Appendix 5.2.4A
Air Quality Modelling Report

Blackwater Gold Project

Air Quality Modelling Technical Data Report

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ACRONYMS

Abbreviations and Units of Measure	Definition
°C	degrees Celsius
AQMG	air quality modelling guideline
ASL	above sea level
BC	British Columbia
BC MOE	British Columbia Ministry of Environment
BC EAA	British Columbia Environmental Assessment Act
BC EMA	British Columbia Environmental Management Act
CDED	Canadian Digital Elevation Data
cm	centimetre
CMS	continuous monitoring station
CO	carbon monoxide
CPF	centre process facility
CWS	Canada-wide standards
d	day
EIS	Environmental Impact Statement
g	gram
g/s	grams per second
h	hour
h/y	hours/year
ha	hectare
HNO_3	nitric acid
km	kilometre
km/h	kilometres per hour
kW	kilowatt
l	litre
l/h	litres/hour
LSD	legal site description
LSA	local study area
m	metre
m/s	metres per second
mE	metres east
mm	millimetres
MMscf/d	million standard cubic feet per day
mN	metres north

Abbreviations and Units of Measure	Definition
Mt/y	Mega tonnes per year
NAAQO	Canadian National Ambient Air Quality Objectives
N_2O	nitrous oxide
NAD	North American Datum
No	number
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3	nitrate
NOx	nitrogen oxides
OLM	Ozone Limited Method
oz	ounce
PM	particulate matter
PM_{10}	inhalable particulate matter with aerodynamic diameter less than 10 µm
$PM_{2.5}$	respirable particulate matter with aerodynamic diameter less than 2.5 µm
s	second
SO_2	sulphur dioxide
SO_4	sulphate
t	tonne
t/d	tonne per day
t/y	tonnes per year
TDR	Technical Data Report
the Project	Proposed Blackwater Gold Project
TSP	total suspended particulate
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
y	year
$\mu g/m^3$	micrograms per cubic metre
µm	micrometre or micron (10^{-6} m)

1.0 INTRODUCTION

New Gold Inc. (New Gold) is proposing to develop the Blackwater Gold Project (the Project), an open pit gold and silver mine and ore processing facilities with a nominal milling rate capacity of 60,000 t/d (22 Mt/y) over 17 years.

The Project footprint consists of the mine site, the mine access road, and the transmission line. The proposed mine site is situated along the northern flank of Mt. Davidson in the Nechako Plateau, approximately 160 km southwest of the city of Prince George and 110 km southwest of the town of Vanderhoof. The proposed mine site is centered at 53°11'22.872"N, 124°52'0.437"W (5,893,000 mN, 375,400 mE)

An air quality assessment has been prepared to provide context for the application and to ensure compliance with the Air Quality Objectives and Standards in British Columbia (BC MOE, 2009). The objective of the analysis is to predict potential air quality impacts due to the activities in the different phases (construction, operation and post-closure) of the Project.

Modelling methods follow the requirements of the Guidelines for Air Quality Dispersion Modelling in British Columbia (AQMG) (BC MOE, 2008) and the Detailed Model Plan for the Project (AMEC, 2012). The CALPUFF model was selected to assess the impacts from the Project. The pollutants of primary concern from the project include sulphur dioxide (SO2), nitrogen oxides (NOx), total suspended particulate (TSP), particulate matter (PM10 and PM2.5), and carbon monoxide (CO).

Other parameters of interest were also assessed, including visibility (haze), nitrogen deposition and certain parameters used in estimating exposure for the human health assessment (cyanide, metals, Polycyclic Aromatic Hydrocarbons (PAHs) and Volatile Organic Compounds (VOC)).

Baseline information for the Project was assembled from a number of sources, including:

- Published reports and studies relevant to air quality,
- Publically available monitoring data available, and
- Results of field studies undertaken for the Project.

The measured background concentrations from the air quality baseline report were added to the predicted concentrations to assess the additive effect of other sources in the region outside the Air Quality Local Study Area (LSA) and long-range transport of pollutants, as recommended in the AQMG.

There are no major industrial emissions within the Air Quality Local Study Area (LSA). Therefore, only the Project-alone scenario was evaluated for the operation phase of the Project. This scenario includes emissions solely from the Project, including mine pit, CPF, mine fleet, unpaved roads, stockpiles, and dump areas.

This report outlines the assumptions, methodologies, dispersion modelling approach, model input data, and the dispersion modelling results.

1.1 Objectives

Air Quality has intrinsic importance to the health and well-being of humans, wildlife, vegetation, and other biota. This Technical Data Report (TDR) presents the assessment of the potential effects of Project-related atmospheric emissions on air quality and measures these effects against relevant provincial and federal criteria.

Assessment information was obtained from existing literature and technical data sources, engineering estimates, and dispersion model simulations. This TDR contains the following key information:

- A summary of climatic and air quality baseline conditions
- A description of air quality emission estimation techniques
- An inventory of Project air emissions of substances of interest
- A summary of air quality dispersion modelling methods and results
- Project, and cumulative effects assessment based on predicted concentrations of the substances of interest.

1.2 Regulatory/Policy Setting

The BC Environmental Assessment Act (BC EAA) (Government of BC, 2002a) identifies new projects that must be reviewed by the BC Environmental Assessment Office (BC EAO). Pursuant to Part 2 of the BC EAA, Reviewable Projects Regulation (Government of BC, 2002b) review is required for the Project because it would be a new mine facility with a production capacity greater than 75,000 t/y of mineral ore. The Project is designed to have a nominal ore production capacity of 22 Mt/y.

Under the *Canadian Environmental Act, 2012 (CEA Act 2012)* (Government of Canada, 2012a), "an environmental assessment may be required of designated projects." Pursuant to paragraphs 84(a)(e) of the *CEA Act 2012*, *Regulations Designating Physical Activities* (Government of Canada 2012b), an Environmental Impact Statement (EIS) may be required because the Project involves the construction, operations, decommissioning, and abandonment of a gold mine with an ore production capacity greater than 600 t/d. The Project is expected to have a nominal ore production capacity of 60,000 t/d, and therefore will require an EIS.

The environmental assessment for the Project includes requires air quality dispersion modelling be completed in accordance with the Detailed Air Quality Modelling Plan for Blackwater Gold Mine Project (AMEC, 2013). This plan was designed to address the requirements of the AQMG. The predicted ground-level concentrations of various pollutants associated with the Project are evaluated with respect to federal and provincial ambient air quality objectives.

The BC Ministry of Environment and Environment Canada have established ambient air quality objectives for various air contaminants. Table 1.2-1 shows the objectives for the air contaminants of interest considered in this assessment.

The Canadian National Ambient Air Quality Objectives (NAAQO) is a three-tiered system. Each level has a specific concentration for an individual air contaminant, with one or more averaging periods used. For each of the air contaminants, time-averaged concentrations shall not be greater than one of the following:

- The maximum desirable level (Level A) 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 (Level B) is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being; and
- The maximum tolerable level (Level C) denotes the concentration of an air contaminant that requires abatement without delay to avoid further deterioration to an air quality that would endanger the prevailing Canadian life-style or ultimately, to an air quality that would pose a substantial risk to public health.

British Columbia has time-based quality criteria for ambient air concentrations defined at three levels. They are:

- Level A; below this level, air quality is ‘good’. This is the objective for new and proposed discharges and, within the limits of best practicable technology, the objective for existing discharges to be achieved through staged improvements. It represents the maximum desirable concentration.
- Level B; below this level (but above Level A), air quality is ‘fair’. It is the intermediate objective for all existing discharges to meet within a period of time specified by the Director, and as an immediate objective for existing discharges which may be increasing in quantity or altered in quality as a result of process expansion or modification. It represents the maximum acceptable concentration.
- Level C; below this level (but above Level B), air quality is ‘poor’. It is set as the immediate objective for all existing chemical and petroleum industries to reach within a minimum technically feasible period of time. It represents the maximum tolerable concentration. Above this level, air quality is ‘very poor’.

In BC a separate guideline can be used for assessment effects on vegetation. This guideline is referenced in section 11.1.4.5 of the AQMG) (BC MOE, 2008). The method is primarily intended for assessment of sources that are tall and energetic where the pollutants rise and then as they cool and settle onto the topmost parts of trees where the actively growing shoots are most sensitive to SO_2 exposure. SO_2 emissions from the Project are primarily from vehicle exhaust as shown in Table 4.2-1. These sources are relatively close to the ground and tend not to rise up over treetops. The maximum predicted SO_2 values are also very low, as shown in Table 6.3-1, less than 10% of the BC AAQO. Therefore, a separate assessment of effects on vegetation is not provided in this report.

Table 1.2-1: British Columbia and National Ambient Air Quality Objectives [a]

Pollutants	Averaging Period	BC Objective / Guideline ($\mu g/m^3$)			Canada Objective ($\mu g/m^3$)		
		Level A	Level B	Level C	Max. Desirable	Max. Acceptable	Max. Tolerable
SO_2	1-hour	450	900	900-1300	450	900	
	3-hour	375	665		–	–	–
	24-hour	160	260	360	150	300	800
	Annual	25	50	80	30	60	–
NO_2	1-hour	–	–		–	400	1,000
	24-hour	–	–		–	200	300
	Annual	–	–	–	60	100	–
CO	1-hour	14,300	28,000	35,000	15,000	35,000	–
	8-hour	5,500	11,000	14,300	6,000	15,000	20,000
TSP	24-hour	120	200	260	–	120	400
	Annual [b]	60	70	75	60	70	–
PM_{10}	24-hour	50			–	–	–
	Annual	–	–	–	–	–	–
$PM_{2.5}$	24-hour	25[c]			30[d]		
	Annual	8			–		

Note: (a) At a temperature of 25°C and pressure of 101.3 kPa; (b) As a geometric mean; (c) Based on annual 98th percentile; (d) Based on annual 98th percentile value, averaged over three consecutive years.

1.3 Substances of Interest

Measurable parameters facilitate qualitative or quantitative measurement of potential Project and cumulative impacts, and provide a means to determine the level or amount of change to air quality in the region.

Table 1.3-1 provides a summary of the measurable parameters included in the air quality assessment. Atmospheric emissions from the Project include various air contaminants that have the potential to negatively affect human and ecological health.

Table 1.3-1: Measurable Parameters for Air Quality

Project Effect	Measurable Parameter(s) for the Effect	Rationale for Selection of Measurable Parameter[a]
Change in concentration of Air Contaminants of Interest	Predicted concentrations for: • SO_2 • NOx, NO_2 • CO • TSP • PM_{10} • $PM_{2.5}$	Exceedances of the BC and Canadian Ambient Air Quality Objectives can negatively affect human and ecological health

Note: (a) Includes input from consultation with regulators, First Nations, affected stakeholders, and the public, as well as regulatory guidelines, policies, and/or programs.

The following sections provide a detailed description of each selected measurable parameter.

- **SO_2** is a colourless gas with a distinctive pungent sulphur odour. It is produced in combustion processes by the oxidation of sulphur compounds, such as H_2S in fuel. At high enough concentrations, SO_2 can negatively affect plants, as well as humans and or animal health (particularly respiratory systems). Sulphur dioxide can also be further oxidized and may combine with water to form the sulphuric acid component of "acid rain." Project SO_2 emissions are expected to be small, largely confined to the incinerators and mine and construction equipment.
- **NO_x** are produced in most combustion processes, and are almost entirely made up of nitric oxide (NO) and nitrogen dioxide (NO_2). Together, they are often referred to as NO_x. Nitric oxide is a colourless gas with no apparent direct effects on human or animal health, or vegetation at typical ambient levels. Nitrogen dioxide is an orange to reddish gas that is corrosive and irritating. In the context of this Project, NO_x emission sources include construction equipment, haul trucks, vehicles travelled from and to the Project, and heavy mining equipment.
- **CO** is a colourless, odourless gas. A product of incomplete combustion, emission sources include fossil fuel and wood combustion. Motor vehicles, industrial processes and fires are some common sources. The Project CO emission sources include construction equipment, haul trucks, vehicles travelled from and to the Project, and heavy mining equipment.
- **Particulate matter** is classified by the size of the particles. Particle size determines the velocity of gravitational settling, and ease of penetration into the human respiratory tract. Generally, large particles settle out close to their source, and are less likely to penetrate deep into the respiratory tract.
- **TSP** encompasses all size ranges from about 100 micrometres (µm) to the sub-micrometre range. Inhalable (PM_{10}) and respirable ($PM_{2.5}$) particulate matter consist of very small particles of diameters less than 10 and 2.5 µm, respectively. Greater concern about fine particles has prompted research resulting in new sampling methods and criteria in recent years. In June 2000, the Canadian Council of Ministers of the Environment (CCME, 2000) adopted, in principle, a Canada-Wide Standard (CWS) for respirable particulate matter. The CWS includes a 24-hour average $PM_{2.5}$ standard of 30 µg/m^3. Achievement is to be

based on the 98th percentile of the ambient values averaged over three consecutive years. The BC AAQO of $PM_{2.5}$ is 25 g/m^3 for a 24-hour averaging period 98th percentile value over one year and 8 g/m^3 for the annual averaging period.

- **Other Parameters** Certain other parameters were modelled as they are of interest for purposes other than comparing to the BC AAQO. The parameters are:
  - Visibility (haze)
  - Nitrogen deposition
  - CN
  - Metals
  - PAHs
  - VOCs

Visibility is an aesthetic issue of interest in the assessment and results of this modelling is used in the visibility impact assessment. Nitrogen species are nutrients and deposition of these substances are used in the vegetation assessment. CN, Metals, PAHs and certain VOCs are of interest in the human health assessment. Results of this modelling were used as exposure estimates in that assessment.

2.0 STUDY AREAS BOUNDARIES

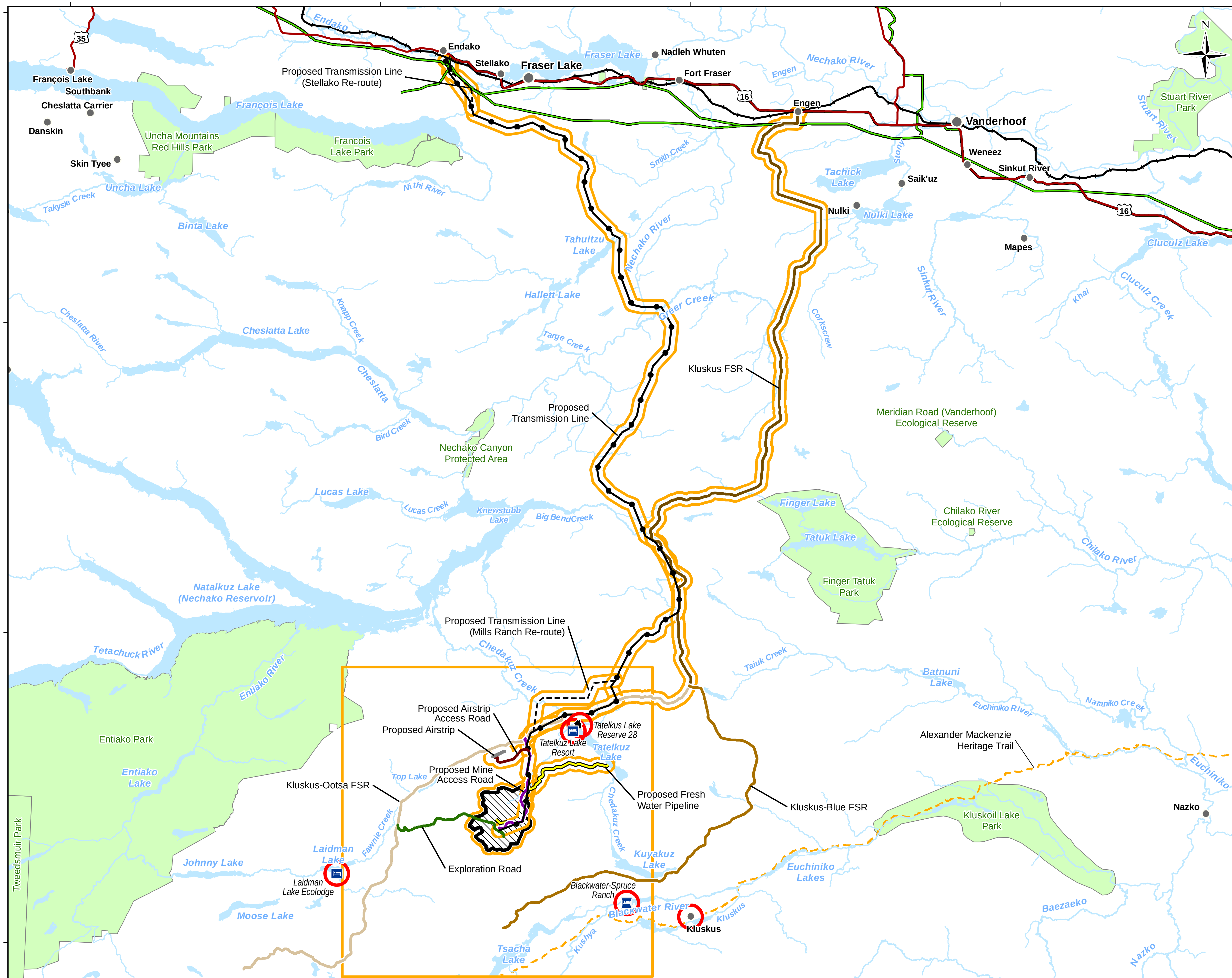
2.1 Spatial Boundaries

The boundaries are selected to cover the geographic extent in which the potential air quality effects of the Project are expected to be measurable. The BC AQMG recommends that the assessment area be sufficiently large to depict concentrations amounting to 10% or more of the regulatory objectives. Spatial boundaries for the air quality assessment were established based on the BC AQMG. Based on this information, the LSA was established as measuring 40 km by 40 km centered on the Project site. This proposed study area was discussed with BC MOE. Table 2.1-1 describes the study area defined for the air quality assessment, and Figure 2.1-1 shows the study area in relation to the Project site.

The spatial boundaries associated with air quality are described below in Table 2.1-1.

Table 2.1-1: Spatial Boundary Associated with Air Quality

Valued Component	Study Area	Description
Air Quality	LSA	Mine site: an area 40 km x 40 km centred on the proposed open pit. Off site: 3-km wide corridor centred on the footprint of the proposed road access route, transmission line, and water supply pipeline.
	RSA	There is no RSA as there are no significant air emissions sources close enough to the project to have significant interactions.



Legend

- Populated Place
- Recreation Lodge
- Homestead
- Highway
- Kluskus FSR
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Railway
- Existing Transmission Line
- Stream
- Waterbody
- Parks & Protected Areas

Project Components

- Exploration Road
- Proposed Mine Access Road
- Proposed Transmission Line
- Proposed Transmission Reroute
- Proposed Fresh Water Pipeline
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site

Air Quality and Climate

- Local Study Area (LSA)
- Receptor Location

Note: Regional Study Area (RSA) is the same as the LSA

Scale: 1:500,000

0 5 10 20 Kilometres

Reference
BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Air Quality and Climate Study Areas

DATE: September, 2014	ANALYST: WR	Figure 2.1-1	
JOB No: VE52420	QA/QC: GH	PDF FILE: 04-100-001_v5_Air_SA_Receptor.pdf	
GIS FILE: 04-100-001_v5_Air_SA_Receptor.mxd			
PROJECTION: UTM Zone 10	DATUM: NAD83	amec	

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2.2 Temporal Boundaries

The temporal boundaries for the Project identify the time periods of the construction, operations, closure, and post-closure phases of the Project, for which the potential Project effects will be assessed.

The preliminary temporal boundaries of the Project are as follows:

- The construction phase is scheduled to occur over two years, starting immediately following receipt of the required permits;
- The operations phase is scheduled to extend for approximately 17 years, starting once the plant site is constructed, commissioned, and ready for ore processing;
- The closure phase is estimated to occur during the three years following the cessation of mining and ore processing activities, when the mine site buildings and infrastructure will no longer be needed. Activities will include decommissioning of plant facilities and infrastructure and their abandonment and removal from the mine site, and the implementation of the site reclamation plan; and
- The post-closure phase is estimated to start immediately after completion of the closure activities and last approximately 84 years.

Temporal boundaries for the air quality assessment also include several time averaging periods. Ground-level concentrations of air contaminants are estimated and presented for one-hour, 3-hour, 8-hour, 24-hour, and annual averaging periods, depending on the contaminant. These averaging periods were selected to correspond with the relevant regulatory ambient air quality criteria.

3.0 BASELINE CLIMATE AND AMBIENT AIR QUALITY

Baseline information is used to characterize the pre-project conditions for air quality. There was no pre-existing air quality data, therefore data from other sites perceived to be representative of the project location were used. In addition, PM monitoring commenced at the Project site in 2012.

3.1 Sources

Baseline information within the Project's LSA was assembled from a number of sources, including:

- Published reports and studies relevant to air quality,
- Publically available monitoring data, and
- Results of field studies undertaken for the Project.

Table 3.1-1 provides background concentrations for substances of concern.

Table 3.1-1: Background Concentrations

Species	Averaging Period	Baseline Value ($\mu g/m^3$)
SO_2	1-hour	1
	3-hour	
	24-hour	
	Annual	
NO_2	1-hour	8
	24-hour	
	Annual	
CO	1-hour	120
	8-hour	
TSP	24-hour	18
	Annual	
PM_{10}	24-hour	9
	Annual	
$PM_{2.5}$	24-hour	4
	Annual	

4.0 AIR EMISSIONS ESTIMATION

4.1 Project Construction Emissions

Construction of the Project will create emissions similar to those from operations, but in smaller quantities. The primary sources of air emissions during this phase will be dust suspension from vehicle and heavy equipment travel and material handling (grading, dumping) and exhaust from diesel combustion.

There will be up to three small incinerators used for disposing of camp food waste. These units have a capacity of 1,080 kg/d each. The camps have a waste management plan that minimizes plastic burning and therefore dioxin/furan and hydrochloric acid formation, therefore these parameters are not included in the Project assessment. These units are currently permitted under Approval No. 105913 under the *Environmental Management Act*. The incinerators have a primary and secondary combustion chambers to ensure complete combustion of organic material.

Some emissions from the construction phase will occur throughout the operations phase, and are therefore added to the Project operations emissions to be conservative.

An equipment list for construction activities was compiled as part of the emissions inventory. Details of the equipment such as power ratings, fuel consumption, and projected operating times are based on information from manufacturer specifications and experience with similar projects. All equipment is powered with diesel fuel and conservatively assumed to operate 24 hours per day.

Construction phase emissions were calculated for the following contaminants: SO_2, NO_X, CO, TSP, PM_{10} and $PM_{2.5}$. Emission factors for all on-site construction equipment were generated using the US EPA NONROAD and MOVES2010b model. Table 4.1-1 provides a summary of the emission estimates.

