6. ASSESSMENT OF AIR QUALITY AND GREENHOUSE GASES EFFECTS

6.1 INTRODUCTION

The Murray River Coal Project (the Project) will result in emissions of criteria air contaminant (CACs), dust and greenhouse gases (GHG). The CAC and dust emissions will affect local air quality, which is an important environmental factor in ensuring the conservation of local vegetation, wildlife, and human health. The change in ambient air quality has been assessed to ensure conservation of the environment and compliance with federal and British Columbia (BC) regulations. GHGs are associated with climate change. There are no standards associated with GHG emissions; however, there are reporting regulations and federal reduction targets.

The air quality assessment draws on local and regional baseline data, and results from detailed dispersion modelling used to predict the potential impact of emissions from the Project. Details of the existing baseline and air quality modelling are summarised in this chapter and further details are included in Appendices 6-A and 6-B, respectively. The analysis of air quality focuses on seven contaminants: particulates (TSP, PM_{10} and $PM_{2.5}$), NO_2, SO_2, CO, and dustfall.

Meteorological conditions are an important consideration when assessing air quality as they influence the behaviour of emissions following release. As such, meteorological data forms a key input to the dispersion modelling. In addition, meteorology is also a major consideration for the design, construction and maintenance of the proposed development. Solar radiation and precipitation data provide information for the design of water management infrastructure and water balance calculations. Baseline meteorological data are summarised in this chapter, and a full meteorological baseline report is provided in Appendix 6-C.

6.2 REGULATORY AND POLICY FRAMEWORK

6.2.1 Air Quality

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 come into effect in 2015 and 2020.

At a provincial level, 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, 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 levels discussed above for the Federal objectives.

Other air quality objectives relevant to the 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. The aim of the objectives is to protect the quality of BC's environment for the benefit of present and future citizens of the province, intending to minimize the effect of known or potential harmful changes in receiving environments (BC MOE 1979).

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. Air quality standards or criteria for industrial settings are defined by occupational health and safety codes.

Relevant federal and provincial ambient air quality criteria are presented in Table 6.2-1. As a conservative approach, the most stringent values have been used for this assessment.

In addition to the federal and provincial regulations, there is also a BC Air Quality Dispersion Modelling Guideline (BC MOE 2008). 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 6-B, Conceptual Model Plan) was prepared based on the best practices from the BC Model Guideline and was approved on April 9, 2014.

A guidance document, "Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators" has been produced by the BC MOE to outline and define the baseline study requirements and information considerations necessary to propose a mineral development project in the Province of British Columbia (BC MOE 2012). The document focuses on the collection, analysis, interpretation, and submission of baseline information as part of a proposal to develop a mining project in BC.

Table 6.2-1. 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 2013).
c BC MOE (2013a).
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
fe 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

6.2.2 Greenhouse Gas

At present there are no specific regulations that govern the GHG emissions from the Project, however, there are relevant reporting thresholds set by federal and provincial government. At a federal level, facilities emitting over 50,000 tonnes of carbon dioxide equivalent[1] (CO_2e) are required to report emissions to Environment Canada under the *Greenhouse Gas Emissions Reporting Program*

[1] Carbon dioxide equivalent (CO_2e). A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP).

(2014a). At a provincial level, facilities emitting over 10,000 tonnes of CO_2e must report to the BC MOE and those emitting over 25,000 tonnes of CO_2e must also have their emissions verified by an independent and accredited third party under the BC Reporting Regulation (BC Reg 376/2010) of the *Greenhouse Gas Reduction (Cap and Trade) Act* (2008).

Current scientific knowledge does not allow for the effects of the individual project phases on climate change to be assessed. The Project is therefore assessed in terms of CO_2e produced and compared with sector, provincial, federal, and international levels, consistent with guidance by the Canadian Environmental Assessment (CEA) Agency (2003).

6.3 Regional Overview

6.3.1 Air Quality

The air quality in the Project area and elsewhere in northeastern BC is mainly unaffected by anthropogenic sources, reflecting the Project's remoteness. There are a number of anthropogenic sources within the region, including 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.

6.3.2 Climate

The region is frequently influenced by moist air from the Pacific as well as drier continental air, as it is close to the leeward side of the Rocky Mountains' Hart Ranges. The topography of the region plays a large role in the Project's climate as precipitation, air temperature, snow depth, and wind speed and direction are highly variable within the region. The orographic influence due to mountains within the area, as well as the inflow of moist air from the Pacific meeting with drier continental air masses, means that precipitation is highly variable over the Project area.

6.3.3 GHG Emissions

Environment Canada (EC) is responsible for preparing Canada's official national inventory, which includes details of emissions from each province and territory (EC 2014b). In 2012, the most recent annual dataset, Canada's total GHG emissions were estimated to be 699 Mt CO_2e, of which 60,100 kt CO_2e were emitted in BC.

Since 2010, facilities emitting over 50,000 t of CO_2e have been required to report emissions to EC for the Greenhouse Gas Emissions Reporting Program. For the 2012 calendar year, 549 facilities reported their GHG emissions, 75 of which were located in BC. The total annual emissions from these facilities (14,225 kt CO_2e) equalled 6% of the total facility-reported GHG emissions in 2012 (EC 2014a).

6.4 Historical Activities

Several historic and current human activities are within close proximity to the proposed Project area. These include mining exploration and production, oil and gas, forestry, tourism/recreation and hunting/trapping.

