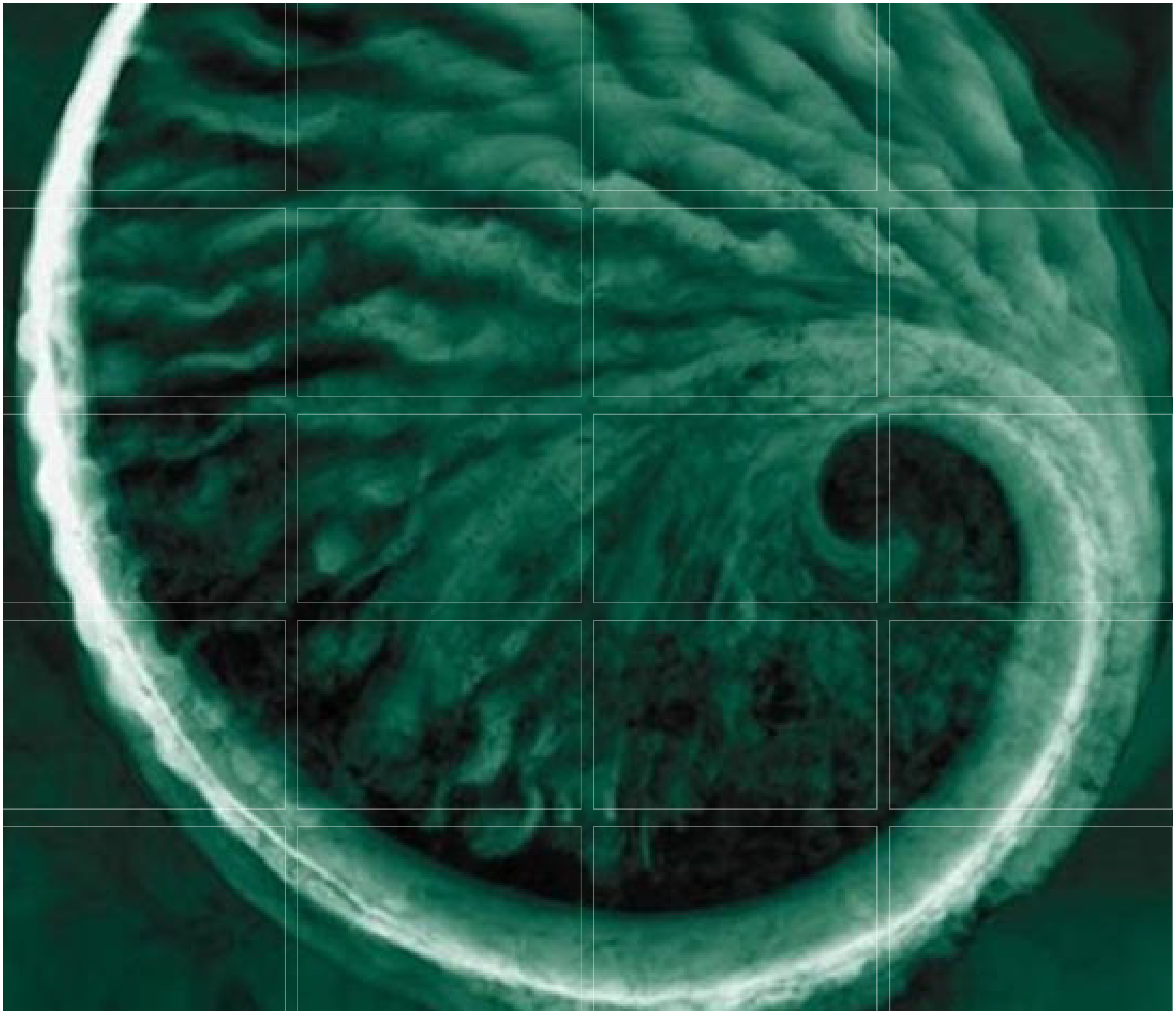
Appendix 6-B

Murray River Coal Project: Air Quality Modelling Report



Prepared for:

hd Mining

MURRAY RIVER COAL PROJECT

Air Quality Modelling Report

July 2014

ERM

The world's leading sustainability consultancy

HD Mining International Ltd.

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EXECUTIVE SUMMARY

An air quality modelling study for the proposed Murray River Coal Project (the Project) was completed in order to provide a basis for an air quality effects assessment, which is a required component of the Environmental Impact Statement for the Project.

The air dispersion model CALPUFF-ISC was used for the study. The following pollutants were included in the assessment; sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), total suspended particulates (TSP), respirable particulate matter (PM_{10}); fine particulate matter ($PM_{2.5}$) and dust deposition. Acid deposition and metal deposition were also calculated in order to inform the Human Health and Terrestrial Ecosystems effects assessments. An emissions inventory, incorporating estimated maximum emissions rates associated with Project activities, was used as input for the air dispersion model.

British Columbia's ambient air quality standards were used as threshold values for CO, TSP, PM_{10}, $PM_{2.5}$ concentrations and dust deposition. For NO_2, which is not included in the British Columbia standards, the National Ambient Air Quality Objective (NAAQO) maximum desirable level was used. For SO_2 the NAAQO was also used as it is more stringent that the BC objective. These standards, objectives and guidelines were developed to protect all members of the general public, including sensitive individuals and are therefore conservative in nature.

Maximum 1-hour, 24-hour and annual average SO_2 and NO_2 concentrations were predicted to be well below the corresponding objectives at all locations modelled. Maximum 1-hour and 8-hour average CO concentrations, and maximum annual and 24-hour $PM_{2.5}$ concentrations, were also predicted to be well below the corresponding objectives at all locations modelled.

Predicted maximum annual TSP concentrations were all below the objective outside of the fence line[1]. Maximum 24-hour average TSP and PM_{10} concentrations exceeded the standard both inside and outside of the fence line, however, the exceedances were well within the modelling domain. Predicted maximum 24-hour TSP concentrations show exceedances occur 8.2% of the time and predicted maximum 24-hour PM_{10} concentrations show exceedances occur 2.7% of the time. The model was run for the various emission sources separately and therefore the contribution from different sources could be assessed. The exceedances were primarily due to fugitive sources, particularly road dust. There were no exceedances outside the fence line from non-fugitive sources. The model was run assuming no anthropogenic dust control; however mitigation measures such as road watering would reduce the amount of road dust by 75% (US EPA 2006a).

Dust deposition rates were predicted to exceed the most stringent BC objective along the road during the summer. The exceedances extend approximately 1 km from the road, with the majority of exceedances to the east of the road due to the prevailing wind direction.

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[1] A fence line is defined as the limit beyond which public access is restricted ,

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ACRONYMS AND ABBREVIATIONS

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

BC	British Columbia
BC MOE	British Columbia Ministry of Environment
CAAQS	Canadian Ambient Air Quality Standards
CAC	Criteria air contaminants
CCME	Canadian Council of Ministers of the Environment
CCR	Coarse Coal Rejects
CEAA	Canadian Environmental Assessment Agency
CO	Carbon Monoxide
CPP	Coal Processing Plant
CWS	Canada-wide Standards
EIS	Environmental Impact Statement
eq/ha/year	equivalency per hectare per year
masl	metres above sea level
MSC	Meteorological Services of Canada
NAAQO	National Ambient Air Quality Objectives
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
PM_{10}	Particulate matter with diameter less than 10 micron
$PM_{2.5}$	Particulate matter with diameter less than 2.5 micron
the Project	the proposed Murray River Coal Project
Rescan	Rescan Environmental Services Ltd. (now ERM Rescan)
S	second
SO_2	Sulphur Dioxide
SO_x	Sulphur Oxides
TSP	Total suspended particulates
US EPA	United States Environmental Protection Agency
VOC	Volatile organic compounds

1. INTRODUCTION

The Murray River Coal Project (the Project) is a proposed underground coal mine owned by HD Mining International Ltd. (HD Mining), located 12.5 km southwest of the town of Tumbler Ridge, BC (Figure 1-1). Project infrastructure is planned at four locations: the Coal Processing Site, the Decline Site and the Shaft Site (Figure 1-2); a Secondary Shaft Site is planned for later in the mine life.

HD Mining plans to use the long wall mining method to extract the coal, which will then be processed at the Coal Processing Plant (CPP). The mine plan for the Project is a 25 year operating mine life based on current resource estimates.

The activities associated with the Project have the potential to generate emissions of criteria air contaminant (CACs). The purpose of this report is to identify the emissions sources, outline the atmospheric dispersion modelling methodology, and evaluate the predicted air quality levels associated with the Project using applicable ambient air quality criteria, standards, objectives or guidelines.

The objectives of the Air Quality Modelling study are to:

- Present background air quality conditions used in the model;
- Identify the sources of emissions associated with the Project and complete an emissions inventory;
- Evaluate the impact of the various emissions sources on air quality using appropriate air dispersion modelling; and
- Compare the results to relevant air quality objectives and guidelines.

Chapter 2 of this report sets out the scope of the modelling. Chapter 3 sets out the air quality standards, objectives and guidelines and Chapter 4 provides background air quality levels. Chapter 5 provides details of the emissions inventory, Chapter 6 describes the modelling methodology and Chapter 7 presents the modelling results. The conclusions of the modelling study are presented in Chapter 8.

Results of the air dispersion modelling were subsequently used to support the assessment of various Valued Components (VCs) in the effects assessment and to provide required information for other subjects (e.g., Human Health and Terrestrial Ecosystems).

Figure 1-1

Project Location

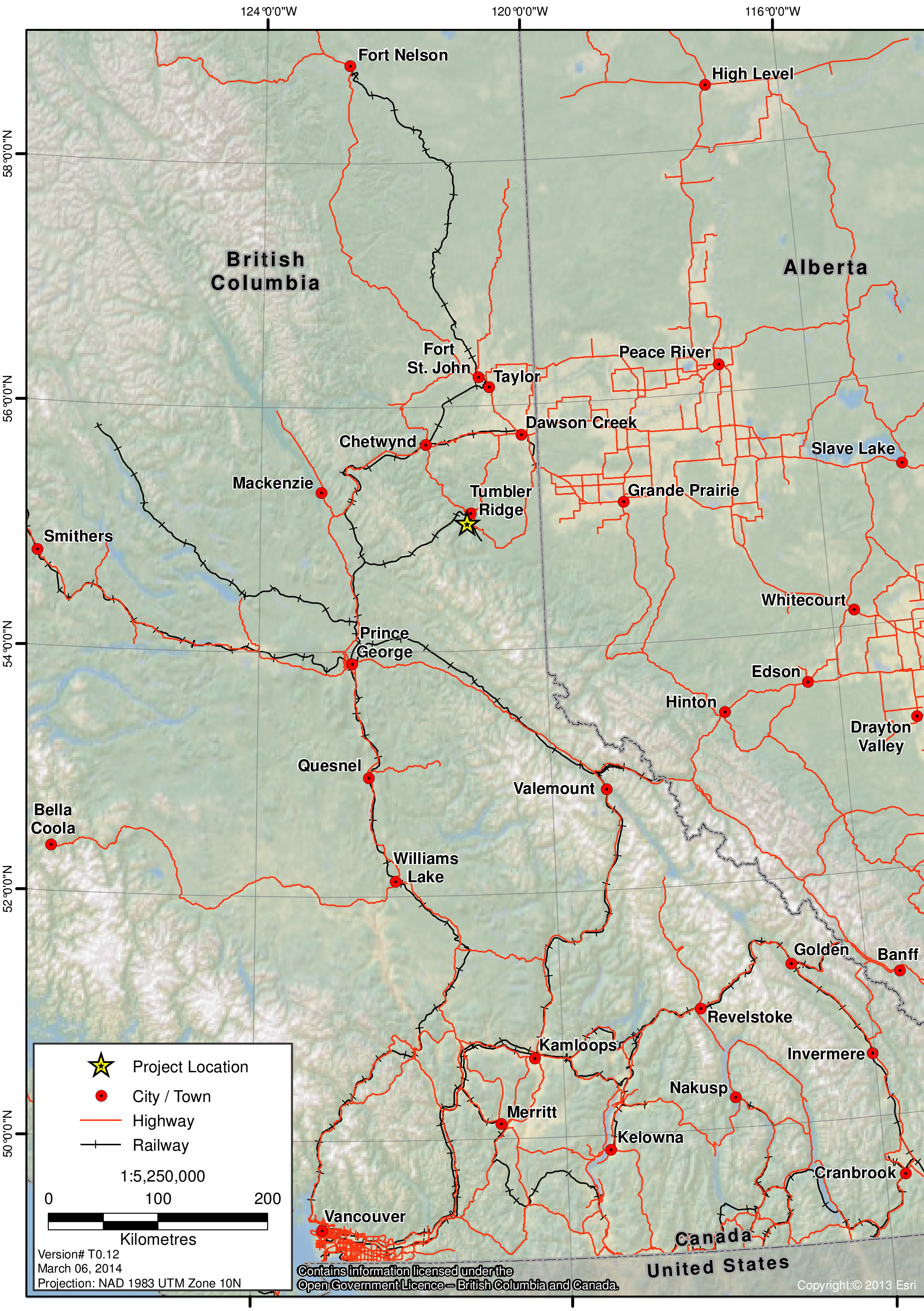

Figure 1-2
Project Site Layout

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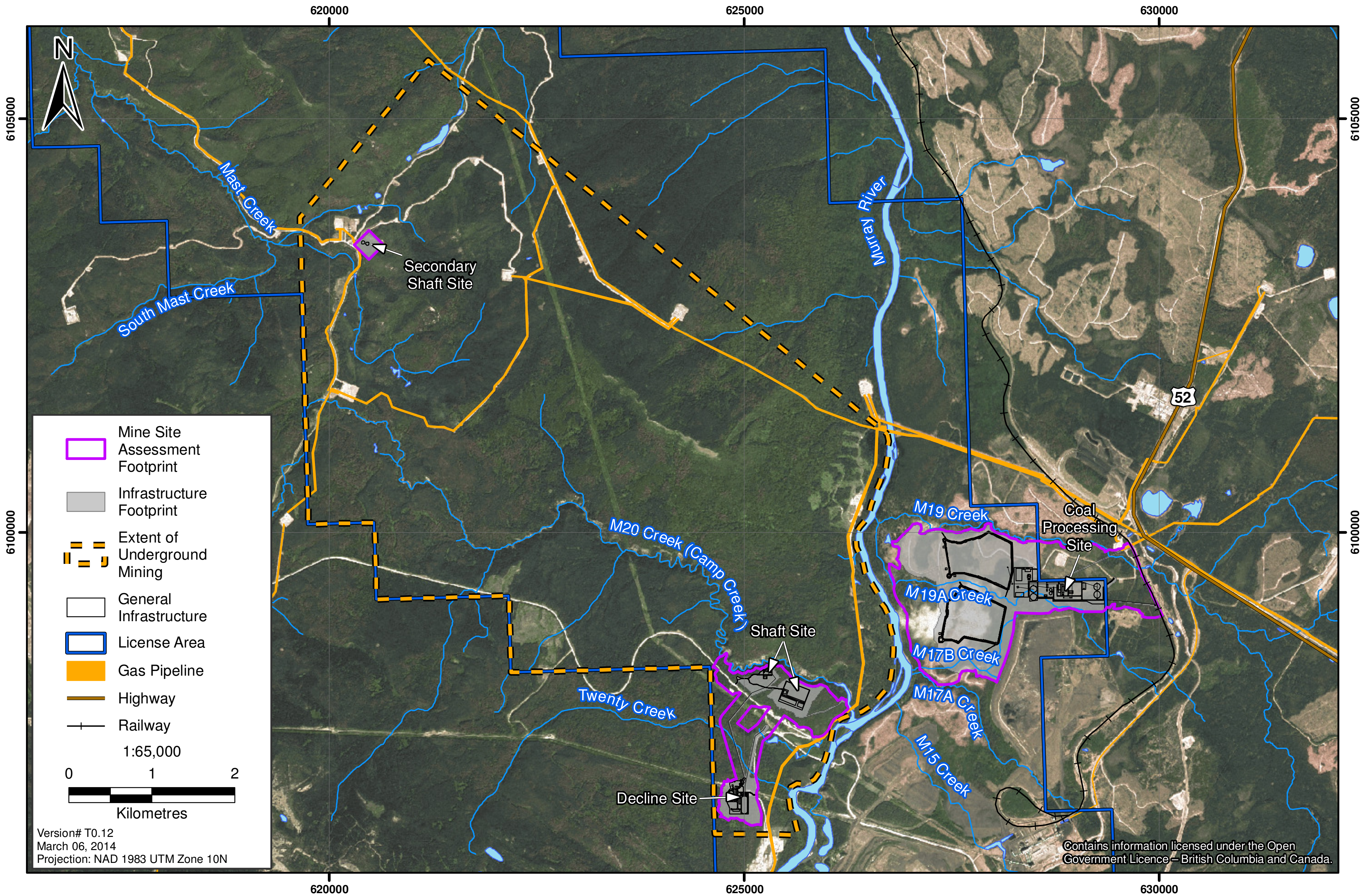


2. SCOPE OF THE ASSESSMENT

2.1 ASSESSMENT APPROACH

The Environmental Impact Statement Guidelines for the Murray River Project (CEAA 2013) and the Final Murray River Coal Project Application Information Requirements (Rescan 2013) form the basis of this air dispersion assessment.

Standard air dispersion modelling techniques, as outlined in the BC MOE Guidelines for Air Quality Dispersion Modelling in British Columbia, were applied to predict the potential air quality effects associated with the Project (BC MOE 2008a). Air dispersion modelling is commonly used to assess air quality effects of a proposed source with respect to federal and provincial ambient air quality objectives. The dispersion model allows an understanding of the interaction of existing and future emission sources with meteorology, topography and existing air quality.

2.2 SPATIAL BOUNDARIES

The air quality modelling domain is presented in Figure 2.2-1. Study areas were established based on the "zone of influence" beyond which the residual effects of the Project are expected to diminish to a negligible state. The expected zone of influence was determined using baseline studies, consultation, and expert knowledge.

The model domain encompasses the coal processing plant, the shaft site and the decline site, with boundaries of 10 km east, south and west from infrastructure, and 15 km north of the infrastructure, to include the District of Tumbler Ridge. By modelling the areas with the highest emissions, it can be assumed that if the effects at these areas are found to be not significant, the potential effect for the entirety of the Project should also be not significant.

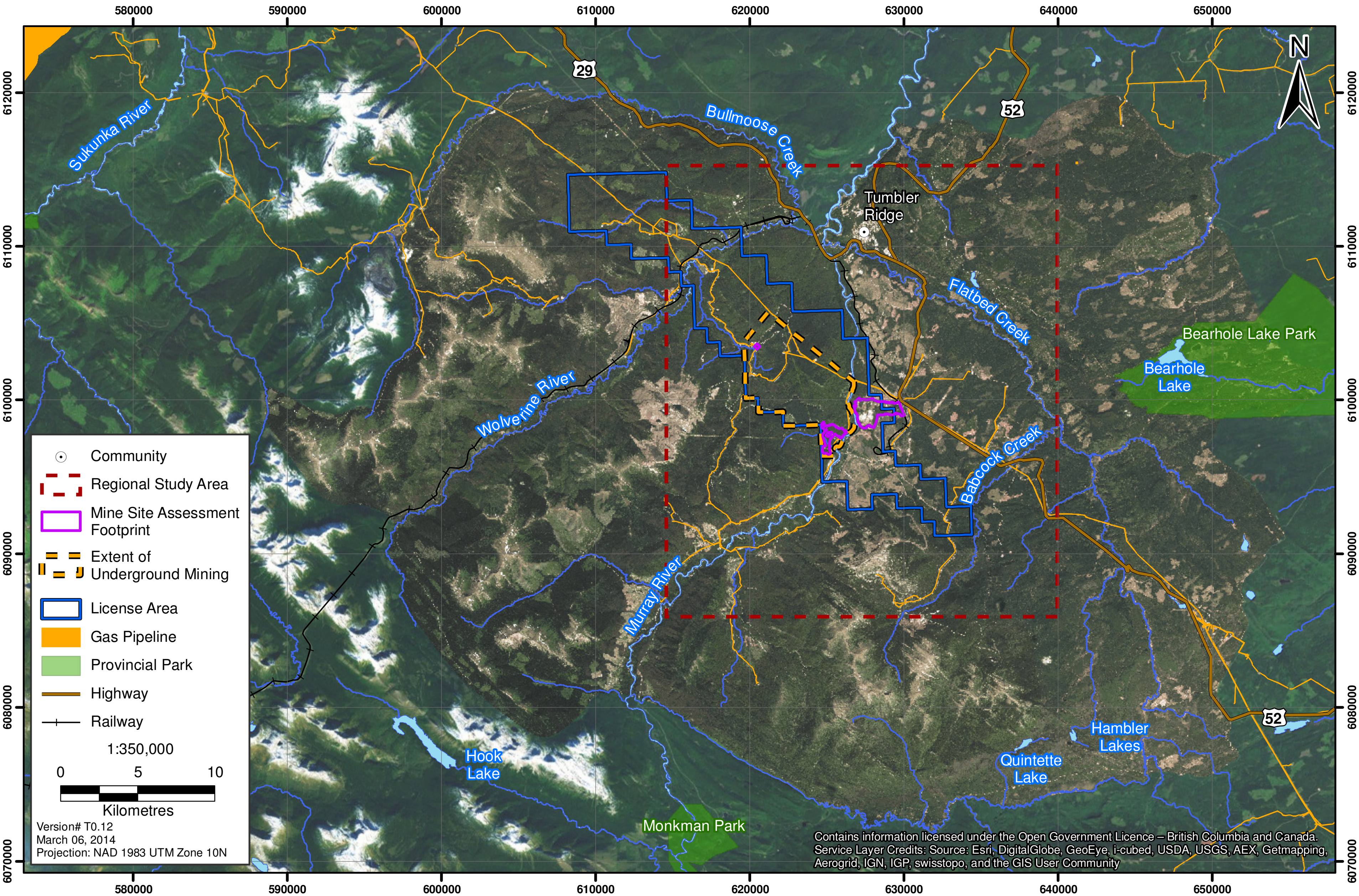
2.3 TEMPORAL BOUNDARIES

The establishment of temporal boundaries is based on the scenario when air quality impacts would be highest throughout the life of the Project. By determining the effects of the year with the highest emissions, it can be assumed that if the effects during these years are found to be not significant, the potential effect for the entirety of the Project should also be not significant.