Table 4.1-1: Summary of Emissions Estimates

	No. of Units	Engine (hp)	SO_2 (t/d)	NOx (t/d)	CO (t/d)	TSP (t/d)	PM_{10} (t/d)	$PM_{2.5}$ (t/d)
Emission from Construction Equipment								
Cat 988 Wheel Loader	1	588	0.0001	0.0121	0.0048	0.0007	0.0007	0.0006
Cat 385 Excavator	1	530	0.0000	0.0055	0.0024	0.0003	0.0003	0.0003
Cat 329 Excavator	1	241	0.0000	0.0017	0.0007	0.0001	0.0001	0.0001
Cat D8 Track Dozer	1	347	0.0000	0.0047	0.0019	0.0002	0.0002	0.0002
Cat 735 Articulated Dump Truck	5	435	0.0002	0.1168	0.0686	0.0089	0.0089	0.0086
Cat 14M Motor Grader	1	294	0.0000	0.0023	0.0009	0.0001	0.0001	0.0001
Cat 735 Water Truck	1	435	0.0000	0.0031	0.0015	0.0001	0.0001	0.0001
Cat CS76 Compactor	1	177	0.0000	0.0026	0.0009	0.0001	0.0001	0.0001
Cat 825 Compactor	2	340	0.0001	0.0213	0.0092	0.0013	0.0013	0.0013
Tracked Percussion Rock Drill (Cat MD5125)	1	325	0.0000	0.0157	0.0044	0.0007	0.0007	0.0007

	No. of Units	Engine (hp)	SO_2 (t/d)	NOx (t/d)	CO (t/d)	TSP (t/d)	PM_{10} (t/d)	$PM_{2.5}$ (t/d)
Cat 430 Backhoe/Loader	1	117	0.0000	0.0012	0.0006	0.0001	0.0001	0.0001
Total	**-**	**-**	**0.000578**	**0.187**	**0.0957**	**0.0126**	**0.0126**	**0.0122**
Emission from Incinerator								
Incinerator	2	**-**	0.054	0.09	0.074	0.116	0.116	0.108
Emission from Material Handling								
Grading	**-**	**-**	-	-	-	2.06	0.645	0.0640
Material Handling	**-**	**-**	-	-	-	1.36	0.645	0.0967
Emission from Travelling on Road	**-**	**-**	0.0000884	0.0128	0.00882	0.552	0.146	0.0148
Total Emission for Construction	**-**	**-**	**0.0546**	**0.277**	**0.170**	**4.11**	**1.56**	**0.295**

4.2 Project Operation Emissions

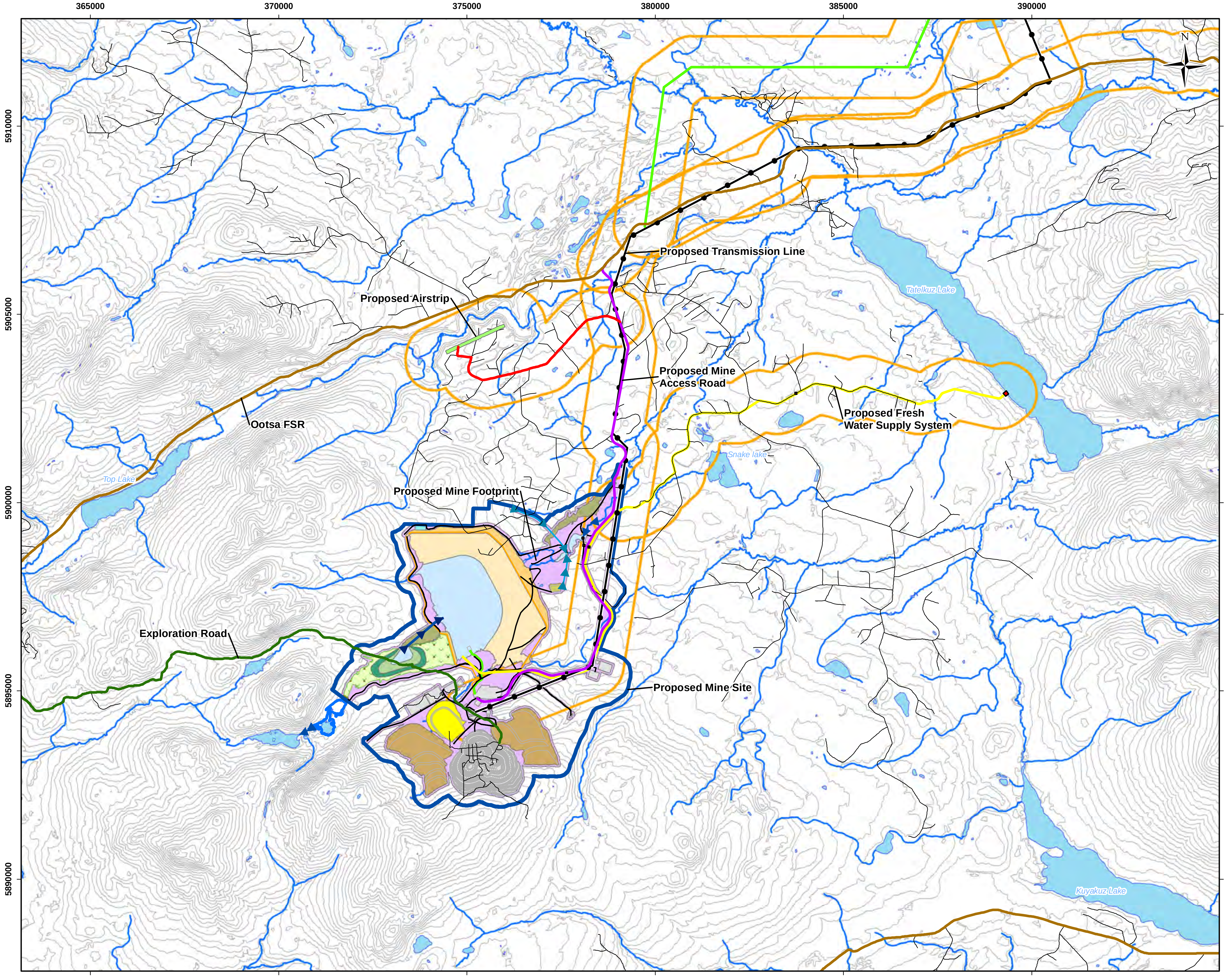
For this project, the some construction and operation activities will occur simultaneously. To be conservative, the Project Case emissions include emissions from the construction phase and operation phase, including mine site (mine fleet, dump areas, and stockpiles), ore processing facility, aviation, and access roads. The total emissions from the Project are summarized in Table 4.2-1.

The emission inventory for the Project is established based on design data, construction plans and operational scenarios. The activities considered for the emissions inventory include: ore and waste rock transportation within the mine site as well as the transportation of materials and products outside the mine site (whether by air or road). Wherever possible, engineering data and manufacturer's specifications are used to estimate emission rates. Where necessary, this information is supplemented by emission factors from the United States Environmental Protection Agency AP-42 (US EPA, 2000). Emissions from mobile sources during construction and operations are estimated using the US EPA models MOVES2010b and NONROAD. The simplified site plan in Figure 4.2-1 shows the locations of the mine pit, stockpiles, dump areas, paved and unpaved roads, aerodrome, ponds, and emission stacks.

Table 4.2-1: Total Emissions from the Project

Emission Type	SO_2 (t/d)	NOx (t/d)	CO (t/d)	PM (t/d)	PM_{10} (t/d)	$PM_{2.5}$ (t/d)
Unpaved Road Total	**-**	**-**	**-**	**5.24**	**1.12**	**0.112**
Primary Crusher/Mill	-	-	-	0.636	0.136	0.0136
Stockpile	-	-	-	0.312	0.0667	0.00667
East Dump	-	-	-	0.287	0.0615	0.00615
West Dump	-	-	-	0.662	0.142	0.0142
PAG Storage	-	-	-	1.22	0.260	0.0260
TSF (Partly one way)	-	-	-	2.13	0.455	0.0455
Unpaved Road Total	**-**	**-**	**-**	**1.10**	**0.284**	**0.0284**
Mine Access Road	-	-	-	0.535	0.134	0.0134
FSR	-	-	-	0.551	0.146	0.0146

Emission Type	**SO_2 (t/d)**	**NOx (t/d)**	**CO (t/d)**	**PM (t/d)**	**PM_{10} (t/d)**	**$PM_{2.5}$ (t/d)**
Airport Access Road	-	-	-	0.0161	0.00427	0.000427
Material Handling Total	**0.0542**	**0.434**	**1.84**	**10.1**	**3.78**	**2.05**
Material Handling	-	-	-	1.36	0.645	0.0967
Screening	-	-	-	0	0	0
Bulldozing in Mine Pit	-	-	-	6.31	2.29	1.85
Blasting	-	-	-	0.00176	0.000915	0.0000528
Grading	-	-	-	2.06	0.645	0.0640
Drilling	-	-	-	0.142	0.0744	0.0112
Topsoil Removing by Scraper	-	-	-	0.145	0.109	0.0163
Overburden Replacement	-	-	-	0.0300	0.0225	0.0135
Explosive Detonation	0.0542	0.434	1.84			
Processing Plant (CPF) Total	-	-	-	**0.0667**	**0.00747**	**0.00112**
Primary Crushing (Gyratory Crusher)	-	-	-	0.0640	0.00640	0.000960
Secondary Crushing (Pebble Crusher)	-	-	-	0.00268	0.00107	0.000161
Dump/Storage Area Total	-	-	-	**3.77**	**1.88**	**0.283**
Topsoil Stockpile	-	-	-	0.152	0.0758	0.0114
Topsoil Stockpile	-	-	-	0.0885	0.0443	0.00664
Topsoil Stockpile	-	-	-	0.0513	0.0257	0.00385
Topsoil Stockpile	-	-	-	0.0543	0.0272	0.00408
Topsoil Stockpile	-	-	-	0.0192	0.00958	0.00144
West Dump Area	-	-	-	0.188	0.0940	0.0141
East Dump Area	-	-	-	0.173	0.0863	0.0130
Low Grade Stockpile	-	-	-	0.0831	0.0415	0.00623
Mine Pit Open Area	-	-	-	0.554	0.277	0.0416
Tailing Beach	-	-	-	2.40	1.20	0.180
Onroad Vehicle Total	**0.000129**	**0.0196**	**0.0217**	**0.000373**	**0.000373**	**0.000372**
Mine Access Road	0.0000884	0.0128	0.00882	0.000232	0.000232	0.000231
FSR	0.0000402	0.00675	0.0126	0.000140	0.000140	0.000140
Airport Access Road	0.000000328	0.0000155	0.000232	0.000000624	0.000000624	0.000000605
Mine Fleet Total	**0.0104**	**6.46**	**0.748**	**0.126**	**0.126**	**0.122**
Aviation	**0.00292**	**0.0239**	**0.0543**	**-**	**-**	**-**
Incinerator	**0.0540**	**0.09**	**0.074**	**0.116**	**0.116**	**0.108**
Refinery System	**-**	**-**	**-**	**0.000326**	**0.000326**	**0.000303**
Blackwater Project Total Emissions	**0.122**	**7.02**	**2.74**	**20.5**	**7.32**	**2.71**



Legend

- Existing Road
- Ootsa FSR
- Exploration Road
- Proposed Mine Access Road
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Re-route)
- Fresh Water Supply System
- Contour (20 m)
- Stream
- Proposed Mine Footprint
- Proposed Mine Site
- Air Quality Local Study Area
- Bog / Wetland Area
- Dam
- Dump
- Embankment Fill
- Emergent Vegetation Wetland
- Environmental Control Dam (ECD)
- Borrow Source
- Fresh water Reservoir
- Low-Grade Stockpile
- Open Pit
- Plant Site
- Pond
- Tailings Beach
- Top Soil
- Topsoil Stockpile
- Upland Beach

Scale:1:100,000

0 1 2 4

Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Site Plan

DATE: October, 2013	ANALYST: PK	**Figure** 4.2-1
JOB No: VE52095	QA/QC: MY	PDF FILE: 04-100-023_site_plan_v3_minsite.pdf
GIS FILE: 04-100-023_site_plan_v3.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

Y:\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\04_air-quality\Baseline\04-100-023_site_plan_v3.mxd

4.3 Project Closure and Post-Closure Emissions

The air emissions associated with the Project closure and post-closure phases will be much less than those from the Project operation phase. Emissions are associated with material handling and equipment use and these activities are less for closure and essentially zero for post-closure activities compared to construction and operation. Therefore, emissions and air quality impacts are conservatively assumed the same for closure as for construction, and zero for post-closure.

5.0 MODELLING APPROACH

This section evaluates the potential for Project-related activities to result in environmental effects on air quality.

To assess potential Project effects related to an increase in air contaminants of interest, a dispersion modelling assessment was completed using the CALPUFF/CALMET modelling system.

The construction emissions related to the Project are small relative to operations. However, some construction emissions, namely the construction of the transmission line and water pipeline, will occur at the same time as the Project operation. As such, they are assessed through dispersion modelling with the Operation Case together to be conservative.

The potential effects from Project operations warrant quantitative assessment through dispersion modelling, which was completed to determine the effects on ground-level concentrations of air contaminants of interest during operations. The predicted ground-level concentrations from this assessment are compared with the relevant ambient air quality criteria to assess the potential effects associated with the Project.

The following sections describe the dispersion modelling methodologies used in. All dispersion modelling was conducted in accordance with the *Detailed Air Quality Modelling Plan for Blackwater Gold Mine Project* (AMEC, 2013), which was prepared to address the requirements of the BC AQMG. This modelling plan is included as an attachment to this appendix.

5.1 The CALPUFF Model

CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, as well as longer-range effects such as chemical transformation, and pollutant removal (wet scavenging and dry deposition) (Scire. 2000). CALPUFF is currently considered the state-of-the-art in regulatory modeling and represents a major improvement over previous models for the following reasons:

- It is applicable over spatial scales from a few metres to hundreds of kilometres, allowing the modeling of both local and regional air impacts;
- It incorporates the BPIP-PRIME downwash algorithm found in other advanced models used to predict building downwash in the vicinity of emission sources;
- It can model wet and dry removal processes (deposition);
- It has algorithms to simulate SO_2 and NO_x chemistry for secondary particulate formation and for predicting acidification;
- It models dispersion in three dimensions, allowing for more realistic plume movement;

- It allows winds to vary in space in response to channelling and blocking by terrain, removing a constraint in older models;
- It can model dispersion in calm winds, another major shortcoming of older models; and
- It has been widely used for research and has thus undergone extensive peer review.

Additional features of the CALPUFF model are provided in Table 5.1-1.

Table 5.1-1: Major Features of the CALPUFF Model

Source Types
• Point sources (constant or variable emissions)
• Line sources (constant emissions)
• Volume sources (constant or variable emissions)
• Area sources (constant or variable emissions)
Non-steady State Emissions and Meteorological Conditions (if CALMET is used)
• Gridded 3D fields of meteorological variables (winds, temperature)
• Spatially variable fields of mixing height, friction velocity, convective velocity scale, Monin-Obukhov length, precipitation rate
• Vertically and horizontally varying turbulence and dispersion rates
• Time-independent source and emissions data
Dispersion Coefficient (σ_y, σ_z) Options
• Direct measurements of σ_v and σ_w
• Estimated values of σ_v and σ_w based on similarity theory
• Micrometeorology dispersion coefficients (rural areas)
• Pasquill-Gifford (PG) dispersion coefficients (rural areas)
• McElroy-Pooler (MP) dispersion coefficients (urban areas)
Vertical Wind Shear
• Puff splitting
• Differential advection and dispersion
Plume Rise
• Partial penetration
• Buoyant and momentum rise
• Stack tip effects
• Vertical wind shear
Dry Deposition
• Gases and particulate matter
• Three options: o Full treatment of space and time variations of deposition with a resistance model o User-specified diurnal cycles for each pollutant o No dry deposition

Chemical Transformation Options
• RIVID/ARM3 scheme chemical mechanism for SO_2, SO_4, NO_x, HNO_3, and NO_3
• Specified hourly time-series of ozone concentrations of transformation rates
Wet Removal
• Scavenging coefficient approach
• Removal rate a function of precipitation intensity and precipitation type
Graphical User Interface
• Click and point model set-up and data input
• Enhanced error checking of model inputs

5.2 The CALMET Pre-processor

Meteorology plays a major role in determining air quality changes downwind of emission sources. Both the wind and atmospheric stability greatly affect dispersion. Local influences due to terrain and land-cover factors are also important.

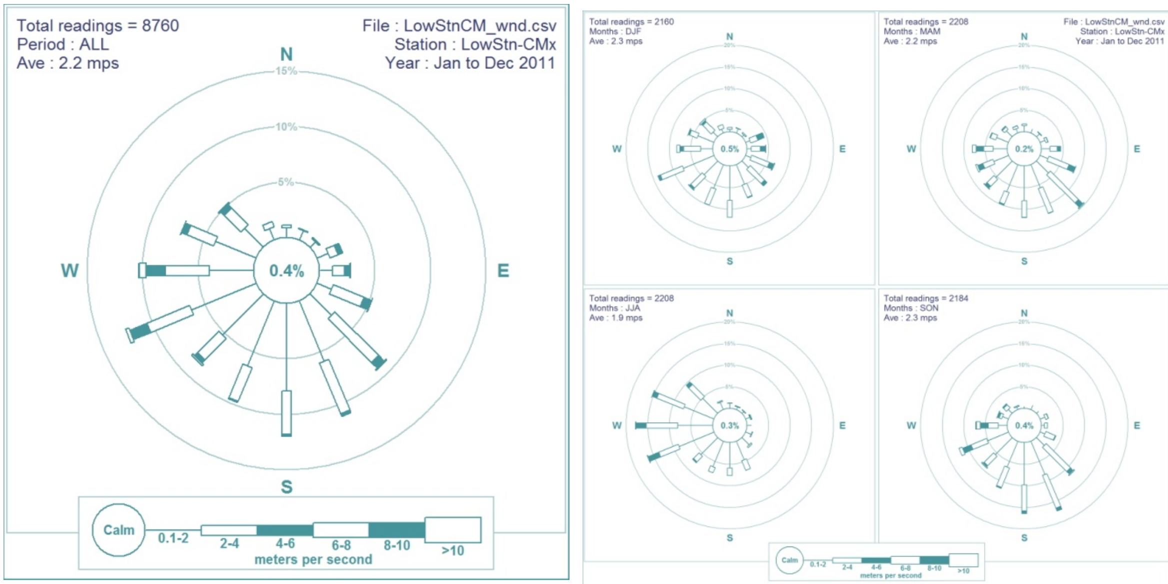
Meteorological input to CALPUFF is generated by the CALMET pre-processor. Inputs to CALMET includes two parts: a one-year (2011) meteorological data set for the modelling domain purchased from Lake Environment and site-specific meteorological data. The former set of meteorological data is the result of MM5 modelling. MM5 is a widely used research and regional forecasting model based on the NCAR-PSU model. MM5 uses global weather observations as its input to generate gridded meteorological data. Site-specific meteorological data from the Low Station were used to adjust the wind field.

Climate data are currently being collected at the low-elevation climatology station (approximately elevation 1,050 masl), which was installed in August 2011 and at the high-elevation climatology station (elevation 1,350 masl), which was installed in July 2012. The high station is located approximately where the access road connects to the proposed mine site. The low station is located just west of Tatelkuz Lake near the mine access road.

Wind speed and direction at the Project site based on CALMET output and site-specific meteorological monitoring stations were processed into wind roses shown in Figure 5.2-1 and Figure 5.2-2.

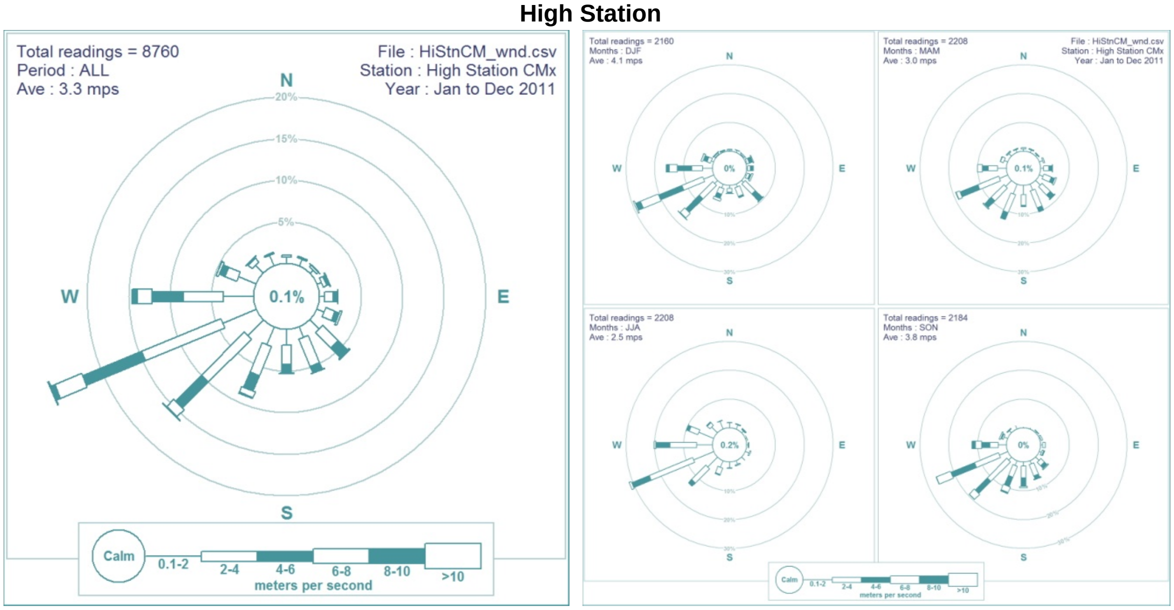
- **CALMET Results**: At the Low Station, the prevailing wind is from west-southwest annually. The wind is from west-southwest, east-southeast, west, and south-southeast for different seasons, respectively. The annual average wind speed is 2.2 mps. At the High Station, the wind is mainly from west-southwest. The annual average wind speed is 3.3 mps.
- **Observation Results**: At the Low Station, the prevailing wind is from west-southwest. The annual average wind speed is 2.7 mps. At the High Station, the wind is mainly from west. The annual average wind speed is 2.7 mps.