The Quintette Coal Mine, about 20 km south of Tumbler Ridge, was an open pit mine that operated between 1982 and 2000. The mine consisted of five open pits in three discrete areas: Sheriff (Wolverine and Mesa Pits), Frame (Shikano Pit) and Babcock (Windy and Window Pits). Mine permits for the Wolverine and Mesa Pits were issued in December 1982 and mining commenced from 1983 until 1998 (Wolverine) and 2000 (Mesa). Raw coal was transported via an overland conveyor from the Mesa and Wolverine Pits to the Quintette plant site for processing. The coal processing plant has been under care and maintenance since the end of mining in 2000; the overland conveyor, which previously crossed through a portion of HD Mining's Decline Site, was decommissioned by Teck in 2011. There are limited emissions associated with the care and maintenance stage of the mine. Teck is currently securing the necessary approvals to re-initiate mining in the Babcock area.

The Bullmoose Coal Mine operated from 1983 to 2003 and was the largest open pit coal mine at the time. The 1.7-million-tonne-per-year operation consisted of an open-pit mine, a plant facility in the Bullmoose Creek valley below the mine, and a separate rail loadout facility on the B.C. Rail branchline. Since the mine closed in 2003, the ambient air quality conditions have been restored to their natural state due to natural air dispersion processes.

Previous exploration in the area included seismic lines and drilling for oil and gas wells which helped target areas for coal exploration. Twelve cutblock licenses exist within the LSA; three of these are held by the proponent. Large portions of the LSA have been recently harvested to remove pine-beetle affected timber. There are limited emissions associated with these activities.

Subsistence activities, such as trapping, hunting, and fishing are common land uses regionally. Three trapping tenures and four guide-outfitting tenures overlap the RSA. The nearest trapline cabin is 1.7 km from the Project on the west bank of Murray River, the nearest campground is 9.5 km north from the Project (near Tumbler Ridge), the nearest hunt camp is 26 km west from the Project, and the nearest residential area (Tumbler Ridge) is 12.4 km north from the Project. There are limited emissions associated with these activities.

The Project is located near two provincial parks and protected areas. Bearhole Lake Provincial Park and Protected Area is located approximately 17 km east of the Project, and Monkman Provincial Park is located approximately 27 km south of the Project.

6.5 BASELINE STUDIES

Baseline monitoring was carried out for air quality and meteorology. Desk based research was carried out to provide sector, provincial, federal, and international baseline GHG levels.

The air quality monitoring program was undertaken in 2011 and consisted of dustfall monitoring. Further details of the air quality baseline program are available in the 2011 Air Quality Baseline Report (Appendix 6-A). The meteorological monitoring program ran from 2011 to 2013. Further details of the meteorology baseline program are available in the 2013 Meteorology Baseline Report (Appendix 6-C).

The objectives of the baseline monitoring studies were to:

- provide understanding of existing baseline conditions in the vicinity of the Project;
- provide a benchmark for evaluating the potential future effects of the Project; and
- support predictive modelling for effect analysis.

The baseline program followed the methods outlined in the AIR and EIS Guidelines.

6.5.1 Air Quality

Baseline air quality data represent ambient air conditions prior to project commencement, due to emissions from both natural and anthropogenic sources. Understanding the existing ambient air quality allows a quantitative assessment of the potential effects of the project-related air contaminant emissions to be undertaken.

The following section describes the baseline air quality conditions with respect to the following:

- CACs:
  - nitrogen oxides,
  - sulphur oxides,
  - carbon monoxide,
  - total suspended particulate (TSP) matter,
  - particulate matter (PM_{10}),
  - respirable particulate matter ($PM_{2.5}$), and
- dust deposition.

6.5.1.1 Data Sources

Continuous ambient monitoring equipment requires power, which can be challenging in remote areas, there is therefore limited background air quality data in north east BC. Project specific air quality monitoring has, therefore, been restricted to passive dustfall monitors. Baseline data were collected at five locations from May to October 2011. The 2011 Air Quality Baseline Report provides details of site specific monitoring (Appendix 6-A).

In the absence of site-specific monitoring data for other pollutants, the BC Modelling Guideline recommends that other monitoring data from similar sources and meteorology be used. As such, the existing air quality across the study area has been determined from available monitoring data from representative stations and a literature review of other air quality studies in the area. Data from three additional stations, Beaverlodge, Tumbler Ridge Industrial Parka and Tumbler Ridge Airport, have been used. The 2011 Air Quality Baseline Report provides further details of available monitoring data in the area (Appendix 6-A).

6.5.1.2 Methods

Site-specific Monitoring

Five locations were selected for dustfall monitoring that were outside the boundaries of the footprint of the proposed coal mine (Figure 6.5-1; Plate 6.5-1). Two of the dustfall stations (DF3 and DF4) were positioned upwind of the future active mine area and two were positioned downwind (DF1 and DF2). A "control" dustfall monitoring station (DF5) was positioned off of the axis of the two predominant wind directions.

Plate 6.5-1. Dustfall Monitoring Station DF5.