Construction will include some site clearing and grubbing, construction of project facilities and installation of infrastructure. Much of the construction work for the mine infrastructure on the west side of Murray River has already been permitted through the Coal Exploration Permit for the project (Permit number CX-9-44, dated 15 March 2012). The previously permitted construction work falls outside the scope of this assessment. Operation will include surface and underground equipment, material handling and processing, stockpiles, road vehicles (both fugitive road dust and exhaust emissions) and rail loadout emissions. Decommissioning and Reclamation will include stockpile recontouring and reclamation activities.

Figure 2.2-1

Spatial Boundaries for Assessment of Air Quality Effects



The air quality assessment will take into account the Construction, Operation, Decommissioning and Reclamation, and Post Closure. However, detailed air quality dispersion modelling has been undertaken for Operation only, as the emissions are expected to be the highest during this phase. A qualitative assessment will be undertaken for all other phases based on the expected emission rates and the predicted concentrations during Operation. This approach was included in the approved Model Plan (Appendix A).

2.4 AIR CONTAMINANTS

The air dispersion modelling study included the following contaminants:

- nitrogen oxide (NOx as NO_2);
- sulphur dioxide (SO_2);
- carbon monoxide (CO);
- total suspended particulates (TSP) matter;
- particulate matter (PM_{10});
- respirable particulate matter ($PM_{2.5}$); and
- dust deposition.

Further details of the air parameters included in the modelling study are listed in Table 2.4-1.

Table 2.4-1. Air Contaminants Included in the Air Quality Modelling Study

Species	Description
Air Contaminants	
Sulphur dioxide (SO_2)	Fossil fuels contain a small amount of organic sulphur compounds. During fuel combustion, the sulphur is oxidized and emitted as SO_2 gas with the engine exhaust. In the atmosphere, SO_2 can further oxidize to sulphate particles, which contribute to acid deposition.
Oxides of nitrogen (NO_x)	NO_x gas primarily consists of nitrogen oxide (NO) and nitrogen dioxide (NO_2). The gasses are emitted with exhaust from combustion engines and products from blasting operations. NO_x can be converted to nitric acid in the atmosphere and thus contribute to acid deposition.
Carbon monoxide (CO)	Carbon monoxide is formed as a result of incomplete combustion of fossil fuels. The gas prevents oxygen from attaching to red blood cells and is therefore toxic at high concentrations.
Total suspended particulates (TSP) matter	TSP are airborne particles that have a diameter of 100 µm or less. Sources of TSP include vehicle and engine exhaust and fugitive dust. Most particles with diameters between 2 and 30 µm are a result of fugitive dust. Fugitive dust is derived from the mechanical disturbance of granular material exposed to the air. Common sources of fugitive dust include unpaved roads, aggregate storage piles and construction operations. Particles can be composed of a wide range of materials, including minerals (sand, rock dust), engine soot, organic materials or salt.
Particulate matter (PM_{10})	PM_{10} particles are a subset of TSP and are defined as particles with a diameter less than 10 µm.
Respirable particulate matter ($PM_{2.5}$)	$PM_{2.5}$ particles are a subset of TSP and are defined as particles with a diameter less than 2.5 µm. These particles are small enough to enter deep into the respiratory system. The majority of particulate matter emitted with diesel engine exhaust is $PM_{2.5}$.
Deposition	
Dust deposition	Small, dry, solid particles projected into the air by natural forces, such as wind or by man-made processes. Dust particles are usually in the size range from about 1 to 100 µm in diameter, and they settle slowly under the influence of gravity and are deposited on the ground.

Other criteria air contaminants include ground level ozone (O_3) and volatile organic compounds (VOCs). Ground level ozone is not emitted in large quantities but is formed in a series of complex atmospheric reactions that involve primary air pollutants such as NO_X and VOCs. The CALPUFF model does not include routines for calculating formation rates of ground level ozone. However, hourly ambient ozone concentrations data can be used by the model to calculate SO_2, NO and NO_2 conversion rates. Emissions of VOCs from Project activities could affect the ambient air quality because of its role in the formation of secondary air contaminants. However, standards or objectives for ambient VOC concentrations have yet to be established for Canada and emission levels are expected to be minimal. These pollutants are not considered further.

An assessment of acid deposition and metal deposition rates was also carried out in order to inform effects assessments of Human Health and Terrestrial Ecosystem VCs.

3. AIR QUALITY STANDARDS, OBJECTIVES, AND GUIDELINES

Air quality standards and objectives are generally intended to protect all members of the general public, including sensitive individuals such as the elderly, infants, and persons with compromised health. Therefore, standards are applicable in areas that are accessible to the general public. Air quality modelling predictions are typically compared to standards and objectives at the fence line of the industrial property where emissions occur. A fence line is defined as the limit beyond which public access is restricted, the fence line is included in the approved Model Plan (Appendix A).

Air quality standards or criteria for industrial settings are defined by occupational health and safety codes. Occupational health air quality standards and criteria allow for higher concentrations of air contaminants because working individuals are assumed to be of reasonably good health and therefore have higher tolerance than sensitive receptors, personal protective equipment is used if provided and exposure is limited to the time spent at the workplace. It is very unlikely that members of the public will be in areas affected by the Project for any extended period of time, therefore the effects assessment using daily and annual standards and objectives as threshold values for the general public is very conservative.

The management of air quality across Canada requires collaboration between multiple governmental levels, including federal, provincial, regional and municipal. At the top tier the federal government issued the *Canadian Environmental Protection Act* (1999) which came into force in March 2000. This act is the main federal legislation for air quality. The federal government has set National Ambient Air Quality Objectives (NAAQOs) and Canadian Ambient Air Quality Standards (CAAQS). CAAQSs are intended to be achievable targets that will reduce health and environmental risks within a specific timeframe, whereas NAAQOs identify benchmark levels of protection for people and the environment. Within the NAAQO three objective values have been recommended; maximum desirable, maximum acceptable and maximum tolerable. New CAAQS for $PM_{2.5}$ were adopted in 2013 and will be effective from 2015 and 2020. The Project is expected to be operational in 2020, however the British Columbia objective is more stringent than the 2020 value and has therefore been used for this assessment.

At a provincial level, British Columbia (BC) has also developed air quality objectives for a number of contaminants under the *Environmental Management Act* which came into force in July 2004. Within BC, the three tiers of Ambient Air Quality Objectives have been established (Level A, Level B and Level C). These are broadly comparable to the desirable, acceptable and tolerable definitions given above for the Federal objectives.

Other air quality objectives relevant to this Project are the Pollution Control Objectives developed for the Mining, Smelting, and Related Industries of British Columbia (BC MOE 1979). These include dustfall objectives ranging from 1.7 to 2.9 $mg/dm^2/day$, averaged over 30 days (BC MOE 1979).

The relevant federal and provincial ambient air quality criteria are summarized in Table 3.1-1.

Table 3.1-1. Federal and Provincial Ambient Air Quality Criteria

		Canada			British Columbia		
		National Ambient Air Quality Objectives[a]		Canadian Ambient Air Quality Standards[b]	Provincial Air Quality Objectives[c]		Pollution Control Objectives[d]
Pollutant	Averaging Time	Maximum Desirable	Maximum Acceptable		Level A	Level B	
SO_2 (μg/m^3)	1-hour	450	900	-	450	900	-
	24-hour	150	300	-	160	260	-
	Annual	30	60	-	25	50	-
NO_2 (μg/m^3)	1-hour	-	400	-	-	-	-
	24-hour	-	200	-	-	-	-
	Annual	60	100	-	-	-	-
CO (μg/m^3)	1-hour	15,000	35,000	-	14,300	28,000	-
	8-hour	6,000	15,000	-	5,500	11,000	-
TSP (μg/m^3)	24-hour	-	120	-	150	200	-
	Annual	60	70	-	60	70	-
PM_{10} (μg/m^3)	24-hour	-	-	-	50		-
$PM_{2.5}$ (μg/m^3)	24-hour	-	-	28[e] (2015) and 27[e] (2020)	25[f]		-
	Annual	-	-	10[g] (2015) and 8.8[g] (2020)	8[h]		-
Dust deposition (mg/dm^2/day)	30-day	-	-	-	-	-	1.7

Notes: (-) dash indicates not applicable
[a] *Environment Canada (1999).*
[b] *CAAQS adopted in 2013 and will be in effect from 2015 and 2020 (CCME 2012).*
[c] *BC MOE (2013).*
[d] *Mining, Smelting, and Related Industries of British Columbia (BC MOE 1979).*
[e] *The 3-year average of the annual 98th percentile of the daily 24-hour average concentrations.*
[f] *Based on annual 98th percentile value.*
[g] *The 3-year average of the annual average concentrations.*
[h] *BC objective of 8 µg/m3 and planning goal of 6 µg/m3 was established in 2009 (BC MOE 2009).*

In addition to the federal and provincial regulation, there is also a BC Model Guideline (BC MOE 2008a). The guideline is intended to provide information for practitioners and for those who use model outputs for decision-making. Details on model approach for source type, model domain and receptor spacing, and interpretation of the model output are provided in the document. The Model Guidelines states a Conceptual Plan, which provides an overview of the planned air quality assessment, should be provided to the Ministry so that the general modelling approach is agreed to before work is started. The Project's Air Dispersion Conceptual Model Plan (Appendix A, Conceptual Model Plan) was prepared based on the best practices from the BC Model Guideline and was approved on April 9, 2014.

4. BACKGROUND AIR QUALITY

4.1 REGIONAL OVERVIEW

The air quality in the area proposed for the Project and elsewhere in northeastern BC is mainly unaffected by anthropogenic sources, reflecting the region's remoteness and the localized nature of anthropogenic air emissions. Anthropogenic sources within the region include the town of Tumbler Ridge and other coal mines, however due to the localized nature of anthropogenic air emissions the air quality in the region is considered to be good.

4.2 BASELINE STUDY

Baseline or background air quality data represent ambient air concentrations prior to the Project commencement due to emissions from both natural and anthropogenic sources (BC MOE 2008a). Understanding the existing ambient air quality allows a quantitative assessment of the potential effects of the project-related air contaminant emissions to be undertaken.

Continuous ambient monitoring equipment requires a steady power supply. This can be challenging in remote areas, which means that background air quality data in north east BC is limited. Due to these challenges, Project specific air quality monitoring has been restricted to passive dustfall monitors.

In the absence of local monitoring data, the BC Modelling Guideline recommends that monitoring data gathered from similar sources and meteorological conditions be used. As such, the existing air quality in the area has been determined from available monitoring data from representative stations and a literature review of other air quality studies in the area. The 2011 Air Quality Baseline Report provides details of available monitoring data in the area (Rescan 2011).

Dustfall monitoring was carried out at five sites from May to October 2011. The results ranged from 0.17 to 1.64 mg/dm^2/day (Rescan 2011). All the samples were below the lower BC MOE limit of 1.7 mg/dm^2/day. The background dust deposition level, calculated as the 98th percentile of measurements taken, was determined to be 1.2 mg/dm^2/day.

For sulphur dioxide and nitrogen dioxide, a background concentration of zero was applied, as recommended by BC MOE, while a background concentration of 232 µg/m^3 was recommended for carbon monoxide. These background values are included in the approved Model Plan (Appendix A).

For TSP, PM_{10} and $PM_{2.5}$, BC MOE recommended using data from a local monitoring site. A 24-hour ambient PM_{10} and $PM_{2.5}$ monitoring station was installed for one year from November 2011 at the Tumbler Ridge Community Centre, however data is not publically available. The two nearest ambient PM_{10} and $PM_{2.5}$ monitoring stations with publically available data are located at the Tumbler Ridge Airport and the Tumbler Ridge Industrial Park. Monitoring at Tumbler Ridge Industrial Park was carried out from August 2008 through November 2008, and monitoring at

Tumbler Ridge Airport data was carried out from September 2006 to November 2008. Both measured 24-hour ambient PM_{10} and $PM_{2.5}$ concentrations every three days (Stantec 2012). At Tumbler Ridge Industrial Park levels were substantially higher than at Tumbler Airport and exceedances of applicable PM_{10} and $PM_{2.5}$ objectives were observed. The high concentrations were attributed to the monitor's close proximity to the parking area, which is a large source of PM emissions from the heavy vehicle traffic. This data is not considered representative of the current Project site conditions, therefore monitoring data from Tumbler Ridge Airport was used. Tumbler Airport did not measure TSP concentrations, therefore the AP-42 aerodynamic particle size multiplier for aggregate handling (U.S. EPA 2006b) was used to convert PM_{10} amounts to TSP values. These same background TSP, PM_{10} and $PM_{2.5}$ values were also used in the Roman Coal Mine Environmental Assessment Report and the Quintette Coal Mine Restart Project (PRC 2010; Stantec 2012).

The background concentrations used in the model are shown in Table 4-2.1.

Table 4-2.1. Assumed Background Air Contaminant Concentrations

Air Contaminant (μg/m³)	Averaging Period	Assumed Background Concentration	Source
Sulphur Dioxide (SO_2)	30 day	0	BC MOE (2014)[a]
Nitrogen Dioxide (NO_2)	30 day	0	BC MOE (2014)[a]
Carbon Monoxide (CO)	Annual	232	BC MOE (2014) [a]
PM_{10}	24 hour	21.4	Tumbler Airport (98th percentile concentrations)
$PM_{2.5}$	24 hour	10.9	Tumbler Airport (98th percentile concentrations)
	Annual	3.3	Tumbler Airport (average of all observed concentrations)
Total Suspended Particulates (TSP)	24 hour	45.2	Determined by converting PM_{10} values at Tumbler Airport to TSP values by applying the AP-42 aerodynamic particle size multiplier for aggregate handling (U.S. EPA 2006b).
	Annual	12.5	
Total Dustfall (mg/dm²/day)	30 day	1.2	On site monitoring (98th percentile concentrations).

[a] *D. Fudge(personal communication, January 17, 2014)*.

5. EMISSIONS INVENTORY

An emissions inventory was prepared for the air quality modelling study which was then used as an input for the air dispersion model. The objective of the emissions inventory was to estimate maximum air emissions of air contaminants from Project activities.

The emissions inventory has been generated from manufacturers' specifications when available, the United States Environmental Protection Agency AP-42 emission factors (US EPA 1995), NONROAD2008 model emission standards (US EPA 2008) and from data provided by the Project engineers.

5.1 EMISSIONS SOURCES

The air emissions associated with the Project within the modelling domains are outlined below:

- Stack emissions from boilers;
- Stack emissions from coal dryer;
- Emissions from underground mining activities through air raises;
- Equipment exhaust emissions from vehicles such as dozers, haul trucks, forklifts, graders, and fuel trucks;
- Exhaust emissions from rail idling;
- Fugitive dust on unpaved roads from vehicles travelling on onsite roads;
- Fugitive dust from stockpiles;
- Fugitive dust from material handling; and
- Fugitive dust emissions from mining activities such as bulldozing and grading.

Each of the emission sources are discussed below. Appendix B provides details of the emissions sources included in the inventory, the emission factors used and the source of each emission factor.

5.1.1 Boilers

There will be seven boilers used during the operation phase, three at the CPP and four at the Decline Site. Pollutants from the boilers include NOx, SO_2, CO, TSP, PM_{10} and $PM_{2.5}$. Emission rates for the boilers were taken from AP42, Chapter 1.4, calculated on the basis of fuel usage (US EPA 1998a). Particulate emission factors were assumed to be the same for TSP, PM_{10} and $PM_{2.5}$. The boilers at the CPP will be operational for 208 days a year and the boilers at the Decline Site will be operational for 365 days a year, however as a conservative approach, all boilers were assumed to be running 24 hours a day, seven days a week throughout the year.

5.1.2 Coal Dryer

Pollutants from the wet deduster include TSP, PM_{10} and $PM_{2.5}$. TSP emission rates from the wet deduster were provided by Taggart Engineering, who developed the CPP design and the ratio of TSP to PM_{10} and $PM_{2.5}$ were calculated using data from AP-42, Appendix B.2 (US EPA 1996).

5.1.3 Emissions from Underground Mining Activities through Air Raises

Coal is cut from the coal face by the shearer or road-header under the action of sprays, the purpose of which is to eliminate fugitive dust. Coal from the longwall faces passes through an enclosed sizing roller to facilitate transport on the conveyor belts. Attached sprays are designed to eliminate fugitive dust. Sprays at all conveyor transfer points are designed to eliminate fugitive dust. By design, the majority of the fugitive dust will be wetted and removed from the air stream before the air exits the mine through the return shaft.

The quantities of dust and diesel particulate matter are regulated by the health provisions of the Health, Safety and Reclamation Code for Mines in British Columbia (BC 2008b), and best mining practises. Coal dust, respirable dusts and silica are restricted to 2, 1.5 and 0.1 mg/m^3 respectively and operational procedures are designed to keep dust levels well below statutory minima.

Diesel exhaust treatments on modern EPA compliant underground coal mine diesel engines can remove 99% of the soot and sulphates, reduce CO emissions by 90% and reduce overall DPM by 96% (Dry System Technologies, 2014). The remaining diesel emissions are diluted by the same air volumes required to dilute and remove methane and are discharged into the airstream which leaves the exhaust shaft.

5.1.4 Equipment Exhaust Emissions

Diesel-powered mining equipment such as loaders, dozers, as well as on-road transport trucks, are all sources of CACs. Emission rates depend on factors such as the engine size (i.e., horsepower rating), emissions control equipment, age of the equipment and sulphur fuel content for SO_2 emissions.

US EPA has developed the NONROAD2008 model to provide emissions factors for predicting accurate and reproducible nonroad emissions inventories (US EPA 2008). NONROAD2008 provides emission estimates based on fuel-use in a diverse collection of vehicles and equipment. Air emissions from the diesel equipment were based on the horsepower (hp) rating and utilization factor for each piece of equipment and emission factors from the NONROAD2008 model. Equipment lists, including operating hours, were supplied by HD Mining, Ausenco and Taggart (Appendix B).

5.1.5 Rail

The rail loadout is expected to be used 330 days a year, with an average of two round trips per day. Each train will take approximately six hours to load, therefore for 12 hours a day there will be a train idling at the loadout. As a conservative assumption, rail idling emission rates were based on a Tier 1 GE AC4400 engine. Rates were obtained from the US EPA Locomotive Emission Standards

Regulatory Support Document (1998b). As a worst case approach the rail idling emissions were assumed to be constant throughout the year.

5.1.6 Unpaved Roads

In addition to tailpipe emissions due to fuel combustion, equipment may also create fugitive dust emissions. When vehicles travel on an unpaved surface, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The increase in traffic on the local roads is minimal as the raw coal is being conveyed underground to the Coal Processing Plant, which is situated beside the rail load out. Personnel will be bussed to site from Tumbler Ridge, and they will use the existing highway and Forest Service Road. There will also be a small number of vehicles used for fuel and equipment transport.