Low Station



Full Year **Seasonal**

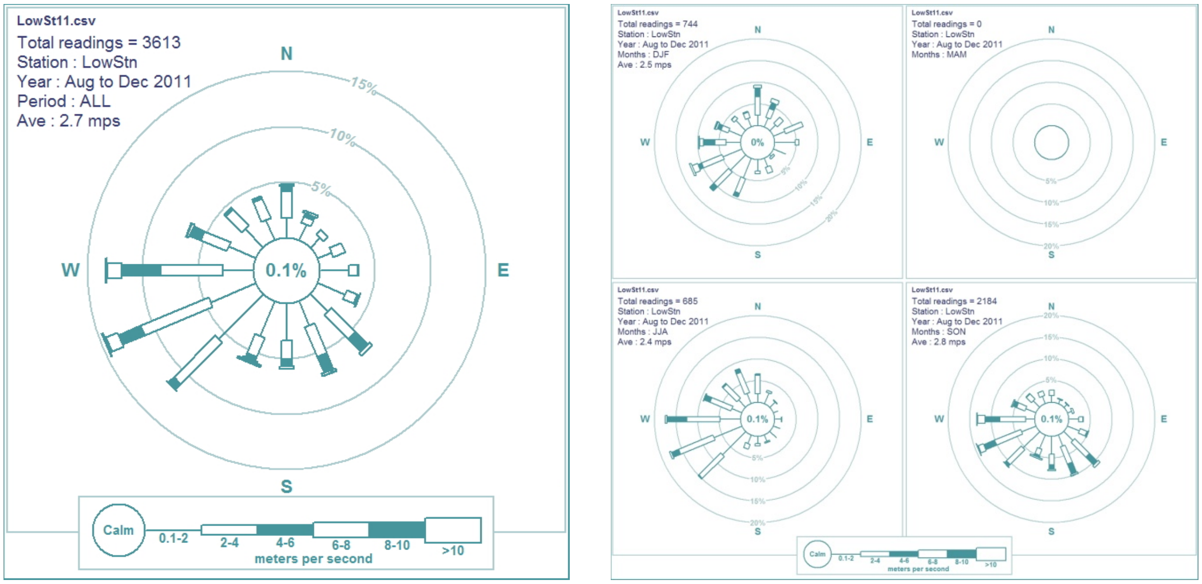
High Station



Full Year **Seasonal**

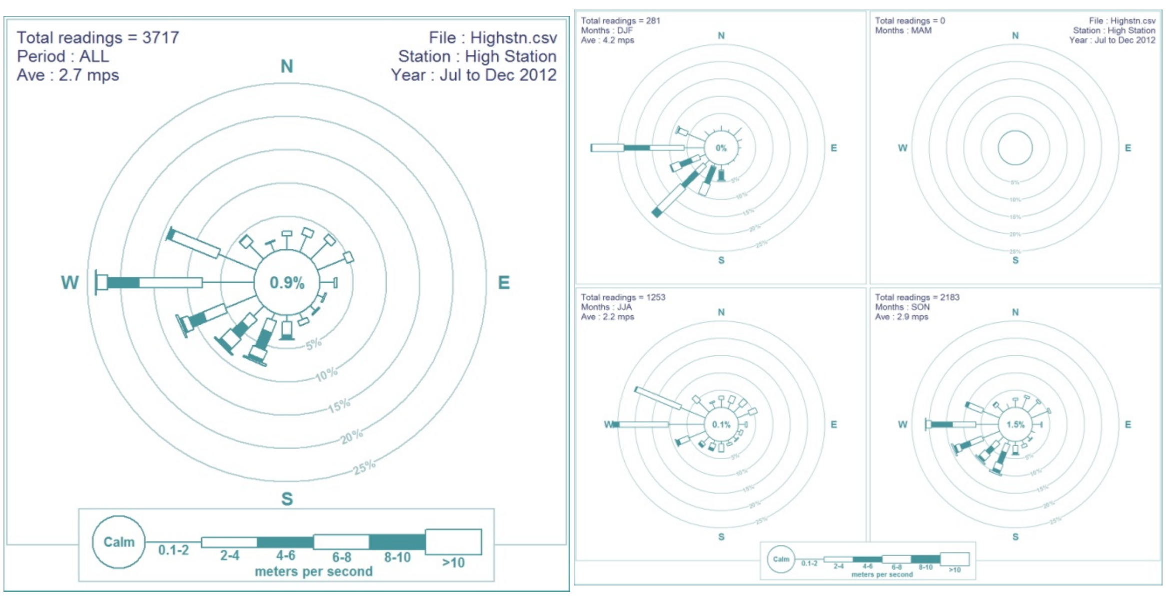
Figure 5.2-1: Wind Speed and Direction Frequencies from 2011 CALMET Data

Low Station



Full Year | **Seasonal**

High Station



Full Year | **Seasonal**

Figure 5.2-2: Wind Speed and Direction Frequencies from two Meteorological Monitoring Stations

5.3 Topography and Receptors

The topography near the Project is mountainous, rough, rolling hills and ridges (Figure 5.3-1). The Project base elevation is approximately 1,400 metres above sea level (masl). Relief within 20 km of the Project varies between 850 masl and 1900 masl.

Canadian Digitial Elevation Database (CDED) topographical data were taken from remote sensing readings collected by the National Aeronautics and Space Administration (NASA); CDED data of 30 m resolution were used (GeoBase, 2011). An in-house terrain pre-processor was used to determine the receptor elevation by a distance-weighted two-dimensional interpolation of the elevation values at the four nearest elevation data nodes surrounding the receptor location.

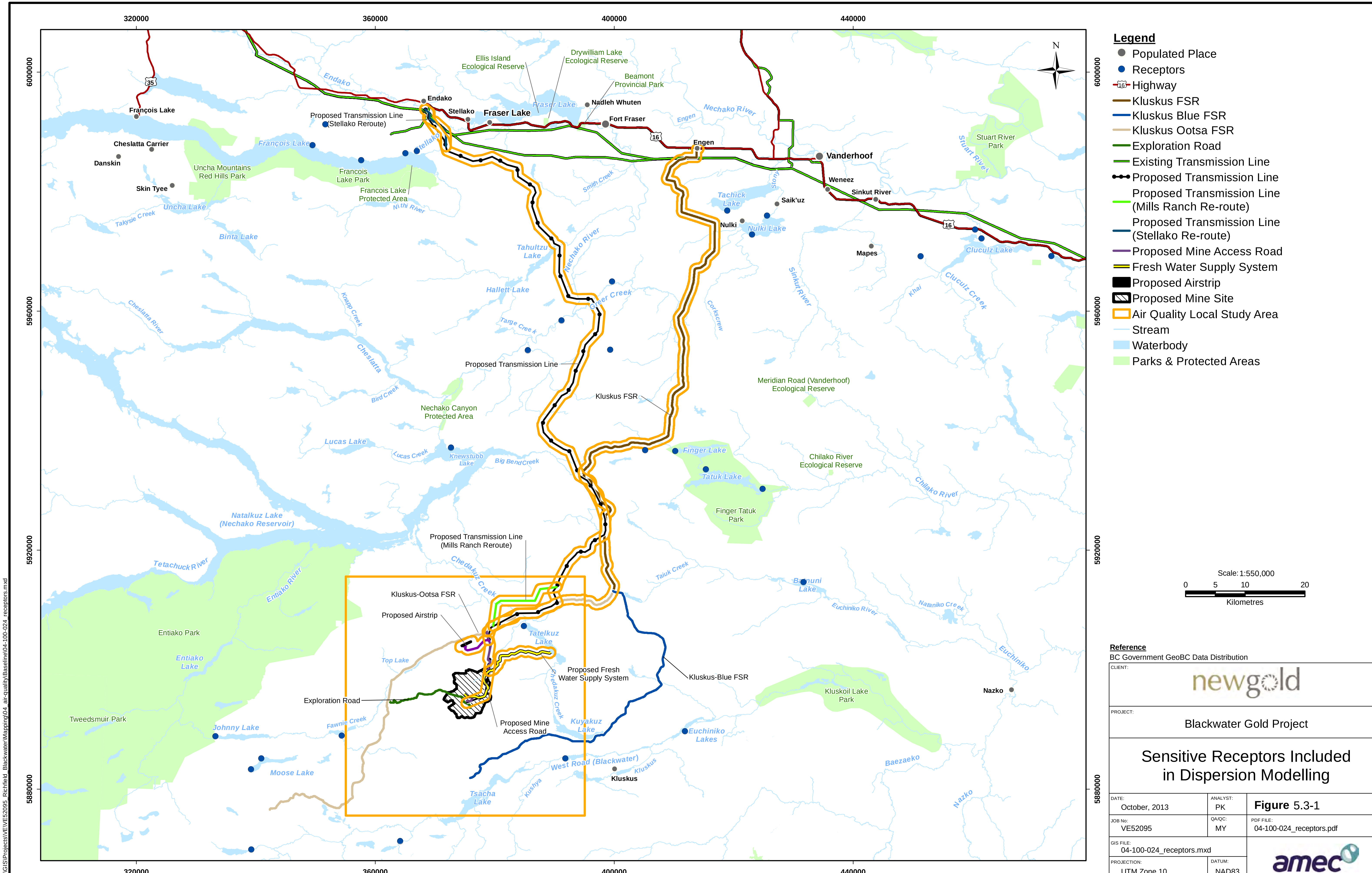
Calculations of ground-level air contaminant concentrations, consistent with the AQMG were made for locations outside the Project site boundary. As the proximity to the Project increased, a series of nested Cartesian grids increased the receptor density. The receptor grids and their corresponding spacing are as follows (Figure 5.3-1):

- 50 m spacing along the Project property boundary
- 100 m spacing within 500 m of Project property boundary
- 250 m spacing within 2 km of Project property boundary
- 500 m spacing within 5 km of Project property boundary
- 1,000 m spacing beyond 5 km of Project property boundary.

A number of sensitive receptors within the LSA were selected for determining maximum predicted ground-level concentrations of air contaminants. Table 5.3-1 and Figure 5.3-1 include the locations of these receptors.

Table 5.3-1: Sensitive Receptors Included in Dispersion Modelling

Name	Type	UTM mE	UTM mE	Elevation (m)
Blackwater-Spruce Ranch	Recreation lodge	391762	5885119	972
Laidman Lake Ecolodge	Recreation lodge	354315	5888940	1020
Pan Phillips Resort	Hunting and fishing lodge	364095	5871295	1083
Tatelkuz Lake Resort	Recreation lodge	384862	5907289	936



Legend
Populated Place
Receptors
Highway
Kluskus FSR
Kluskus Blue FSR
Kluskus Ootsa FSR
Exploration Road
Existing Transmission Line
Proposed Transmission Line
Proposed Transmission Line (Mills Ranch Re-route)
Proposed Transmission Line (Stellako Re-route)
Proposed Mine Access Road
Fresh Water Supply System
Proposed Airstrip
Proposed Mine Site
Air Quality Local Study Area
Stream
Waterbody
Parks & Protected Areas
Scale: 1:550,000
0 5 10 20
Kilometres
Reference
BC Government GeoBC Data Distribution
CLIENT:
newgold
PROJECT:
Blackwater Gold Project
Sensitive Receptors Included in Dispersion Modelling
DATE: October, 2013
ANALYST: PK
Figure 5.3-1
JOB No: VE52095
QA/QC: MY
PDF FILE: 04-100-024_receptors.pdf
GIS FILE: 04-100-024_receptors.mxd
PROJECTION: UTM Zone 10
DATUM: NAD83
amec
320000
360000
400000
440000
6000000
5960000
5920000
5880000
Endako
Stellako
Fraser Lake
Nadleh Whuten
Fort Fraser
Engen
Vanderhoof
Weneez
Sinkut River
Saik'uz
Nulki
Mapes
François Lake
Cheslatta Carrier
Danskin
Skin Tyee
Uncha Mountains Red Hills Park
Francois Lake Park
Francois Lake Protected Area
Ellis Island Ecological Reserve
Drywilliam Lake Ecological Reserve
Beamont Provincial Park
Stuart River Park
Proposed Transmission Line (Stellako Reroute)
Proposed Transmission Line
Kluskus FSR
Meridian Road (Vanderhoof) Ecological Reserve
Nechako Canyon Protected Area
Chilako River Ecological Reserve
Finger Tatuk Park
Finger Lake
Tatuk Lake
Natalkuz Lake (Nechako Reservoir)
Proposed Transmission Line (Mills Ranch Reroute)
Kluskus-Ootsa FSR
Proposed Airstrip
Exploration Road
Proposed Fresh Water Supply System
Kluskus-Blue FSR
Proposed Mine Access Road
Tatelkuz Lake
Kuyakuz Lake
Euchiniko Lakes
Kluskoil Lake Park
Nazko
Kluskus
Entiako Park
Tweedsmuir Park
Johnny Lake
Moose Lake
Tsacha Lake
Entiako Lake
Top Lake
Lucas Lake
Hallett Lake
Tahultzu Lake
Binta Lake
Uncha Lake
Tachick Lake
Nulki Lake
Cluculz Lake
Bamuni Lake
West Road (Blackwater)
Nechako River
Y:\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\04_air-quality\Baseline\04-100-024_receptors.mxd

5.4 NO_X to NO_2 Conversion

Nitrogen oxides are comprised primarily of NO and NO_2. Ambient air quality criteria exist for NO_2 rather than total NO_x. Therefore, it is important to be able to estimate the portion of predicted ground-level NO_x comprised of NO_2. For this assessment, the NO_2 predicted concentrations are determined using the Ozone Limited Method (OLM), which is one method included in the BC AQMG.

The BC MOE Regional Meteorologist, Mr. Dennis Fudge, indicated a preference for using a non-standard NO_x to NO_2 conversion assuming 25 or 50% of NO_x is converted to NO_2. The results of this conversion method are provided for comparison in Table 6.3-2, although for compliance purposes the results of the OLM method are used.

5.5 Nitrogen Deposition

NO_x emissions contribute to the deposition of nitrogen species, which is expressed units of kg N/ha/y. Nitrogen deposition represents the sum of nitrogen species (e.g., NO, NO_2, HNO_3 and NO_3^-). As nitrogen is a nutrient, the deposition of nitrogen substances can influence aquatic and terrestrial ecosystems. As different species in these ecosystems respond to nitrogen loading differently, nitrogen deposition can potentially change ecosystem biodiversity.

5.6 Visibility/Haze

Visibility impairment is caused by adsorption and scattering caused by gases and particles in the atmosphere. Adsorption and scattering are collectively referred to as light extinction. A coherent visible plume that can be attributable to a single development (or even a single stack) is referred to as plume blight. Haze is a general reduction in visibility over a wide geographic area that cannot be attributable to a single source and is usually due to cumulative emissions from multiple sources.

The Project's precursor NO_X, SO_2 and PM emissions contribute to the formation of regional haze. The NO_X and SO_2 emissions can form particulate nitrates (NO_3^-) and sulphates SO_4^{-2}), respectively; which can convert into ammonium nitrate (NH_4NO_3) and ammonium sulphate ($(NH_4)_2SO_4$). These ammonium compounds are hygroscopic and can grow because of the presence of water vapour; with larger particle sizes further impairing visibility.

5.7 Greenhouse Gases (GHGs)

The Project will result in GHG emissions from the combustion of fossil fuels that produce CO_2, methane (CH_4) and nitrous oxide (N_2O).

The GHG emissions from the Project are estimated and are compared to the total BC emissions and the total emissions for Canada. GHG emissions are expressed in carbon dioxide equivalent (CO_2E). Factors for global-warming potential used to convert carbon dioxide, methane and nitrous oxide emissions to carbon dioxide equivalents are 1 for CO_2, 21 for CH_4 and 310 for N_2O emissions (WMO 2007).

5.8 Dispersion Modelling Scenarios

There are no major industrial emissions within the LSA. Therefore, only the Project-alone scenario was evaluated for the operation phase of the Project. This scenario includes emissions solely from the Project, Including mine pit, CPF, mine fleet, paved and unpaved roads, stockpiles and dump areas.

5.9 Modelling Non-Point Sources

5.9.1 Open Mine Pits

Mine pits were assumed to be area sources with the initial vertical dispersion parameter of 16m based on previously submitted EIAs for similar facilities. Mine fleet exhaust was assumed to be emitted from a height of 5 m above the surface. The initial vertical dispersion parameter was set to be 2.33 m following the ISC3 user manual recommendation that the initial vertical dispersion parameter is 1/2.15 of its physical height (U.S. EPA, 1995).

5.9.2 Tailings Ponds

Tailings ponds were assumed to be flat area sources with effective emission height of 0 m and initial vertical dispersion parameters of 3.3 m.

5.9.3 Project Process Fugitive Emissions

Project process fugitive emissions were modelled as area sources with effective emission height of 3 m and initial vertical dispersion parameters of 5 m.

5.9.4 Unpaved Roads

Emissions of vehicles travelling along the haul ways, Forest Service Road, and access roads within the domain, were modelled as area sources with an effective emission height of 5.0 m.

5.9.5 Dump Areas

Emissions of dump areas were modelled as volume sources with an effective emission height of 50 m and the initial vertical dispersion parameter of 46.5 m.

6.0 DISPERSION MODELLING RESULTS

6.1 Construction Phase

The emissions associated with peak construction activities, have been conservatively assessed in conjunction with the operations phase emissions since some construction activities will occur during the operations phase. The operational emissions are significantly larger than the construction emission rates. Specifically, peak construction emission rates range from 4% to 21% of the Project operations emission rates.

6.2 Road Operation

To assess the air quality impacts of the section outside of the LSA for the forest service road and mine access road resulting from the Project, dispersion modelling were conducted based on the emission rates and parameters in Table 4.2-1. Results are shown in Table 6.2-1 and are summarized below. Maximum concentrations for roadway emissions are all on or very near the road boundary.

Table 6.2-1: Project Case Maximum Predicted Ground-Level Concentrations within the LSA

Distance (m)	SO_2_1h	NO_2_1h	CO_1h	TSP_24h	PM_{10}_24h	$PM_{2.5}$_24h
Regulatory Objectives	450	400	143000	120	50	25
Background Concentration	1	8	120	18	9	4
Roads	1.05	16.4	129	**222**	**54.7**	8.66
50	1.03	12.6	126	104	35.7	6.74
100	1.02	11.0	124	59.1	21.6	5.31
200	1.02	10.7	123	43.6	14.6	4.59
300	1.02	10.5	123	37.2	12.8	4.41
400	1.01	10.2	123	33.4	11.9	4.31
500	1.01	9.87	122	30.8	11.9	4.31
1000	1.01	9.32	121	25.8	9.99	4.11
1500	1.00	9.11	121	23.6	9.30	4.04

6.3 Operation Phase

To assess the Project's potential effects on air quality, the CALPUFF dispersion model was run. Dispersion modelling results for predicted ground-level concentrations within the LSA of SO_2, NO_2, CO, TSP, PM_{10}, and $PM_{2.5}$ associated with the Project Case Operation Phase are summarized in Table 6.3-1. These maximum predicted concentrations with the background ambient concentrations are compared to the relevant regulatory objectives.

Isopleth maps show the locations of the maximum concentrations and the dispersion patterns.

The Project-alone case includes the effects of continuous emissions solely from the Project at the peak year. The peak year is the year that the most material is handled. The Project emission sources are detailed in Section 4.2. Dispersion modelling based on the emission rates and parameters in Table 4.2-1 was conducted for the one-year study period. Results of the Project-alone case are shown in Table 6.3-1 and are summarized below. Maximum values for this case are all located on the Project boundary or roads boundary.

Tabl3 6.3-2 provides a comparison of various methods of converting total NO_x to NO_2. As expected, the higher NO_x conversion values provide higher ambient NO_2 concentrations. The number of receptors and the frequency at any single receptor where concentrations over the objective are predicted in Table 6.3-2 is not large. The general area where the higher concentrations are predicted is the same as where the maximum concentrations shown in Figures 6.3-5 , 6 & 7 are found, along the south edge of the plant boundary.

Table 6.3-1: Project Case Maximum Predicted Ground-level Concentrations within the LSA

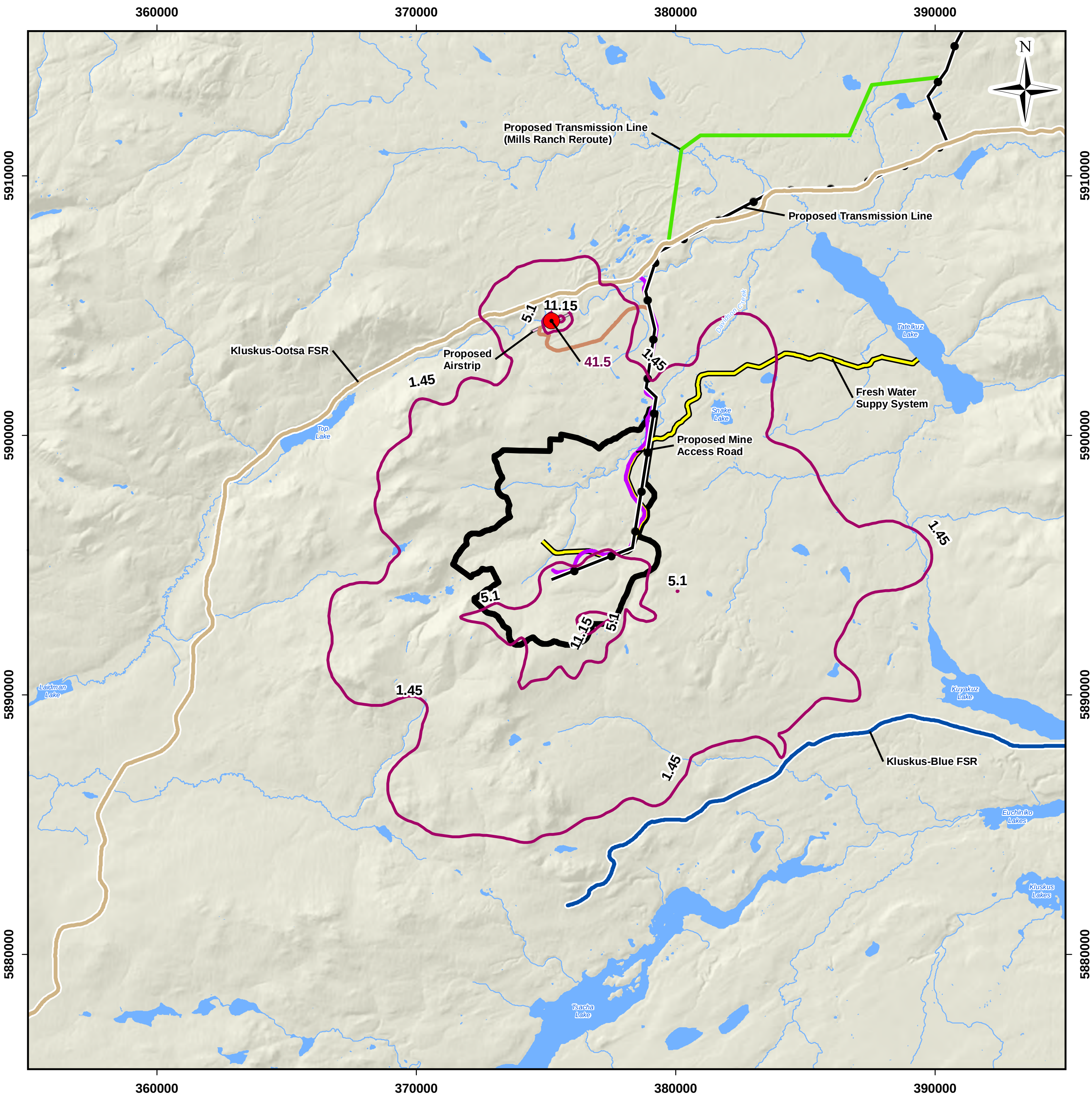
Species	Averaging Period	Max Predicted Concentration (µg/m³)	Including Ambient Background (µg/m³)	Ambient Background (µg/m³)(a)	BC Objective/Guideline (µg/m³)			Canada Objective (µg/m³)		
					Level A	Level B	Level C	Max. Desirable	Max. Acceptable	Max. Tolerable
SO_2	1-hour	40.5	41.5	1	450	900	900-1300	450	900	
	3-hour	26.4	27.4	1	375	665		–	–	–
	24-hour	6.49	7.49	1	160	260	360	150	300	800
	Annual	1.59	2.59	1	25	50	80	30	60	–
NO_2	1-hour	285	293	8	–	–		–	400	1,000
	24-hour	87.8	95.8	8	–	–		–	200	300
	Annual	34.3	42.3	8	–	–	–	60	100	–
CO	1-hour	761	881	120	14,300	28,000	35,000	15,000	35,000	–
	8-hour	257	377	120	5,500	11,000	14,300	6,000	15,000	20,000
TSP	24-hour	207	225	18	120	200	260	–	120	400
	Annual(b)	69.7	87.7	18	60	70	75	60	70	–
PM_{10}	24-hour	47.8	56.8	9	50			–	–	–
$PM_{2.5}$	24-hour	19.0	23.0	4	25(c)			30(d)		
	Annual	4.28	8.28	4	8			–		

Notes:
(a) For details on background concentrations, refer to **Section 3.0** and **Table 3.1-1**.
(b) As a geometric mean.
(c) Based on the 98th percentile value for one year.
(d) The Canada-Wide Standard is referenced to the 98th percentile value averaged over three consecutive years.
– No objective has been established for this category.