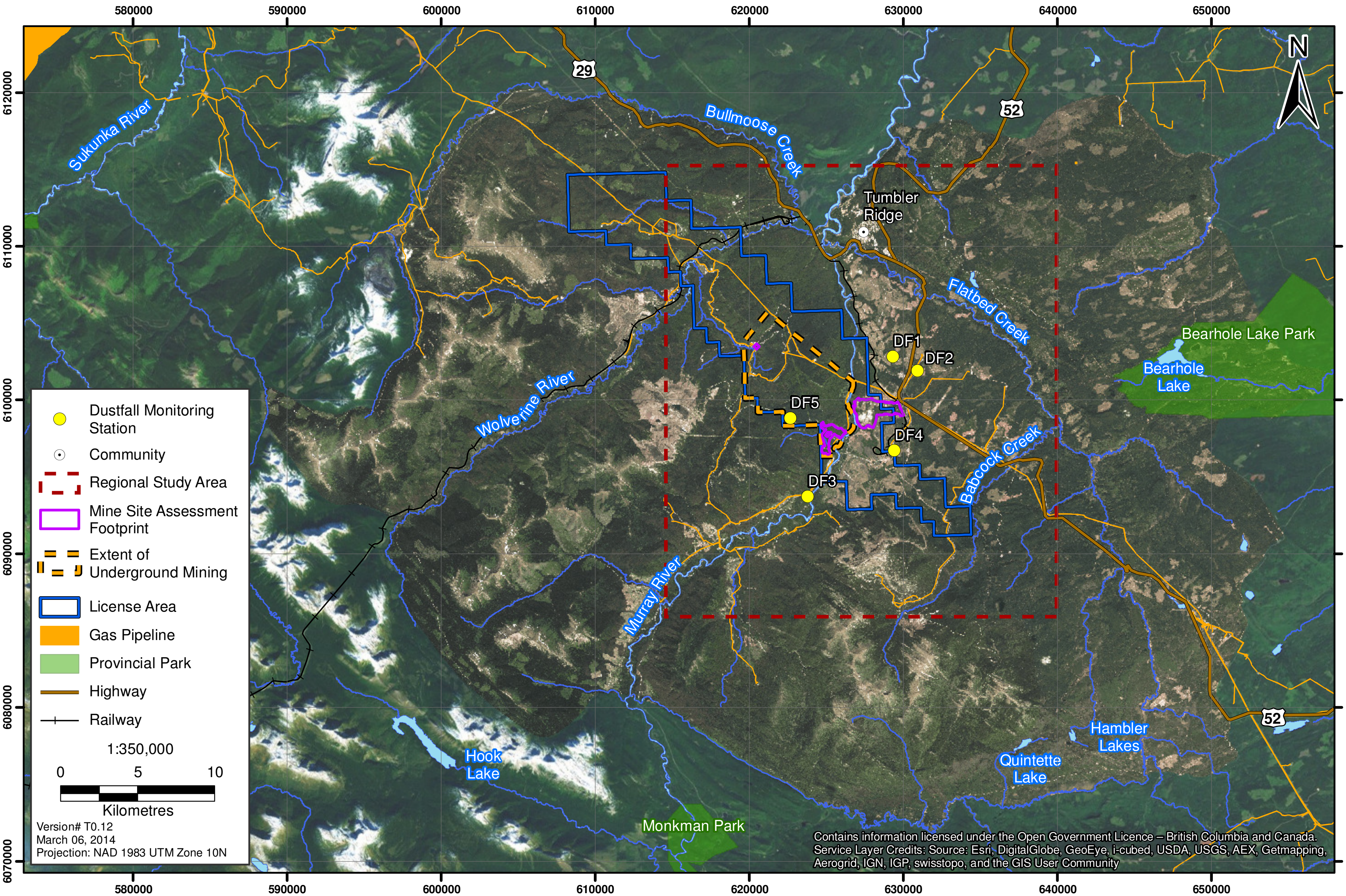
Dustfall was monitored for five months; from mid-May to mid-October 2011. Each site required a monthly visit to exchange canisters and ensure the site had not been tampered with. Two of the dustfall stations had been vandalized and monitoring was not carried out for three months.

Details of the dustfall monitoring program are provided in the 2011 Air Quality Baseline Report (Appendix 6-A). The full dustfall methodology is contained in ASTM D 1739–98 (reapproved 2010) Standard Test Method for Collection and Measurement of Dustfall (Settleable Particulate Matter) (ASTM 2010). The guidance provided in the Water and Air Baseline Monitoring Guidance Document for Mine Proponents and Operators was also followed.

Local Monitoring

Monitoring data for three local stations, Beaverlodge, Tumbler Ridge Industrial Park, and Tumbler Ridge Airport, were available.

Figure 6.5-1
2011 Dustfall Monitoring Stations



Tumbler Ridge Airport and the Tumbler Ridge Industrial Park, both operated by Peace River Coal Inc. (PRC), are the two nearest ambient PM_{10} and $PM_{2.5}$ monitoring stations with publically available data. Monitoring at Tumbler Ridge Industrial Park was carried out from August 2008 to November 2008, and monitoring at Tumbler Ridge Airport 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). 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 Beaverlodge station, operated by Alberta Environment, is the nearest NO_2 and SO_2 monitoring station with publically available data, it also monitors PM_{10} and $PM_{2.5}$. Monitoring data is available for 2006 to 2012.

6.5.1.3 *Characterization of Air Quality Baseline Conditions*

Criteria Air Contaminants (CACs)

Nitrogen Dioxide

Monitored NO_2 concentrations at the Beaverlodge station for 2006 to 2012 are presented in Table 6.5-1. Monitored NO_2 concentrations were well below the most stringent objectives.

Table 6.5-1. Monitored NO_2 Concentrations ($\mu g/m^3$), Beaverlodge (2006-2012)

Year	Maximum 1-hour Average	Maximum 24-hour Average	Annual Average
Relevant objective	*400*[a]	*200*[a]	*60*[a]
2006	72.9	43.6	8.6
2007	63.9	38.0	8.0
2008	60.2	45.3	8.0
2009	93.8	64.1	8.8
2010	67.5	46.2	8.9
2011	59.4	39.6	5.8
2012	75.8	40.4	6.8

[a] *Most stringent objective presented.*

Sulphur Dioxide

Monitored SO_2 concentrations at the Beaverlodge station for 2006 to 2012 are presented in Table 6.5-2. Monitored SO_2 concentrations were also well below the most stringent objectives.

