to be higher than the standards during the construction of the NPAR but lower than the standards during the use of both the NPAR and Proposed Tłįchǫ Road Route.
- **TSP**: Concentrations of TSP are predicted to be higher than the standards during the construction and operation of the NPAR and the use of the Proposed Tłįchǫ Road Route.

10.6 Residual Impact Classification

The purpose of the residual impact classification is to describe the residual air quality effects associated with the NICO Project in terms of compliance with applicable ambient air quality guidelines. The ambient air quality guidelines that were used for this exercise are the NWT Air Quality Standards (GNWT 2011b) and the National Ambient Air Quality Objectives (Environment Canada 1981). The residual effect classification uses a scale of common words, rather than numbers or units to describe the residual effects from the NICO Project on air quality. The use of common words or criteria is a requirement in the TOR (MVRB 2009). The following criteria were used to assess the residual effects from the NICO Project (Table 10.6-1):

- direction;
- magnitude;

- geographic extent;
- duration;
- reversibility;
- frequency; and
- likelihood.

10.6.1 Methods

Generic definitions have been provided for each of the impact criteria in the Assessment Approach (Section 6). For criteria such as frequency and likelihood, the definitions can be applied consistently across all VC endpoints. Similarly, reversibility is defined as the likelihood and time required for a component (e.g., population) or system to recover after removal of the stressor and is a function of resilience. Reversibility is applied to all combinations of magnitude, geographic extent, and duration.

The scale of classifications (e.g., high, low, local, regional, and short- and long-term) for magnitude, geographic extent, and duration is dependent on each VC endpoint, and the associated effects statement. Although professional judgement is inevitable in some cases, a strong effort was made to classify effects using scientific principles, supporting evidence, and a conservative approach where uncertainties exist.

The impact classification for air quality followed the general approach outlined in Section 6. Definitions for each criterion are provided below; and details of the selected impact classification criteria for air quality are presented in Table 10.6-1:

- Direction indicates whether the projected impact is negative (i.e., less favourable), positive (i.e., beneficial), or neutral (i.e., no change). The direction of all air quality effects is considered to be negative.
- Magnitude is a measure of the intensity of the projected impact. The 4 scales of intensity are negligible, low, moderate, or high (i.e., a measure of the degree of modelled change in an air quality constituent). Magnitude was assessed using the NWT Air Quality Standards and National Ambient Air Quality Objectives, which are collectively referred to as applicable ambient air quality standards.
- Where quantitative values were available (e.g. modelling predictions), the magnitude of an effects pathway for air quality was determined as follows:
    - the magnitude was classified as “negligible” if there was no predicted increase, or the predicted increase due to the NICO Project emissions was less than 1% of the relevant ambient air quality standard. Predicted increases of this magnitude should not be measurable;
    - a “low” magnitude was assigned when an increase was predicted; however, the maximum value remains below the most stringent ambient air quality standard;
    - a “moderate” magnitude was assigned when the predicted maximum concentration falls between the most stringent and least stringent ambient air quality standard (excluding federal “tolerable” level); and
    - a “high” magnitude would be assigned when the predicted maximum concentration is greater than the least stringent ambient air quality standard.

- Geographic extent refers to area impacted. For most air quality key impact parameters, effects are largest nearest the source (local effects) and decrease rapidly with distance from the source.
- Duration refers to the overall time frame during which the impact may occur. This value ranges from short-term (does not extend past the construction phase) to long-term (effect extends past mine closure).
- Frequency refers to how often the projected impact will occur. The scales of frequency are isolated, periodic, and continuous. NICO Project air emissions are generally continuous, and, therefore, the potential frequency of impact is continuous, even though the frequency at which predicted concentrations exceed guideline values may vary.
- Impacts are reversible if the impact will last for only a finite and reasonable period of time. Impacts are irreversible if they will last indefinitely. Reversibility must be evaluated separately for any air quality impacts that are long-term in duration.
- 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.