Table 6.3-2: NOx Conversion Methodology Comparison

Conversion Methodology	Averaging Period	Max Predicted Concentration including background (mg/m3)	Canada Objective (mg/m3) Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Frequency over objective at receptor with maximum predicted value hrs	days	yrs	Number of receptors over objective
Total	1-hour	2695	–	400	1,000				Not Calculated
	24-hour	504	–	200	300				
	Annual	124	60	100	–				
50%	1-hour	1352	–	400	1,000	68			338
	24-hour	252	–	200	300		6		25
	Annual	62	60	100	–			1	5
25%	1-hour	680	–	400	1,000	16			16
	24-hour	132	–	200	300		0		0
	Annual	37	60	100	–			0	0
OLM	1-hour	293	–	400	1,000	0			0
	24-hour	95.8	–	200	300		0	0	0
	Annual	42.3	60	100	–			0	0

- **SO_2** —The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the Project-alone case are 41.5, 27.4, 7.49 and 2.59 µg/m^3 , respectively. These concentrations are much lower than the most stringent regulatory objectives. Isopleth maps of maximum predicted ground-level SO_2 concentrations for the project-alone case are shown in **Figures 6.3-1** through **6.3-4**. The predicted maxima for all averaging period are located along the airstrip boundary.
- **NO_2** —The maximum predicted 1-hour, 24-hour, and annual average NOx concentrations associated with the Project-alone case are equal to 2,687, 488, and 108 µg/m^3, respectively. For NO_2 the corresponding values are 293, 95.8, and 42.3 µg/m^3, after applying the OLM. These concentrations are much lower than the most stringent regulatory objectives. The predicted maxima for all averaging periods are located at the southern edge of the Project property boundary. Isopleth maps of maximum predicted NO_2 concentrations for the project-alone case are shown in **Figures 6.3-5** through **6.3-7**.
- **CO**—Maximum predicted 1-hour and 8-hour average CO concentrations for the Project alone case are 881 and 377 µg/m^3, respectively. These concentrations are lower than the most stringent regulatory objectives. The predicted maxima for 1-hour and 8-hour averaging period are located at the airstrip boundary. Isopleth maps of maximum predicted CO concentrations for the Project-alone case are shown in **Figures 6.3-8** and **6.3-9**.
- **TSP**—The maximum predicted 24-hour and annual average TSP concentrations for the Project-alone case are 225 and 87.7 µg/m^3, respectively. These exceed the BC MOE TSP objectives of 120 and 60 µg/m^3. The areas of the exceedances for 24 hour and annual averaging periods are 2.81 and 0.02 km^2, respectively. The exceedance is predicted to occur for 56 days during the year. The predicted maxima for 24-hour and annual averaging period are located at the airstrip access road and FSR boundary, respectively. Isopleth maps of maximum predicted ground-level TSP concentrations for the Project- alone case are shown in **Figures 6.3-10** and **6.3-11**.
- **PM_{10}**—The maximum predicted 24-hour PM_{10} concentration for the Project-alone case is 56.8 µg/m^3. This is greater than the BC MOE PM_{10} objective of 50 µg/m^3. The predicted area of exceedance for the 24 hour averaging period is 0.102 km^2. The exceedance is predicted to occur for 42 days during the year. The predicted maximum for 24-hour averaging period is located at the FSR boundary. Isopleth map of maximum predicted ground-level PM_{10} concentrations for the project- alone case is shown in **Figure 6.3-12**.
- **$PM_{2.5}$** —The predicted 98th percentile 24-hour and maximum annual average $PM_{2.5}$ concentrations for the Project-alone case are 23.0 and 8.28 µg/m^3, respectively. The maximum annual average concentration exceeds the BC MOE $PM_{2.5}$ objective of 8 µg/m^3. The area of exceedance for the annual averaging period is approximately 0.12 km^2. The predicted maxima for the 24-hour and annual averaging periods are located along the southern edge of the Project property boundary. Isopleth maps of maximum predicted ground-level $PM_{2.5}$ concentrations for the Project-alone case are shown in **Figures 6.3-13** and **6.3-14**.



Legend

- Projected Maximum SO_2 Concentration
- Maximum Predicted One-hour Average SO_2 Concentrations ($\mu g/m^3$) One-hour AAQO: 450 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4

Kilometres

CLIENT:	newgold
PROJECT:	Blackwater Gold Project

Maximum Predicted One-hour Average Ground-level SO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-1
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GIS FILE: 04-100-015_Max_1hour_SO2_8.5x11_portrait.mxd		amec
PROJECTION: UTM Zone 10	DATUM: NAD83	

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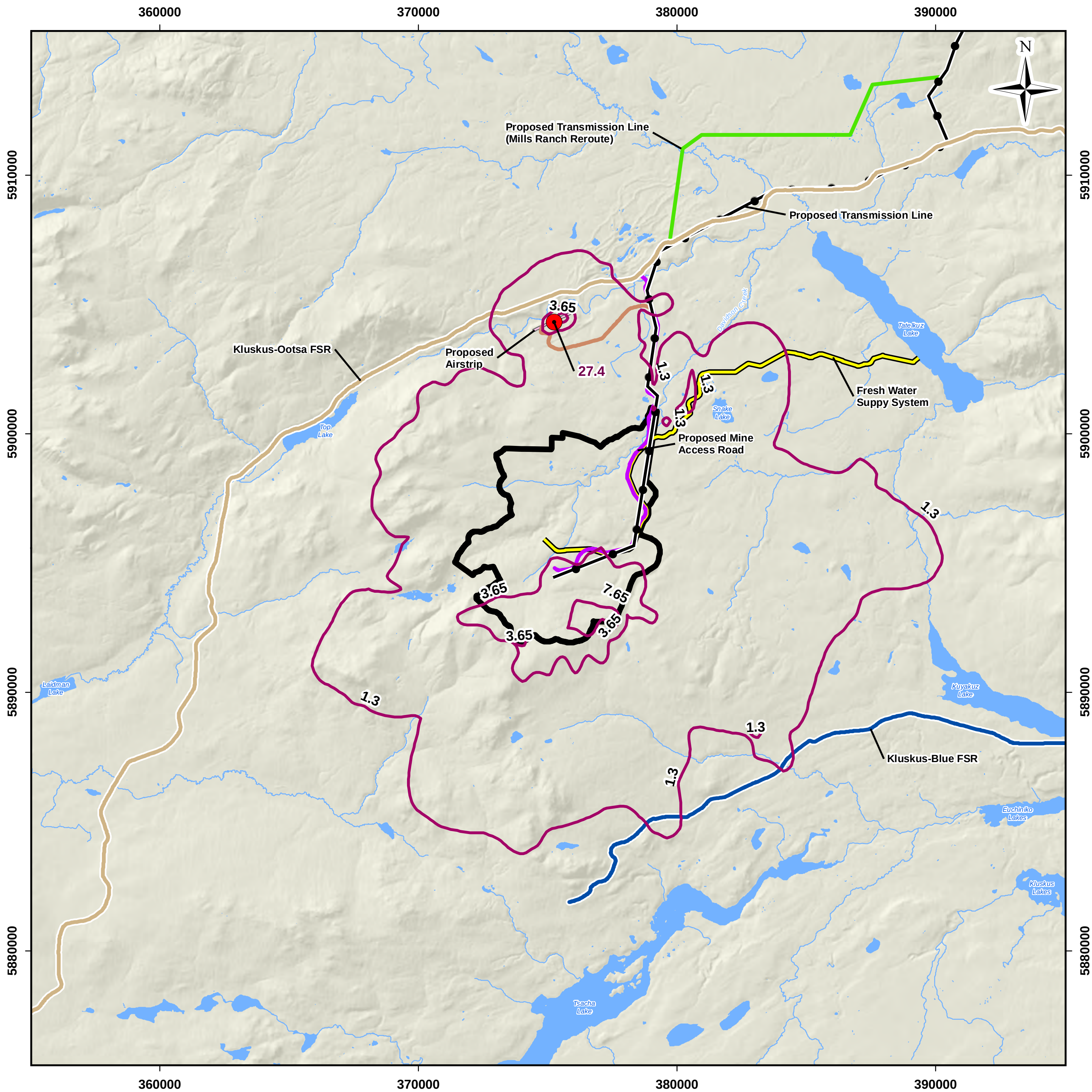

Legend

- Projected Maximum SO_2 Concentration
- Maximum Predicted 3-hour Average SO_2 Concentrations (µg/m^3) 3-hour AAQO: 375 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4 Kilometres

CLIENT:	newgold
PROJECT:	Blackwater Gold Project
	Maximum Predicted 3-hour Average Ground-level SO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration
DATE: October, 2013	ANALYST: PK
Figure 6.3-2	
JOB No: VE52277	QA/QC: MY
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GIS FILE: 04-100-016_Max_3hour_SO2_8.5x11_portrait.mxd	
PROJECTION: UTM Zone 10	DATUM: NAD83
amec	

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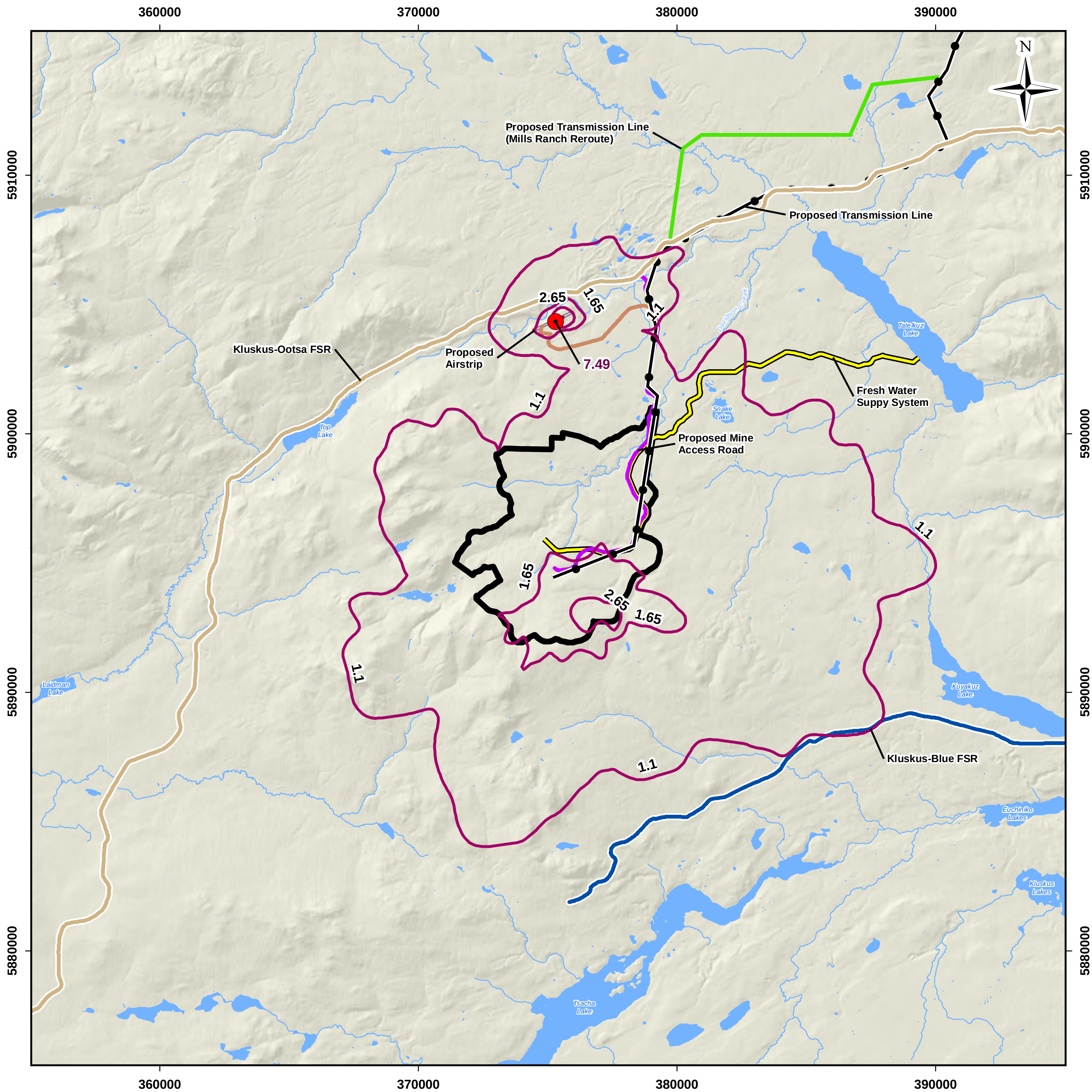

Legend

- Projected Maximum SO_2 Concentration
- Maximum Predicted 24-hour Average SO_2 Concentrations (µg/m^3) 24-hour AAQO: 160 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715
0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted 24-hour Average Ground-level SO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-3
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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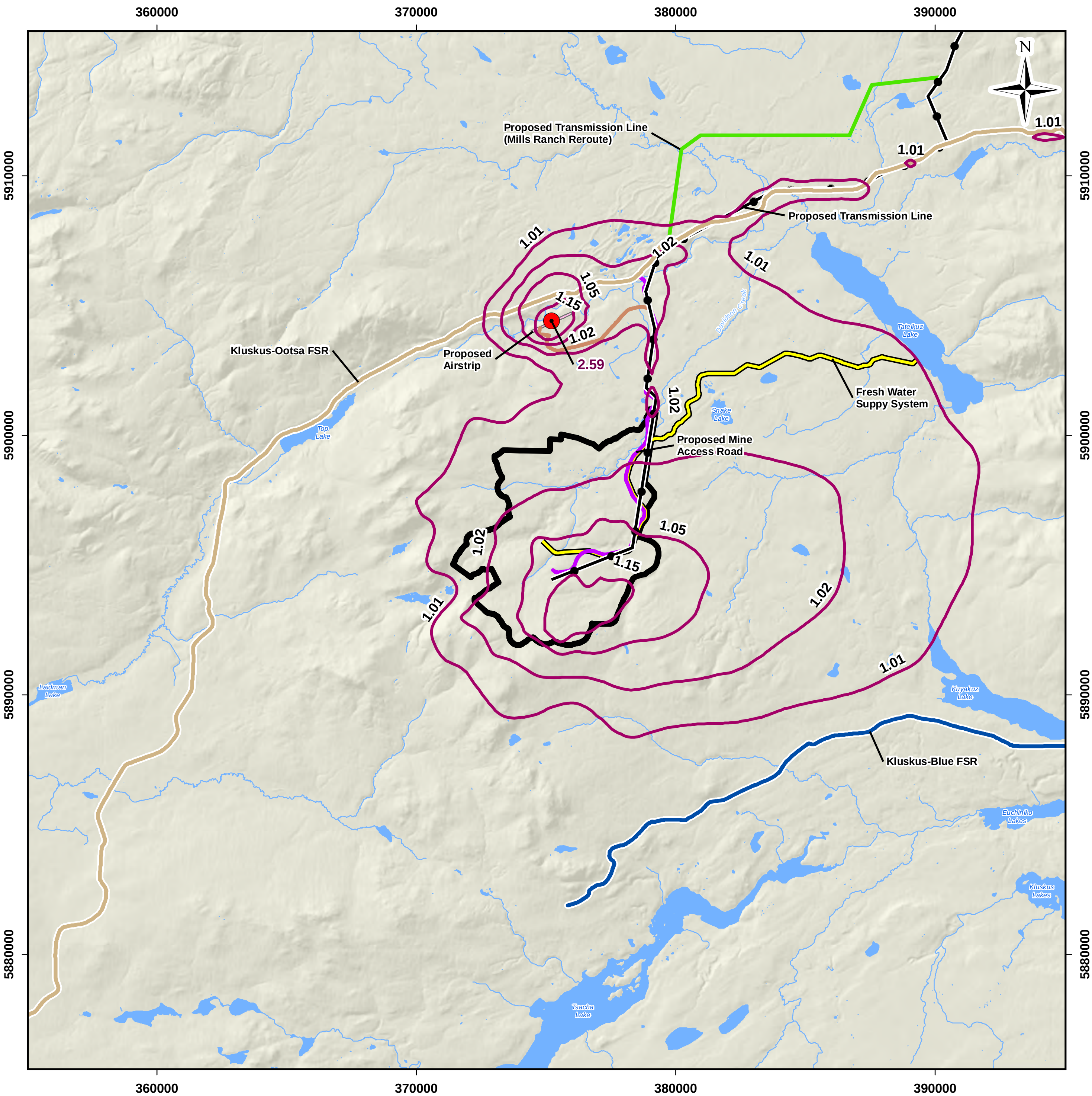

Legend

- Projected Maximum SO_2 Concentration
- Maximum Predicted Annual Average SO_2 Concentrations (µg/m^3) Annual AAQO: 25 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715
0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted Annual Average Ground-level SO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-4
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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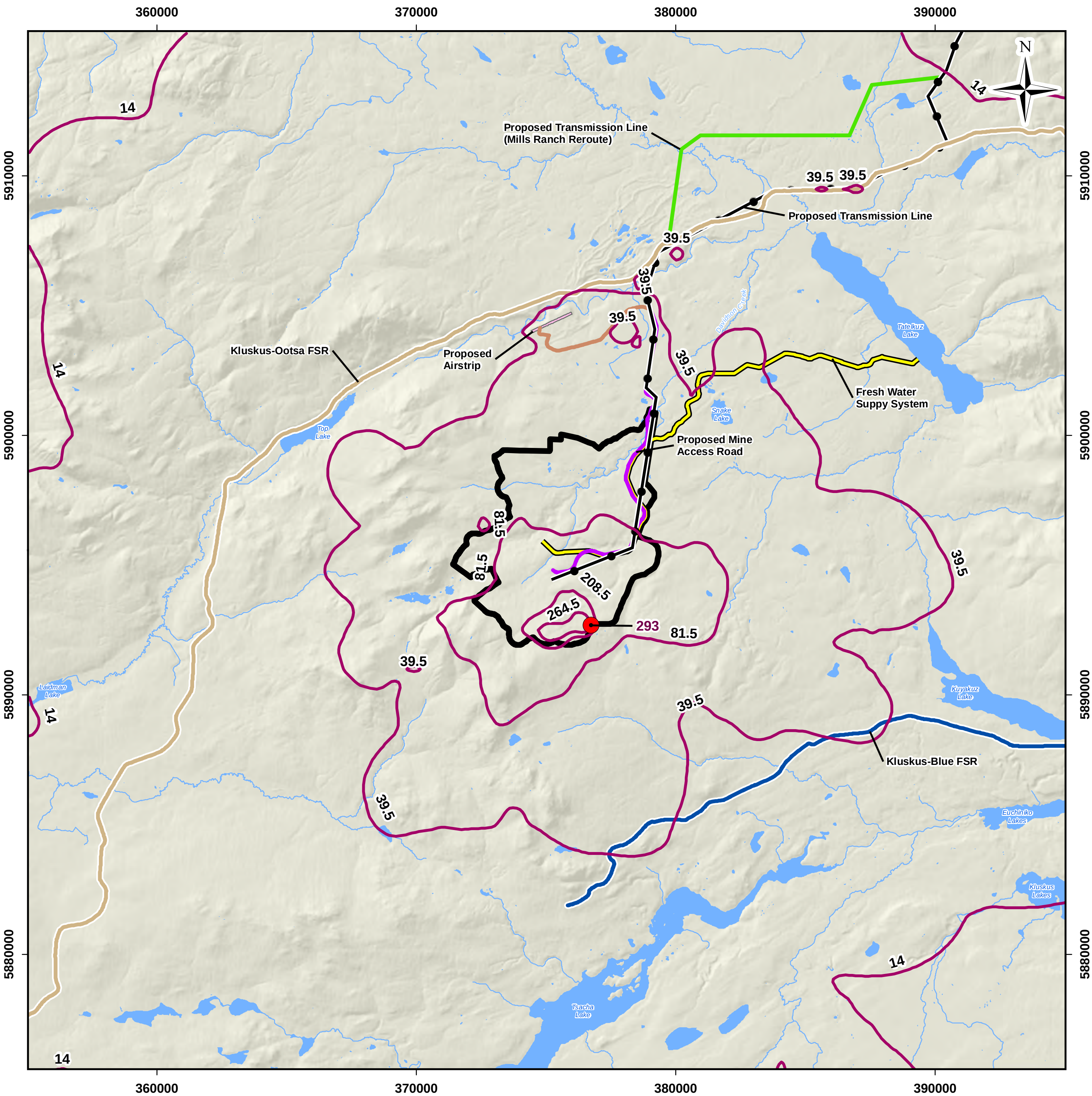

Legend

- Projected Maximum NO_2 Concentration
- Maximum Predicted One-hour Average NO_2 Concentrations (µg/m^3) One-hour AAQO: 400 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted One-hour Average Ground-level NO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-5
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PROJECTION: UTM Zone 10	DATUM: NAD83	amec

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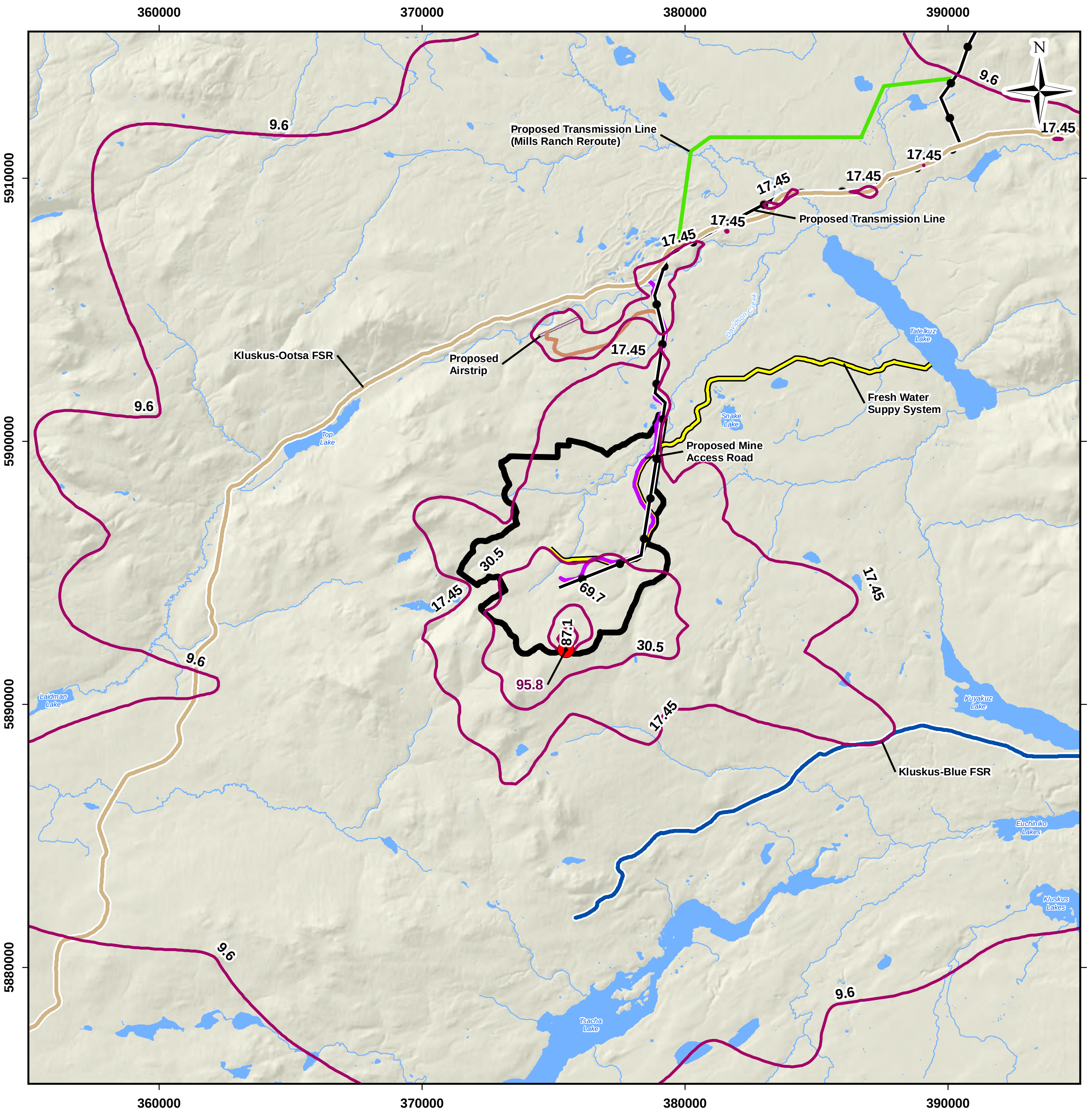