Table 6.5-2. Monitored SO_2 Concentrations ($\mu g/m^3$), Beaverlodge (2006-2012)

Year	Maximum 1-hour Average	Maximum 24-hour Average	Annual Average
Relevant objective	*450*[a]	*150*[a]	*25*[a]
2006	57.7	9.2	1.6
2007	141.5	18.2	1.5

(continued)

Table 6.5-2. Monitored SO_2 Concentrations ($\mu g/m^3$), Beaverlodge (2006-2012; completed)

Year	Maximum 1-hour Average	Maximum 24-hour Average	Annual Average
Relevant objective (cont'd)	*450*[a]	*150*[a]	*25*[a]
2008	88.6	7.2	1.2
2009	45.2	13.6	1.0
2010	31.1	5.3	1.1
2011	95.8	14.0	0.9
2012	19.2	6.6	0.8

[a] *Most stringent objective presented.*

Carbon Monoxide

There are no site-specific or local background concentrations available for CO. The Ministry of Environment's Mobile Air Monitoring Laboratory (MAML) was deployed to monitor air quality, including CO concentrations, in five communities in the north east of British Columbia during 2010 and 2011. The closest site was Kelly Lake, approximately 70 km northeast of the Murray River Project. The maximum CO concentrations were around 400 $\mu g/m^3$ at Kelly Lake, approximately 3% of the objective (BC MOE 2011). The concentrations at the Murray River site are also expected to be well below the objective.

Particulate Matter

Background PM_{10} concentrations are available from monitoring carried out at the Tumbler Ridge Airport station and Tumbler Ridge Industrial Park. Background $PM_{2.5}$ concentrations are also available from monitoring at the Tumbler Ridge Airport station and Tumbler Ridge Industrial Park, as well as more recent monitoring from the Beaverlodge station. Available PM_{10} and $PM_{2.5}$ monitoring data is presented in Tables 6.5-3 and 6.5-4, respectively.

Table 6.5-3. Monitored PM_{10} Concentrations ($\mu g/m^3$), Tumbler Ridge Airport (2006-2008) and Tumbler Ridge Industrial Park (2008)

	Maximum 24-hour Average	
Year	Tumbler Ridge Airport	Tumbler Ridge Industrial Park
Relevant objective	*50*	*50*
2006	21[a]	-
2007	39	-
2008	29	63[b]

[a] *Based on four months of data (September to December)*
[b] *Based on four months of data (August to November)*

There were no monitored exceedances of BC's PM_{10} objective at the Tumbler Ridge Airport station in 2006 to 2008. However, there is a potential exceedance monitored at the Tumbler Ridge Industrial station in 2008.

Table 6.5-4. Monitored $PM_{2.5}$ Concentrations (µg/m³), Tumbler Ridge Airport (2006-2008) and Beaverlodge (2006-2012)

	Tumbler Ridge Airport	Tumbler Ridge Industrial Park	Beaverlodge		
Year	Maximum 24-hour Average	Maximum 24-hour Average	Maximum 24-hour Average	98th Percentile of 24-hour Averages	Annual Average
Relevant objective	-[a]	-[a]	-[a]	*25*	*8*
2006	21[b]	-	66.8	13.0	3.9
2007	24	-	19.2	10.0	3.0
2008	59	32	16.5	10.3	3.1
2009	-	-	35.0	16.5	5.2
2010	-	-	53.0	27.9	10.0
2011	-	-	84.8	19.9	6.7
2012	-	-	35.8	25.6	8.3

[a] *24-hour $PM_{2.5}$ objective is based on annual 98th percentile value.*
[b] *Based on two months of available data.*

There were monitored $PM_{2.5}$ exceedances of the 24-hour and annual objectives in 2010 and 2012 at the Beaverlodge monitoring station. There were potential exceedances at the Tumbler Ridge Airport and Tumbler Ridge Industrial stations in 2008. The objective applies to the 98th percentile of 24-hour average concentrations, which will be lower than the maximum 24-hour average concentration presented in Table 6.5-4. The raw monitoring data were not available for these stations and therefore it is not possible to confirm the occurrence of this potential exceedance. Both monitoring stations are located in more urbanised areas than the Project site, and therefore $PM_{2.5}$ concentrations would likely be substantially lower across the Project site.

No baseline monitoring of TSP has been carried out in the study area, or at the Tumbler Ridge or Beaverlodge stations. The National Air Pollution Surveillance (NAPS) Network was contacted to identify if any monitoring had been carried out in the surrounding are, however no TSP monitoring has been carried out since the 1990's. Therefore the AP-42 aerodynamic particle size multiplier for aggregate handling (U.S. EPA 2006a) was used to convert PM_{10} concentrations to TSP values (Table 6.5-5). These calculated background TSP values were also used in the Roman Coal Mine Environmental Assessment Report and the Quintette Coal Mine Restart Project (PRC 2010; Stantec 2012).

Table 6.5-5. Predicted TSP Background Concentrations (µg/m³)

Averaging Period	Assumed Background Concentration
24 hour	45.2
Annual	12.5

Current Sources of CACs

The British Columbia Emissions Inventory of Criteria Air Contaminants was compiled as a collaborative effort involving Metro Vancouver (formerly GVRD, Greater Vancouver Regional District) and Environment Canada. Data specific for the District Municipality of Tumbler Ridge were extracted from the 2006 Environment Canada Emissions Inventory of Criteria Air Contaminant (W. McCormic, pers. comm.) and are displayed in Table 6.5-6. The main sources of emissions are point sources (NOx and CO), industrial area sources (SOx) and dust from unpaved roads (TSP, PM_{10} and $PM_{2.5}$).