For vehicles travelling on an unpaved road, the fugitive dust emissions are a function of the road surface silt content and the mean vehicle weight. All roads are subject to some natural mitigation, because of precipitation and snow cover. The number of days in a year with at least 0.254 mm (0.1 in) of precipitation is considered in the emission estimation. The precipitation and snow cover data from the Murray River meteorological station was used. The emissions were not corrected for any anthropogenic dust controls such as road watering or chemical spray.

5.1.7 Stockpile Wind Erosion

During periods of high winds, wind-blown coal dust from the open stockpiles may be a source of emissions. Meteorological conditions, frequency and extent of pile disturbances, silt content, and moisture levels are the most important factors in determining the magnitude of wind-blown dust from stockpiles.

The fastest mile method was used to estimate emissions from open stockpiles using the magnitude of wind gusts (US EPA 2006b). For an uncrusted coal pile, assuming threshold friction velocity of 1.12 m/s and roughness height of 0.3 cm, as suggested by the US EPA, wind erosion occurs only when wind speeds exceed 21 to 23 m/s at 10 m above ground. For fine coal dust on a concrete pad, assuming threshold friction velocity of 0.54 m/s and roughness height of 0.2 cm, as suggested by the US EPA, wind erosion occurs only when wind speeds exceed 10 to 11 m/s at 10 m above ground. The maximum hourly wind speed collected at the Murray River meteorological station was 20.8 m/s, however this occurred in December when the piles will be frozen and therefore not a significant source of dust. The second highest wind speed of 19.7 m/s occurred in April 2011. In order to trigger wind erosion on unpaved coal piles, the instantaneous wind speed has to be greater than 21 m/s, therefore emissions from the uncrusted coal piles were not included in the modelling. However, emissions from the material drop onto the stockpiles have been included (details of the material handling methodology are provided in Section 5.1.7). In order to trigger wind erosion on uncrusted coal piles, the instantaneous wind speed has to be greater than 10 m/s, therefore emissions from the fine coal dust on a concrete pad were included in the modelling.

TSP, PM_{10} and $PM_{2.5}$ emissions for wind erosion and maintenance of active coal storage piles were calculated using the emission factor from AP-42, Section 11.9 (US EPA 1998c). The TSP emission factors consider maintenance of active coal stockpiles (recontouring, loading), therefore it was assumed emissions associated with pile disturbances from loading activities would be accounted for in the emission calculation. The particle size multipliers from AP-42, Section 13.2.5 for PM_{10} and $PM_{2.5}$ were applied to calculate emissions of fine particulates (US EPA 2006c).

All the stockpiles will be watered in order to minimise dust. A control efficiency of 75% was applied to all the stockpile wind erosion emission rates (US EPA 1984). The stockpiles are likely to be frozen during the winter months, however as a worst case approach the emissions were modelled for the whole year.

5.1.8 Material Handling

The material is proposed to be transported underground, wherever possible, and where overland transport is required, covered conveyors will be used. Coal handling activities at the mine site include: loading of raw coal onto the conveyor, eight transfer points along the length of the conveyor, loading and unloading of coal in the coal storage areas, and loading of trains. The length of the conveyor will be covered and the transfer points are all located within buildings and are therefore expected to produce minimal emissions. The two areas where potential emissions have been identified are the loading of the coal at the railway loading station and the drop from the conveyor to the CCR area.

Emission factors provided in US EPA AP-42, Section 13.2.4 (2006b) were used to calculate particulate emissions for the drop from the conveyor to the CCR area. Emission factors provided in US EPA AP-42 Section 11.19.2 (2004) were used to calculate particulate emissions for the loading of the coal at the railway loading station. There are no emission factors specific for conveyor transport of coal, therefore, particulate emissions of TSP, PM_{10} and $PM_{2.5}$ were calculated using factors for crushed stone conveyor transfers. The controlled conveyor transfers point emission rates were used as sprays will be used to reduce dust emissions.

5.1.9 Equipment Activities

In order to calculate emissions from equipment activities, emission factors provided in US EPA's AP-42, Section 11.9 (US EPA 1998c) were applied. Fugitive dust emissions were calculated for grading and bulldozing activities.

There is not expected to be any surface blasting or drilling and therefore these activities will not impact on local air quality and have not been included in the assessment.

5.1.10 Emission Estimation Limitations

The emission factors from US EPA AP-42 used in the calculation of emission rates have varying degrees of confidence levels. Every effort was made to use site-specific correction parameters so that the highest data quality rating could be achieved, however there is a degree of uncertainty associated with the predicted emission rates. Mining operations were considered at maximum handling rates and in many cases include equipment operating continuously. This high level of activity is unlikely and therefore this is a conservative approach.

Fugitive dust sources were modelled separately from other sources of TSP, PM_{10} and $PM_{2.5}$. The rational for this is that there are larger uncertainties associated with fugitive dust emission factors from AP-42. Fugitive dust sources are also expected to have the highest contribution of TSP, PM_{10} and $PM_{2.5}$, therefore by modelling the fugitive and non-fugitive sources separately the contribution of the different sources can be analysed.

5.2 EMISSION SUMMARY

Table 5.2-1 presents the total emissions for each of the various sources. The largest contributor to NO_x, SO_x and CO emissions, is the underground exhaust emissions, followed by the boiler emissions. The equipment emissions only contribute a very small fraction of these emissions. The unpaved road dust and coal dryer have the most significant contribution to TSP, PM_{10} and $PM_{2.5}$ emissions.

Table 5.2-1. Emissions Summary

Sources	Emissions (t/y) CAC					
	NO_x	SO_x	CO	TSP	PM_{10}	$PM_{2.5}$
Coal Dryer	-	-	-	46.7	41.2	27.4
Boilers	32.0	0.2	26.9	2.4	2.4	2.4
Equipment	8.1	0.0	2.7	0.4	0.4	0.4
Road dust	-	-	-	47.0	12.1	1.2
Grading	-	-	-	1.6	0.5	0.0
Bulldozing	-	-	-	10.6	2.7	0.4
Stockpiles	-	-	-	16.5	8.3	1.2
Material handling	-	-	-	1.2	0.4	0.1
Underground	68.1	59.0	329.2	22.7	22.7	17.0
Rail	6.5	0.0	2.2	0.2	0.2	0.2
Total	**108.2**	**59.3**	**358.8**	**149.2**	**90.7**	**50.3**

Table 5.2-2 presents the TSP, PM_{10} and $PM_{2.5}$ emissions associated with non-fugitive and fugitive sources, and also the emissions attributed to coal and non-coal sources. There are a similar proportion of emissions from fugitive and non-fugitive sources for TSP, whereas for PM_{10} and $PM_{2.5}$ non-fugitive sources are the largest contributor. The main source of non-fugitive coal dust is the coal dryer and the main source of fugitive coal dust are the stockpiles.

Table 5.2-2. Emissions Summary

Sources	Emissions (t/y)		
	TSP	PM_{10}	$PM_{2.5}$
Non-fugitive dust - non-coal	2.9	2.9	2.9
Non-fugitive dust -– coal	69.4	63.9	44.5
Fugitive dust - non-coal	48.6	12.6	1.3
Fugitive dust -– coal	28.4	11.3	1.7
Total	**149.2**	**90.7**	**50.3**

6. MODELLING METHODOLOGY

6.1 MODEL SELECTION

The CALPUFF air dispersion modelling system (US EPA approved version 5.8.4), run in ISC mode, was chosen for the modelling study. The CALPUFF modelling system is a non-steady-state Lagrangian Gaussian air quality modelling system for regulatory use.

The US EPA has promulgated the use of CALPUFF for long range dispersion model studies and for near field studies on a case-by-case basis (US EPA 2003). CALPUFF offers considerable flexibility with respect to meteorological, geo-physical and emissions inputs.

There is inherent uncertainty associated with the use of any model as real world processes, such as atmospheric conditions, are simplified. In general, air dispersion models accurately but conservatively predict atmospheric concentrations and deposition levels so that model results are often interpreted with the understanding that the predicted effects are likely overestimated.

6.2 MODEL DOMAINS AND RECEPTORS

The model domain encompasses the coal processing plant, the shaft site and the decline site, with boundaries of 10 km east, south and west from infrastructure and 15 km north of the infrastructure (to include the District of Tumbler Ridge) (Figure 2.2-1). The size of the modelling domain was established such that the majority of air contaminant species would approach background concentrations within the modelling domain. For species with predicted maximum concentrations that were well above background concentrations, it was ensured that areas of potential exceedances of standards and objectives were well within the modelling domains.

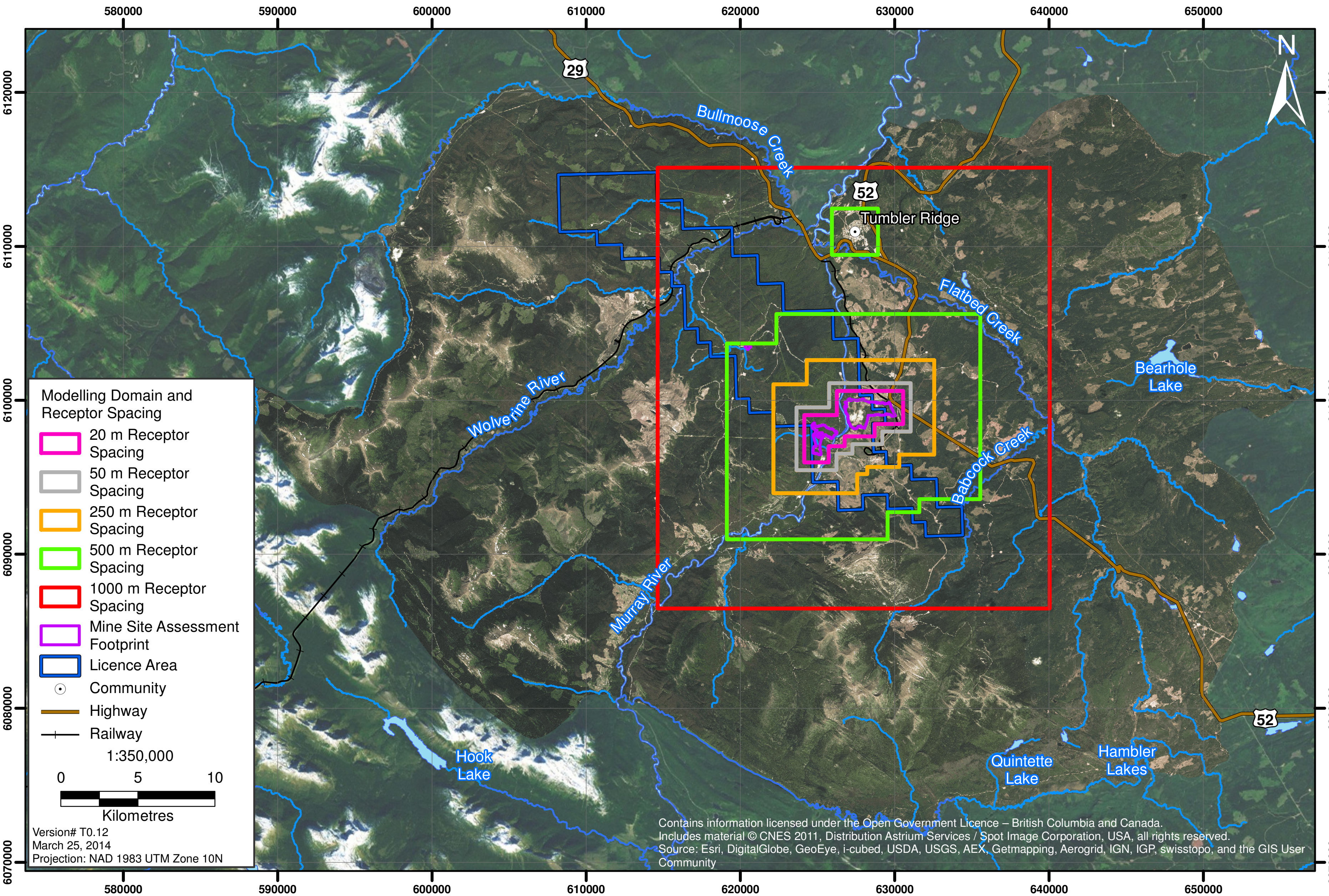
A Cartesian grid of discrete receptors was applied with the following spatial resolution, as suggested in the BC Model Guideline (2008a):

- 20 m spacing along the boundary of the Project;
- 50 m spacing within 500 m of the Project boundary;
- 250 m spacing within 2 km of the Project boundary;
- 500 m spacing within 5 km of the Project boundary, and also a 3 by 3 km area encompassing Tumbler Ridge; and
- 1000 m spacing beyond 5 km of the Project.

Additional receptors were also chosen in order to support the information required for other subjects (e.g., Human Health and Terrestrial Ecosystems). Receptor locations were determined using baseline data. The human health receptors included a worst case receptor in Tumbler Ridge, located at the Health Centre in the southeast of the city. Suitable receptors were also selected from other environmental assessments for neighbouring projects to support the cumulative effects assessment.

Figure 6.2-1 presents the air dispersion modelling domain and the receptor grid selected for the model runs.

Figure 6.2-1
Model Domain and Receptor Locations



6.3 MODEL INPUT PARAMETERS

6.3.1 Meteorological Input Data

Air dispersion models require input of meteorological data to generate a model meteorological field from which air dispersion characteristics are calculated. Site specific or local observed surface and upper air meteorological data are preferred as model inputs. Typically, hourly records of various meteorological parameters are required. For projects located in remote regions local or regional meteorological data is often limited or unavailable, particularly upper air data (BC MOE 2008a).

The site-specific meteorological monitoring program for the Project began in 2011 with the commissioning of the Murray River meteorological station. The climatic variables monitored by the meteorological station are air temperature, precipitation as rainfall, solar radiation, wind speed and wind direction (ERM Rescan 2014). CALPUFF was run using meteorology data for the period of January through December, 2012.

CALPUFF can utilize CALMET three-dimensional meteorological fields or ISCST3 steady-state Gaussian model derived from single-station winds. The project is located in an area of uniform terrain with rolling hills (729 to 1,815 masl); therefore, CALPUFF in the simplified ISC mode is considered sufficient for this assessment. The methodology was proposed in the approved Conceptual Model Plan. The modelling was conducted for 2012 as it was the most recent year with a complete year of meteorological data available.

ISC mode will be used which requires the following meteorological parameters:

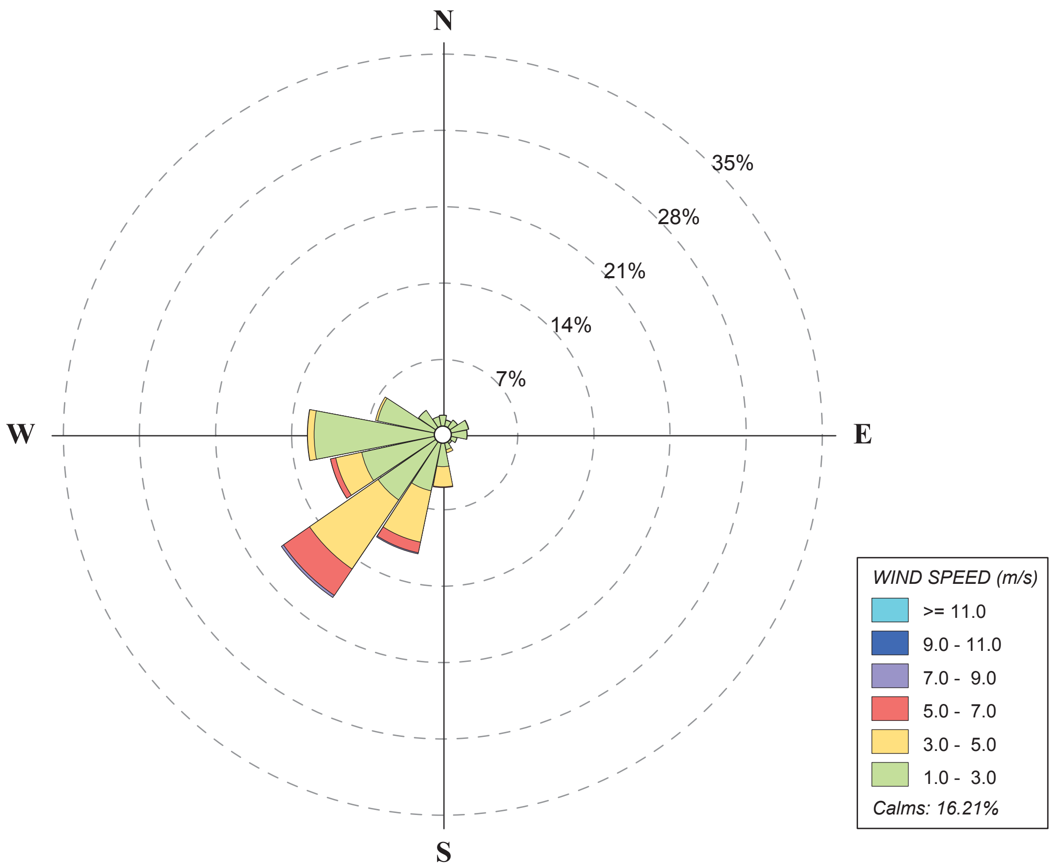
- Wind direction;
- Wind speed;
- Temperature;
- Pasquill-Gifford (PG) atmospheric stability class; and
- Mixing height.

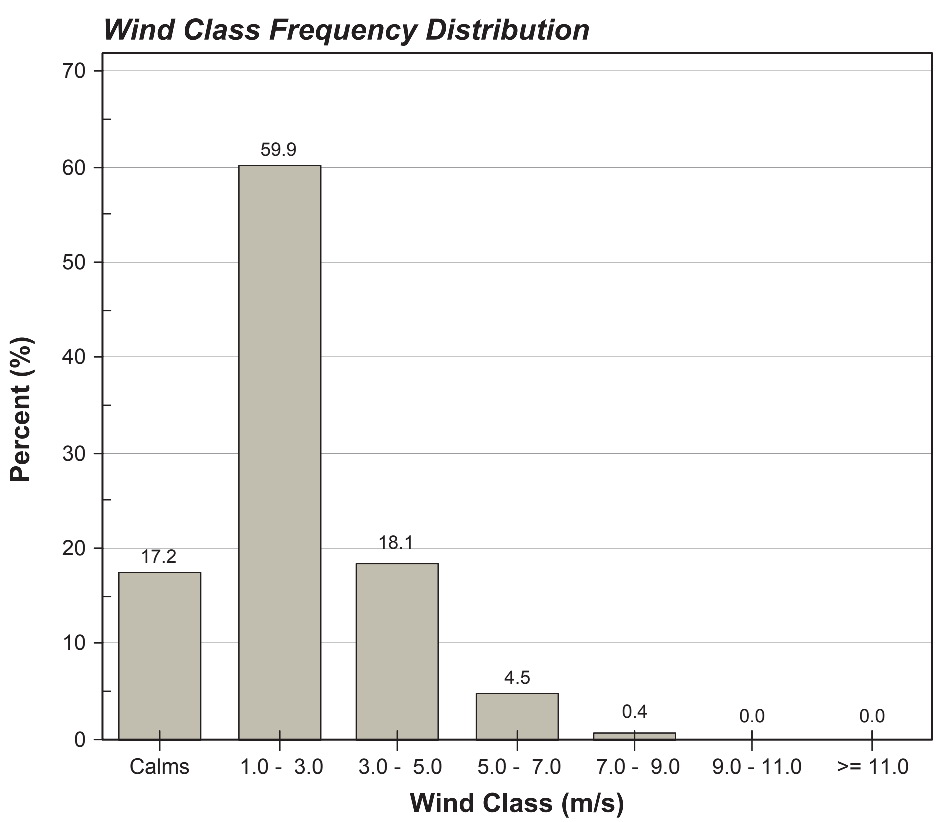
6.3.1.1 Wind Direction/Speed

Wind direction and wind speed were obtained from the Murray River meteorological station. The height of the anemometer is 10 m, and therefore suitable for modelling purposes. Figure 6.3-1 shows the 2012 wind rose and frequency distributions for Murray River Meteorological Station. Meteorological data from Tumbler (Denison) station operated by the BC Forest Service Protection, Chetwynd Airport (ID 1181508) by EC MSC, and Dawson Creek Airport (ID 1182289) by EC MSC were used in the data QA/QC process in preparation of creating meteorology data for the model. Linear interpolation was used to fill missing wind speed. Winds less than 1 m/s were adjusted to 1 m/s as per BC Model Guideline (BC MOE 2008a).

Figure 6.3-1

Murray River Meteorological Station Wind Data, 2012





6.3.1.2 *Temperature*

Temperature data was obtained from the Murray River meteorological station.