Legend

- Projected Maximum NO_2 Concentration
- Maximum Predicted 24-hour Average NO_2 Concentrations (µg/m^3) 24-hour AAQO: 200 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted 24-hour Average Ground-level NO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-6
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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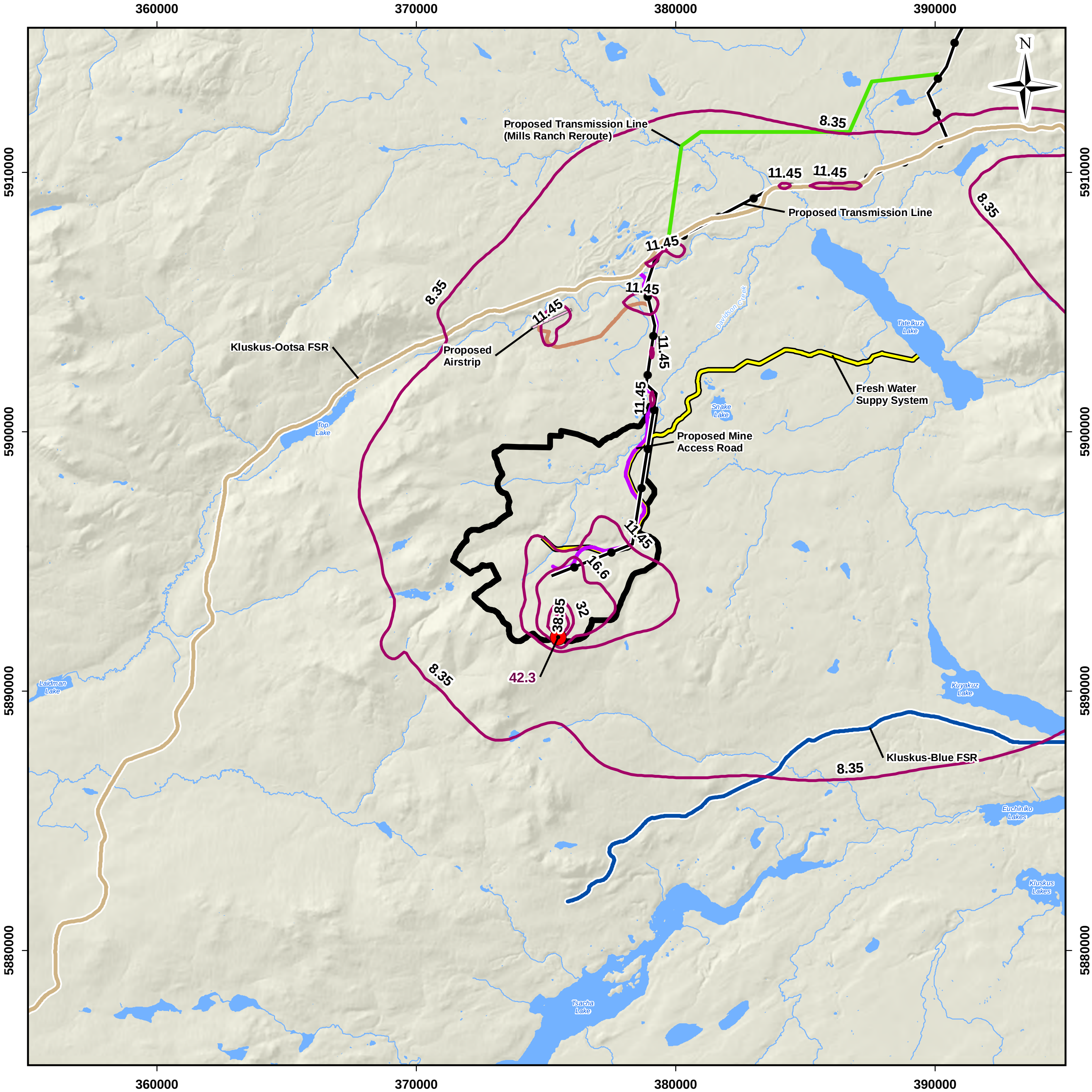

Legend

- Projected Maximum NO_2 Concentration
- Maximum Predicted Annual Average NO_2 Concentrations (µg/m^3) Annual AAQO: 60 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Scale: 1:216,715

0 1 2 4
Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted Annual Average Ground-level NO_2 Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-7
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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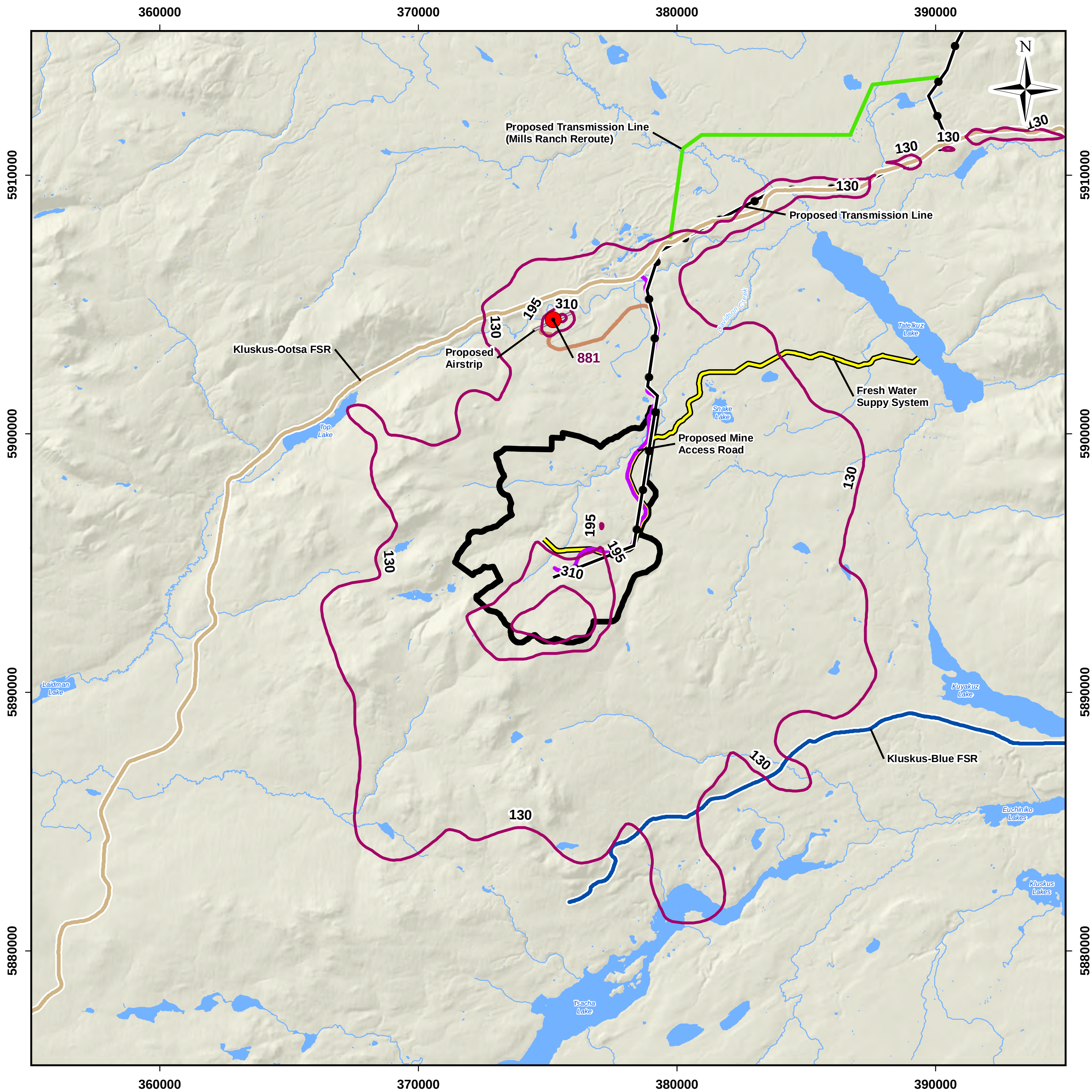

Legend

- Projected Maximum CO Concentration
- Maximum Predicted One-hour Average CO Concentrations (µg/m^3) One-hour AAQO: 14300 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted One-hour Average Ground-level CO Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-8
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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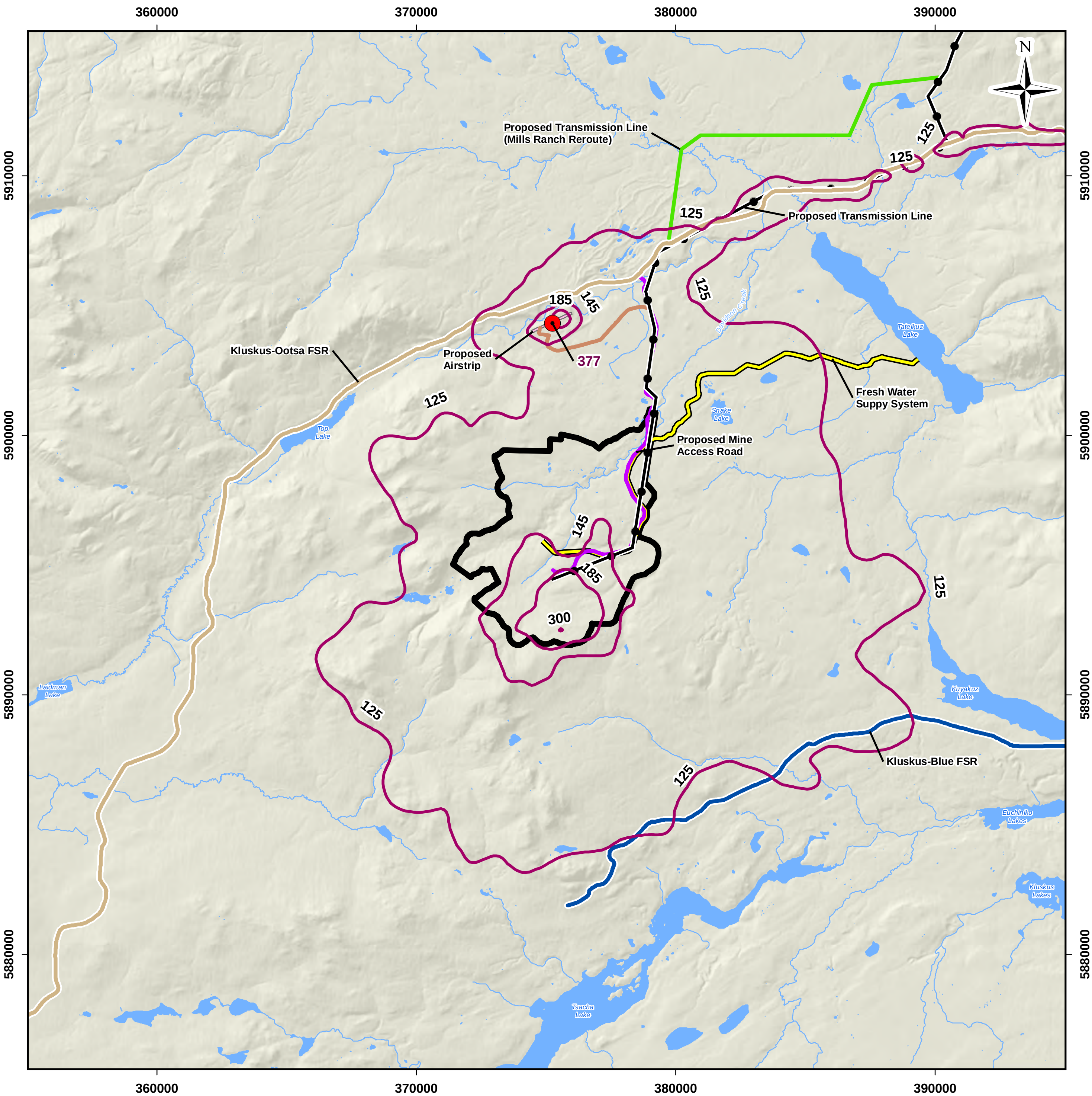

Legend

- Projected Maximum CO Concentration
- Maximum Predicted 8-hour Average CO Concentrations (µg/m^3)
  8-hour AAQO: 5500 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted 8-hour Average Ground-level CO Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-9
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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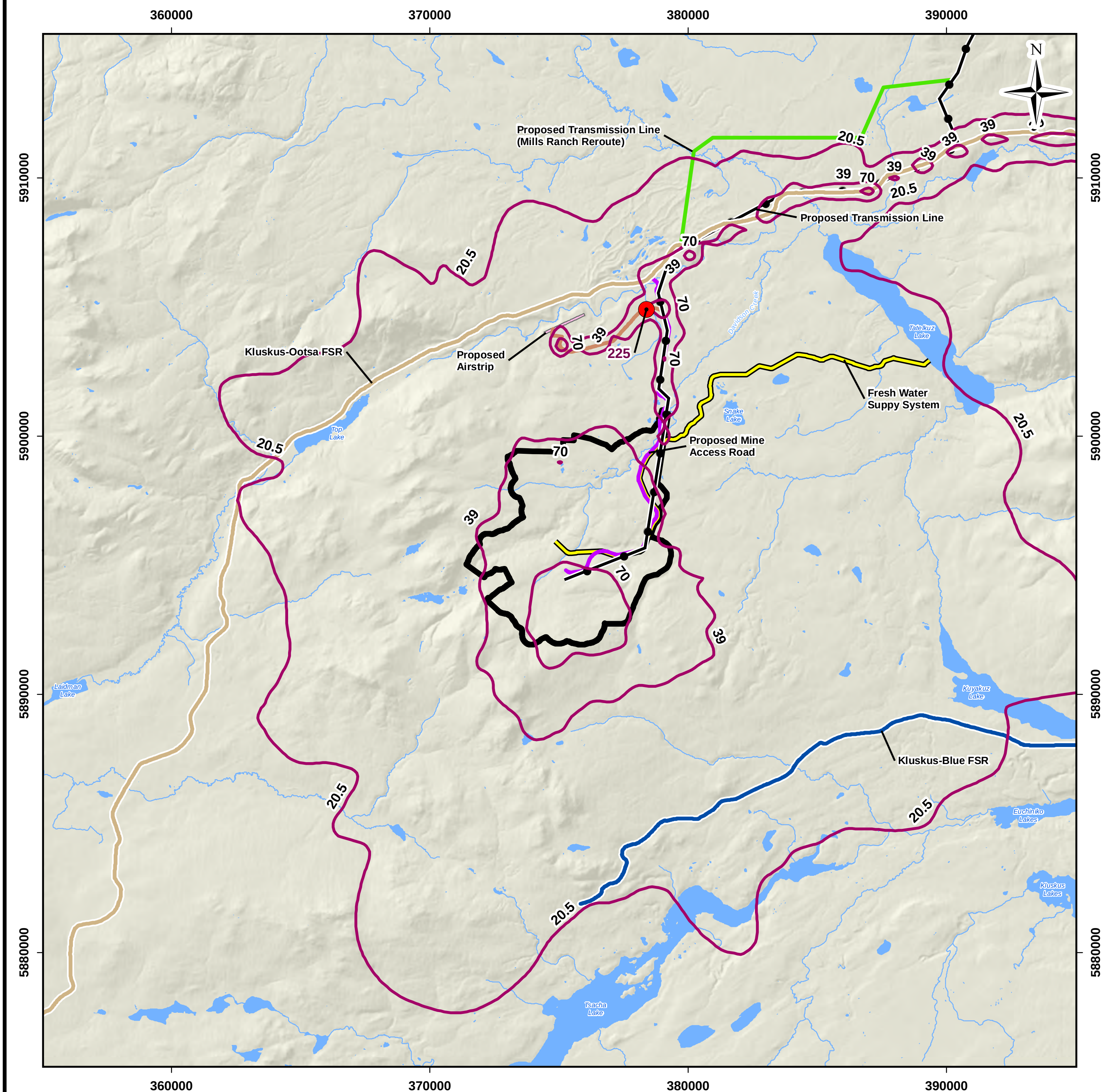

Legend

Projected Maximum TSP Concentration

Maximum Predicted 24-hour Average TSP Concentrations (µg/m^3)

24-hour AAQO: 120 ug/m^3

Kluskus-Blue FSR

Kluskus-Ootsa FSR

Proposed Transmission Line

Proposed Transmission Line (Mills Ranch Reroute)

Proposed Mine Access Road

Fresh Water Supply System

Proposed Airstrip Access Road

Proposed Airstrip

Proposed Mine Site

Stream

Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4

Kilometres

CLIENT: newgold	
PROJECT: Blackwater Gold Project	
Maximum Predicted 24-hour Average Ground-level TSP Concentrations (ug/m^3) Associated with the Project with Background Concentration	
DATE: October, 2013	ANALYST: PK
JOB No: VE52277	QA/QC: MY
GIS FILE: 04-100-018_Max_24hour_TSP_8.5x11_portrait.mxd	
PROJECTION: UTM Zone 10	DATUM: NAD83

Figure 6.3-10

PDF FILE: 04-100-018_Max_24hour_TSP_8.5x11_portrait.pdf

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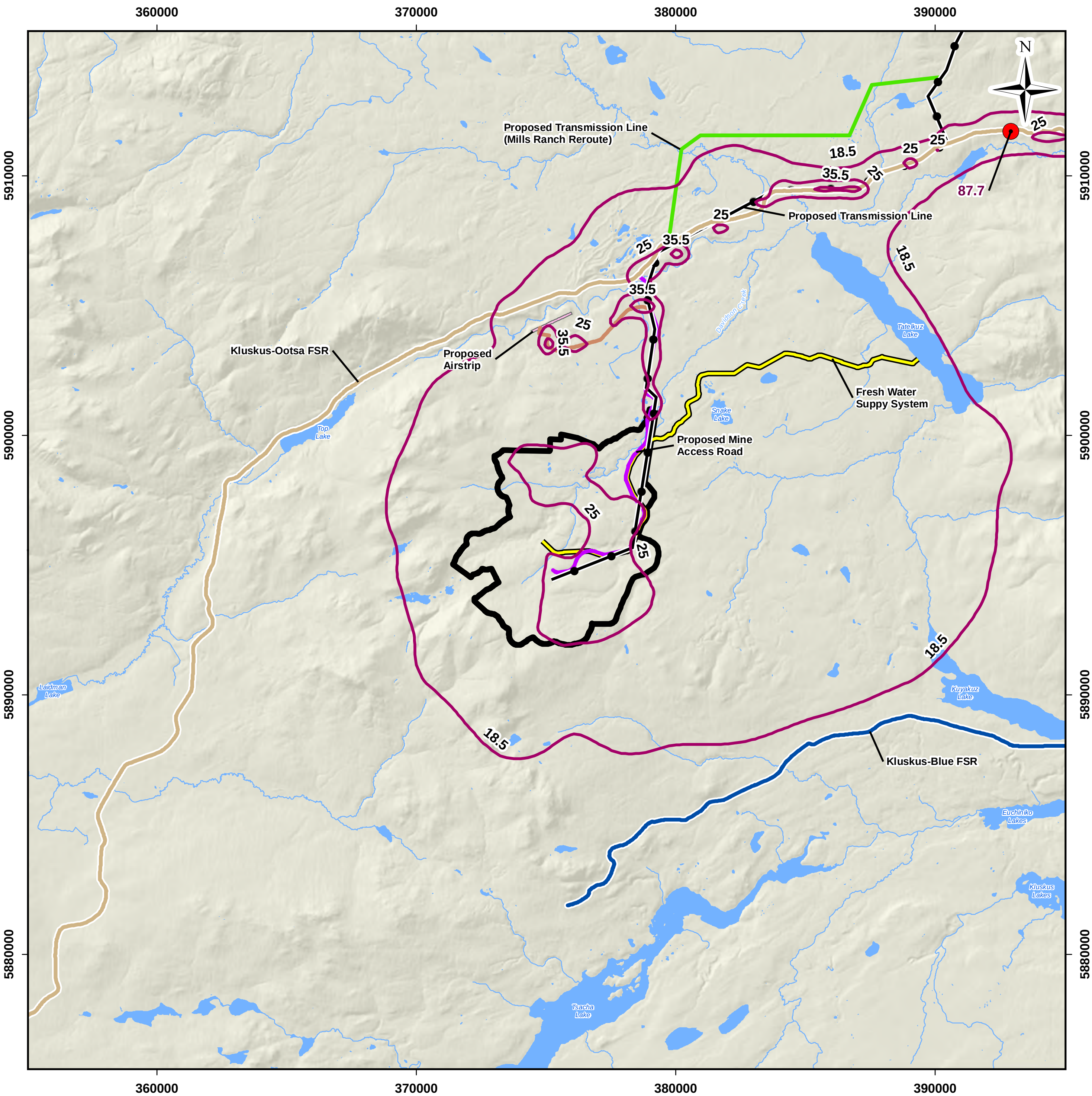

Legend

- Projected Maximum TSP Concentration
- Maximum Predicted Annual Average TSP Concentrations (µg/m^3) Annual AAQO: 60 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4