Table 6.5-6. Air Emissions inside the District Municipality of Tumbler Ridge

	Emissions (tonnes/year)					
Categories/Sectors	TPM	PM_{10}	$PM_{2.5}$	SO_X	NO_X	CO
Point Sources						
Coal Mining Industry	404.9	211.2	50.9	32.6	484.4	761.0
Total	**404.9**	**211.2**	**50.9**	**32.6**	**484.4**	**761.0**
Area Sources						
Industrial	19.5	17.0	15.7	618.2	157.9	270.2
Mining	583.5	84.7	26.8	46.7	0.1	0.1
Power generation	0.1	0.1	0.1	0.1	1.9	0.5
Residential Heating	11.7	11.1	11.0	0.2	4.2	69.3
Unpaved roads	1,229.7	233.2	31.6	0.0	0.0	0.0
Agriculture	65.7	34.4	2.4	0.0	0.0	0.0
Other	12.2	4.4	1.7	0.4	0.8	1.0
Total	**1,922.3**	**384.8**	**89.2**	**665.5**	**164.9**	**341.2**
Mobile Sources						
Aircraft	0.2	0.2	0.2	1.3	20.5	6.2
Heavy-duty diesel vehicles	0.6	0.6	0.5	0.3	21.6	4.8
Heavy-duty gasoline trucks	0.1	0.1	0.1	0.0	6.0	32.5
Light-duty diesel vehicles	0.0	0.0	0.0	0.0	0.3	0.3
Light-duty gasoline vehicles	0.2	0.1	0.1	0.1	32.0	609.8
Other mobile sources	3.1	3.1	2.6	0.9	24.5	228.5
Total	**4.1**	**4.1**	**3.5**	**2.6**	**104.8**	**882.1**
Grand total	**2,331.3**	**600.2**	**143.6**	**700.8**	**754.0**	**1,984.3**

Source: W. McCormick, BC MOE (pers. comm.).

A search of the National Pollutant Release Inventory identified five sources within Tumbler Ridge in 2012 (Environment Canada 2014a). The emissions are presented in Table 6.5-7. The Perry Creek coal mine has the highest emissions for all pollutants except sulphur dioxide, the Bullmoose oil and gas facility has the highest sulphur dioxide emissions.

Dustfall

Monitored dustfall results are presented in Table 6.5-8.

Table 6.5-7. Tumbler Ridge NPRI Emission Sources 2012 (tonnes)

Company Name	Facility Name	Sector	NO_2	SO_2	CO	TSP	PM_{10}	$PM_{2.5}$
Apache Canada Ltd.	b-57-G/93-I-09	Oil and Gas Extraction	101	-	-	-	0.04	0.04
Pacific Northern Gas Ltd.	Tumbler Ridge Gas Plant	Natural Gas Distribution	-	6.4	-	-	-	-
Walter Canadian Coal Partnership	Wolverine Group - Perry Creek Mine	Coal Mining	195	246	285	11,025	3,994	222
Husky Oil Operations Ltd.	Bullmoose	Oil and Gas Extraction	-	455	-	-	-	0.4
Apache Canada Ltd.	Ojay 8501	Oil and Gas Extraction	2.9	-	-	-	-	-

Table 6.5-8. Murray River Monitored Dustfall (mg/dm²/day)

Date	DF1	DF2	DF3	DF4	DF5	Average
May/June 2011	1.09	1.64	1.31	1.18	1.03	1.31
June/July 2011	-	0.71	-	0.89	0.59	0.80
July/August 2011	-	0.44	-	0.51	0.13	0.48
August/September 2011	-	0.48	-	0.59	0.41	0.54
September/October 2011	0.17	0.22	0.18	0.32	0.17	0.22
Average	0.63	0.70	0.75	0.70	0.47	-

All samples collected at the Murray River sites were below the lower BC MOE limit of 1.7 mg/dm²/day. Dustfall collected during May and June was significantly higher than other 30 day periods. This higher level of dustfall may have occurred because snow cover had melted, however, vegetation had not yet grown to prevent re-suspension of dust by the wind.

In addition, dustfall monitoring has been conducted for a number of mine sites in north east BC, including: Hermann Mine, Wolverine Mine, Trend Small Mine and Dillon Mine (Pomeroy 2007) (Table 6.5-9). Dustfall monitoring from other mine sites in the area show that peak dustfall rates may exceed the BC MOE limits close to the sources. However, these studies show that dust levels fall rapidly with distance from the project boundaries such that background levels are acceptable.

6.5.2 Climate and Meteorology

The following section describes the existing baseline meteorological conditions of the area with respect to:

- wind;
- precipitation;
- air temperature;
- humidity;

- solar radiation; and
- evaporation.

Table 6.5-9. Range of Dustfall Measurements from Mines in North East BC

Project	Dates	Minimum Dustfall (mg/dm²/day)	Maximum Dustfall (mg/dm²/day)
Hermann Mine	August to September 2006	<0.1	0.28
Wolverine Mine	July to October 2006	<0.1	3.08
Trend Small Mine	January to June 2006	<0.1	76.0
Dillon Mine	February to November 2005	<0.1	72.3
Dillon Mine	January to October 2006	<0.1	4.99
Vicinity of Bullmoose and Quintette Mines	1993 to 2000	<0.1	11.0

Source: Pomeroy 2007

Due to the mountainous terrain of the region, the weather can vary significantly in different parts of the Project area and over relatively short distances. The baseline meteorology study has drawn on data from regional meteorology stations and a site specific meteorology station.

6.5.2.1 Data Sources

Meteorological data is available from an onsite monitoring station, and regional stations operated by the Meteorological Service of Canada (MSC) and the BC Ministry of Forest, Lands, and Natural Resources Operations – Wild Fire Management Branch. The locations of the stations are shown in Figure 6.5-2. Due to the mountainous terrain of the region, meteorological conditions can vary significantly spatially. It is important to use meteorological data that is as close to the Project as possible, located in comparable terrain and at a similar elevation, in order to get the best representation of the Project's climate.

The Murray River meteorological station was installed on March 8, 2011 (Plates 6.5-2 and 6.5-3) in a laydown area beside the Mast Road near kilometre four. Data collection at this station commenced on March 9, 2011. The location of the Project meteorological station is provided in Figure 6.5-3 and Table 6.5-10.