6.3.1.3 *Mixing Heights*

Mixing heights were calculated using methods outlined in Appendix A of the BC Model Guideline (BC MOE 2008a). In this method, the mechanically mixed layer heights can be calculated based on 10-metre-level wind speed and latitude of the location.

6.3.1.4 *Atmospheric Stability*

Atmospheric stability is the tendency for air to rise and fall without direct forcing. A stable atmosphere is one where the atmosphere inhibits vertical motion, and is a concern to air quality as pollutants cannot be dispersed vertically. An unstable atmosphere is one where the atmosphere promotes vertical motion helping to disperse any pollutants. The Pasquill-Gifford (P-G) stability class is an atmospheric stability classification scheme which ranges from Class 1 (Very Unstable) to Class 6 (Stable). This stability class is required by the CALPUFF model due to its large influence on air pollution dispersion.

The P-G stability class was estimated based on turbulent fluctuation measures outlined in Section 7.6.3 of the BC Model Guideline (BC MOE 2008a).

6.3.2 Buildings

The presence of large buildings near point emission sources may influence ground level concentrations of air pollutants because of the building downwash effect. Building downwash occurs when the aerodynamic turbulence induced by nearby buildings cause a pollutant emitted from an elevated source to be mixed rapidly toward the ground (downwash), resulting in higher ground level concentrations. All the buildings on site were included in dispersion modelling with the Building Profile Input Program (BPIP). The building heights used in the building downwash effect are shown in Table 6.3-1.

Table 6.3-1. Building Dimensions

Name	Height (m)	X length (m)	Y length (m)	Name	Height (m)	X length (m)	Y length (m)
"Baby decline" portal	4.5	12.0	30.0	Separating and breaking building	41.5	14.0	48.0
Ventilation Heater (west)	4.5	8.0	15.0	Main plant	28.7	24.0	72.0
Ventilation Heater (2)	4.5	8.0	15.0	Flotation/filter building	23.3	23.0	72.5
Hoist house	12.5	20.0	20.0	Dry building	22.0	48.0	16.5
Hoist house power distribution room	5.0	20.0	8.0	Tailing-coal filter press building	19.3	21.0	45.5

(continued)

Table 6.3-1. Building Dimensions (completed)

Name	Height (m)	X length (m)	Y length (m)	Name	Height (m)	X length (m)	Y length (m)
Garage	3.9	9.0	6.0	Thickener Pump room	10.5	8.4	12.7
Equipment Warehouse, Grease depot and Rock Power Storeroom	4.8	21.0	51.0	Air compressor room and Medium warehouse (magnetite room)	5.6	8.4	51.5
Office, lamproom, and bathroom building	9.6	19.5	69.0	Power room of separating and breaking building	11.2	12.0	26.0
Gas boiler room	7.5	19.8	33.0	Power room of main plant	15.0	15.0	30.0
Mine Repair Shop	8.5	15.0	84.5	Joint building (Office Area)	5.8	35.0	9.0
Distribution control room of 230 kv substation	10.1	41.4	10.5	Boiler room	8.0	33.0	22.0
230 substation generator room	6.0	8.5	27.5	Boiler room	8.8	12.0	30.0
Fire fighting material warehouse	4.8	15.0	12.0	Thickener building (north)	10.0	35	
Rescue team and fire fighting station	7.8	24.0	12.0	Thickener building (south)	10.0	35	

6.3.3 Emission Sources

Three types of emission sources were included in the model, point sources, volume sources and area sources. The point sources model input parameters are listed in Table 6.3-2. Stack height, exhaust temperature and velocity were provided by the Project engineers, Taggart.

The equipment and mine activity sources were modelled as volume sources and area sources and are listed in Table 6.3-3 and 6.3-4. Area emission rates in $g/s/m^2$ were calculated by dividing instantaneous emission rates, by the area. Due to limitations in the area source module in CALPUFF, the area is restricted to being a five-sided polygon.

6.3.4 CALPUFF Switches

The CALPUFF switches configure the method and assumptions used in the model. The CALPUFF model switches used in the Project are detailed in Table 6.3-5. All of the switches were configured in accordance with the BC Model Guideline (BC MOE 2008a).

Dust deposition was calculated using deposition velocities during post processing, rather than modelled directly in CALPUFF. This approach was included in the approved Conceptual Model Plan (Appendix A) and further ensures conservative values for dustfall and particulate concentrations as this method does not reduce particulate levels as it is removed from the air in the form of dustfall.

Table 6.3-2. Implementation of Point Sources

Emission Source	Location	UTM Coordinates		Stack Height (m above ground)	Stack Inner Diameter (m)	Velocity m/s	Exhaust Temperature (°C)	Emission Rates (g/s)					
		(mE)	(mN)					NO_x	SO_x	CO	TSP	PM_{10}	$PM_{2.5}$
Coal dryer	Coal Processing Site	628939	6099286	30	2	15.9	70	n/a	n/a	n/a	5.0	4.4	2.9
CPP Boiler stack #1	Coal Processing Site	628633	6099240	15	0.6	10.0	180	0.213	0.001	0.179	0.016	0.016	0.016
CPP Boiler stack #2	Coal Processing Site	628624	6099239	15	0.6	10.0	180	0.213	0.001	0.179	0.016	0.016	0.016
CPP Boiler stack #3	Coal Processing Site	628641	6099240	15	0.6	10.0	180	0.213	0.001	0.179	0.016	0.016	0.016
South Site Boiler stack #4	Decline Site	624857	6096907	15	0.6	7.6	180	0.162	0.001	0.136	0.012	0.012	0.012
South Site Boiler stack #5	Decline Site	624877	6096902	15	0.6	7.6	180	0.162	0.001	0.136	0.012	0.012	0.012
South Site Boiler stack #6	Decline Site	624856	6096900	15	0.6	7.6	180	0.162	0.001	0.136	0.012	0.012	0.012
South Site Boiler stack #7	Decline Site	624875	6096895	15	0.6	7.6	180	0.162	0.001	0.136	0.012	0.012	0.012
Initial Shaft	Decline Site	625297	6098325	0	6.5	5.4	20	1.1	0.9	5.2	0.4	0.4	0.3
Secondary Shaft	Secondary Site	620409	6103503	0	6.5	5.4	20	1.1	0.9	5.2	0.4	0.4	0.3
Rail	Coal Processing Site	630008	6099141	4.6	1.0	1.0	147	0.5	0.0	0.2	0.01	0.01	0.01

Table 6.3-3. Implementation of Volume Sources

Emission Source	Location	Effective Height (m)	Length of Side (m)	Emission Rate (g/m^3-s)					
				NO_x	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Material handling	CCR pile	2	7	n/a	n/a	n/a	0.001	0.001	0.0001
	Rail loadout	1.5	1	n/a	n/a	n/a	0.07	0.022	0.006

Table 6.3-4. Implementation of Area Sources

Emission Source	Location	Modelled Area (m^2)	Emission Rate (g/m^2-s)					
			NO_x	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Vehicle Emissions (exhaust)	Shaft Site	78,621	1.0E-06	3.8E-09	3.5E-07	5.7E-08	5.7E-08	5.5E-08
	Decline Site	86,017	2.2E-07	9.7E-10	7.1E-08	9.7E-09	9.7E-09	9.4E-09
	South site road	91,982	3.7E-07	1.9E-09	1.2E-07	1.6E-08	1.6E-08	1.5E-08
	Shaft site road	17,321	2.9E-07	1.3E-09	9.3E-08	1.2E-08	1.2E-08	1.2E-08
	Decline site road	11,327	3.7E-07	1.9E-09	1.2E-07	1.6E-08	1.6E-08	1.5E-08
	CCR pile	407,012	5.8E-08	2.1E-10	1.8E-08	3.2E-09	3.2E-09	3.1E-09
	CPP plant	254,268	2.9E-07	9.2E-10	1.1E-07	2.0E-08	2.0E-08	1.9E-08
	CPP Road	21,869	6.5E-07	3.9E-09	2.1E-07	2.6E-08	2.6E-08	2.5E-08
Unpaved Road Dust (fugitive dust)	Shaft Site/Decline Site road	91,982	n/a	n/a	n/a	2.1E-05	5.5E-06	5.5E-07
	Shaft Site road	17,321	n/a	n/a	n/a	2.1E-05	5.5E-06	5.5E-07
	Decline Site road	11,327	n/a	n/a	n/a	2.1E-05	5.5E-06	5.5E-07
	Coal Processing Site Road	21,869	n/a	n/a	n/a	1.8E-05	4.6E-06	4.6E-07
Grading	Decline Site	86,017	n/a	n/a	n/a	2.9E-07	8.6E-08	9.1E-09
	Shaft Site	78,621	n/a	n/a	n/a	2.9E-07	8.6E-08	9.1E-09
Bulldozing	Coal Processing Site	519	n/a	n/a	n/a	1.8E-05	4.8E-06	4.0E-07
	CCR pile	3,115	n/a	n/a	n/a	1.2E-07	2.0E-08	1.2E-08
Stockpiles	Clean Coal #1 (North)	5,027	n/a	n/a	n/a	3.4E-05	1.7E-05	2.6E-06
	Clean Coal #2 (South)	5,027	n/a	n/a	n/a	3.4E-05	1.7E-05	2.6E-06
	Flotation Clean Dump Point	4,992	n/a	n/a	n/a	1.2E-05	5.9E-06	8.9E-07
	Midding coal dump point	4,788	n/a	n/a	n/a	2.5E-05	1.3E-05	1.9E-06

Table 6.3-5. CALPUFF Model Switch Settings

Parameter	Default	Project	Explanation and Justification
MGAUSS	1	1	
MCTADJ	3	3	
MCTSG	0	0	
MSLUG	0	0	
MTRANS	1	0	ISC method used
MBDW	2	2	
MTIP	1	1	
MSHEAR	0	0	
MSPLIT	0	0	
MCHEM	1	1	
MAQCHEM	0	0	
MWET	1	0	Deposition not modelled
MDRY	1	0	Deposition not modelled
MDISP	2 or 3	2	
MTURBVW	3	3	
MDISP2	2	2	
MROUGH	0	0	
MPARTL	1	0	ISC method used
MTINV	0	0	
MPDF	0 or 1	1	
MSGTIBL	0	0	
MBCON	0	0	
MFOG	0	0	
MREG	0	0	

6.4 MODEL RUN PARAMETERS

The output from the CALPUFF model is 1-hour average concentrations at each of the modelled receptor points, for each hour of meteorology included in the ISC data file. This assessment was based on a full year of meteorological data. Hourly data was then post-processed to determine the maximum predicted 1-hour average, 8-hour average, 24-hour average, monthly or annual concentrations at each of the receptors. The first highest concentration was determined for all pollutants. For $PM_{2.5}$ the seventh highest value was also calculated in order to calculate the 98^{th} percentile.

Fugitive dust sources were modelled separately from other sources of TSP, PM_{10} and $PM_{2.5}$. The rational for this is that there are large uncertainties associated with fugitive dust emission factors from AP-42. AP-42 emission factors were used for fugitive dust emissions from unpaved roads, stockpiles, material handling, grading and bulldozing. Fugitive dust sources are also expected to have the highest contribution of TSP, thereby by modelling the fugitive and non-fugitive sources separately the contribution of the different sources can be analysed.

Several assumptions were used in the modelling study to ensure that predicted concentrations of air contaminants would reflect a reasonably conservative scenario. Many of the emissions sources for the Project would not be active 24 hours a day, however, it was assumed that estimated maximum emissions occurred continuously throughout the year. This assumption was made to ensure that maximum hourly emissions would coincide with the meteorological conditions that were least ideal for dispersion. While this approach may result in reasonable estimates of maximum hourly ambient air contaminant concentrations, the predicted 24-hour and annual average concentrations are overestimated.

6.5 MODEL RUN POST PROCESS

6.5.1 Nitrogen Dioxide

In CALPUFF, NO_2 emissions are modelled as NO_X emissions. NO_X from internal combustion sources is mainly comprised of NO gas (approximately 90%) with approximately 5% to 10% NO_2 and smaller quantities of other oxides of nitrogen. In the atmosphere, ozone readily oxidizes NO to NO_2. A NO_x to NO_2 conversion rate of 50% was used (Conceptual Model Plan, Appendix A).

6.5.2 Dust Deposition

Dust deposition was calculated using deposition velocities during post processing, rather than modelled directly in CALPUFF. This approach was included in the approved Conceptual Model Plan. A deposition velocity of 1.67 cm/s was applied to the modelled TSP concentrations (Tombach and Brewer, 2005). This deposition velocity has also been used in other studies in the area (Teck Coal Limited 2011; RWDI 2012). By applying deposition velocities during post processing, rather than modelling deposition, the concentrations modelled in CALPUFF are larger as deposition will not have been taken into account.

6.5.3 Metals and Acid Deposition

A portion of the fugitive dust concentrations predicted by the model will be comprised of metals such as iron, aluminium and calcium. As an approximate approach, and in the absence of detailed metals analyses from all dust deposition sources, metals content in the rock was applied to dust concentration results. Metal proportions in rock were available from baseline samples. Results from the metal content of fugitive dust were used to inform the assessment of Human Health and Terrestrial Ecosystems VCs.

Acid deposition primarily occurs as a result of atmospheric oxidation of sulphur dioxide to sulphate (sulphuric acid) and oxidation of nitrogen dioxide to nitrate (nitric acid). Acid deposition can be quantified as potential acid input, which is a measure of the combined input of sulphur and nitrogen derived acid species. Acid deposition values were calculated using the approach outlined in AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air was used (Environment Agency 2006). Acid deposition results were used to inform the assessment of Terrestrial Ecosystems VCs.

7. MODELLING RESULTS

As discussed in Section 3, ambient air quality standards are applicable to the area beyond the fence line. The concentrations within the fence line fall under the occupational health and safety (OH&S) regulations and not under ambient air quality standards/objectives.

The maximum air contaminant concentrations resulting from the Project emission scenarios are presented in Table 7.1-1. A discussion of these results for each scenario is presented in the following sections, along with maps showing where predicted maximum air contaminants are above the relevant standard or objective. Maps showing the geographic distribution of maximum air concentrations for the contaminants which were below the relevant standard or objective are included in Appendix C.

Table 7.1-1. Predicted Maximum Air Contaminants Resulting from Project Activities

		Concentrations (µg/m³) and Dust Deposition Rate (mg/dm²/day)				
Pollutant	Averaging Period	Objective	Background	Maximum Predicted Concentration (Project)	Maximum Predicted Concentration (Project + Background)	Frequency of Exceedance per Year (%)
SO_2	1-hour	450	0	20	20	-
	24-hour	150	0	4.0	4.0	-
	Annual	25	0	0.3	0.3	-
NO_2[b]	1-hour	400	0	68	68	-
	24-hour	200	0	23	23	-
	Annual	60	0	3.9	3.9	-
CO	1-hour	14,300	232	113	345	-
	8-hour	5,500	232	65	297	-
TSP	24-hour	120	45.2	**173**	**218**	8.2
	Annual	60	12.5	34	46	-
PM_{10}	24-hour	50	21.4	45	**67**	2.7
$PM_{2.5}$	24-hour [a]	25	10.9	7.5	18	-
	Annual	8	3.3	1.9	5.2	-
Dustfall	30-day	1.7	1.2	1.1	**2.3**	50

Notes:
Exceedances highlighted in bold.
[a] *Based on annual 98th percentile value.*

7.1 SO_2

Predicted maximum 1-hour, 24-hour and annual average SO_2 concentrations were all well below the objectives at all locations modelled. The maximum predicted hourly concentration of 20 µg/m³ is 4.4% of the objective, the maximum predicted 24 hour concentration of 4 µg/m³ is 2.7% of the objective and the maximum predicted annual concentration of 0.3 µg/m³ is 1.2% of the objective.

7.2 NO_2

Predicted maximum 1-hour, 24-hour and annual average NO_2 concentrations were below the objectives, at all locations modelled. The maximum predicted hourly concentration of 68 $\mu g/m^3$ is 17% of the objective, the maximum predicted 24 hour concentration of 23 $\mu g/m^3$ is 11.5% of the objective and the maximum predicted annual concentration of 3.9 $\mu g/m^3$ is 6.5% of the objective.

7.3 CO

Predicted maximum 1-hour and 8-hour average CO concentrations were both well below the objectives at all locations modelled. The maximum predicted hourly concentration of 345 $\mu g/m^3$, which includes a background of 232 $\mu g/m^3$, is 2.4% of the objective and the maximum predicted 8 hour concentration of 297 $\mu g/m^3$, which includes a background of 232 $\mu g/m^3$, is 5.4% of the objective.

7.4 TSP

Predicted maximum annual TSP concentrations were all below the objective outside of the fence line. The maximum predicted annual concentration of 46 $\mu g/m^3$, which includes a background of 12.5 $\mu g/m^3$, is 76.7% of the objective.

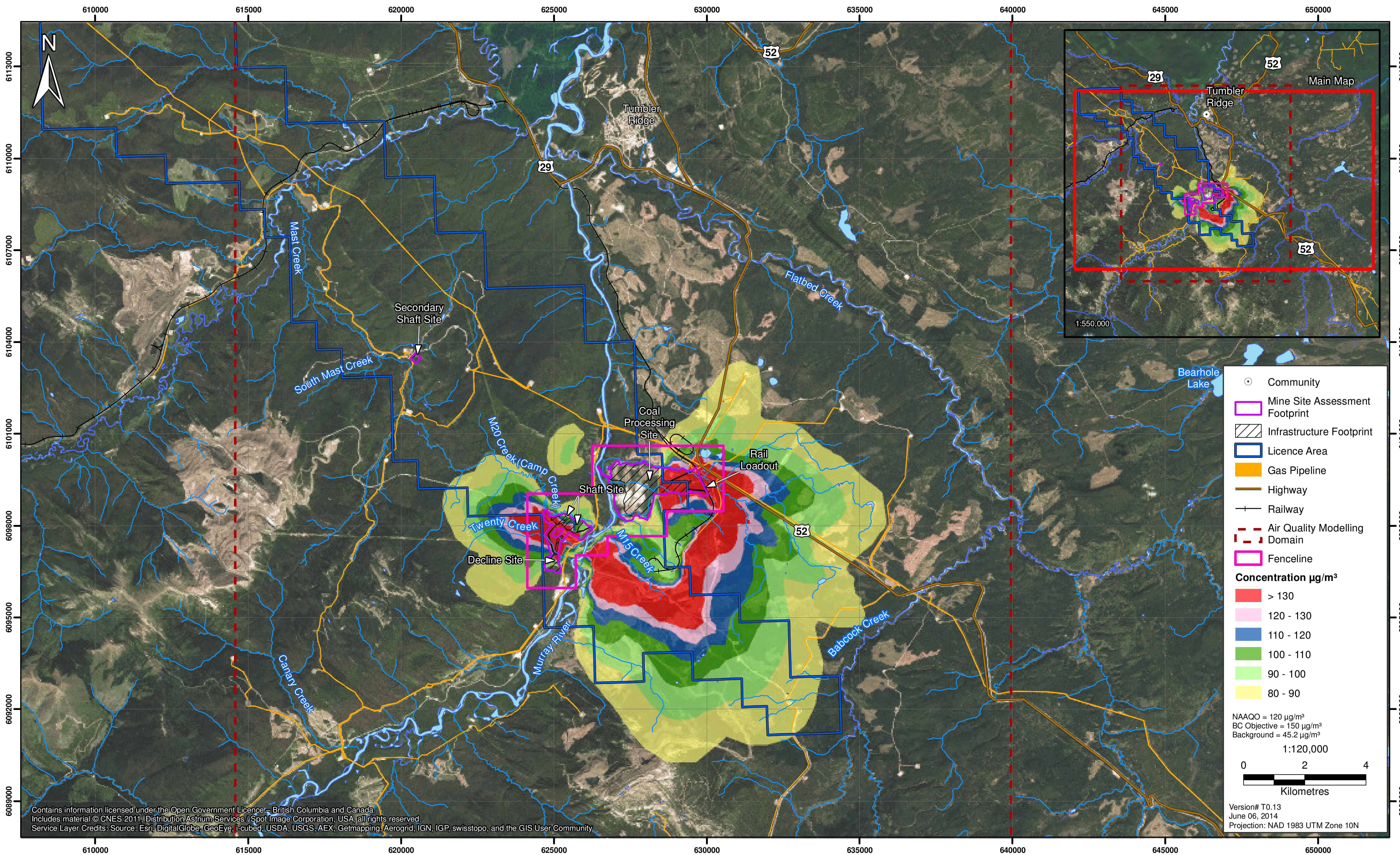
The maximum 24-hour average TSP concentrations exceeded the standard both inside and outside of the mine site, however, the exceedances were well within the modelling domain. This is similar to results from other mine sites in the area which also predicted exceedances of 24-hour average TSP concentrations (Stantec 2012). The exceedances extend approximately 1.3 km from the road, with the majority of exceedances to the east of the road due to the prevailing wind direction. Figure 7.4-1 shows the 24-hour average TSP concentration contours.