Kilometres

CLIENT: newgold		
PROJECT: Blackwater Gold Project		
Maximum Predicted Annual Average Ground-level TSP Concentrations (ug/m^3) Associated with the Project with Background Concentration		
DATE: October, 2013	ANALYST: PK	**Figure** 6.3-11
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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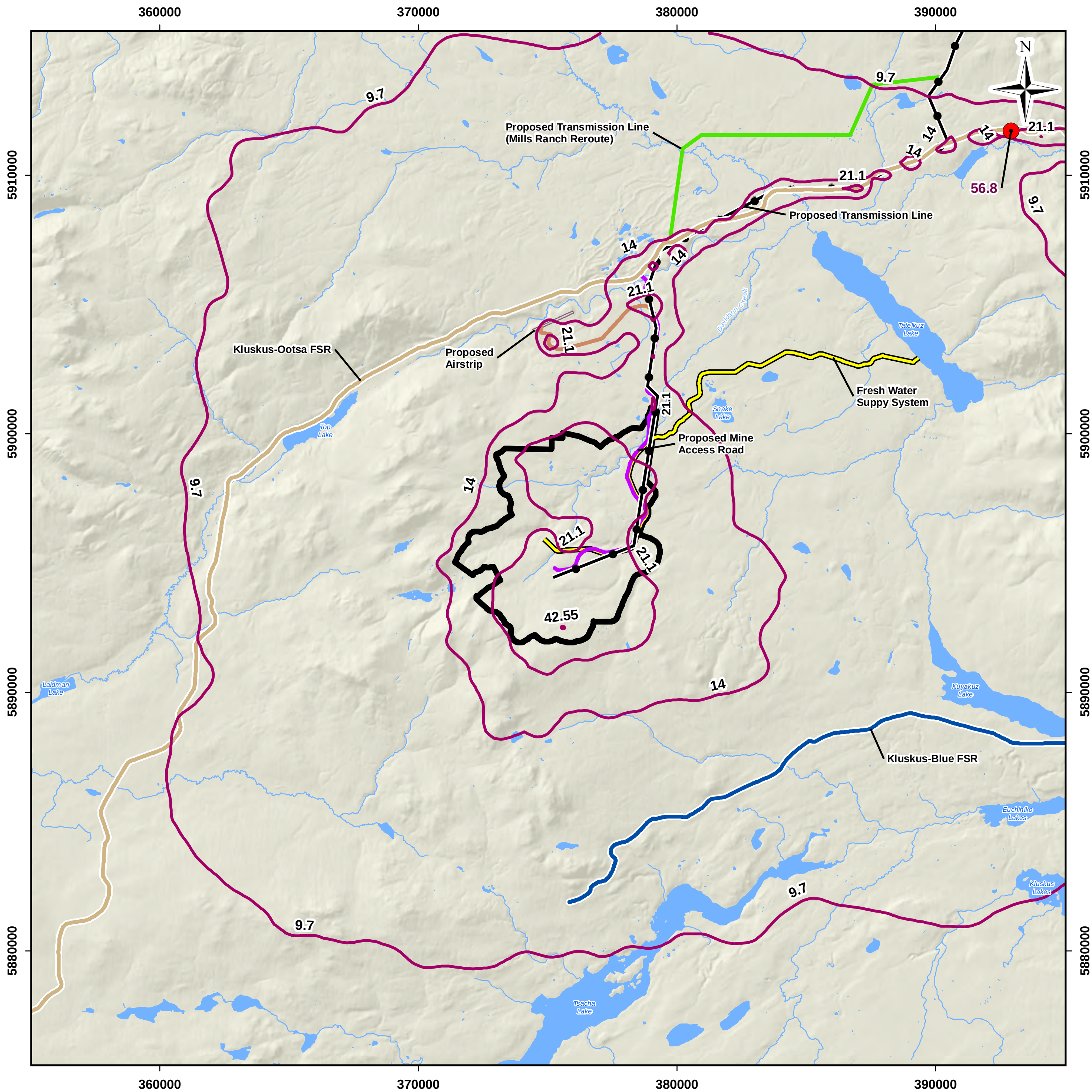

Legend

- Projected Maximum PM_{10} Concentration
- Maximum Predicted 24-hour Average Ground-level PM_{10} Concentrations ($\mu g/m^3$)
  24-hour AAQO: 50 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted 24-hour Average Ground-level PM_{10} Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-12
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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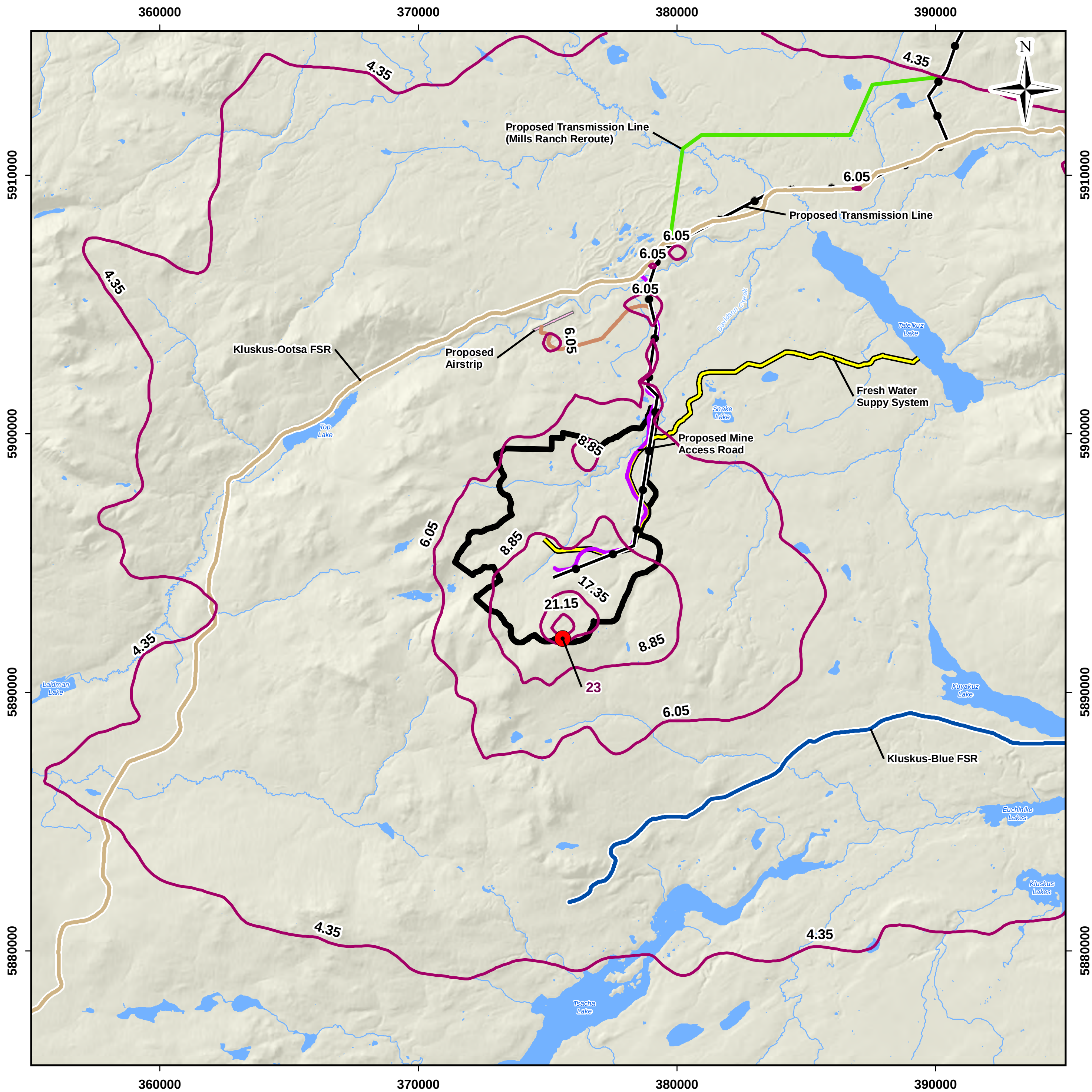

Legend

- Projected Maximum $PM_{2.5}$ Concentration
- Predicted 98th Percentile 24-hour Average Ground-level $PM_{2.5}$ Concentrations (µg/m^3)
  24-hour AAQO: 25 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted 24-hour Average Ground-level $PM_{2.5}$ Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-13
JOB No: VE52277	QA/QC: MY	PDF FILE: 04-100-021_PM25_24_hr_8.5x11_portrait.pdf
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PROJECTION: UTM Zone 10	DATUM: NAD83	

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- Nitrogen Deposition—Nitrogen deposition affects vegetation growth and can be off concern as high deposition may limit certain species. This parameter was predicted for use in the vegetation assessment. The highest nitrogen deposition occurs in the central portion of the LSA, which is where the precursor NOX emissions are greater. The lowest values occur in the northern portion of the LSA. For most of the LSA, the predicted nitrogen deposition is in the 0.1 to 0.5 kg N/ha/y range. About 6 km^2 (0.3%) of the LSA has predicted deposition greater than 8 kg N/ha/y. The isopleth map of the modelled Nitrogen Deposition is shown in **Figure 6-3.15**.
- Visibility/Haze -- Haze index is a method of examining light extinction resulting from haze and is designed to correspond linearly to perceived changes in visibility. The haze index is expressed in 'deciview' units where a visibility change of 1 dv being regarded as a "just noticeable" change in visibility. 'Visual range' isused as another indicator of haze; and is related to the haze index as shown in **Table 6.3 -3**.

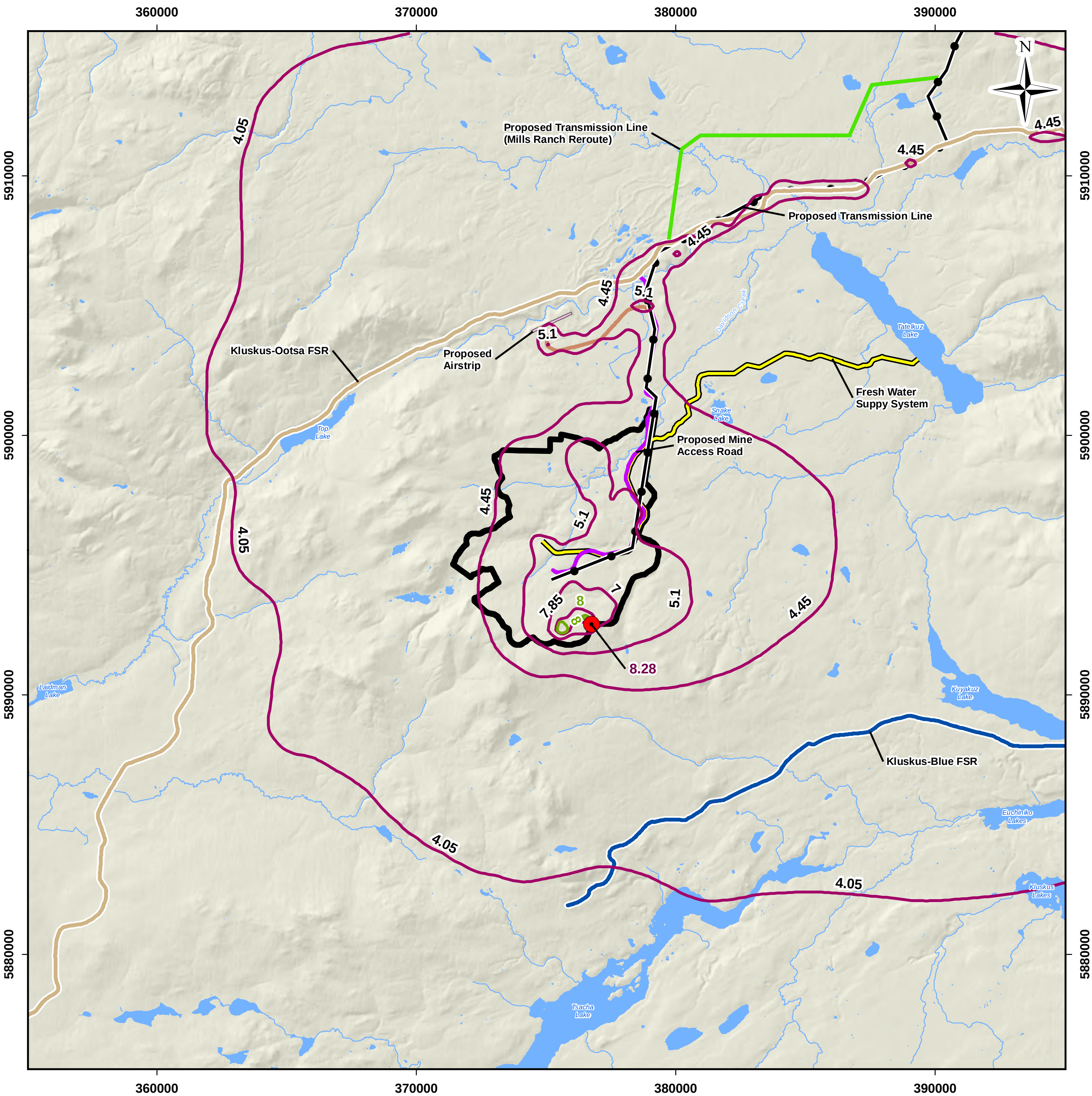
Table 6.3-3: Relationship between Visibility and Haze Index

Haze Index (dv)	Category
<14	excellent visibility
15~20	good visibility
21~24	fair visibility
25~28	poor visibility
>29	very poor visibility

For much of the LSA, the change is less than 1 dv. The maximum haze index change is about 2.38 dv due to very low baseline haze index in the region. Haze index are much less than 14 dv, which indicates the excellent visibility within the LSA. Figure 6.3-16 shows the haze in the LSA.

GHG—The estimated GHG emissions from the Project depend on the operating parameters in place and production level. During Project operation, GHG emissions result from mobile, aviation, and stack sources. The GHG emissions estimate is based on the following:

- Emissions from mobile sources during construction and operations are estimated using the US EPA models MOVES2010b and NONROAD.
- Emissions from aviation combustion sources are estimated based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- Emissions from stationary combustion source are estimated based on the previous air quality assessments.



Legend

- Projected Maximum $PM_{2.5}$ Concentration
- Maximum Predicted Annual Average Ground-level $PM_{2.5}$ Concentrations (µg/m^3) Annual AAQO: 8 ug/m^3
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted Annual Average Ground-level $PM_{2.5}$ Concentrations (ug/m^3) Associated with the Project with Background Concentration

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-14
JOB No: VE52277	QA/QC: MY	PDF FILE: 04-100-022_PM25_Annual_8.5x11_portrait.pdf
GIS FILE: 04-100-022_PM25_Annual_8.5x11_portrait.mxd		amec
PROJECTION: UTM Zone 10	DATUM: NAD83	

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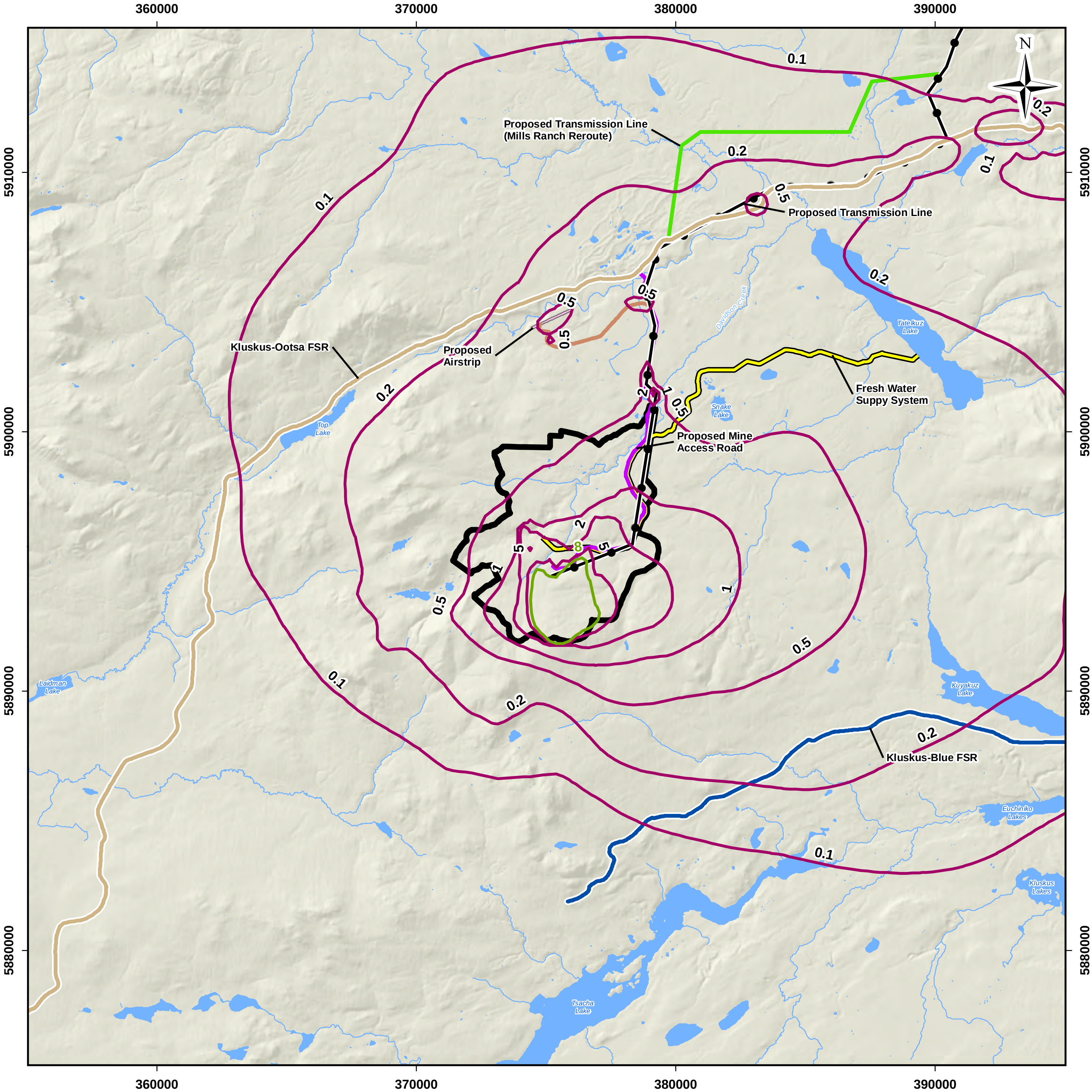

Legend

Maximum Predicted Annual Average Nitrogen Deposition (kg N/ha/y)
Kluskus-Blue FSR
Kluskus-Ootsa FSR
Proposed Transmission Line
Proposed Transmission Line (Mills Ranch Reroute)
Proposed Mine Access Road
Fresh Water Supply System
Proposed Airstrip Access Road
Proposed Airstrip
Proposed Mine Site
Stream
Waterbody

Reference
BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT: newgold

PROJECT: Blackwater Gold Project

Maximum Predicted Annual Average Nitrogen Deposition (kg N/ha/y) Associated with the Project

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-15
JOB No: VE52277	QA/QC: MY	PDF FILE: 04-100-025_Max_Annual_NDep_8.5x11_portrait.pdf
GIS FILE: 04-100-025_Max_Annual_NDep_8.5x11_portrait.mxd		amec
PROJECTION: UTM Zone 10	DATUM: NAD83	

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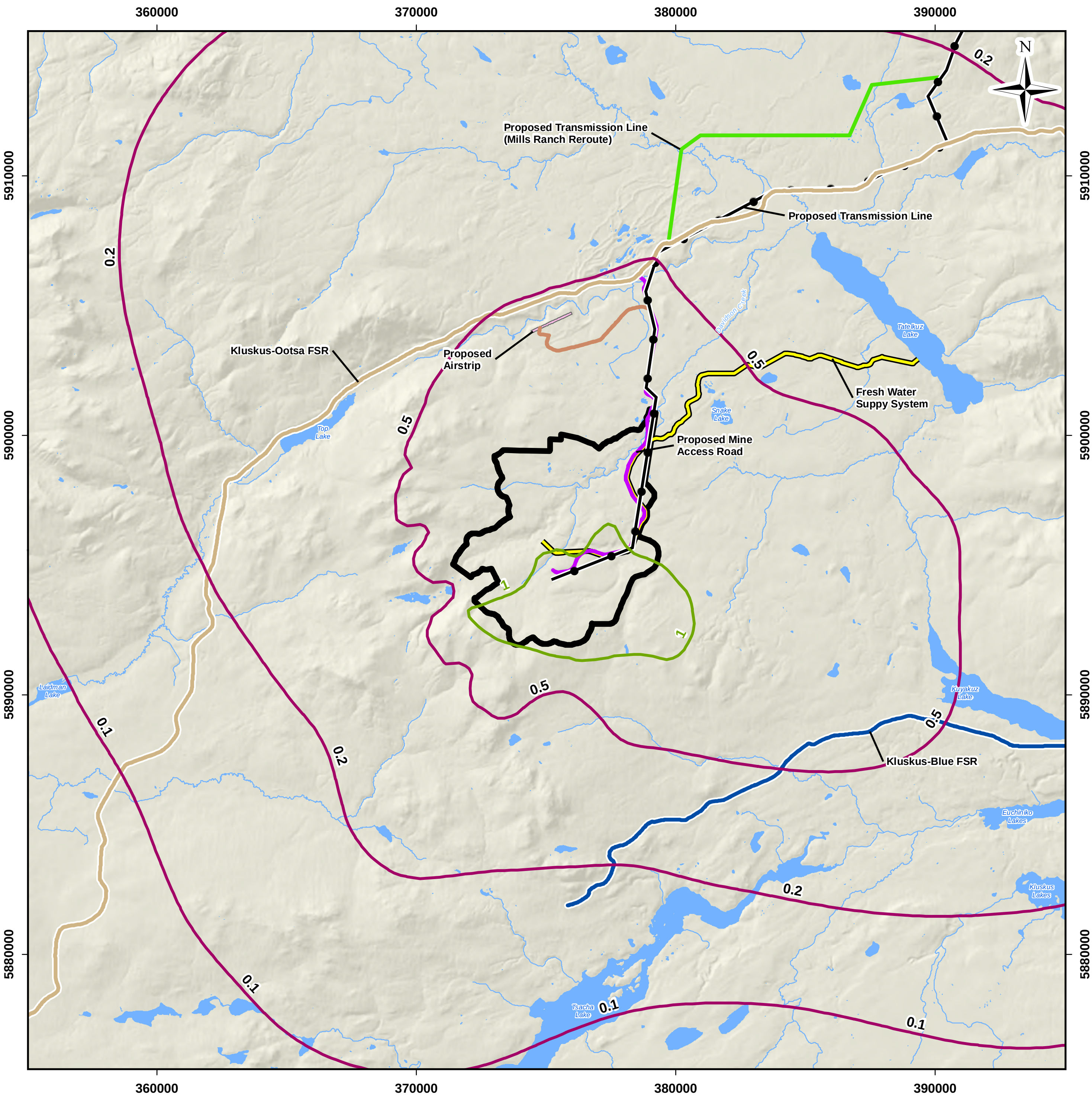

Legend

- Predicted Region Haze (dv)
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch Reroute)
- Proposed Mine Access Road
- Fresh Water Supply System
- Proposed Airstrip Access Road
- Proposed Airstrip
- Proposed Mine Site
- Stream
- Waterbody

Reference

BC Government GeoBC Data Distribution

Scale: 1:216,715

0 1 2 4
Kilometres

CLIENT:	newgold
PROJECT:	Blackwater Gold Project

Predicted Region Haze (dv) Associated with the Project

DATE: October, 2013	ANALYST: PK	**Figure** 6.3-16
JOB No: VE52277	QA/QC: MY	PDF FILE: 04-100-026_Haze_8.5x11_portrait_8.5x11_portrait.pdf
GIS FILE: 04-100-026_Haze_8.5x11_portrait_8.5x11_portrait.mxd		amec
PROJECTION: UTM Zone 10	DATUM: NAD83	

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GHG--The estimated GHG emissions from the Project depend on the operating parameters in place and production level. During Project operation, GHG emissions results from mobile, aviation and stack sources. The GHG emissions estimate is based on the following:

- Emissions from mobile sources during construction and operations are estimated using the US EPA models MOVES2010b and NONROAD.
- Emissions from aviation combustion sources are estimated based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- Emissions from stationary combustion source are estimated based on US EOA AP-42 emission factors.