Table 10.6-1: Definitions of Terms Used in the Residual Impact Classification

Direction	Magnitude	Geographic Extent	Duration	Reversibility	Frequency	Likelihood
Negative: a less favourable change relative to baseline values or conditions **Positive:** an improvement over baseline values or conditions	**Negligible:** modelled increase less than 1% of the relevant ambient air quality standard **Low:** maximum value remains below the most conservative (stringent) ambient air quality standard – federal "desirable" level **Moderate:** maximum concentration falls between the most conservative and least conservative ambient air quality standard (although not the "tolerable" federal level) **High:** maximum is greater than the least conservative ambient air quality standard (although not the "tolerable" federal level)	**Local:** small-scale direct and indirect impact from the NICO Project (e.g., footprint, physical hazards, and dust deposition) **Regional:** the predicted maximum spatial extent of combined direct and indirect impacts from the NICO Project that exceed local-scale effects (can include cumulative direct and indirect impacts from the NICO Project and other developments at the regional scale) **Beyond Regional:** cumulative local and regional impacts from the NICO Project and other developments extend beyond the regional scale	**Short-term:** impact is reversible at end of construction **Medium-term:** impact is reversible at the end of closure **Long-term:** impact is reversible within a defined length of time beyond closure	**Reversible:** impact will not result in a permanent change in concentrations or deposition **Irreversible:** impact is not reversible within the temporal boundary of the assessment (i.e., duration of impact is undefined or permanent)	**Isolated:** confined to a specific discrete period **Periodic:** occurs intermittently but repeatedly over the assessment period **Continuous:** will occur continually over the assessment period	**Unlikely:** the impact is likely to occur less than once in 100 years **Possible:** the impact is possible within a year; or at least one chance of occurring in the next 100 years **Likely:** the impact is probable within a year; or at least one chance of occurring in the next 10 years **Highly Likely:** the impact is very probable (100% chance) within a year

10.6.2 Results

A summary of residual impacts is presented in Table 10.6-2 for each assessment endpoint (e.g., 1-hour SO_2). The magnitude impact ratings for substances with ambient air quality standards are discussed below for each of the air quality assessment endpoints:

- **SO_2** : Predicted ground-level SO_2 concentrations are considered low in magnitude at all receptor locations because predictions are substantially less than the applicable NWT Air Quality Standards. This impact determination is based largely on the assumption that diesel used for the NICO Project will contain 15 ppmw sulphur or less. Considering that the current federal regulation on “sulphur in diesel” stipulates that on-road and non-road vehicles must be using 15 ppmw ultra low sulphur diesel by 1 December 2011, there is a high confidence that the impact determination is appropriate.
- **NO_2** : Predicted ground-level NO_2 concentrations varied in magnitude from low for 1-hour and 24-hour NO_2 concentrations to moderate for annual NO_2 concentrations. Depending on the approach used in the modelling to convert NO_X to NO_2, predicted concentrations could be lower than the most stringent ambient guideline. Using the ozone limiting method to determine NO_2 concentrations results in the predicted annual concentrations that are slightly above (i.e., approximately 10%) the standard just outside the NICO Project Lease Boundary. Due to the low release heights of most NO_X emissions (e.g., fleet vehicles and other mobile equipment), the largest effects are in the immediate vicinity of the low level emission sources.
- **CO**: Predicted 1-hour and 8-hour ground-level CO concentrations is considered low in magnitude at all receptor locations because predictions are substantially less than the applicable NWT Air Quality Standards.
- **$PM_{2.5}$**: Predicted 24-hour $PM_{2.5}$ concentrations are considered high in magnitude since predicted concentrations outside the NICO Project Lease Boundary are above the NWT Air Quality Standard. This rating is based on NICO Project emissions during the winter months in which no mitigation of road dust was assumed. This is a conservative assumption keeping in mind that precipitation and snow accumulation on the road surface would provide some degree of natural mitigation of dust emissions during the winter. While there is some uncertainty in the estimated fugitive dust emissions, other approved hard-rock open pit mining operations in the NWT experience elevated PM levels on an intermittent basis (IEMA 2009, 2010). Due to the generally conservative nature of fugitive and wind-blown emission estimates, there is a high degree of confidence that actual concentrations will be less than modelled results.
- **TSP**: Predicted 24-hour and annual TSP concentrations are above NWT Air Quality Standards outside the development area; therefore, the magnitude of the impact is high. Uncertainty in modelled results is considered high given the uncertainty in estimating fugitive dust emissions (Section 10.8). Due to the conservative nature of the road dust emission estimates, there is a high degree of confidence that actual concentrations will be less than the modelled results.