To examine the nature of the predicted exceedances, a frequency analysis was completed. It was predicted that these TSP exceedances outside of the mine site will occur 8.2% of the time. The model was run for each source separately and therefore the contribution from different sources can be assessed. This also allows the results from fugitive and non-fugitive sources to be calculated separately, as fugitive dust emission factors have a lower confidence level. Table 7.4-1 shows the exceedances outside of the site area were from fugitive sources, primarily from road dust. The model has been run assuming no anthropogenic dust control; however, mitigation measures such as road watering would significantly reduce the amount of unpaved road dust.

Table 7.4-1. TSP Sources

Pollutant	Averaging Period	Objective	Background	Maximum Predicted Concentrations (Project + Background)			
				Non-fugitive	Fugitive	Road Dust	Total
TSP	24-hour	120	45.2	66.0	217.4	215.1	218.1

Figure 7.4-1
Maximum Total 24-hour TSP Concentrations



7.5 PM_{10}

Maximum 24-hour average PM_{10} concentrations exceeded the standard both inside and outside of the mine site, however the exceedances were well within the modelling domain. This is similar to results from other mine sites in the area which also predicted exceedances of 24-hour average PM_{10} concentrations (Stantec 2012). The exceedances extend approximately 500 m from the road, with the majority of exceedances to the east of the road due to the prevailing wind direction. Figure 7.5-1 shows the 24-hour average PM_{10} concentration contours.

To examine the nature of the predicted exceedances, a frequency analysis was completed. It was predicted that these PM_{10} exceedances outside of the mine site will occur 2.7% of the time. The model was run for each source separately and therefore the contribution from different sources can be assessed. This also allows the results from fugitive and non-fugitive sources to be calculated separately, as fugitive dust emission factors have a lower confidence level. Table 7.5-1 shows the exceedances outside of the site area were from fugitive sources, primarily from road dust. The model has been run assuming no anthropogenic dust control; however, mitigation measures such as road watering would significantly reduce the amount of unpaved road dust.

Table 7.5-1. PM_{10} Sources

Pollutant	Averaging Period	Objective	Background	Maximum Predicted Concentrations (Project + Background)			
				Non-fugitive	Fugitive	Road Dust	Total
PM_{10}	24-hour	50	21.4	39.8	65.9	65.2	66.6

7.6 $PM_{2.5}$

Predicted maximum 24-hour and annual average $PM_{2.5}$ concentrations were below the objectives, at all locations modelled. The maximum predicted 24 hour concentration of 18 $\mu g/m^3$, which includes a background of 10.9 $\mu g/m^3$, is 72% of the objective and the maximum predicted annual concentration of 5.2 $\mu g/m^3$, which includes a background of 3.3 $\mu g/m^3$, is 65% of the objective.

7.7 Dust Deposition

Dust deposition rates were predicted to be above the most stringent BC objective along the road. This is consistent to other mine sites in the area (Stantec 2012). The exceedances extend approximately 1 km from the road, with the majority of exceedances to the east of the road due to the prevailing wind direction. The maximum 30 day deposition is 2.3 $mg/dm^2/day$, over 70% (1.2 $mg/dm^2/day$) of which is attributed to the background dustfall. The maximum predicted concentration, without background dustfall is 1.1 $mg/dm^2/day$. Figure 7.7-1 shows the monthly dustfall contours.

To examine the nature of the predicted exceedances, a frequency analysis was completed. It was predicted that these dustfall exceedances outside of the mine site will occur for six months of the year. These exceedances are expected to occur during the summer months as during the winter months the roads will be covered in snow and therefore will not be producing appreciable quantities of dust.

The model has been run assuming no anthropogenic dust control; however, mitigation measures such as road watering would reduce the amount of unpaved road dust by 75% (US EPA 2006a).

Figure 7.5-1
Maximum Total 24-hour PM_{10} Concentrations

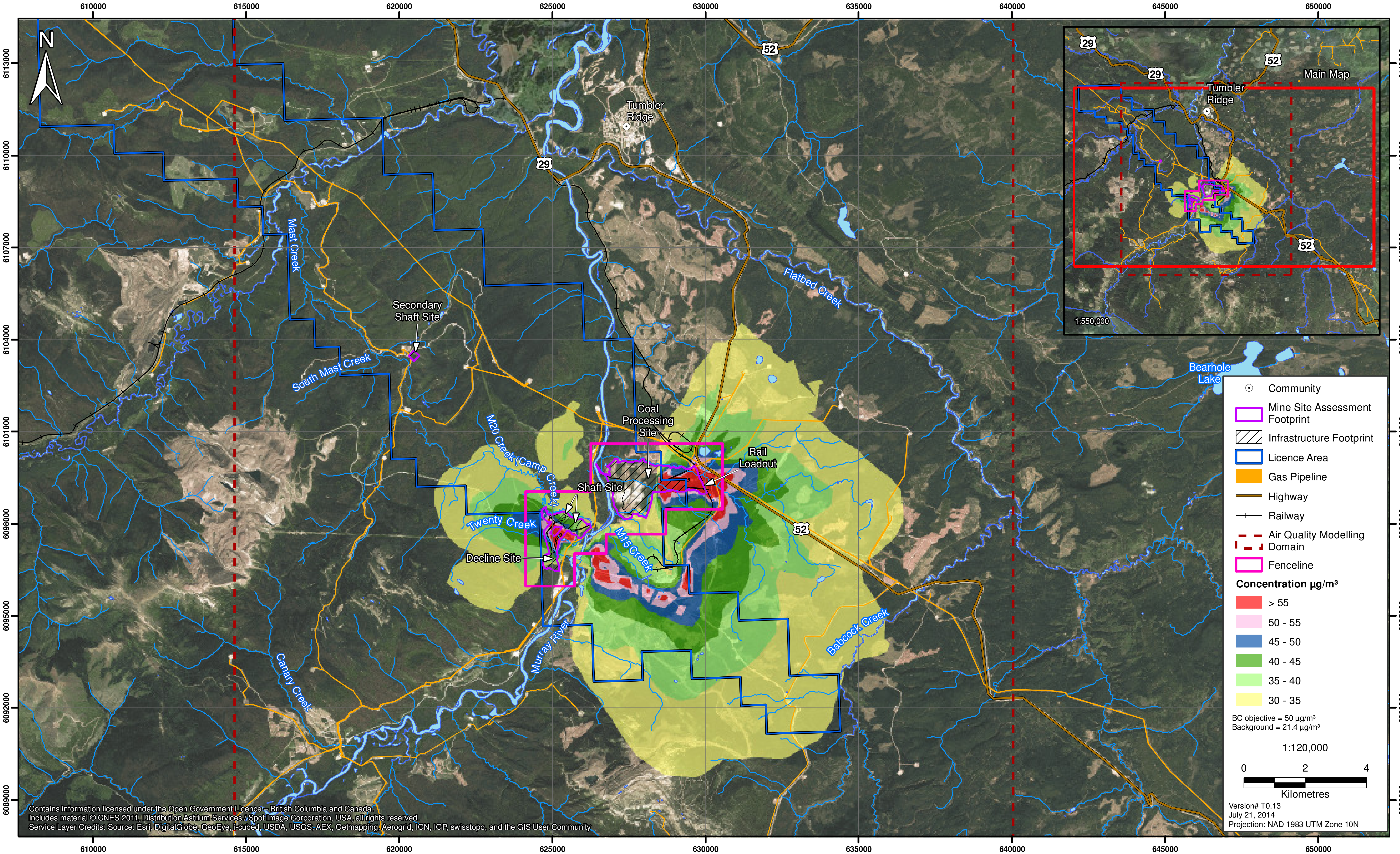
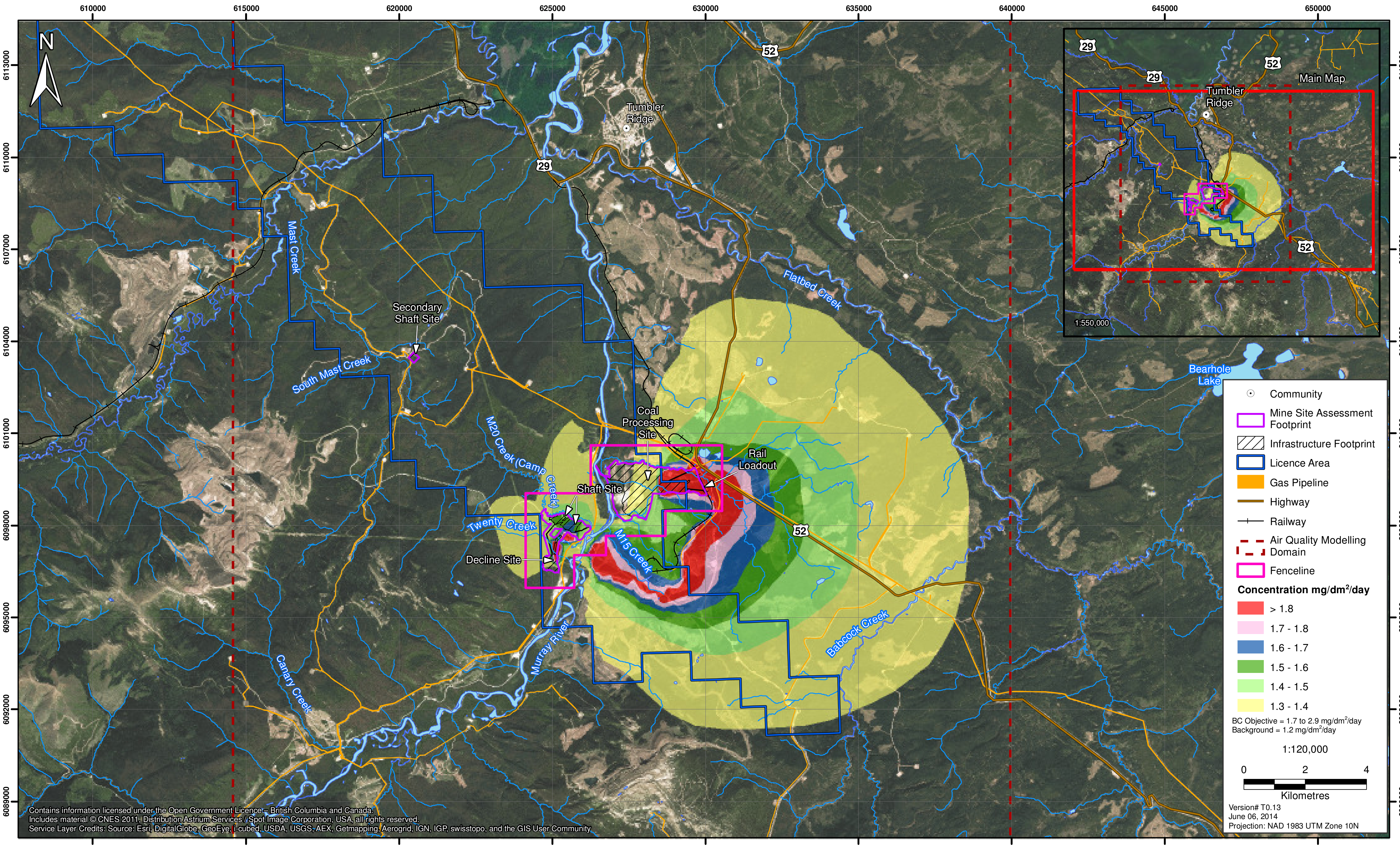


Figure 7.7-1
Predicted Maximum 30-day Dust Deposition



8. CONCLUSIONS

The air quality modelling study for the Project included an assessment of increases in the concentrations of various contaminants associated with the Murray River Coal Project. Concentrations were predicted using the CALPUFF model and compared to ambient air quality criteria.

Maximum 1-hour, 24-hour and annual average SO_2 and NO_2 concentrations were predicted to be well below the corresponding objectives at all locations modelled. Maximum 1-hour and 8-hour average CO concentrations were also predicted to be well below the corresponding objectives at all locations modelled.

Maximum TSP, PM_{10} and $PM_{2.5}$ concentrations as well as dust deposition rates are difficult to predict because of the inherent uncertainties associated with the emissions estimates. Maximum annual concentrations were predicted to be well below the ambient air quality standards outside the fence line. The modelling predictions show 24-hour average concentrations were below the objective for $PM_{2.5}$, however, there were exceedances of TSP and PM_{10} objectives. Predicted maximum 24-hour TSP concentrations show exceedances occur 8.2% of the time and predicted maximum 24-hour PM_{10} concentrations show exceedances occur 2.7%. These exceedances are primarily due to fugitive emissions, in particular unpaved road dust. The model has been run assuming no anthropogenic dust control, however, mitigation measures such as road watering would reduce the amount of unpaved road dust by 75% (US EPA 2006a).

Dust deposition rates were predicted to be above the most stringent BC objective along the road during the summer. The exceedances extend approximately 1 km from the road, with the majority of exceedances to the east of the road due to the prevailing wind direction.

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An explanation of the acronyms used throughout this reference list can be found in the *Acronyms and Abbreviations* section.

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Appendix A

Conceptual Model Plan

Table B.1 - Conceptual Model Plan

Date: 8 April, 2014

Facility Name: Murray River Coal Project

Company: HD Mining International Ltd.
Suite 433 – 595 Burrard Street
P.O. Box 49161
Vancouver, BC V7X 1J1
Tel: 604-689-8669
Fax: 604-689-0969
Website: www.hdminingintl.com

Location (Lat., Long.): E 121˚54’03”-121˚18’07”, N 54°56’59’-55°09’59”

Air Quality Consultant and Contact Name:
ERM Consultants Canada Ltd (Rescan)
15th Floor, 1111 West Hastings Street
Vancouver, BC V6E 2J3
Tel: 604-689-9460
Fax: 604-687-4227
Website: www.rescan.com

Contact name: Derek Shaw and Kiri Heal

Ministry Contact (Air Quality Assessment): Dennis Fudge

Assessment Type: ***Answer 2 or 3.*** This assessment is to support the Environmental Assessment for the proposed coal project and therefore a Level 2 assessment is required.

Anticipated sources to be modelled and corresponding contaminants:

HD Mining International Ltd. (HD Mining) proposes to develop the Murray River Coal Project (the Project) as a six million tonnes per annum (6 Mtpa) underground metallurgical coal mine, with an estimated mine life of 31 years. The Murray River property is located 12.5 km south of Tumbler Ridge, British Columbia (Figure 1). It covers an area of 16,024 hectares and is situated on Crown Land within the Peace River Regional District. Figure 2 shows the preliminary site layout.

Figure 1

Project Location

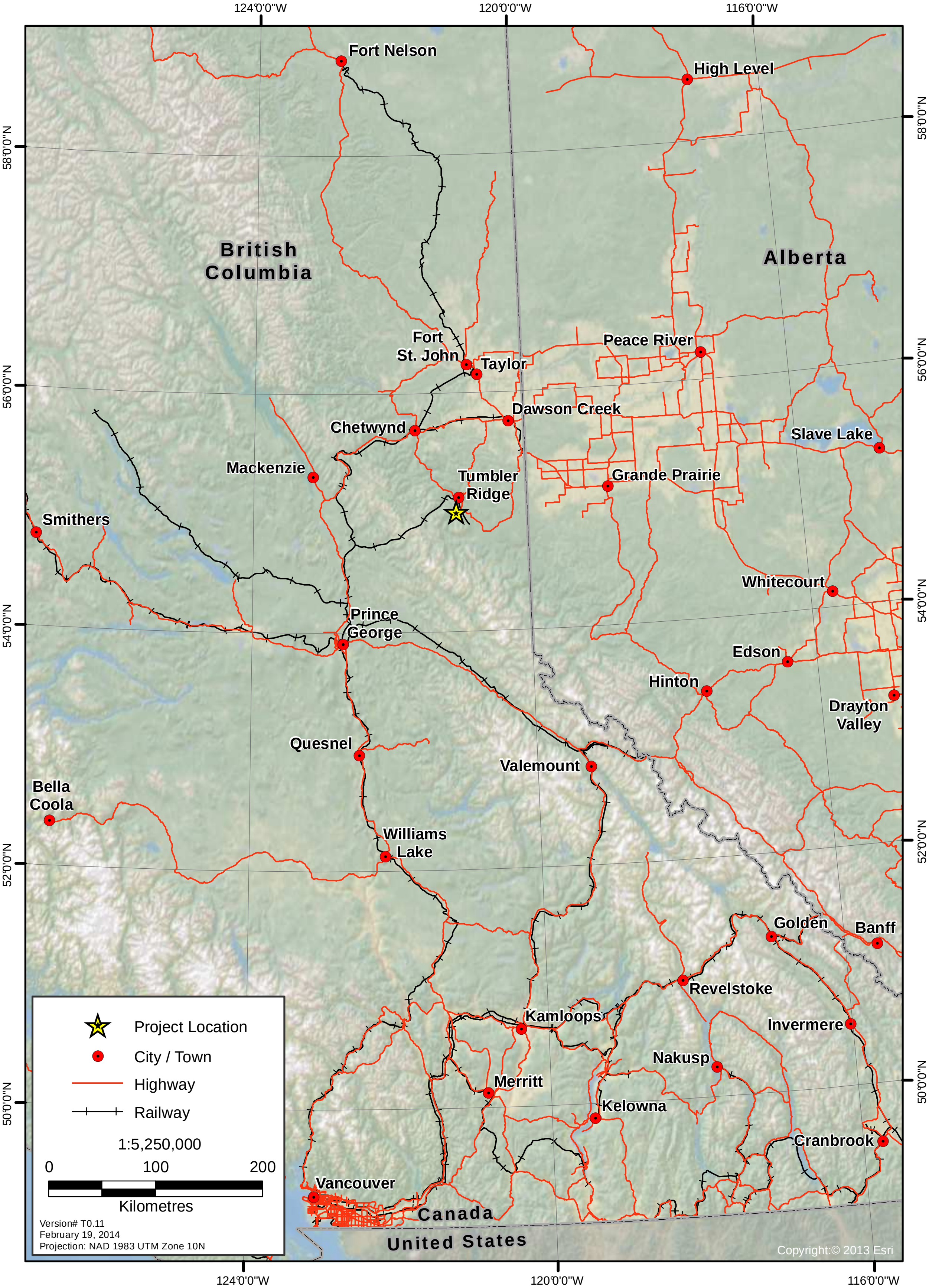
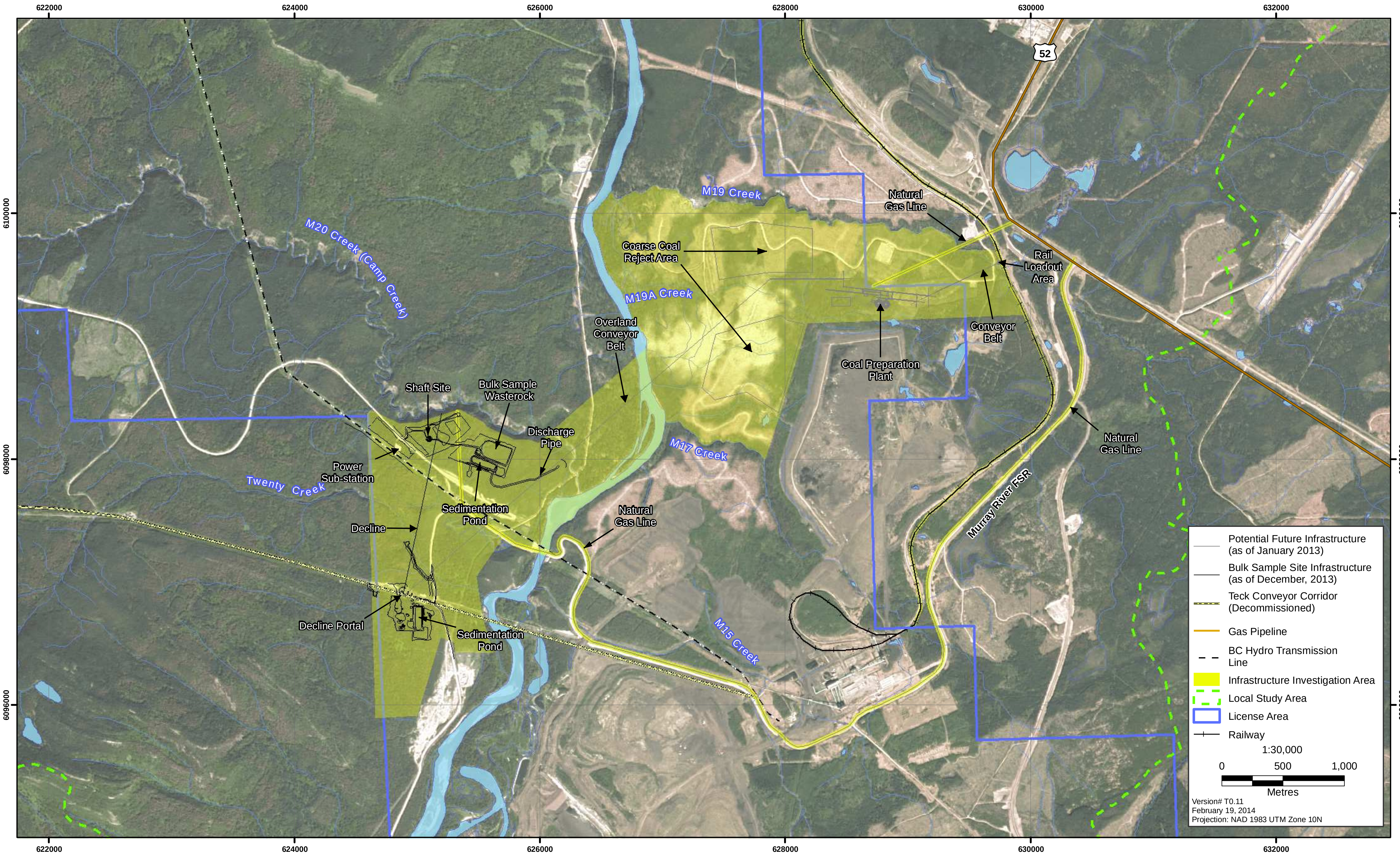


Figure 2
Preliminary Site Layout



The air quality assessment will take into account the construction, operation and closure/reclamation phases. However, detailed air quality dispersion modelling will be undertaken for the operation phase only, when the emissions are expected to be the highest. A qualitative assessment will be undertaken for the construction and closure/reclamation phases based on the expected emission rates and the predicted concentrations during the operation phase.