Table 6.3-4 provides a summary of the GHG emissions from the Project. At full production, the total emissions from the Project are estimated to be 0.41 kt CO_2E/d, which is equivalent to 114 kt CO_2E/y. Table 6.3-5 compares the Project GHG emissions estimate with the BC and Canadian totals. The Project operations are estimated to add 0.24% and 0.02% to the 2010 provincial and 2011 national totals, respectively (BC MOE, 2012; Environment Canada, 2013).

Table 6.3-4: GHG Emissions from the Project

Source	Total CO_2e Emissions (kt/y)
Onroad Vehicles	0.4
Mine Fleet	165.4
Aviation	3.4
Waste Incinerators	2.4
Total	171.5

Table 6.3-5: Comparison of Project GHG Emissions

Project GHG Emissions Comparison	Total GHG Emissions (kt CO_2E/y)
BC's GHG Emissions (2010)	62,000
Canada's GHG Emissions (2011)	702,000
Project Estimated GHG Emissions	171
Project GHG Emissions as a Percentage	**Percent of Total GHG Emissions (%)**
Percent of BC Total	0.24
Percent of Canada Total	0.02

Notes: CO_2E = Carbon dioxide equivalent units that convert non-CO_2 species (CH_4 and N_2O) using global warming potentials.

Source: BC totals are from BC MOE 2012 and Canada totals are from Environment Canada (2013).

The following modelling results are primarily used in the health risk assessment for exposure information (Table 6.3-6). The predicted ambient concentrations are compared to objectives from a number of other jurisdictions as shown in Tables 6.3-7 through 6.3-15. The comparative guidelines are from (in order of appearance in the above listed tables)

Manitoba (Manitoba 2005), Ontario (Ontario 2012), Alberta (Alberta 2013) and the World Health Organization (WHO 2000).

Table 6.3-6: Special Receptor Predicted Concentrations for CACs

Location	Concentration (ug/m3)													
	SO_2				NO_2			CO		TPM		PM_{10}	$PM_{2.5}$	
	1 hour	3 hour	24 hour	Annual	1 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual	24 hour	24 hour	Annual
Blackwater-Spruce Ranch	1.11	1.08	1.04	1	20.4	11	8.23	123	122	19.8	18.1	10.1	4.6	4.08
Laidman Lake Ecolodge	1.09	1.06	1.02	1	13.4	9.39	8.05	122	121	19.1	18	9.39	4.24	4.02
Pan Phillips Resort	1.07	1.04	1.01	1	13.3	8.88	8.02	122	121	18.6	18	9.15	4.08	4.01
Tatelkuz Lake Resort	1.22	1.16	1.06	1.01	28.2	12.3	8.64	127	124	21.4	18.7	10.7	4.92	4.2

Cyanide (CN)—Whole ore leaching (WOL) with CN is selected for recovering gold from ore on the property. This results in the emission of CN. The predicted ambient concentrations are considered for the human health risk assessment. The modelling results for metal on sensitive receptors are provided in the tables below.

Table 6.3-7: Predicted CN Concentrations for Sensitive Receptors

	Sensitive Receptors	Max. Predicted 1-h Concentrations (µg/m³)	Max. Predicted 24-h Concentrations (µg/m³)	Max. Predicted Annual Concentrations (µg/m³)
CN	Blackwater-Spruce Ranch	3.18E-02	1.14E-02	7.92E-04
	Laidman Lake Ecolodge	2.02E-02	7.80E-03	1.73E-04
	Pan Phillips Resort	1.32E-02	1.98E-03	3.67E-05
	Tatelkuz Lake Resort	1.40E-01	2.88E-02	3.72E-03

Although no ambient objectives are in place for cyanide in BC, guidelines have been established in some other jurisdictions for hydrogen cyanide for certain averaging periods. These guidelines are presented in Table 6.3-8. Although these guidelines should not be used to assess regulatory compliance, a review of the maximum concentrations indicates that all of the maximum predicted values are less than the presented guidelines.

Table 6.3-8: Published Ambient Guidelines for Cyanide

Guideline (µg/m³)	Averaging Time	Source
40	1-hour	Manitoba Air Quality Criteria
8.0	24-hour	Ontario Ambient Air Quality Criteria
3.0	Annual	Manitoba Air Quality Criteria

Metals—the metal species that were assessed for this Project include: Aluminum (Al), Antimony (Sb), Arsenic (As), Barium (Ba), , Cadmium(Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Lead (Pb), Manganese (Mn), Molybdenum (Mo), Nickel (Ni), Selenium (Se), Silver (Ag), Strontium (Sr), Thallium(Ti), Tin (Sn), Vanadium (V), and Zinc (Zn).

The predicted ambient concentrations are considered for the human health risk assessment. The modelling results for metal on sensitive receptors are provided in Table 6.3-9.

Table 6.3-9: Predicted Metal Concentrations for Sensitive Receptors

Metals	Sensitive Receptors	Max. Predicted 1-h Concentrations (µg/m³)	Max. Predicted 24-h Concentrations (µg/m³)	Max. Predicted Annual Concentrations (µg/m³)
Ag	Blackwater-Spruce Ranch	1.00E-03	3.34E-04	2.53E-05
	Laidman Lake Ecolodge	4.60E-04	1.88E-04	5.03E-06
	Pan Phillips Resort	3.93E-04	1.03E-04	1.54E-06

Metals	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
	Tatelkuz Lake Resort	1.44E-03	6.20E-04	7.23E-05
Al	Blackwater-Spruce Ranch	5.76E-01	1.87E-01	1.42E-02
	Laidman Lake Ecolodge	2.58E-01	1.04E-01	2.78E-03
	Pan Phillips Resort	2.26E-01	5.80E-02	8.63E-04
	Tatelkuz Lake Resort	7.83E-01	3.47E-01	3.48E-02
As	Blackwater-Spruce Ranch	1.39E-02	4.51E-03	3.42E-04
	Laidman Lake Ecolodge	6.22E-03	2.51E-03	6.72E-05
	Pan Phillips Resort	5.46E-03	1.40E-03	2.08E-05
	Tatelkuz Lake Resort	1.89E-02	8.37E-03	8.36E-04
Ba	Blackwater-Spruce Ranch	3.51E-03	1.17E-03	8.90E-05
	Laidman Lake Ecolodge	1.61E-03	6.59E-04	1.76E-05
	Pan Phillips Resort	1.38E-03	3.59E-04	5.39E-06
	Tatelkuz Lake Resort	5.05E-03	2.18E-03	3.41E-04
Cd	Blackwater-Spruce Ranch	5.04E-04	1.71E-04	1.30E-05
	Laidman Lake Ecolodge	2.34E-04	9.65E-05	2.58E-06
	Pan Phillips Resort	1.97E-04	5.21E-05	7.83E-07
	Tatelkuz Lake Resort	7.45E-04	3.17E-04	5.00E-05
Co	Blackwater-Spruce Ranch	1.20E-05	1.88E-06	1.30E-07
	Laidman Lake Ecolodge	5.18E-06	7.84E-07	2.56E-08
	Pan Phillips Resort	1.82E-06	3.10E-07	5.71E-09
	Tatelkuz Lake Resort	2.44E-05	9.19E-06	1.74E-06
Cr	Blackwater-Spruce Ranch	1.49E-03	4.85E-04	3.67E-05
	Laidman Lake Ecolodge	6.68E-04	2.70E-04	7.23E-06
	Pan Phillips Resort	5.86E-04	1.50E-04	2.24E-06
	Tatelkuz Lake Resort	2.04E-03	8.99E-04	9.85E-05
Cu	Blackwater-Spruce Ranch	3.05E-01	9.90E-02	7.49E-03
	Laidman Lake Ecolodge	1.36E-01	5.50E-02	1.47E-03
	Pan Phillips Resort	1.20E-01	3.07E-02	4.57E-04
	Tatelkuz Lake Resort	4.14E-01	1.83E-01	1.83E-02
Mn	Blackwater-Spruce Ranch	4.47E-03	1.45E-03	1.10E-04
	Laidman Lake Ecolodge	2.00E-03	8.08E-04	2.16E-05
	Pan Phillips Resort	1.76E-03	4.50E-04	6.70E-06
	Tatelkuz Lake Resort	6.09E-03	2.69E-03	2.76E-04
Mo	Blackwater-Spruce Ranch	5.46E-03	1.77E-03	1.34E-04
	Laidman Lake Ecolodge	2.44E-03	9.86E-04	2.64E-05
	Pan Phillips Resort	2.15E-03	5.50E-04	8.18E-06
	Tatelkuz Lake Resort	7.42E-03	3.29E-03	3.31E-04
Ni	Blackwater-Spruce Ranch	1.00E-03	3.27E-04	2.47E-05
	Laidman Lake Ecolodge	4.48E-04	1.81E-04	4.86E-06
	Pan Phillips Resort	3.92E-04	1.01E-04	1.50E-06
	Tatelkuz Lake Resort	1.38E-03	6.06E-04	7.15E-05
Pb	Blackwater-Spruce Ranch	2.73E-02	8.90E-03	6.74E-04
	Laidman Lake Ecolodge	1.23E-02	4.96E-03	1.33E-04
	Pan Phillips Resort	1.07E-02	2.76E-03	4.11E-05

Metals	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
	Tatelkuz Lake Resort	3.74E-02	1.65E-02	1.75E-03
Sb	Blackwater-Spruce Ranch	2.00E-03	6.62E-04	5.02E-05
	Laidman Lake Ecolodge	9.10E-04	3.71E-04	9.94E-06
	Pan Phillips Resort	7.84E-04	2.04E-04	3.05E-06
	Tatelkuz Lake Resort	2.83E-03	1.23E-03	1.65E-04
Se	Blackwater-Spruce Ranch	1.00E-02	3.27E-03	2.47E-04
	Laidman Lake Ecolodge	4.48E-03	1.81E-03	4.86E-05
	Pan Phillips Resort	3.92E-03	1.01E-03	1.50E-05
	Tatelkuz Lake Resort	1.38E-02	6.07E-03	7.07E-04
Sn	Blackwater-Spruce Ranch	5.00E-04	1.67E-04	1.27E-05
	Laidman Lake Ecolodge	2.28E-04	9.35E-05	2.50E-06
	Pan Phillips Resort	1.96E-04	5.10E-05	7.67E-07
	Tatelkuz Lake Resort	7.15E-04	3.09E-04	5.57E-05
Sr	Blackwater-Spruce Ranch	9.93E-04	3.22E-04	2.44E-05
	Laidman Lake Ecolodge	4.44E-04	1.79E-04	4.80E-06
	Pan Phillips Resort	3.90E-04	9.99E-05	1.49E-06
	Tatelkuz Lake Resort	1.35E-03	5.97E-04	5.96E-05
V	Blackwater-Spruce Ranch	1.49E-03	4.85E-04	3.67E-05
	Laidman Lake Ecolodge	6.67E-04	2.69E-04	7.22E-06
	Pan Phillips Resort	5.86E-04	1.50E-04	2.23E-06
	Tatelkuz Lake Resort	2.03E-03	8.99E-04	9.29E-05
Zn	Blackwater-Spruce Ranch	9.05E-02	2.95E-02	2.23E-03
	Laidman Lake Ecolodge	4.06E-02	1.64E-02	4.40E-04
	Pan Phillips Resort	3.55E-02	9.13E-03	1.36E-04
	Tatelkuz Lake Resort	1.24E-01	5.47E-02	5.98E-03

Although no ambient objectives are in place for metals in BC, guidelines have been established in some other jurisdictions for certain metals. These guidelines are presented in Table 6.3-10. Although these guidelines should not be used to assess regulatory compliance, a review of the maximum concentrations indicates that all of the maximum predicted values are less than the presented guidelines, with the exception of 24-hour chromium at the Blackwater-Spruce Ranch and 24-hour and annual chromium at Tatelkuz Lake Resort.

Table 6.3-10: Published Ambient Guidelines for Metals

Metal	Guideline (μg/m^3)	Averaging Time	Source
Ag	1.0	24-hour	Ontario Ambient Air Quality Criteria
As	0.1 0.3 0.01	1-hour 24-hour Annual	Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria Alberta Ambient Air Quality Objective
Ba	10	24-hour	Ontario Ambient Air Quality Criteria
Cd	0.025 0.005	24-hour Annual	Ontario Ambient Air Quality Criteria WHO Guideline Value
Co	0.1	24-hour	Ontario Ambient Air Quality Criteria
Cr	1.0 0.00035 0.00007	1-hour 24-hour Annual	Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria Ontario Ambient Air Quality Criteria
Cu	50	24-hour	Manitoba Air Quality Criteria
Mo	120	24-hour	Ontario Ambient Air Quality Criteria
Mn	2.0 0.1 0.2 0.15	1-hour 24-hour Annual Annual	Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria Alberta Ambient Air Quality Objective WHO Guideline Value
Ni	6.0 0.1 0.05 0.02	1-hour 24-hour Annual Annual	Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria
Se	10	24-hour	Ontario Ambient Air Quality Criteria
V	1.0 2.0	24-hour 24-hour	WHO Guideline Value Ontario Ambient Air Quality Criteria
Zn	120	24-hour	Ontario Ambient Air Quality Criteria

PAH—the PAHs that were assessed for this Project include Acenaphthylene, Aromatic C17-C34, Aromatic C9-C16 (includes Acenaphthene and Anthracene), Benzo(a)anthracene, Benzo(a)pyrene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenz(a,h) anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, and Pyrene.

The predicted ambient concentrations are considered for the human health risk assessment. The modelling results for PAHs on sensitive receptors are provided in Table 6.3-11.

Table 6.3-11: Predicted PAH Concentrations for Sensitive Receptors

PAHs	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m^3)	Max. Predicted 24-h Concentrations (μg/m^3)	Max. Predicted Annual Concentrations (μg/m^3)
Acenaphthylene	Blackwater-Spruce Ranch	1.08E-05	2.55E-06	1.97E-07
	Laidman Lake Ecolodge	4.56E-06	1.16E-06	4.27E-08
	Pan Phillips Resort	4.53E-06	7.44E-07	1.87E-08
	Tatelkuz Lake Resort	1.72E-05	4.31E-06	6.28E-07
Aromatic C17-C34	Blackwater-Spruce Ranch	2.94E-09	7.94E-10	5.68E-11
	Laidman Lake Ecolodge	1.50E-09	3.59E-10	1.26E-11

PAHs	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
	Pan Phillips Resort	1.26E-09	2.31E-10	4.90E-12
	Tatelkuz Lake Resort	5.65E-09	1.18E-09	1.27E-10
Aromatic C9-C16	Blackwater-Spruce Ranch	4.31E-06	1.02E-06	7.89E-08
	Laidman Lake Ecolodge	1.83E-06	4.67E-07	1.71E-08
	Pan Phillips Resort	1.81E-06	2.98E-07	7.51E-09
	Tatelkuz Lake Resort	6.89E-06	1.79E-06	2.67E-07
Benz(a)anthracene	Blackwater-Spruce Ranch	2.56E-09	6.90E-10	4.94E-11
	Laidman Lake Ecolodge	1.30E-09	3.12E-10	1.09E-11
	Pan Phillips Resort	1.09E-09	2.00E-10	4.26E-12
	Tatelkuz Lake Resort	4.91E-09	1.03E-09	1.11E-10
Benzo(a)anthracene	Blackwater-Spruce Ranch	5.33E-03	1.43E-03	1.13E-04
	Laidman Lake Ecolodge	2.14E-03	6.00E-04	2.44E-05
	Pan Phillips Resort	2.22E-03	3.64E-04	1.10E-05
	Tatelkuz Lake Resort	2.02E-02	7.04E-03	1.17E-03
Benzo(a)pyrene	Blackwater-Spruce Ranch	2.40E-03	5.72E-04	4.45E-05
	Laidman Lake Ecolodge	1.01E-03	2.60E-04	9.70E-06
	Pan Phillips Resort	1.01E-03	1.66E-04	4.26E-06
	Tatelkuz Lake Resort	3.82E-03	1.07E-03	1.63E-04
Benzo(g,h,i)perylene	Blackwater-Spruce Ranch3	1.72E-05	4.08E-06	3.14E-07
	Laidman Lake Ecolodge	7.30E-06	1.86E-06	6.83E-08
	Pan Phillips Resort	7.24E-06	1.19E-06	2.99E-08
	Tatelkuz Lake Resort	2.75E-05	6.84E-06	9.91E-07
Benzo(k)	Blackwater-Spruce Ranch	2.37E-09	6.39E-10	4.57E-11
	Laidman Lake Ecolodge	1.21E-09	2.89E-10	1.01E-11
	Pan Phillips Resort	1.01E-09	1.86E-10	3.95E-12
	Tatelkuz Lake Resort	4.55E-09	9.51E-10	1.02E-10
Chrysene	Blackwater-Spruce Ranch	6.51E-05	1.86E-05	1.34E-06
	Laidman Lake Ecolodge	1.91E-05	5.05E-06	2.59E-07
	Pan Phillips Resort	2.18E-05	5.16E-06	1.31E-07
	Tatelkuz Lake Resort	1.15E-03	5.22E-04	6.64E-05
Dibenz(a,h)anthracene	Blackwater-Spruce Ranch	3.46E-03	8.22E-04	6.32E-05
	Laidman Lake Ecolodge	1.47E-03	3.75E-04	1.37E-05
	Pan Phillips Resort	1.46E-03	2.39E-04	6.02E-06
	Tatelkuz Lake Resort	5.53E-03	1.39E-03	2.02E-04
Fluoranthene	Blackwater-Spruce Ranch	7.96E-05	1.89E-05	1.46E-06
	Laidman Lake Ecolodge	3.38E-05	8.62E-06	3.16E-07
	Pan Phillips Resort	3.35E-05	5.51E-06	1.39E-07
	Tatelkuz Lake Resort	1.27E-04	3.20E-05	4.67E-06
Fluorene	Blackwater-Spruce Ranch	3.12E-08	8.43E-09	6.03E-10
	Laidman Lake Ecolodge	1.59E-08	3.81E-09	1.34E-10
	Pan Phillips Resort	1.33E-08	2.45E-09	5.20E-11
	Tatelkuz Lake Resort	6.00E-08	1.25E-08	1.35E-09
Indeno(1,2,3-cd)pyrene	Blackwater-Spruce Ranch	6.24E-05	1.48E-05	1.14E-06
	Laidman Lake Ecolodge	2.65E-05	6.75E-06	2.48E-07

PAHs	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
	Pan Phillips Resort	2.63E-05	4.31E-06	1.08E-07
	Tatelkuz Lake Resort	9.96E-05	2.49E-05	3.63E-06
Naphthalene	Blackwater-Spruce Ranch	3.88E-03	1.07E-03	8.47E-05
	Laidman Lake Ecolodge	1.54E-03	4.54E-04	1.80E-05
	Pan Phillips Resort	1.57E-03	2.64E-04	8.14E-06
	Tatelkuz Lake Resort	1.80E-02	8.41E-03	1.17E-03
Phenanthrene	Blackwater-Spruce Ranch	3.02E-03	8.04E-04	6.34E-05
	Laidman Lake Ecolodge	1.22E-03	3.46E-04	1.36E-05
	Pan Phillips Resort	1.21E-03	2.06E-04	6.09E-06
	Tatelkuz Lake Resort	1.07E-02	5.03E-03	7.24E-04
Pyrene	Blackwater-Spruce Ranch	4.69E-02	1.12E-02	8.71E-04
	Laidman Lake Ecolodge	1.98E-02	5.08E-03	1.90E-04
	Pan Phillips Resort	1.97E-02	3.24E-03	8.34E-05
	Tatelkuz Lake Resort	7.47E-02	2.10E-02	3.23E-03

Although no ambient objectives are in place for PAHs in BC, guidelines have been established in some other jurisdictions for certain PAHs. These guidelines are presented in Table 6.3-12. Although these guidelines should not be used to assess regulatory compliance, a review of the maximum concentrations indicates that the 24-hour benzo(a)pyrene guidelines is exceeded at all four locations and the lower annual guideline is exceeded at the Blackwater-Spruce Rance and the Tatelkuz Lake Resort. The naphathalene guidelines are not predicted to be exceeded at any of the four locations.

Table 6.3-12: Published Ambient Guidelines for PAHs

PAH	Guideline (μg/m³)	Averaging Time	Source
Benzo(a)pyrene	0.00005 0.0003 0.00001	24-hour Annual Annual	Ontario Ambient Air Quality Criteria Alberta Ambient Air Quality Objective Ontario Ambient Air Quality Criteria
Naphthalene	50 22.5	10-minute 24-hour	Ontario Ambient Air Quality Criteria Ontario Ambient Air Quality Criteria

VOC—the non-PAH VOCs that were assessed for this Project include: 1,3-Butadiene, Acetaldehyde, Acrolein, Aliphatic Aldehydes, Aliphatic C17-C34, Aliphatic C5-C8, Aliphatic C9-C16, Aliphatic Ketones, Aromatic Ketones, Benz(a)anthracene, Benzaldehyde, Benzene, Benzo(b)fluoranthene, Benzo(g,h,i)fluoranthene, Benzofuran, Butane, Carboxylic Acids, Cyclopenta(cd)pyrene, Ethylbenzene, Formaldehyde, Hexane, Methacrolein, Phenothiazine, Propane, Propylene, Styrene, Toluene, Xylenes.

The predicted ambient concentrations are considered for the human health risk assessment. The modelling results for VOCs on sensitive receptors are provided in Table 6.3-13.