Five meteorology stations operated by MSC are located in the Murray River regional area; however, three of the stations are currently inactive. The regional stations with a long period of record provide a good comparison for the data collected by the Murray River meteorological station. Available climate normals from the region, which summarize the average climatic conditions, are compared to the data collected from the Project meteorological station. The Tumbler Ridge meteorological station commenced operation in 1985 and ceased in 2003. EC did not publish climate normal for this station; however, averages of data collected from 1985 to 2002 were calculated in the same fashion to represent long term climate normals at this location.

Figure 6.5-2
Murray River and Regional Meteorological Stations

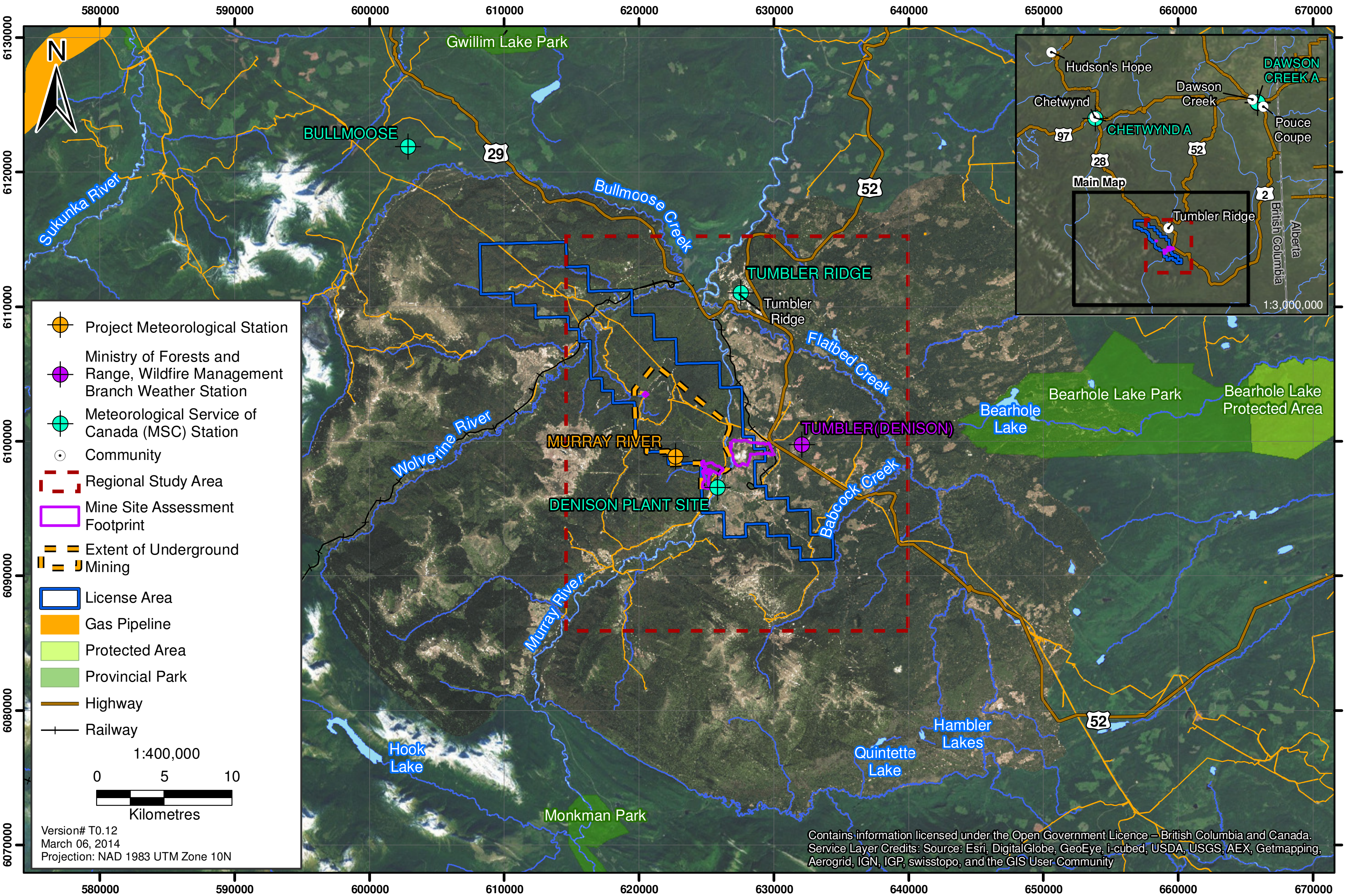
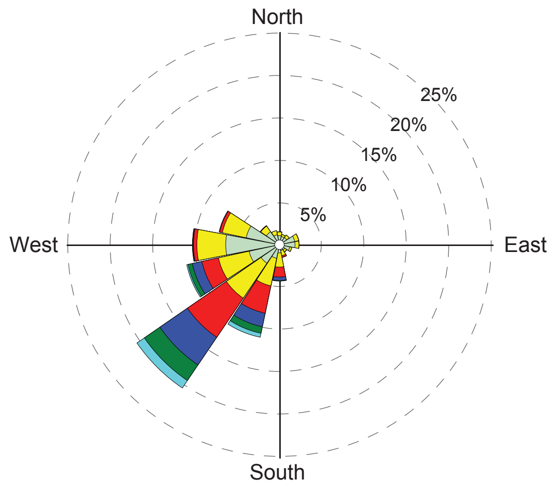
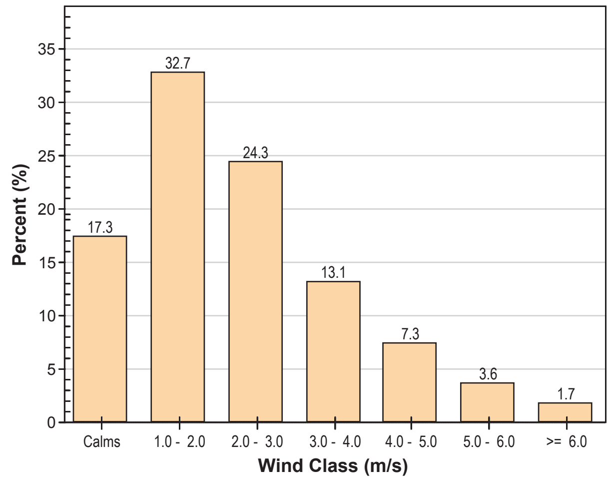