Table 10.6-2: Summary of Residual Impact Classification of Valid Pathways for Incremental and Cumulative Effects to Air Quality

Effects Statement	Pathway	Direction	Magnitude - Cumulative	Geographic Extent - Cumulative	Duration	Frequency	Reversibility	Likelihood
1-h SO_2 Concentration	Equipment and fleet exhaust. Waste incinerator exhaust. Mining and material storage, •Mining equipment including fleet and material conveyance systems, •Milling, •On-site facilities (e.g., power generation and heat recovery systems, waste incinerator)	negative	low	local	medium-term	continuous	reversible	likely
24-h SO_2 Concentration		negative	low	local	medium-term	continuous	reversible	likely
Annual SO_2 Concentration		negative	low	local	medium-term	continuous	reversible	likely
1-h NO_2 Concentration	Equipment and fleet exhaust. Waste incinerator exhaust. Mining and material storage, •Mining equipment including fleet and material conveyance systems, •Milling, •On-site facilities (e.g., power generation and heat recovery systems, waste incinerator)	negative	low	local	medium-term	continuous	reversible	likely
24-h NO_2 Concentration		negative	low	local	medium-term	continuous	reversible	likely
Annual NO_2 Concentration		negative	moderate	local	medium-term	continuous	reversible	likely
1-h CO Concentration	Equipment and fleet exhaust. Waste incinerator exhaust. Mining and material storage, •Mining equipment including fleet and material conveyance systems, •Milling, •On-site facilities (e.g., power generation and heat recovery systems, waste incinerator)	negative	low	local	medium-term	continuous	reversible	likely
8-h CO Concentration		negative	low	local	medium-term	continuous	reversible	likely

Table 10.6-2: Summary of Residual Impact Classification of Valid Pathways for Incremental and Cumulative Effects to Air Quality (continued)

Effects Statement	Pathway	Direction	Magnitude - Cumulative	Geographic Extent - Cumulative	Duration	Frequency	Reversibility	Likelihood
24-h $PM_{2.5}$ Concentration	Equipment and fleet exhaust. Waste incinerator exhaust. Mining and material storage, •Mining equipment including fleet and material conveyance systems, •Milling, •On-site facilities (e.g., power generation and heat recovery systems, waste incinerator)	negative	high	local	medium-term	continuous	reversible	likely
24-h TSP Concentration	Fugitive emissions (e.g., dust), and equipment and fleet exhaust	negative	high	local	medium-term	continuous	reversible	likely
Annual TSP Concentration		negative	high	local	medium-term	continuous	reversible	likely

h = hour; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; PM = particulate matter; TSP = total suspended particulates.

10.7 Environmental Significance

10.7.1 Methods

The classification of residual impacts on valid pathways for each VC provides the foundation for determining environmental significance from the NICO Project on assessment endpoints; however, significance is only determined for assessment endpoints, and not individual pathways, as assessment endpoints represent the ultimate ecological properties and services of the VC that should be protected for use by future human generations (Section 6). Magnitude, geographic extent, and duration are the principal criteria used to predict significance. Duration of impacts, which includes reversibility, is a function of ecological resilience, and these ecological principles are applied to the evaluation of significance. Other criteria, such as frequency and likelihood, are used as modifiers (where applicable) in the determination of significance.