Table 6.3-13: Predicted VOC Concentrations for Sensitive Receptors

VOCs	Sensitive Receptors	Max. Predicted 1-h Concentrations (µg/m³)	Max. Predicted 24-h Concentrations (µg/m³)	Max. Predicted Annual Concentrations (µg/m³)
1,3-butadiene	Blackwater-Spruce Ranch	7.58E-04	2.02E-04	1.25E-05
	Laidman Lake Ecolodge	2.77E-04	5.16E-05	2.87E-06
	Pan Phillips Resort	3.35E-04	3.83E-05	1.36E-06
	Tatelkuz Lake Resort	7.38E-03	1.66E-03	2.43E-04
Acetaldehyde	Blackwater-Spruce Ranch	4.64E-09	1.25E-09	8.97E-11
	Laidman Lake Ecolodge	2.37E-09	5.66E-10	1.99E-11
	Pan Phillips Resort	1.98E-09	3.64E-10	7.74E-12
	Tatelkuz Lake Resort	8.92E-09	1.86E-09	2.01E-10
Acrolein	Blackwater-Spruce Ranch	3.97E-03	1.09E-03	8.59E-05
	Laidman Lake Ecolodge	1.58E-03	4.62E-04	1.83E-05
	Pan Phillips Resort	1.59E-03	2.70E-04	8.26E-06
	Tatelkuz Lake Resort	1.79E-02	8.38E-03	1.16E-03
Aliphatic aldehydes	Blackwater-Spruce Ranch	4.49E-03	1.07E-03	8.21E-05
	Laidman Lake Ecolodge	1.91E-03	4.87E-04	1.79E-05
	Pan Phillips Resort	1.89E-03	3.11E-04	7.82E-06
	Tatelkuz Lake Resort	7.18E-03	1.80E-03	2.62E-04
Aliphatic C17-C34	Blackwater-Spruce Ranch	2.13E-06	5.04E-07	3.83E-08
	Laidman Lake Ecolodge	9.10E-07	2.29E-07	8.35E-09
	Pan Phillips Resort	9.03E-07	1.48E-07	3.64E-09
	Tatelkuz Lake Resort	3.39E-06	6.52E-07	7.65E-08
Aliphatic C5-C8	Blackwater-Spruce Ranch	6.89E-03	1.64E-03	1.28E-04
	Laidman Lake Ecolodge	2.91E-03	7.47E-04	2.78E-05
	Pan Phillips Resort	2.89E-03	4.76E-04	1.22E-05
	Tatelkuz Lake Resort	1.10E-02	3.06E-03	4.67E-04
Aliphatic C9-C16	Blackwater-Spruce Ranch	2.62E-03	7.63E-04	5.83E-05
	Laidman Lake Ecolodge	1.04E-03	2.98E-04	1.27E-05
	Pan Phillips Resort	1.19E-03	1.82E-04	5.74E-06
	Tatelkuz Lake Resort	1.33E-02	3.93E-03	6.91E-04
Aliphatic ketones	Blackwater-Spruce Ranch	6.15E-08	1.77E-08	1.28E-09
	Laidman Lake Ecolodge	1.70E-08	5.07E-09	2.50E-10
	Pan Phillips Resort	2.12E-08	4.65E-09	1.24E-10
	Tatelkuz Lake Resort	1.01E-06	4.61E-07	5.88E-08
Aromatic Ketones	Blackwater-Spruce Ranch	3.23E-09	8.71E-10	6.23E-11
	Laidman Lake Ecolodge	1.65E-09	3.93E-10	1.38E-11
	Pan Phillips Resort	1.38E-09	2.53E-10	5.38E-12
	Tatelkuz Lake Resort	6.20E-09	1.30E-09	1.40E-10
Benzaldehyde	Blackwater-Spruce Ranch	7.09E-05	1.68E-05	1.30E-06
	Laidman Lake Ecolodge	3.01E-05	7.68E-06	2.82E-07
	Pan Phillips Resort	2.99E-05	4.91E-06	1.23E-07
	Tatelkuz Lake Resort	1.13E-04	2.84E-05	4.14E-06
Benzene	Blackwater-Spruce Ranch	2.28E-03	5.97E-04	3.67E-05
	Laidman Lake Ecolodge	8.06E-04	1.57E-04	8.37E-06
	Pan Phillips Resort	9.84E-04	1.11E-04	4.00E-06
	Tatelkuz Lake Resort	2.32E-02	5.29E-03	7.99E-04
Benzo(b)fluoranthene	Blackwater-Spruce Ranch	2.16E-06	5.14E-07	3.97E-08
	Laidman Lake Ecolodge	9.15E-07	2.34E-07	8.62E-09
	Pan Phillips Resort	9.07E-07	1.49E-07	3.78E-09
	Tatelkuz Lake Resort	3.46E-06	9.35E-07	1.42E-07

VOCs	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
Benzo(g,h,i)fluoranthene	Blackwater-Spruce Ranch	2.15E-06	5.09E-07	3.91E-08
	Laidman Lake Ecolodge	9.12E-07	2.32E-07	8.51E-09
	Pan Phillips Resort	9.05E-07	1.49E-07	3.72E-09
	Tatelkuz Lake Resort	3.43E-06	8.25E-07	1.17E-07
Benzofuran	Blackwater-Spruce Ranch	4.23E-04	1.03E-04	8.22E-06
	Laidman Lake Ecolodge	1.76E-04	4.59E-05	1.80E-06
	Pan Phillips Resort	1.76E-04	2.92E-05	7.97E-07
	Tatelkuz Lake Resort	7.74E-04	2.46E-04	4.14E-05
Butane	Blackwater-Spruce Ranch	1.18E-08	3.20E-09	2.29E-10
	Laidman Lake Ecolodge	6.05E-09	1.44E-09	5.07E-11
	Pan Phillips Resort	5.06E-09	9.29E-10	1.97E-11
	Tatelkuz Lake Resort	2.28E-08	4.76E-09	5.13E-10
Carboxylic acids	Blackwater-Spruce Ranch	2.06E-02	5.47E-03	4.22E-04
	Laidman Lake Ecolodge	8.47E-03	2.25E-03	9.32E-05
	Pan Phillips Resort	8.79E-03	1.44E-03	4.15E-05
	Tatelkuz Lake Resort	6.44E-02	1.56E-02	2.82E-03
Cyclopenta(cd)pyrene	Blackwater-Spruce Ranch	3.02E-09	8.15E-10	5.84E-11
	Laidman Lake Ecolodge	1.54E-09	3.68E-10	1.29E-11
	Pan Phillips Resort	1.29E-09	2.37E-10	5.03E-12
	Tatelkuz Lake Resort	5.80E-09	1.21E-09	1.31E-10
Ethylbenzene	Blackwater-Spruce Ranch	6.08E-04	1.95E-04	1.39E-05
	Laidman Lake Ecolodge	2.54E-04	6.48E-05	3.11E-06
	Pan Phillips Resort	3.21E-04	4.65E-05	1.42E-06
	Tatelkuz Lake Resort	4.23E-03	9.08E-04	1.39E-04
Formaldehyde	Blackwater-Spruce Ranch	2.17E-04	5.16E-05	3.97E-06
	Laidman Lake Ecolodge	9.21E-05	2.35E-05	8.62E-07
	Pan Phillips Resort	9.14E-05	1.50E-05	3.78E-07
	Tatelkuz Lake Resort	3.47E-04	8.69E-05	1.27E-05
Hexane	Blackwater-Spruce Ranch	6.06E-04	1.64E-04	1.17E-05
	Laidman Lake Ecolodge	3.10E-04	7.40E-05	2.60E-06
	Pan Phillips Resort	2.59E-04	4.75E-05	1.01E-06
	Tatelkuz Lake Resort	1.17E-03	2.44E-04	2.62E-05
Methacrolein	Blackwater-Spruce Ranch	1.59E-04	3.71E-05	2.08E-06
	Laidman Lake Ecolodge	5.37E-05	1.12E-05	4.75E-07
	Pan Phillips Resort	6.02E-05	7.16E-06	2.36E-07
	Tatelkuz Lake Resort	1.90E-03	4.42E-04	6.95E-05
Phenothiazine	Blackwater-Spruce Ranch	3.64E-02	8.72E-03	6.80E-04
	Laidman Lake Ecolodge	1.53E-02	3.95E-03	1.48E-04
	Pan Phillips Resort	1.53E-02	2.52E-03	6.52E-05
	Tatelkuz Lake Resort	5.80E-02	1.71E-02	2.68E-03
Propane	Blackwater-Spruce Ranch	4.31E-05	1.02E-05	7.88E-07
	Laidman Lake Ecolodge	1.83E-05	4.66E-06	1.71E-07
	Pan Phillips Resort	1.81E-05	2.98E-06	7.50E-08
	Tatelkuz Lake Resort	6.88E-05	1.75E-05	2.57E-06
Propylene	Blackwater-Spruce Ranch	3.11E-03	8.20E-04	6.34E-05
	Laidman Lake Ecolodge	1.28E-03	3.39E-04	1.40E-05
	Pan Phillips Resort	1.32E-03	2.16E-04	6.24E-06
	Tatelkuz Lake Resort	9.45E-03	2.28E-03	4.08E-04
Styrene	Blackwater-Spruce Ranch	3.01E-03	7.15E-04	5.50E-05

VOCs	Sensitive Receptors	Max. Predicted 1-h Concentrations (μg/m³)	Max. Predicted 24-h Concentrations (μg/m³)	Max. Predicted Annual Concentrations (μg/m³)
	Laidman Lake Ecolodge	1.28E-03	3.26E-04	1.20E-05
	Pan Phillips Resort	1.27E-03	2.08E-04	5.24E-06
	Tatelkuz Lake Resort	4.81E-03	1.21E-03	1.76E-04
Toluene	Blackwater-Spruce Ranch	1.91E-02	5.11E-03	3.98E-04
	Laidman Lake Ecolodge	8.19E-03	2.22E-03	8.62E-05
	Pan Phillips Resort	7.70E-03	1.33E-03	3.75E-05
	Tatelkuz Lake Resort	5.56E-02	2.51E-02	3.80E-03
Xylenes	Blackwater-Spruce Ranch	8.17E-03	2.29E-03	1.48E-04
	Laidman Lake Ecolodge	3.07E-03	5.64E-04	3.36E-05
	Pan Phillips Resort	3.79E-03	4.64E-04	1.57E-05
	Tatelkuz Lake Resort	7.45E-02	1.68E-02	2.50E-03

Although no ambient objectives are in place for VOCs in BC, with the exception of formaldehyde, guidelines have been established in some other jurisdictions for certain VOCs. These guidelines are presented in Table 6.3-14. Although these guidelines should not be used to assess regulatory compliance, a review of the maximum concentrations indicates that all of the maximum predicted concentrations are below the published guidelines.

Table 6.3-14: Published Ambient Guidelines for VOCs

VOC	Guideline (μg/m³)	Averaging Time	Source
1,3-butadiene	10	24-hour	Ontario Ambient Air Quality Criteria
	2.0	Annual	Ontario Ambient Air Quality Criteria
Acetaldehyde	500	30-minute	Ontario Ambient Air Quality Criteria
	90	1-hour	Alberta Ambient Air Quality Objective
	2000	24-hour	WHO Tolerable Concentration
	500	24-hour	Ontario Ambient Air Quality Criteria
	50	Annual	WHO Tolerable Concentration
Acrolein	50	30-minute	WHO Guideline Value
	4.5	1-hour	Alberta Ambient Air Quality Objective
	0.4	24-hour	Alberta Ambient Air Quality Objective
Benzene	30	1-hour	Alberta Ambient Air Quality Objective
	2.3	24-hour	Ontario Ambient Air Quality Criteria
	3	Annual	Alberta Ambient Air Quality Objective
	0.45	Annual	Ontario Ambient Air Quality Criteria
Ethylbenzene	1900	10-minute	Ontario Ambient Air Quality Criteria
	2000	1-hour	Alberta Ambient Air Quality Objective
	1000	24-hour	Ontario Ambient Air Quality Criteria
	22000	Annual	WHO Guideline Value
Formaldehyde	65	1-hour	Alberta Ambient Air Quality Objective
	370	1-hour	BC Ambient Air Quality Objective Episode Level
Hexane	21000	1-hour	Alberta Ambient Air Quality Objective
	7000	24-hour	Alberta Ambient Air Quality Objective
	2500	24-hour	Ontario Ambient Air Quality Criteria
Propylene	4000	24-hour	Ontario Ambient Air Quality Criteria
Toluene	1000	30-minute	WHO Guideline Value
	1880	1-hour	Alberta Ambient Air Quality Objective
	400	24-hour	Alberta Ambient Air Quality Objective
	2000	24-hour	Ontario Ambient Air Quality Criteria
	260	1-week	WHO Guideline Value
Xylenes	3000	10-minute	Ontario Ambient Air Quality Criteria

VOC	Guideline ($\mu g/m^3$)	Averaging Time	Source
	2300	1-hour	Alberta Ambient Air Quality Objective
	4800	24-hour	WHO Guideline Value
	730	24-hour	Ontario Ambient Air Quality Criteria
	700	24-hour	Alberta Ambient Air Quality Objective
	870	Annual	WHO Guideline Value

Other Species—the other species that were assessed for this Project include Ca, Fe, Ga, Hg, In, K, La, Mg, Pd, Si, and Ti.

The modelling results for these species on sensitive receptors are provided in Table 6.3-15.

Table 6.3-15: Predicted Other Species Concentrations for Sensitive Receptors

Other Species	Sensitive Receptors	Max. Predicted 1-h Concentrations ($\mu g/m^3$)	Max. Predicted 24-h Concentrations ($\mu g/m^3$)	Max. Predicted Annual Concentrations ($\mu g/m^3$)
Ca	Blackwater-Spruce Ranch	4.48E-02	1.46E-02	1.11E-03
	Laidman Lake Ecolodge	2.01E-02	8.14E-03	2.18E-04
	Pan Phillips Resort	1.76E-02	4.52E-03	6.74E-05
	Tatelkuz Lake Resort	6.16E-02	2.71E-02	3.23E-03
Fe	Blackwater-Spruce Ranch	3.68E-01	1.19E-01	9.04E-03
	Laidman Lake Ecolodge	1.65E-01	6.65E-02	1.78E-03
	Pan Phillips Resort	1.44E-01	3.70E-02	5.51E-04
	Tatelkuz Lake Resort	5.01E-01	2.21E-01	2.29E-02
Ga	Blackwater-Spruce Ranch	4.48E-04	1.46E-04	1.10E-05
	Laidman Lake Ecolodge	2.01E-04	8.11E-05	2.17E-06
	Pan Phillips Resort	1.76E-04	4.51E-05	6.72E-07
	Tatelkuz Lake Resort	6.12E-04	2.70E-04	2.88E-05
Hg	Blackwater-Spruce Ranch	2.34E-06	5.39E-07	3.25E-08
	Laidman Lake Ecolodge	1.59E-06	2.68E-07	9.04E-09
	Pan Phillips Resort	4.54E-07	9.87E-08	1.47E-09
	Tatelkuz Lake Resort	3.64E-06	1.05E-06	1.43E-07
In	Blackwater-Spruce Ranch	5.02E-04	1.69E-04	1.28E-05
	Laidman Lake Ecolodge	2.32E-04	9.54E-05	2.55E-06
	Pan Phillips Resort	1.97E-04	5.17E-05	7.76E-07
	Tatelkuz Lake Resort	7.33E-04	3.14E-04	4.26E-05
K	Blackwater-Spruce Ranch	1.37E-01	4.45E-02	3.37E-03
	Laidman Lake Ecolodge	6.13E-02	2.47E-02	6.62E-04
	Pan Phillips Resort	5.38E-02	1.38E-02	2.05E-04
	Tatelkuz Lake Resort	1.86E-01	8.24E-02	8.26E-03
La	Blackwater-Spruce Ranch	4.55E-05	1.55E-05	1.31E-06
	Laidman Lake Ecolodge	2.36E-05	1.07E-05	2.87E-07
	Pan Phillips Resort	1.80E-05	3.06E-06	6.63E-08
	Tatelkuz Lake Resort	1.14E-03	4.05E-04	6.68E-05
Mg	Blackwater-Spruce Ranch	1.05E-04	3.35E-05	2.79E-06
	Laidman Lake Ecolodge	5.02E-05	2.37E-05	6.32E-07
	Pan Phillips Resort	3.88E-05	6.97E-06	1.42E-07
	Tatelkuz Lake Resort	1.88E-03	6.75E-04	1.14E-04
Pd	Blackwater-Spruce Ranch	2.02E-04	6.94E-05	5.29E-06

Other Species	Sensitive Receptors	Max. Predicted 1-h Concentrations (µg/m^3)	Max. Predicted 24-h Concentrations (µg/m^3)	Max. Predicted Annual Concentrations (µg/m^3)
	Laidman Lake Ecolodge	9.49E-05	3.94E-05	1.05E-06
	Pan Phillips Resort	7.94E-05	2.11E-05	3.18E-07
	Tatelkuz Lake Resort	3.07E-04	1.29E-04	2.58E-05
Si	Blackwater-Spruce Ranch	1.26E+00	4.11E-01	3.11E-02
	Laidman Lake Ecolodge	5.66E-01	2.29E-01	6.12E-03
	Pan Phillips Resort	4.97E-01	1.27E-01	1.90E-03
	Tatelkuz Lake Resort	1.72E+00	7.61E-01	7.72E-02
Ti	Blackwater-Spruce Ranch	1.79E-02	5.80E-03	4.39E-04
	Laidman Lake Ecolodge	7.99E-03	3.23E-03	8.64E-05
	Pan Phillips Resort	7.02E-03	1.80E-03	2.68E-05
	Tatelkuz Lake Resort	2.43E-02	1.08E-02	1.08E-03

Although no ambient objectives are in place for the other species in BC guidelines have been established in some other jurisdictions in some cases. These guidelines are presented in Table 6.3-16. Although these guidelines should not be used to assess regulatory compliance, a review of the maximum concentrations indicates that all of the maximum predicted concentrations are below the published guidelines.

Table 6.3-16: Published Ambient Guidelines for Other Species

Species	Guideline (µg/m^3)	Averaging Time	Source
Fe	4.0	24-hour	Ontario Ambient Air Quality Criteria
Hg	2.0 1.0	24-hour Annual	Ontario Ambient Air Quality Criteria WHO Guideline Value
Pd	10	24-hour	Ontario Ambient Air Quality Criteria
Ti	120	24-hour	Ontario Ambient Air Quality Criteria

7.0 SUMMARY AND CONCLUSIONS

New Gold has proposed to develop the Blackwater Gold Project (the Project), an open pit gold and silver mine and associated ore processing facilities. The Project is located approximately 160 km southwest of the city of Prince George, B.C.

This air quality assessment has been conducted in support of an environmental assessment for the Project. To determine the potential effects on ambient air quality associated with emissions from the Project operation, dispersion modelling was conducted for the Project-alone case at the peak period. The background concentrations were added to the predicted concentrations from the Project case to assess cumulative effects.

The results of this assessment show that the maximum predicted ground-level concentrations for the TSP, PM_{10} and $PM_{2.5}$ predictions exceed the applicable objectives. Ground-lelel concentrations for all other contaminants are below the relevant regulatory objectives.

The maximum predicted TSP and PM_{10} concentrations are adjacent to the roads boundary and the predicted concentration decrease rapidly with distance from the roads. The maximum $PM_{2.5}$ concentrations are predicted to occur along the southern edge of the Project property (towards the peak of Mt. Davidson) and predicted concentrations decrease rapidly with distance from the Project site. The predictions are conservative, worst-case scenarios, assuming continuous peak construction and operation emissions for the entire duration of the project. Therefore, it is expected that actual concentrations from operations will be lower than predicted.

8.0 MODEL ASSUMPTIONS AND LIMITATIONS

The assessment of air quality depends on air dispersion models that are used to evaluate the impacts of the ambient air quality from the corresponding facility or the project assessed. By definition, air quality models can only approximate atmospheric processes. The assessment relies on the completeness, preciseness and/or representativeness of the combination of input data sets including:

- Facility/Project information;
- Extrapolation of meteorological data with limited observation data, such as surface winds, temperatures and mixing heights;
- Emission rates estimated based on a combination of emission factors, manufacturer specifications, and engineering estimates;
- Non site-specific default parameters used in the development of the emission rates; and
- Simplifications and accuracy limitations related to source data;

Models are designed to incorporate substantial conservatism in the methods to ensure that potential impacts are not understated. As with any model or simulation there are limits to the degree of accuracy with which the model corresponds with observations. In order to simplify the modeling procedure while increasing the likelihood of overestimating actual concentrations, additional assumptions are made including:

- All facility sources were simultaneously operating on a continuous basis at maximum capacity; and
- All activities, such as road traffic and fugitive emissions, emit at their maximum levels.

As with any predictive model, uncertainty is inherent in CALPUFF. Limitations arise due to gaps and uncertainties in various model inputs, including the following:

- Lack of surface and upper-air meteorological observations over many sections of the air quality study areas;
- Simplification of the flow into grid-box averages, which eliminates smaller-scale details;
- Uncertainties of land cover characteristics;
- Simplification of emission rates as constant continuous values;
- Uncertainties in source characteristics, including the approximation of area, line and volume sources using simple shapes; and
- Inability to resolve small-scale features surrounding receptors that may influence pollutant behaviour.

Finally, the imperfect state of the science of atmospheric modelling contributes to uncertainty in accurately simulating the behaviour of the atmosphere and the dispersion of pollutants. The accuracy of the results of dispersion modelling remains heavily dependent on the current understanding of the atmosphere.

Despite these uncertainties, dispersion models remain useful because their results tend to over predict actual conditions (Scire *et al.* 2000). Such a property is deliberately retained in CALPUFF through the selection of model parameters and in setting emission parameters during its application. Dispersion model results should be considered reasonably representative in cases where predicted concentrations are within a factor of two of monitored concentrations and when the maximum concentrations predicted by the model occur under the same meteorological conditions as the monitored maxima.

Near major sources of NO_x and SO_2 and surface-based sources such as roads and non-industrial community emissions, predicted concentrations and deposition rates are significantly higher than observed. This is likely the result of the RIVAD/ARM3 chemical transformation algorithms in the model. This limitation has been partially addressed through the use of the ozone limited method (OLM) that more accurately represents the chemical transformation process for nitrogen oxides based on local observations. Additionally, difficulties in accurately approximating effective release parameters at short distance scales may contribute to over-predictions.

In evaluating the potential effects of nitrogen deposition, all nitrogen deposited to soil or water is assumed to be chemically and/or biologically processed in a manner that: 1) leads to acidification of the system; and 2) leads to growth (microbial or plant) and potential eutrophication of the system. Thus, nitrogen deposition is treated as if it contributes fully to both acidification and eutrophication, which is conservative.

A great deal of NO_x is transformed into nitric acid (HNO_3) during the early life of the plume, and HNO_3 is then lost to the surface within a few hours (AMEC 2004). The CALPUFF predictions herein assume that all available nitrogen is transformed into nitrate particles before being deposited to the surface. Therefore, the nitrogen deposition estimates presented are expected to be substantially overstated.

8.1 MODELING NON-Point Sources

While stack emissions are straightforward to model, other sources require some representation or parameterization in order to be modeled. This section describes how mines, stockpiles, material handling, urban areas and highways were treated in CALPUFF. Fugitive emissions such as windblown dust, heavy equipment exhausts and vehicular traffic were treated as area sources. The coordinates of the corners of the sources were obtained and the sources are represented as polygons. There is large degree of variability of the emission within the area source so emissions are averaged over the area. The CALPUFF model requires initial vertical dispersion (σ_z) and release height to model area sources.

8.1.1 Open Mine Pits

Mine pits were assumed to be area sources with a characteristics dept up to 50 m below the surface. The initial vertical dispersion parameter was set at 16 m based on previously submitted EIAs. Mine fleet exhaust was assumed to be emitted from a height of 10 m above the surface; this is based on physical height of the loaded Caterpillar 797 truck. The initial vertical dispersion parameter was set to be 4.65 m following the ISC3 manual that the initial vertical dispersion parameter is $\mathbf{1}/_{\mathbf{2.15}}$ of its physical height (US EPA 1995).

8.1.2 Roads

Emissions of vehicles travelling along roads were modeled as area sources with an effective emission height of 3.0 m.

The emission inventory and calculation of emission factors for the Project are detailed in Section 4 of the Air Quality Modelling Technical Data Report in Appendix 5.2.4A.

The CALPUFF model incorporates conservative assumptions in the model code. Where assumptions are made in the air quality modelling regarding data choices and modelling parameters these also tend to be conservative and therefore there is a high degree of certainty that teh model predictions are conservative.

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