Figure 6.5-3

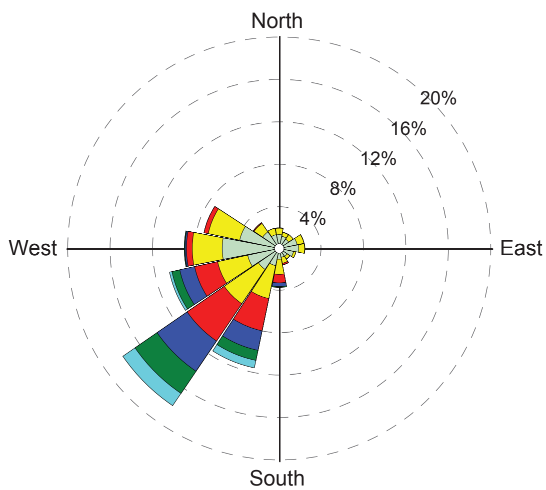
Murray River Windrose, March 9, 2011 to March 9, 2013

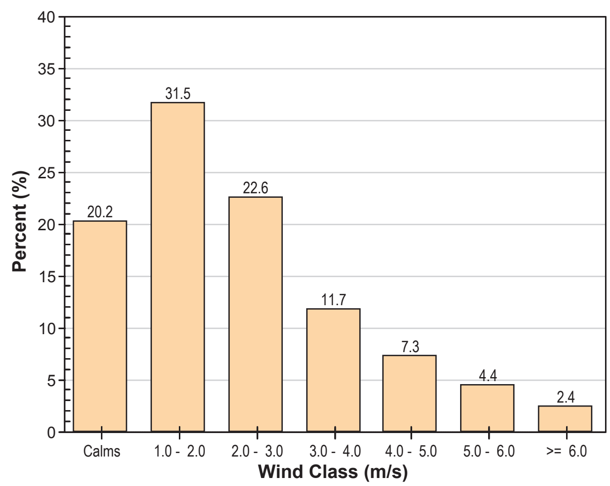
Annual



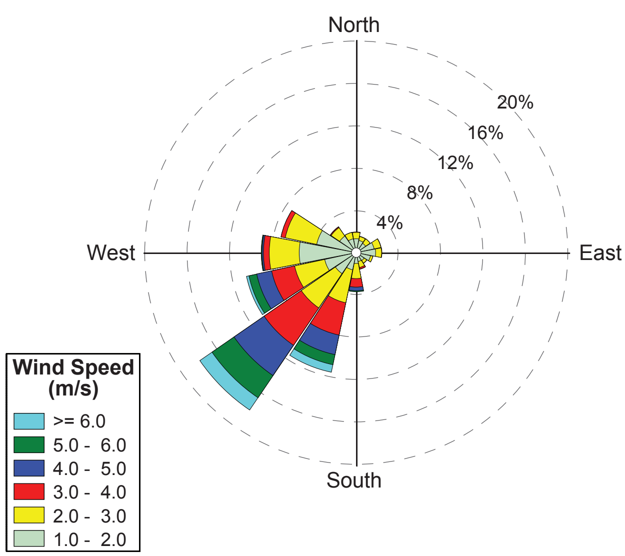


Winter





Summer



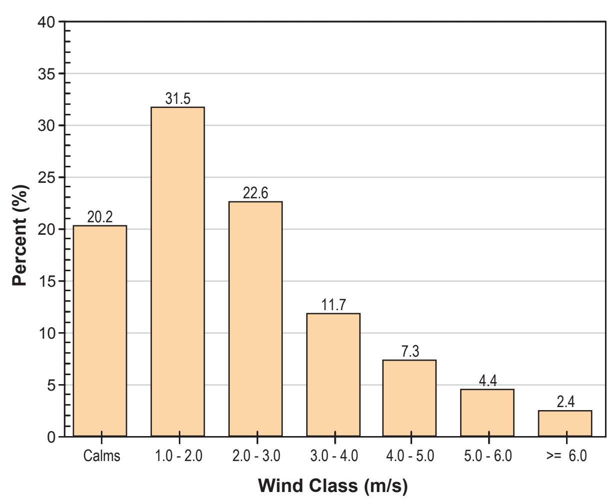


Plate 6.5-2. Facing south east, the Murray River meteorological station (March 8, 2011).

Plate 6.5-3. Facing south, the Murray River meteorological station (October 19, 2012).

Table 6.5-10. Automated Weather Stations in the Region

Station Name	Location			Time Period	Meteorological Parameters	Status
	Climate ID	(Lat., Long., Elevation)	Distance from Murray River Station			
Murray River	n/a	55.02°N 121.08°W 1,055 masl	n/a	3/9/2011 to 12/31/2013	Air Temperature Precipitation Snow Depth Wind Speed and Direction Solar Radiation Barometric Pressure Relative Humidity	Active
Denison Plant Site	1182427	55°N 121.03°W 854 masl	3.8 km southeast	7/1/1982 to 5/31/1997	Air Temperature Precipitation Snow Depth	Inactive
Tumbler Ridge	1188297	55.13°N[a] 121.01°W[a] 824 masl	13.2 km north northeast	3/1/1985 to 3/31/2003 Climate Normals[b]	Air Temperature Precipitation Snow Depth	Inactive

(continued)

Table 6.5-10. Automated Weather Stations in the Region (completed)