The evaluation of significance considers the entire set of pathways that influence a particular assessment endpoint. The relative contribution of each pathway is then used to determine the significance of the NICO Project on assessment endpoints. For example, a pathway with a high magnitude, large geographic extent, and long-term duration would be given more weight in determining significance relative to pathways with smaller scale effects. The relative impact from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to assessment endpoints would also be assumed to contribute the most to the determination of environmental significance.

The following information is used in the evaluation of the significance of incremental and cumulative impacts from the NICO Project on VC assessment endpoints:

- Results from the residual impact classification of valid pathways.
- Magnitude, geographic extent, and duration of the impact as principal criteria, with frequency and likelihood as modifiers.
- Application of professional judgment and ecological principals, such as resilience, to predict the duration and associated reversibility of impacts.

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 was 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 NICO Project as it pertains to air quality on human health and other VCs is analyzed by each discipline (e.g., human health, wildlife, etc.) and presented in other KLOIs 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, it would receive a moderate significance 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 high significance rating.

10.7.2 Results

A summary of the significance determinations for each air assessment endpoint is provided in Table 10.7-1. The predicted impacts from the NICO Project ranged from insignificant for SO_2, NO_2 (except annual NO_2), and CO concentration endpoints to moderate for particulate matter endpoints (i.e., $PM_{2.5}$ and TSP). Once mine emissions cease, the air quality effects due to air emissions from the NICO Project will stop immediately; therefore, even though some of the magnitude ratings are high (e.g., particulate matter), they, on their own, are not sufficient to result in a high significance rating.

Regardless of this significance analysis, ambient air quality monitoring plans will be implemented and Fortune plans to incorporate the results of its monitoring program into its emission management plans to continuously improve air quality. This is an appropriate response to the predicted results and it will also increase the certainty that impacts will not be greater than expected.

Table 10.7-1: Summary of the Significance of Effects to Air Quality

Valued Component Assessment Endpoints	Cumulative Magnitude	Geographic Extent - Cumulative	Duration	Reversibility	Cumulative Significance
1-h SO_2 Concentration	low	local	medium-term	reversible	insignificant
24-h SO_2 Concentration	low	local	medium-term	reversible	insignificant
Annual SO_2 Concentration	low	local	medium-term	reversible	insignificant
1-h NO_2 Concentration	low	local	medium-term	reversible	insignificant
24-h NO_2 Concentration	low	local	medium-term	reversible	insignificant
Annual NO_2 Concentration	moderate	local	medium-term	reversible	low
1-h CO Concentration	low	local	medium-term	reversible	insignificant
8-h CO Concentration	low	local	medium-term	reversible	insignificant
24-h $PM_{2.5}$ Concentration	high	local	medium-term	reversible	moderate
24-h TSP Concentration	high	local	medium-term	reversible	moderate
Annual TSP Concentration	high	local	medium-term	reversible	moderate

h = hour; SO_2 = sulphur dioxide; NO_2 = nitrogen dioxide; CO = carbon monoxide; PM = particulate matter; TSP = total suspended particulates.

10.8 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 over-estimated.

The model as applied to the NICO Project and described in detail in Appendix 10.I has a number of limitations that result in model uncertainty. These include the following:

- Emissions associated with industrial activities are reasonably well defined and were largely taken from recent applications. However, the emissions from non-industrial activities within regional communities are more difficult to predict.
- Emissions from area sources are difficult to estimate and simulate in dispersion models. The NICO Project area emission sources include Open Pit, roads, and mine rock piles.
- Characterization of emissions near Open Pit and other sources of mechanically generated particulate are uncertain. Most estimates of particulate emissions for mining activities are based on U.S. EPA emission factors. Many of these factors have limited applicability outside of the area in which they were developed (typically south-western United States coal mines).
- In cold weather conditions, such as those experienced at the NICO 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.
- When reliable emission estimation methods were not available for a particular compound, representative monitoring data were added to the model predictions. This approach was adopted for NO_X, SO_2, $PM_{2.5}$, PM_{10} and TSP.