The construction phase will include some site clearing and grubbing, construction of project facilities and installation of infrastructure. Much of the construction work for the mine infrastructure on the west side of Murray River has already been permitted through the Coal Exploration Permit for the project (Permit number CX-9-44, dated 15 March 2012). The previously permitted construction work falls outside the scope of this assessment. The operation phase will include surface and underground equipment, material handling and processing, stockpiles, road vehicles (both fugitive road dust and exhaust emissions) and rail loadout emissions. The closure and reclamation phase will include stockpile recontouring and reclamation activities.

As previously discussed, modelling will be undertaken to predict concentrations of NOx, SOx, CO, TSP, PM_{10} and $PM_{2.5}$ [1]. For the NOx to NO_2 conversion, either a rate of 100% conversion, or if exceedances are identified, a rate of 50% or 25% conversion, will be applied[2]. For remote sites it is difficult to determine background concentrations using data from a distant site, therefore, for SO_2, VOC and NO_2 zero will be used, for CO 200 ppb will be used, and for dustfall, TSP and PM data from a local monitoring site will be used[2]. Dust deposition rates will be calculated from modelled TSP concentrations using deposition velocities[3]. In addition, as stipulated in the Draft Environmental Impact Statement Guidelines (Canadian Environmental Assessment Agency, May 2013), the potential impacts of the Project on VOC concentrations will be considered based on estimated emission rates and professional judgement. VOCs will be included in the modelling if deemed necessary.

The material is proposed to be transported underground, wherever possible, and where overland transport is required, covered conveyors will be used, therefore material transportation will not be a large source of dust or particulate matter emissions to the ambient air. Material handling points will be included in the emissions inventory and the modelling. There is not expected to be any surface blasting or drilling and therefore these activities will not impact on local air quality and have not been included in the assessment.

Source	**Source Type (point, line, area, volume)**	**Contaminant(s) SO_2, CO, H_2S, PM_{10}, $PM_{2.5}$ . . .**
Surface Equipment		
Coal preparation plant	Point and area, as applicable	NOx, SOx, CO, TSP, PM_{10}, $PM_{2.5}$, VOC (if deemed necessary), dust deposition

[1] Telephone conversation between Derek Shaw (Atmospherics Discipline Manager, Rescan ERM) and Dennis Fudge (Air Quality Meteorologist, BC MoE), early August 2012

[2] Email conversation between Nicki Casley (Consultant, Rescan ERM) and Dennis Fudge (Air Quality Meteorologist, BC MoE), 20th January 2014.

[3] Telephone conversation between Kiri Heal (Consultant, Rescan ERM) and Dennis Fudge (Air Quality Meteorologist, BC MoE), 19th February 2014.

Source	Source Type (point, line, area, volume)	Contaminant(s) SO_2, CO, H_2S, PM_{10}, $PM_{2.5}$ . . .
Material handling and processing	Area and volume	TSP, PM_{10}, $PM_{2.5}$, dust deposition
Heat, hot water and boiler houses	Point	NOx, SOx, CO, TSP, PM_{10}, $PM_{2.5}$, dust deposition
Underground equipment		
Underground equipment [a]	Point	NOx, SOx, CO, TSP, PM_{10}, $PM_{2.5}$, VOC (if deemed necessary), dust deposition
Other sources		
Stockpiling	Area	TSP, PM_{10}, $PM_{2.5}$, dust deposition
Road vehicle exhaust[b]	Area	NOx, SOx, CO, VOC (if deemed necessary), TSP, PM_{10}, $PM_{2.5}$, dust deposition
Road dust	Area or volume	TSP, PM_{10}, $PM_{2.5}$, dust deposition
Rail loadout facility	Volume	TSP, PM_{10}, $PM_{2.5}$, dust deposition

Notes:
[a] Emissions from underground equipment will be emitted through the ventilation shaft and will be modelled as a point source. Emissions will be estimated by assuming that the air quality underground meets the Worksafe BC limit values, i.e. limit value (mg/m^3) multiplied by the volume flowrate (m^3/s).
[b] Emissions from Highway 52 traffic has been scoped out of the modelling.

Anticipated model domain and receptors (preliminary domain dimension, receptor grid/locations, sensitive receptors)

The proposed modelling domain is shown in Figure 3. The domain is centered on the proposed Project, and extends 10 km east, south, and west, and 15 km north (to include the District of Tumbler Ridge).

A Cartesian grid of discrete receptors will be applied with the following spatial resolution, as suggested in the *Guidelines for Air Quality Dispersion Modelling in British Columbia* (2008):
- 20 m spacing along the boundary of the Project;
- 50 m spacing within 500 m of the Project boundary;
- 250 m spacing within 2 km of the Project boundary;
- 500 m spacing within 5 km of the Project boundary, and also a 3 by 3 km area encompassing Tumbler Ridge; and
- 1000 m spacing beyond 5 km of the Project.

.

Sensitive receptors will also be included in the modelling at relevant wildlife locations (based on findings from habitat suitability modelling), First Nation camps and cabins (based on findings from the Land Resources study conducted for the EA) and at least one worst case relevant receptor in Tumbler Ridge (likely the Health Centre in the southeast of the city). Suitable receptors will also be selected from other environmental assessments for neighbouring projects to support the cumulative effects assessment, if required.

Figure 3
Proposed Modelling Domain and Receptor Spacing

ERM

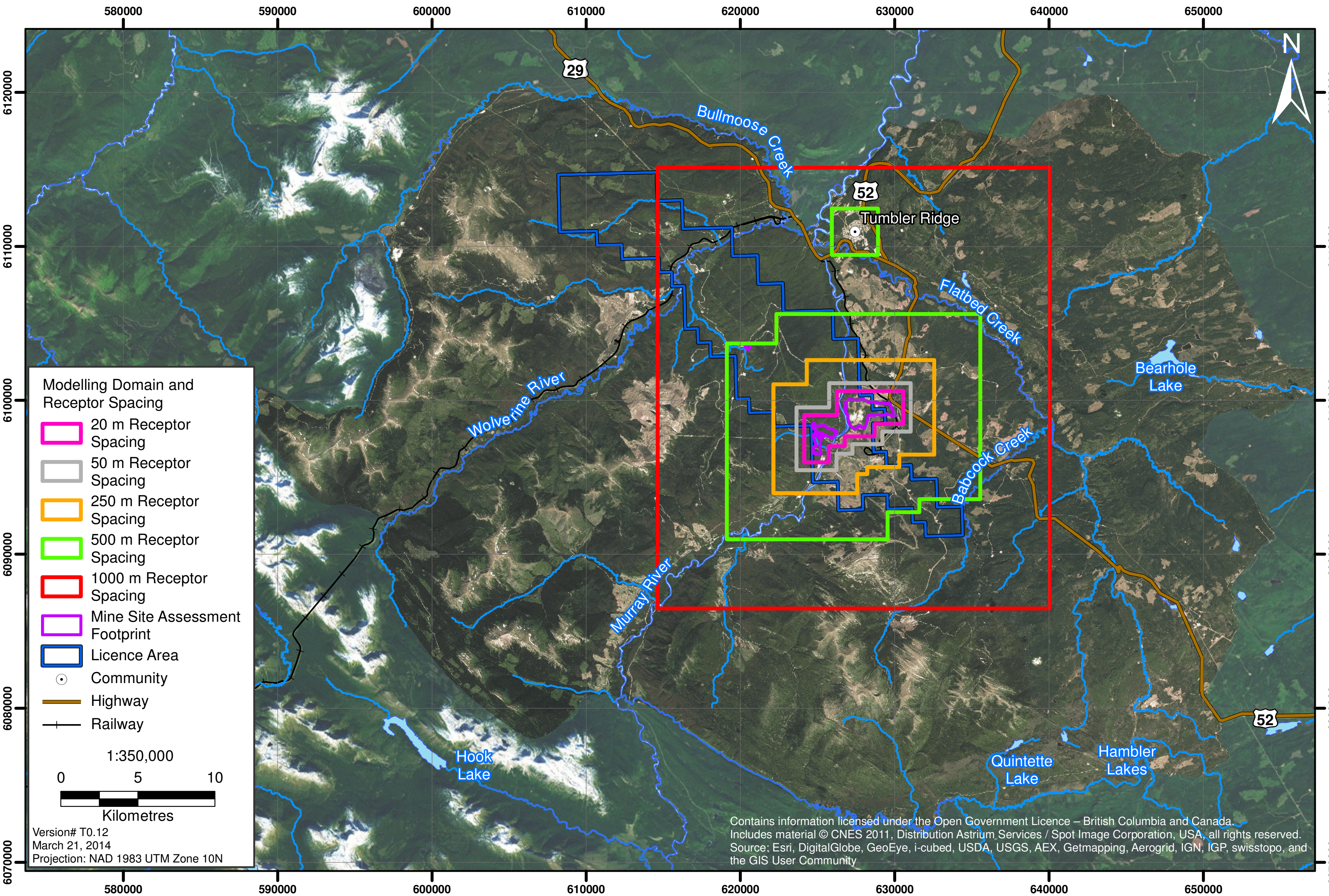


Table B.1 - Conceptual Model Plan (cont'd)

Terrain characteristics within domain: flat terrain or complex terrain (i.e., will complex flow need to be considered?)

The Project is located in an area of complex terrain and these effects will be included in the modelling. It is anticipated that terrain elevations for the modelling domain will be extracted from 1:50,000 scale Canadian Digital Elevation Data.

Dominant land cover: forested, urban, industrial, rock, water, grassland:

The land cover is predominantly forested. Data from BTM will be used in the modelling.

Existing air quality situation (pristine, industrial, urban):

The air quality across the majority of the modelling domain is pristine. Available data shows that pollutant concentrations are highest across the Tumbler Ridge area with monitored exceedences occurring at the Tumbler Ridge Airport and Tumbler Ridge Industrial Park monitoring stations.

Background concentrations will be determined from a baseline monitoring programme completed in 2011 and local monitoring from Tumbler Ridge, Tumbler Ridge airport and Beaverlodge.

Potential meteorological data sources (site specific or offsite measured surface/upper-air, mesoscale model data):

It is proposed that the CALPUFF in ISC mode will be used which requires the following meteorological parameters:

- Wind direction;
- Wind speed;
- Temperature;
- Pasquill-Gifford (PG) atmospheric stability class; and
- Mixing height.

Wind direction, wind speed and temperature data will be obtained from Rescan's Project specific meteorological station. This station was installed within the local study area in March 2011 at 55.02˚N, 121.08˚W, 1,055 masl in accordance with guidelines developed by the Meteorological Services of Canada (MSC 2004). The height of the anemometer is 10 m. This station is still active and data is routinely downloaded and QA/QC'd in accordance with current best practices. Data from the following active regional monitoring stations will be used in the QA/QC process:

- Tumbler (Denison) operated by the BC Forest Service Protection less than 10 km from the Murray River Station;
- Chetwynd A operated by EC MSC approximately 82 km north west of the Murray River station; and

- Dawson Creek A operated by EC MSC approximately 98 km north east of the Murray River station.

If necessary, data from the above stations will be used to supplement those from the Project station in order to develop a complete dataset. The completeness of these data sets will be presented in the report and, where necessary, data gaps will be filled by interpolation or with information from nearby relevant stations.

PG stability class will be calculated using the method based on Turbulent Fluctuation Measures as outlined in the *Guidelines for Air Quality Dispersion Modelling in British Columbia* (March 2008). The mixing height will be calculated in accordance with Section 7.7 of these modelling guidelines.

The modelling will be conducted for 2012 as a complete year of meteorological data is currently available for this year.

Identify possible model(s) to be applied:

Based on communications with Dennis Fudge (MoE)[1] it was agreed that AERMOD capabilities are insufficient for this assessment. It is proposed that the most updated US EPA approved CALPUFF model will be used to predict pollutant concentrations. The current US EPA approved CALPUFF version 5.8.4[4] contains updates only to recognized bug fixes described in MCB-E MCB-F and MCB-G from the previous version 5.8, level 070623.

The model will be run in the ISC mode option as the CALMET-level of modelling sophistication is not deemed necessary. This is in line with similar air quality assessments in the area.

Identify any potential modelling requirements due to Canada/U.S. transboundary issues:

None. The site is located over 60 km west of the Alberta border and over 600 km north of the US. As such, the Project is not expected to result in any transboundary effects to areas outside BC.

Anticipated ministry review completion date of conceptual model plan:

Ideally the review will be completed by mid-April to allow time to update our modelling methodology and prevent the need for re-runs. Additional information or a detailed model plan can be provided upon request.

Ministry Acceptance of Plan:___________________________ Date:___________________

[4] Approved on December 4, 2013. http://www.epa.gov/scram001/dispersion_prefrec.htm.

Appendix B

Emission Sources

APPENDIX B. EMISSION SOURCES

Table B-1. Stack Air Emission Sources and Characteristics

Stack Description	Location	Operating Hours	Control Device	Emission Factor (g/s)						Emission Source
				NO_x	SO_x	CO	TSP	PM_{10}	$PM_{2.5}$	
Coal dryer	Coal Processing Site	2592	Cyclone	n/a	n/a	n/a	5.0	4.4	2.9	Taggart
CPP Boiler stack #1	Coal Processing Site	4992	-	0.213	0.001	0.179	0.016	0.016	0.016	US EPA AP-42, Ch1.4 Natural gas boiler emissions
CPP Boiler stack #2	Coal Processing Site	4992	-	0.213	0.001	0.179	0.016	0.016	0.016	US EPA AP-42, Ch1.4 Natural gas boiler emissions
CPP Boiler stack #3	Coal Processing Site	4992	-	0.213	0.001	0.179	0.016	0.016	0.016	US EPA AP-42, Ch1.4 Natural gas boiler emissions
South Site Boiler stack #4	Decline Site	8760	-	0.162	0.001	0.136	0.012	0.012	0.012	US EPA AP-42, Ch1.4 Natural gas boiler emissions
South Site Boiler stack #5	Decline Site	8760	-	0.162	0.001	0.136	0.012	0.012	0.012	US EPA AP-42, Ch1.4 Natural gas boiler emissions
South Site Boiler stack #6	Decline Site	8760	-	0.162	0.001	0.136	0.012	0.012	0.012	US EPA AP-42, Ch1.4 Natural gas boiler emissions
South Site Boiler stack #7	Decline Site	8760	-	0.162	0.001	0.136	0.012	0.012	0.012	US EPA AP-42, Ch1.4 Natural gas boiler emissions
Initial Shaft	Decline Site	8760	-	1.1	0.9	5.2	0.4	0.4	0.3	BC Health and Safety Code
Secondary Shaft	Secondary Site	8760	-	1.1	0.9	5.2	0.4	0.4	0.3	BC Health and Safety Code
Rail	Coal Processing Site	330	-	0.5	0.0	0.2	0.01	0.01	0.01	US EPA Locomotive Emission Standards Regulatory Support Document

[a] *The CPP boilers will only be running 208 days a year, however they have been included in the model as a full year (8760 hours) as worst case.*

Table B-2. Equipment Air Emission Sources and Characteristics

Type of Equipment	Units Year 3	Fuel Type	Power (hp)	Load Factor	Operating Days per Year (per unit)	Emission Factor (g/km) NOx	SOx	CO	TSP	PM10	PM2.5	Emission Source
Decline Site and Shaft Site												
Excavator	1	Diesel	200	0.59	330	0.83	0.004	0.23	0.04	0.04	0.03	NONROAD (2008)
Folklift	1	Diesel	120	0.59	330	1.72	0.004	0.72	0.17	0.17	0.16	NONROAD (2008)
Loader	1	Diesel	200	0.59	330	1.36	0.004	0.46	0.09	0.09	0.08	NONROAD (2008)
Mobile Crane	1	Diesel	250	0.43	200	1.43	0.004	0.32	0.06	0.06	0.06	NONROAD (2008)
Grader	1	Diesel	250	0.59	180	1.01	0.004	0.31	0.05	0.05	0.05	NONROAD (2008)
Dump Truck	1	Diesel	424	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Ford 150PU	15	Diesel	302	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Manlift	1	Diesel	60	0.21	330	5.08	0.006	4.48	0.63	0.63	0.61	NONROAD (2008)
Fuel transport	1	Diesel	400	0.59	36	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Equipments/parts transport	1	Diesel	400	0.59	180	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Commute bus	4	Diesel	250	0.59	330	0.45	0.004	0.14	0.02	0.02	0.02	NONROAD (2008)
CPP												
FordF-150	3	Gasoline	302	0.59	330	0.52	0.00	0.20	0.02	0.02	0.02	NONROAD (2008)
Ford(Explorer)	2	Gasoline	291	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Folklift	2	Diesel	120	0.59	330	0.45	0.004	0.14	0.02	0.02	0.02	NONROAD (2008)
Loader	2	Diesel	200	0.59	330	1.72	0.004	0.72	0.17	0.17	0.16	NONROAD (2008)
Loader	1	Diesel	73	0.59	330	1.36	0.004	0.46	0.09	0.09	0.08	NONROAD (2008)
Dozer (CPP)	3	Diesel	230	0.59	330	3.22	0.005	1.54	0.16	0.16	0.16	NONROAD (2008)
Dozer (CCR pile)	2	Diesel	230	0.59	330	1.04	0.004	0.32	0.06	0.06	0.06	NONROAD (2008)
Fuel transport	1	Diesel	400	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Bottled Agent transport	1	Diesel	400	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Magnetite transport	1	Diesel	400	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Equipments/parts transport	1	Diesel	400	0.59	330	0.82	0.004	0.27	0.04	0.04	0.03	NONROAD (2008)
Commute bus	2	Diesel	250	0.59	330	0.45	0.004	0.14	0.02	0.02	0.02	NONROAD (2008)

Table B-3. Unpaved Road Dust Air Emission Sources and Characteristics

Type of Equipment	Weight Ton	Speed (km/hr)	Load Factor	Operating Hours	Emissions Factors (g/km)						Emission Source
					NO_x	SO_x	CO	TSP	PM_{10}	$PM_{2.5}$	
Decline Site and Shaft Site											
Ford 150PU	3	30	0.59	248	-	-	-	782	202	20	AP-42 Chapter 13.2.2 Unpaved Roads
Fuel transport	9	30	0.59	1	-	-	-	1,267	327	33	AP-42 Chapter 13.2.2 Unpaved Roads
Equipments/parts transport	9	30	0.59	37	-	-	-	1,213	313	31	AP-42 Chapter 13.2.2 Unpaved Roads
Commute bus	7	30	0.59	1023	-	-	-	1,111	287	29	AP-42 Chapter 13.2.2 Unpaved Roads
CPP											
FordF-150	3	30	0.59	248	-	-	-	722	186	19	AP-42 Chapter 13.2.2 Unpaved Roads
Ford(Explorer)	2	30	0.59	330	-	-	-	669	173	17	AP-42 Chapter 13.2.2 Unpaved Roads
Fuel transport	9	30	0.59	4	-	-	-	1267	327	33	AP-42 Chapter 13.2.2 Unpaved Roads
Bottled Agent transport	9	30	0.59	1	-	-	-	1267	327	33	AP-42 Chapter 13.2.2 Unpaved Roads
Magnetite transport	9	30	0.59	2	-	-	-	1213	313	31	AP-42 Chapter 13.2.2 Unpaved Roads
Equipments/parts transport	9	30	0.59	6	-	-	-	1213	313	31	AP-42 Chapter 13.2.2 Unpaved Roads
Commute bus	7	30	0.59	72	-	-	-	1111	287	29	AP-42 Chapter 13.2.2 Unpaved Roads