These uncertainties were mitigated with the following methods and assumptions:

- Modelling was conducted using the operating year (Year 4) with the maximum emission rates from the NICO Project. Other operating years are expected to have emission rates that are a fraction of Year 4. Therefore, the modelling results shown in this DAR are the maximum concentration and deposition values that are estimated to result from the NICO Project.
- The modelling was based on the assumption that most equipment will be operating at maximum capacity on a continuous basis. This assumption can lead to an overestimation of the potential NICO Project impacts for the longer averaging periods (24-h and annual).
- Although precipitation and snow accumulation on the haul road surface will provide some degree of natural mitigation of the road dust emissions during the winter, the winter road dust emissions modelled in the Application Case were based on the conservative assumption of no natural mitigation. The predicted concentrations, therefore, are conservative.

Fortune will develop and execute emissions management and ambient air quality monitoring programs as appropriate.

10.9 Monitoring and Follow-up

The predicted ambient air quality concentrations will be considered in the design of an appropriate monitoring program and the development of mitigation and adaptive management strategies. These programs and strategies are intended to minimize emissions from the NICO Project and their impacts. A meeting with Environment Canada in May 2010 resulted in the agreement that the intended management plans and proposed monitoring program for the NICO Project need only be outlined in the way of headings in this DAR because the NICO Project is currently at the environmental assessment stage (D. Fox, Environment Canada, 2010, pers. comm.). Detailed management plans and monitoring program will be required if the NICO Project progresses to the permitting stage (D. Fox, Environment Canada, 2010, pers. comm.). Based on this understanding, this section provides an outline required for the management plans and monitoring programs. If the NICO Project progresses to the permitting stage, appropriate management plans will be developed and described including the following:

- specific mitigation and adaptive management strategies to minimize contaminant loading by fugitive dust from the handling and transport of raw ore and concentrate; and
- emissions from incineration.

10.9.1 Monitoring Program and Mitigation and Adaptive Strategies

The monitoring program and mitigation and adaptive management strategy will include the following components:

- regulatory review that identifies legislation, regulatory and policy requirements considered in the program;
- scope that provides a description of the scope of the program;
- goals that outline all of the goals of the program;
- air quality monitoring program (Section 10.9.1.1);
- emissions monitoring program (Section 10.9.1.2);
- mitigative and adaptive strategies (Section 10.9.1.3);
- response planning describing strategies for responding to events of significant emission rates or air quality impacts (including the development of thresholds that would elicit a response depending on the severity); and
- annual report describing procedures for the preparation of annual reports and their ancillary components, (e.g., references, glossary, concordance tables).

10.9.1.1 Air Quality Monitoring Program

Evaluation of local conditions and predicted air concentrations should be considered when defining the monitoring requirements. The process of developing an air quality monitoring plan will include the following tasks:

- Identification of monitoring requirements, including the following:
  - the location of the meteorological station;
  - air quality parameters to be monitored; and
  - frequency, and location of sampling.
- Proposal of Monitoring Techniques and Equipment appropriate to meet the monitoring requirements.
- Data Analysis: Defining procedures for the compilation and analysis of the monitoring data.

- Quality Assurance/Quality Control Procedures: Describing procedures for conducting quality assurance/quality control on the monitoring results.
- Implementation of the Monitoring Program: Describing the schedule and resources (including training) necessary to implement the Monitoring Program.
- Recordkeeping: Describing the procedures for recordkeeping for the information related to the Monitoring Program, for the purpose of audits and continuous improvement of the Program.
- Monitoring Program Review: Describing the procedures for the periodic review of the Monitoring Program (continuous improvement), including stages to reduce the monitoring requirements.

10.9.1.2 Emission Monitoring Program

Along with the evaluation of local conditions and predicted air concentrations through physical monitoring, ongoing validation of the project emissions should also be considered in developing this component of the monitoring program. This validation program may include the following:

- Project Emissions: Developing the methodology for describing and quantifying the emissions from the NICO Project (annual reporting).
- Fuel Use Summary: Developing methodology for the use of annual fuel consumption data to calculate the NICO Project emissions.