Table B-4. Stockpiles and Material Handling

Emission Source	Mitigation	Emission Rate (g/m^2-s)						Source
		NO_x	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	
Stockpiles								
Clean Coal #1 (North)	Spray	-	-	-	3.4E-05	1.7E-05	2.6E-06	AP42 - 11.9 Western Surface Coal Mining
Clean Coal #2 (South)	Spray	-	-	-	3.4E-05	1.7E-05	2.6E-06	AP42 - 11.9 Western Surface Coal Mining
Flotation Clean Dump Point	Spray	-	-	-	1.2E-05	5.9E-06	8.9E-07	AP42 - 11.9 Western Surface Coal Mining
Midding coal dump point	Spray	-	-	-	2.5E-05	1.3E-05	1.9E-06	AP42 - 11.9 Western Surface Coal Mining
Material handling								
CCR pile	Spray	-	-	-	0.001	0.001	0.0001	AP-42 - 13.2.4 Aggregate Handling and Storage Piles
Rail loadout	Spray	-	-	-	0.07	0.022	0.006	AP-42 - 11.19 Western Surface Coal Mining

Table B-5. Activity Air Emission Sources and Characteristics

Source	Speed (km/h)	Distance (km/yr)	Silt Content (%)	Moisture Content	Emission Factor (kg/km)						Emission Source
					NO_2	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$	
Graders	11.4	1,065	n/a	n/a	-	-	-	1.49	0.44	0.05	AP-42 Chapter 11.9 Western Surface Coal Mining (grading)
Bulldozers (CPP)	n/a	n/a	8.6	6.9	-	-	-	17.7	4.7	0.4	AP-42 Chapter 11.9 Western Surface Coal Mining (bulldozing of overburden)
Bulldozers (CCR pile)	n/a	n/a	13	22	-	-	-	0.5	0.1	0.05	AP-42 Chapter 11.9 Western Surface Coal Mining (bulldozing of overburden)

Appendix C

CALPUFF Contour Plots

Figure C-1
Predicted Maximum 1-hour Average SO_2 Concentrations

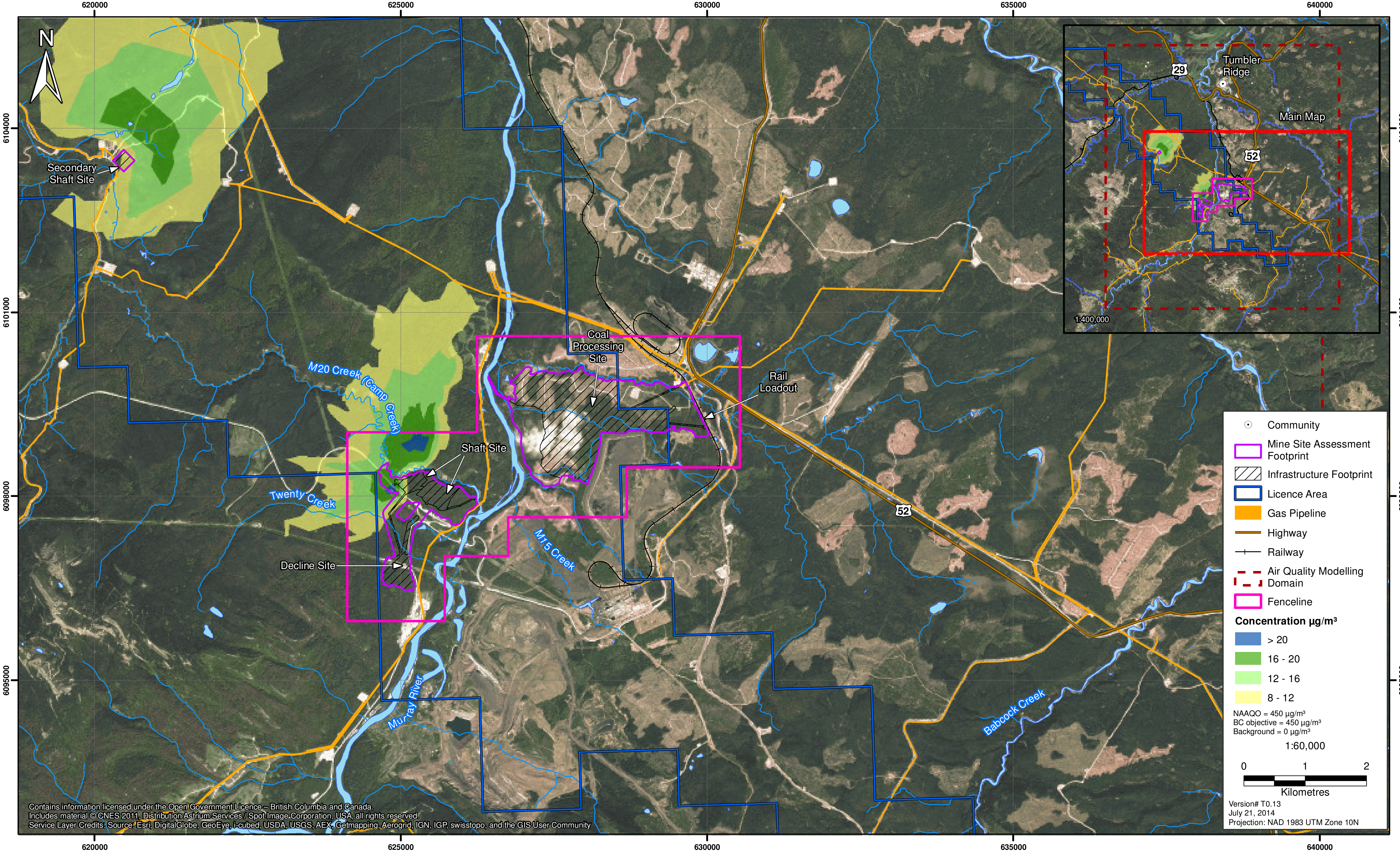


Figure C-2

Predicted Maximum 24-hour Average SO_2 Concentrations

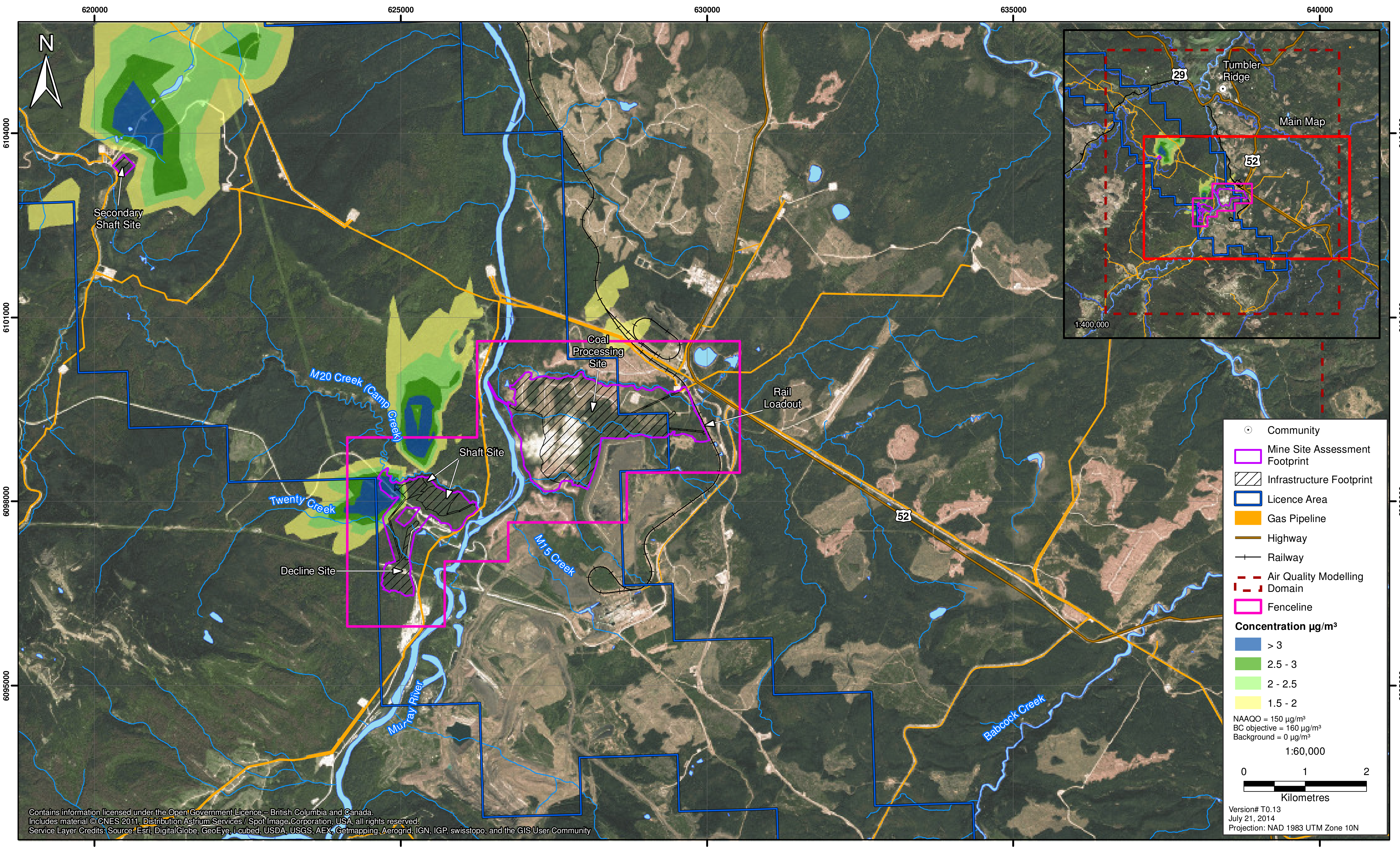


Figure C-3
Predicted Maximum Annual Average SO_2 Concentrations

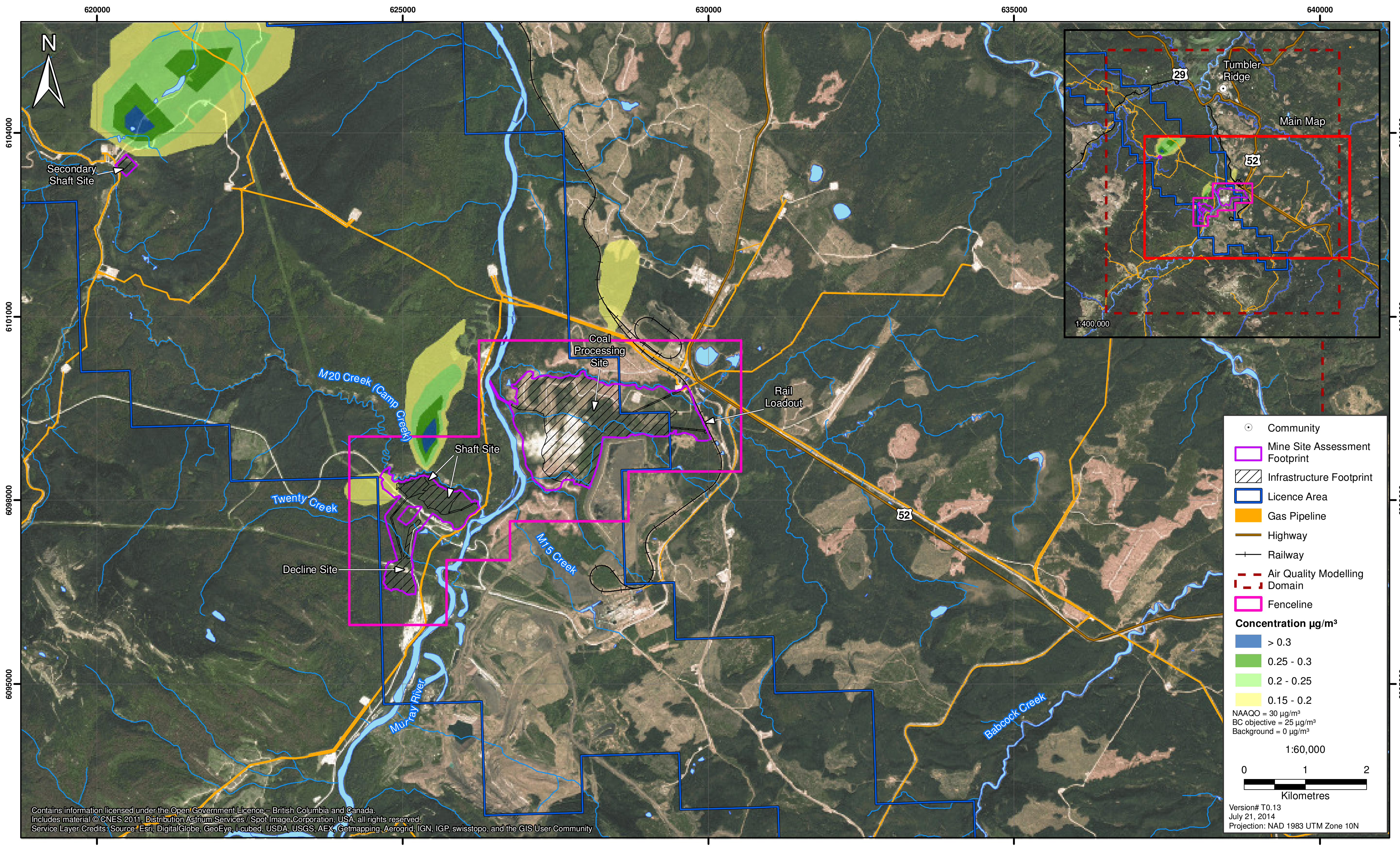


Figure C-4

Predicted Maximum 1-hour Average NO_2 Concentrations

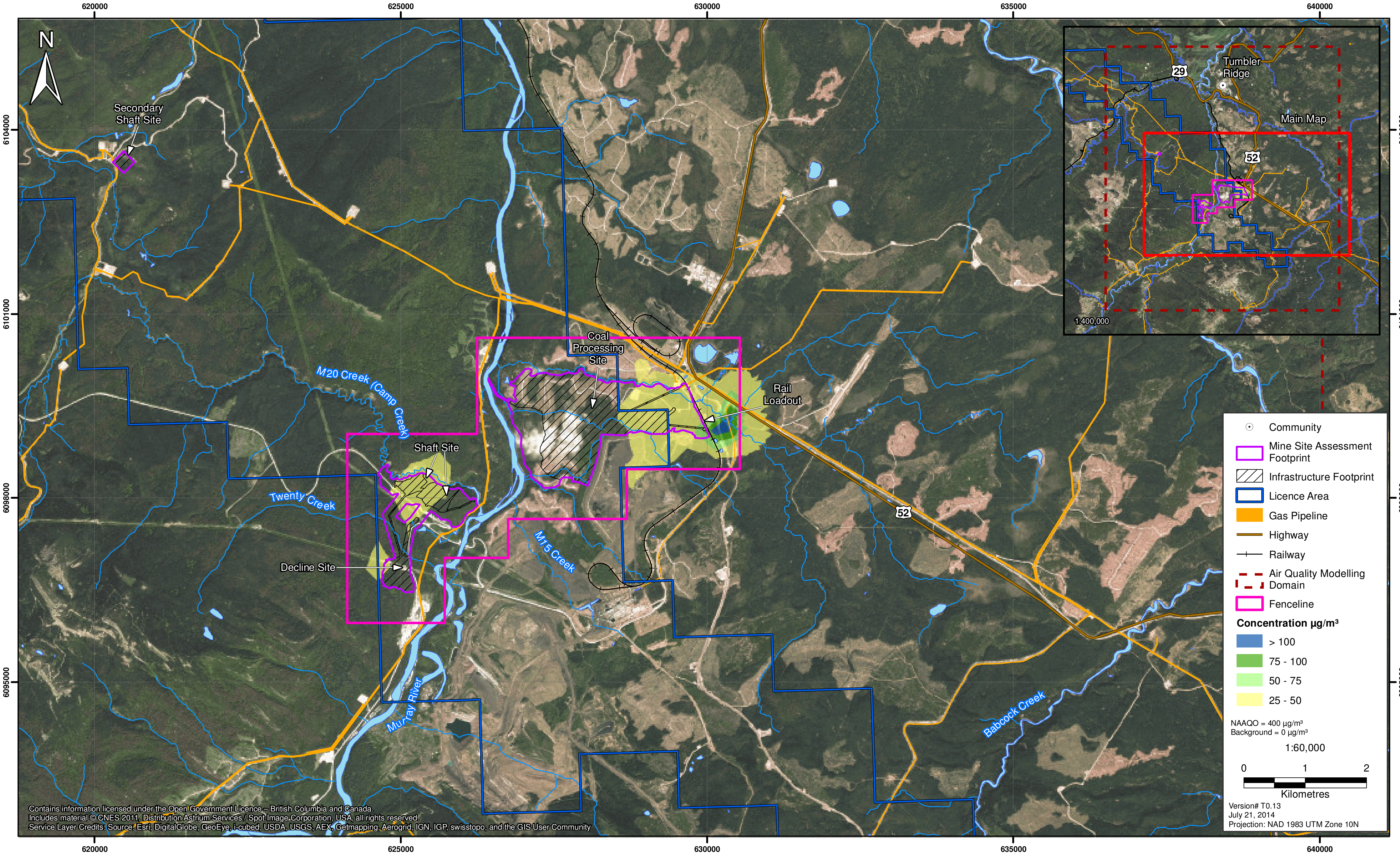


Figure C-5
Predicted Maximum 24-hour Average NO_2 Concentrations

ERM

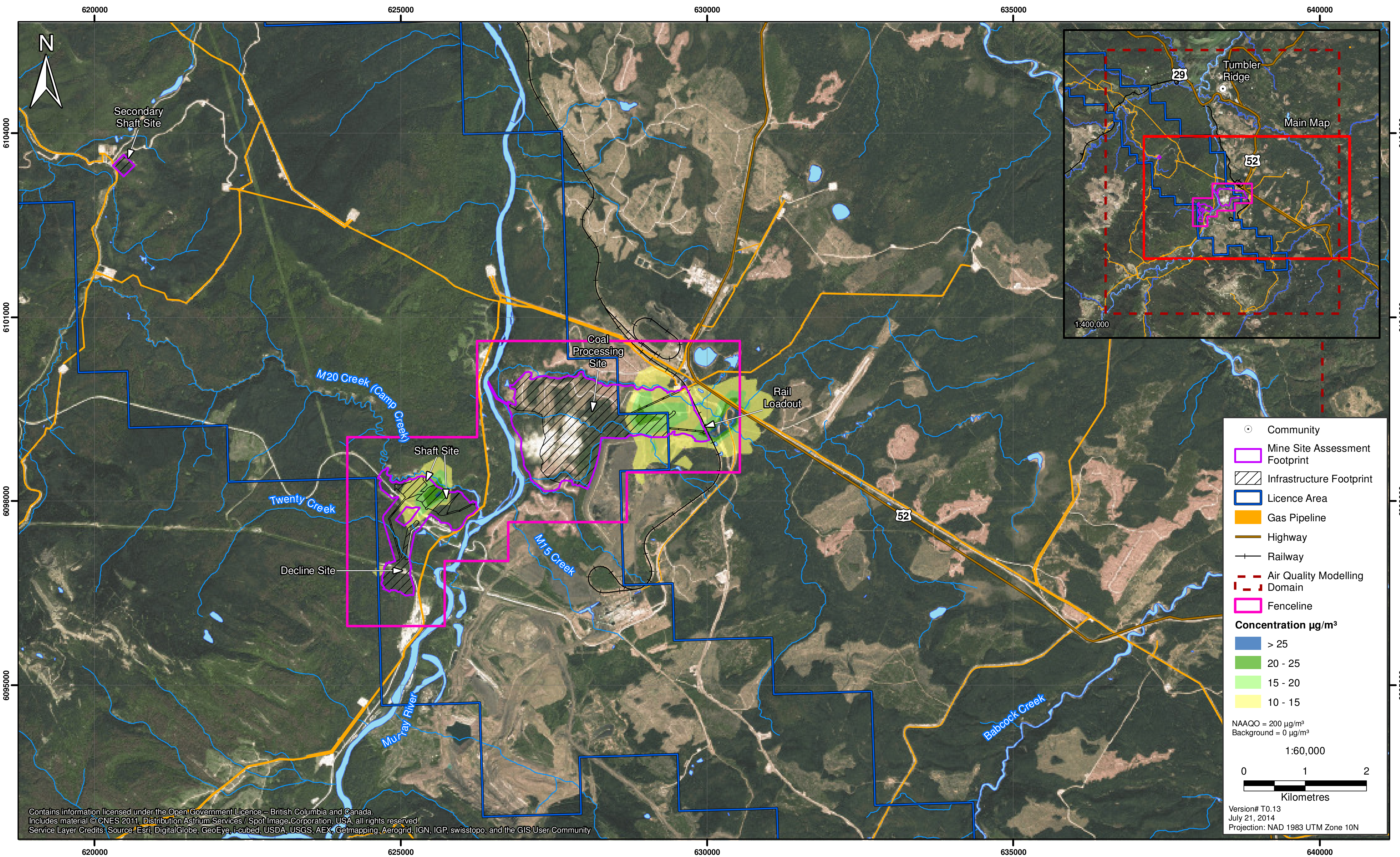


Figure C-6
Predicted Maximum Annual Average NO_2 Concentrations

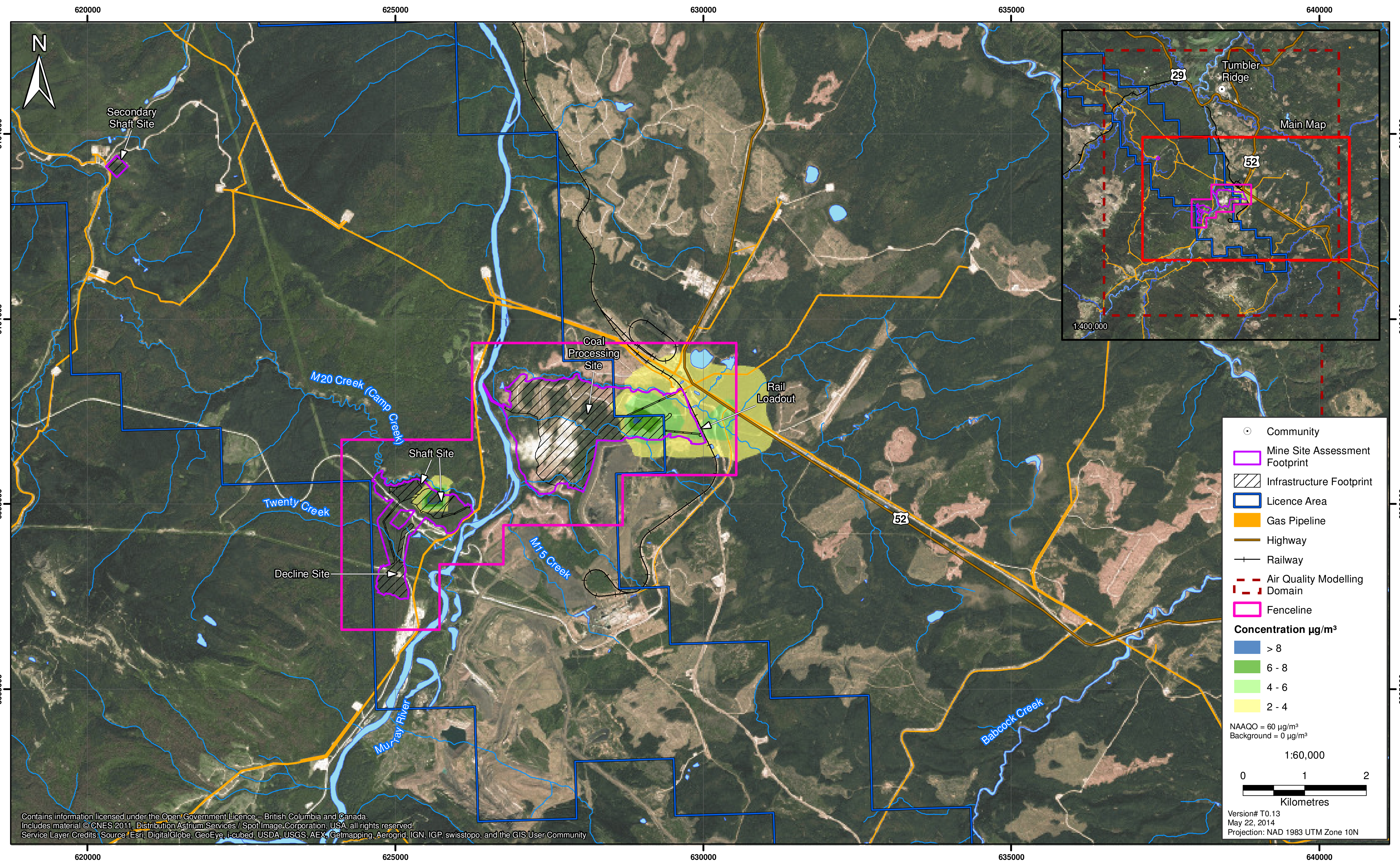


Figure C-7

Predicted Maximum 1-hour Average CO Concentrations

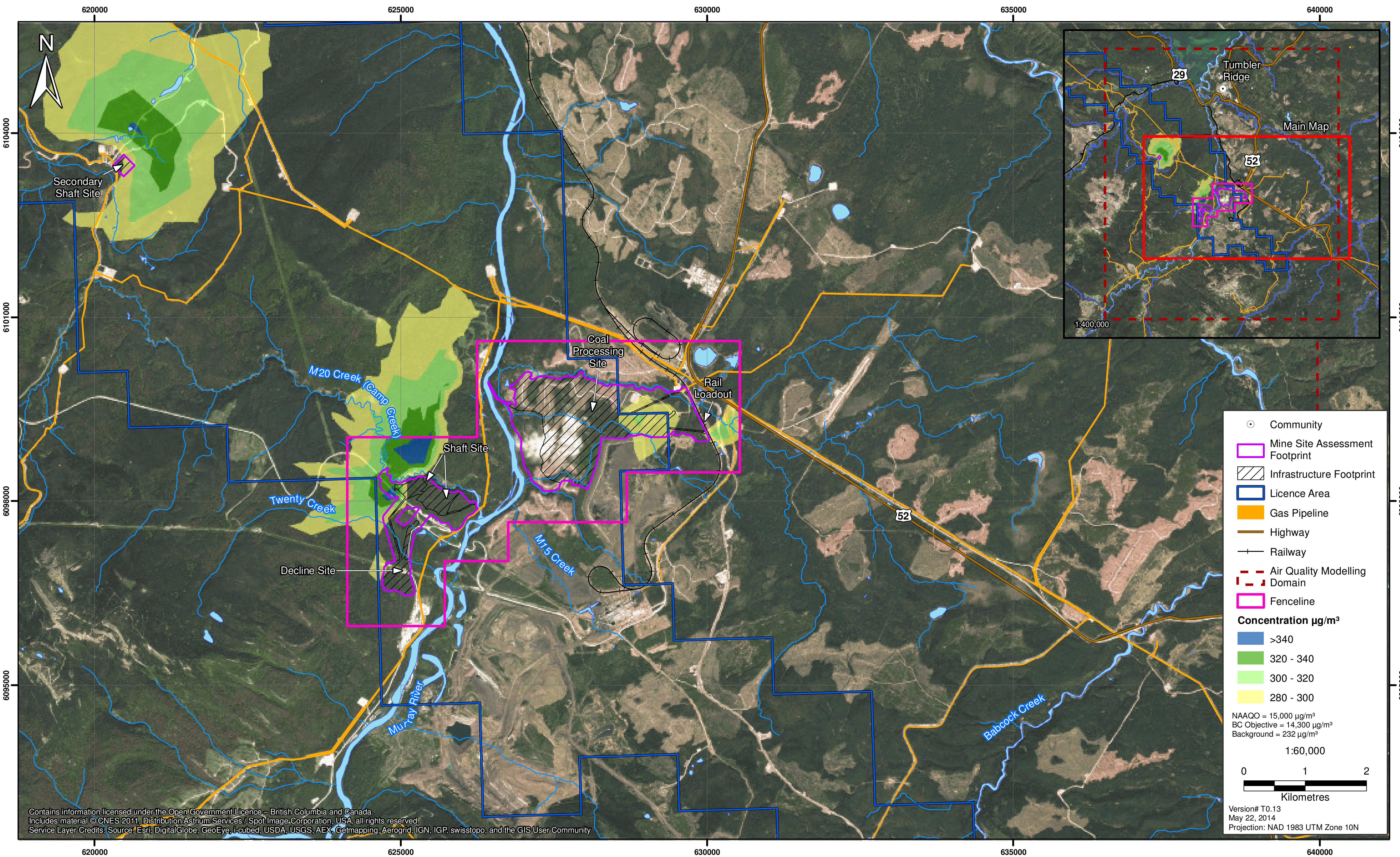


Figure C-8
Predicted Maximum 8-hour Average CO Concentrations

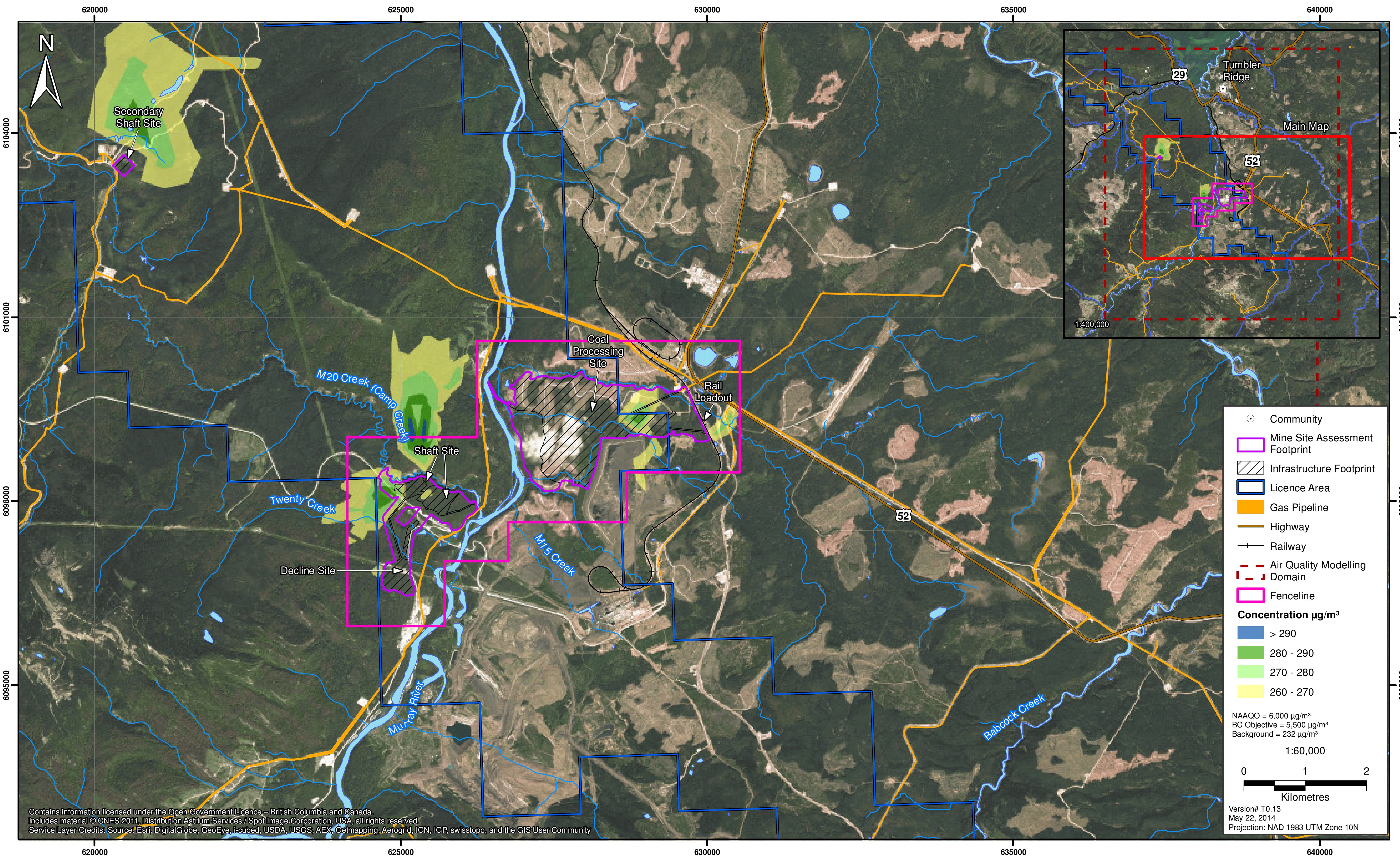


Figure C-9
Predicted Maximum Annual Average TSP Concentrations

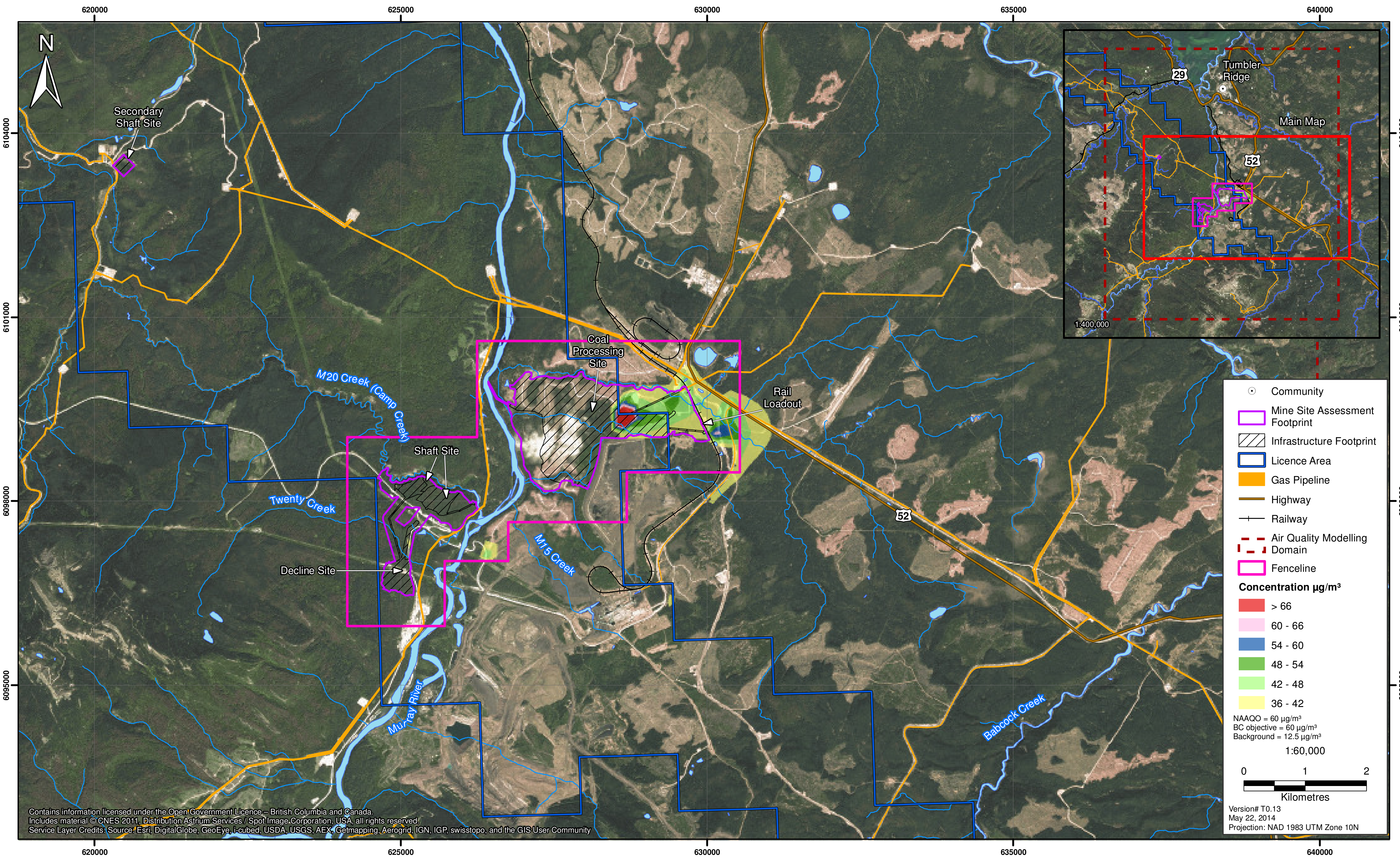


Figure C-10

Predicted Maximum 24-hour Average $PM_{2.5}$ Concentrations

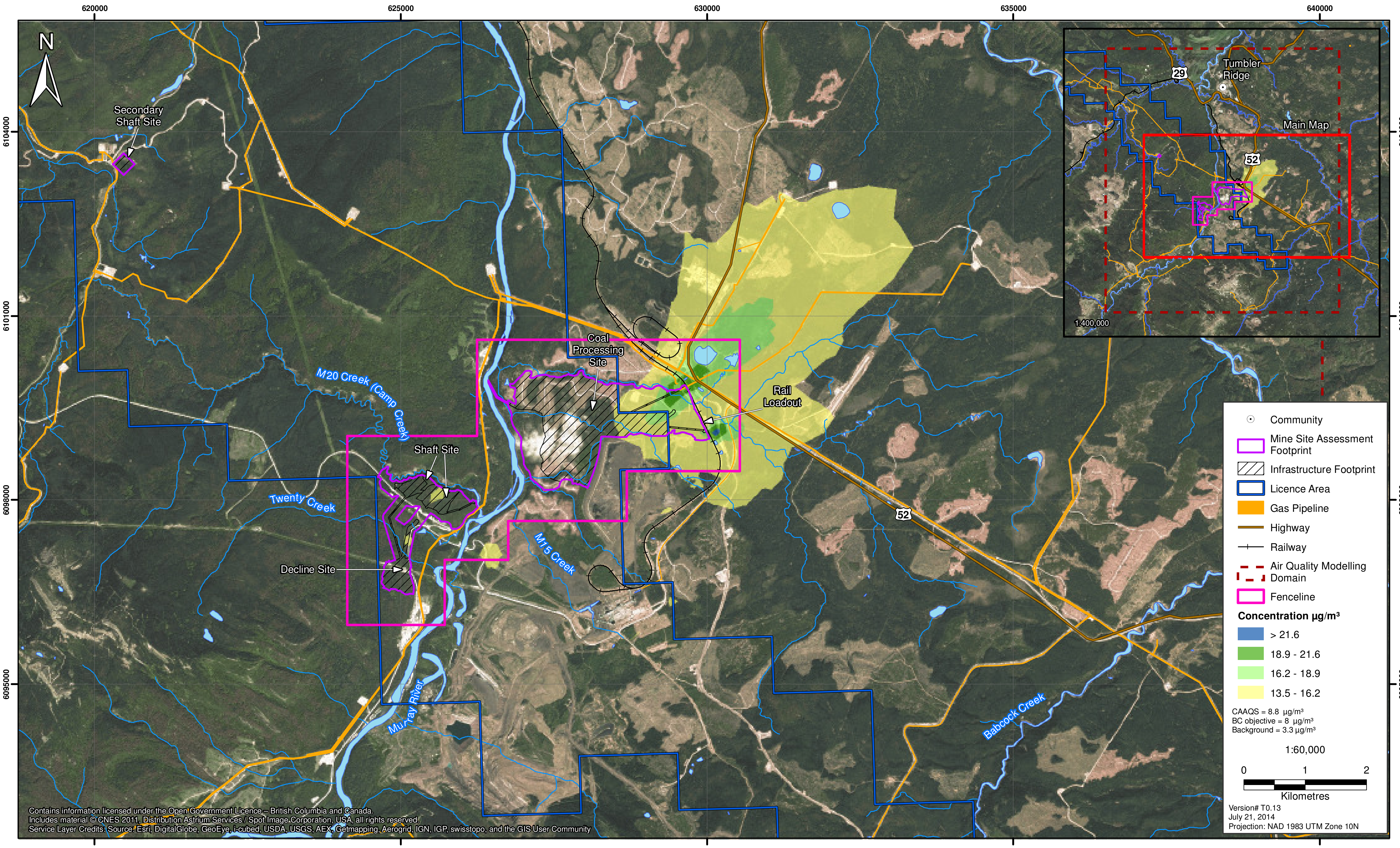


Figure C-11
Predicted Maximum Annual Average $PM_{2.5}$ Concentrations