10.9.1.3 Mitigation and Adaptive Strategies

Evaluation of Predicted Impacts from the Project Emissions

The process of developing a plan to address the predicted impacts from the project emissions will be developed. It is expected to include the following:

- identifying Mitigation and Adaptive Strategies to minimize the impacts of the NICO Project emissions on local air quality;
- implementing the Mitigation and Adaptive Strategies;
- describing the schedule and resources necessary to implement the Mitigation and Adaptive Strategies; and
- describing the procedures for the periodic review of the Mitigation and Adaptive Strategies (continuous improvement).

10.9.2 Best Management Practices Plan to Control Fugitive Dust and Metals Emissions

A Best Management Practices Plan to Control Fugitive Dust and Metals Emissions will also be developed should the project be developed. This plan would include consideration of the following components:

- Identification of Sources of Fugitive Dust and Metal Emissions within the NICO Facility: Describing sources of fugitive dust and metal emissions within the NICO facility, detailing the areas and operating procedures that result in dust emissions, along with identification of potential causes of high dust emissions from these sources.

- Review of the Composition and Size Range of the Fugitive Dust: Reviewing the composition and size range of fugitive dust at the NICO facility and NPAR based on existing data, if available.
- Preventative Procedures and Control Measures for Control of Fugitive Dust: Describing preventative procedures and control measures to be implemented at the NICO mine site and the NPAR to prevent and minimize the impacts of fugitive dust emissions.
- Preventative Procedures and Control Measures for Control of Metal Emissions: Describing additional preventative procedures and control measures to be implemented at the NICO mine site and NPAR to minimize emissions of metals, including procedures for concentrate bagging, handling (i.e., loading and unloading the bags), transport, and transfer in the transfer facilities.
- Implementation of the Best Management Practices Plan: Describing of schedule and resources (including training) necessary to implement the Best Management Practices Plan.
- Inspection and Monitoring Procedures: Describing inspection and monitoring procedures required to obtain information necessary to support the application of preventative procedures and control measures, as well as information to evaluate the effectiveness of the procedures and measures applied in minimizing the impacts of the air emissions.
- Record Keeping: Describing procedures for recordkeeping the information related to the Best Management Practices Plan, for the purpose of audits and continuous improvement of the Plan.
- Best Management Practices Plan Review: Describing procedures for the periodic review of the BMP Plan (continuous improvement).

10.9.3 Incineration Management Plan

An Incineration Management Plan will be developed if the NICO Project is developed. This plan would consider the following tasks:

- Regulatory Review: Identifying the legal requirements which must be considered in the Incineration Management Plan, and the performance limits applicable for the NICO Project incinerator.
- Identification and Evaluation of Best Practices and Technologies: Identifying and evaluating best operating practices and technologies used for waste incineration in remote industrial sites including consideration of the Environment Canada Technical Guidance Document on Incineration.
- Evaluation of the Proposed Practices and Technology: Evaluating the proposed operating practices and incineration technology with regard to the best practices and technologies to identify eventual opportunities of improvement that should be considered in the plan.
- Strategies and Procedures for Waste Incineration: Describing strategies and procedures for waste incineration to be implemented at the NICO Project to minimize the impacts of its emissions, including waste management practices that can affect the incinerator emissions (e.g., segregation, storage prior to incineration), waste types and quantities that can be treated by the incinerator.
- Implementation of the Incinerator Management Plan: Describing schedule and resources (including training) necessary to implement the Incineration Management Plan.

- Inspection, Testing, and Monitoring: Describing inspection requirements for the strategies and procedures for waste incineration, as well as testing and monitoring requirements to evaluate the effectiveness of the Incineration Management Plan in minimizing impacts of the incinerator air emissions.
- Record Keeping: Describing procedures for recordkeeping the information related to the Incineration Management Plan for the purpose of audits and continuous improvement of the Plan.
- Incinerator Management Plan Review: Describing procedures for the periodic review of the Incinerator Management Plan (continuous improvement).

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