Station Name	Location			Time Period	Meteorological Parameters	Status
	Climate ID	(Lat., Long., Elevation)	Distance from Murray River Station			
Bullmoose	1181120	55.13˚N 121.48˚W 1,102 masl	25.8 km northwest	1981 - 2010 Climate Normals	Air Temperature Precipitation Snow Depth	Inactive
Chetwynd A	1181508	55.69˚N 121.63˚W 610 masl	81.9 km northwest	1981 - 2010 Climate Normals and 2011, 2012 and 2013	Air Temperature Precipitation Snow Depth Wind Speed and Direction	Active
Dawson Creek A	1182289	55.74˚N 120.1˚W 656 masl	98 km northeast	2011, 2012 and 2013	Air Temperature Precipitation Wind Speed and Direction	Active
Tumbler (Denison)	n/a	55.03˚N 120.93˚W 942 masl	9.5 km east	1982-2013	Air Temperature Relative humidity Wind Speed and Direction Precipitation	Active

[a] *The MSC's reported position of Tumbler Ridge station is incorrect based on knowledge from previous studies. The listed position is an estimate of the correct location based on the location of the town of Tumbler Ridge and its topography.*
[b] *Data from 1985 to 2002 were summarized for long term averages to represent climate normal.*

Tumbler (Denison) station, managed by the BC Ministry of Forest, Lands, and Natural Resources Operations – Wild Fire Management Branch, is the closest regional station to the Project that is still active.

6.5.2.2 Methods

Meteorological Monitoring

The Murray River automated meteorology station, is solar powered and collects data 24 hours per day. Baseline data was collected from March 2011 to December 2013. The automated meteorological station includes sensors for:

- wind speed and direction;
- temperature and relative humidity;
- solar radiation;
- atmospheric pressure;
- snow depth; and
- precipitation.

To ensure the station collects representative data the sensors were located according to guidelines set by Environment Canada – Meteorological Services of Canada (EC MSC 2004) *Guidelines for Co-operative Climatological Autostations*. The Environment Canada standards closely follow standards set by the World Meteorological Organization (WMO 1983). These guidelines were established to promote standardization and describe practices, procedures, and specifications for proper siting of instruments, precision and accuracy of measurements, and archive formats. In addition, a wildlife deterrent system was installed around the station to prevent the equipment from being damaged.

All meteorological data were reviewed after collection to remove or correct any erroneous values. The screening criteria used were set by the United States Environmental Protection Agency (US EPA 2000) and Environment Canada (2004), together with professional judgement. Any erroneous data were marked as missing and after data were screened, the recorded hourly and daily values were analysed and processed into daily and monthly summaries.

6.5.2.3 Characterization of Meteorological Baseline Condition

Data collected from the Project-specific meteorological station is summarized in the Murray River 2011 to 2013 Meteorology Baseline Report (Appendix 6-C). The report presents the daily mean, maximum and minimum air temperature, as well as total daily precipitation for the Murray River meteorological station for the period of record.

During the period from March 2011 to December 2013, the mean monthly air temperatures for the Murray River station ranged from a low of -12.9°C in December 2012 to a high of 16.1°C for July 2012. The temperatures are generally similar, or slightly lower, than climate normal recorded in the regional stations, possibly due to the higher elevation of the Murray River meteorology station (around 200 to 400 m higher) than the regional stations, that are typically located in valley bottom settings.

At the Murray River meteorological station the extreme mean daily maximum air temperature of 30.7ºC was recorded on July 1, 2013, and the extreme mean daily minimum air temperature recorded was -36.3ºC on January 17, 2012. The extremes extracted from the climate normal data show an extreme maximum of 35.5˚C monitored on August 13, 1992 at Tumbler Ridge and an extreme minimum of -52˚C monitored on January 25, 1997 at Chetwynd A. The onsite range is not as large as monitored at EC-MSC stations in the region as the monitoring period was a much shorter duration.

A windrose is a joint frequency distribution of wind directions and wind speed. Windroses in the winter (November to May) and summer (June to October), as well as an annual windrose (based on a 24 month period, March 2011 to March 2013), are presented in Figure 6.5-3. The winter and summer windroses at Murray River station show that there is almost no seasonal variation in wind pattern. Wind speeds observed at Murray River station are generally low, with the most frequent wind speeds between 1 and 2 m/s (33% of the time) and calm (wind speed less than 1 m/s) 17% of the time. Winds over 6 m/s occur less than 2% of the time. Winds generally blow from the southwest quadrant (23% of the time).

The recorded snow depth varies significantly with elevation and setting. On average, most climate stations begin to accumulate snow in mid to late October and have it remain until late April to early May. For the period of March 2011 to December 2013, the highest snow depth at the Murray River station was 57.1 cm recorded on December 24, 2012. The highest regional monitored daily snowfall of 47 cm occurred at Bullmoose on November 19, 1994. The highest monitored regional snow depth was 120 cm on February 27, 1994, also at Bullmoose (1,102 masl).

Precipitation varies greatly in BC due to the orographic influence of the mountains, which act as a natural barrier to clouds carrying precipitation. June and July typically receive the most precipitation in the region. This is due to the large convective weather systems that are most active during this time of year. Annual precipitation monitored at the Murray River station was 387.4 mm in 2011, 484.6 mm in 2012, and 583.2 mm in 2013. Neither 2011 nor 2012 has a complete set of data due to the timing of the installation of the station and a malfunction of the precipitation sensor. Climate normal monitored precipitation totals at the nearby EC-MSC stations varies from 485.5 mm at Tumbler Ridge to 788.7 mm at Bullmoose. The 2011 and 2012 site specific values are not comparable due to missing data. 2013 saw higher total precipitation than the regions climate normals, except for MSC station Bullmoose.

Solar radiation is the total frequency spectrum of electromagnetic energy from the sun. Solar energy accounts for 99% of the Earth's energy. The highest daily average solar radiation monitored at Murray River station, 353 W/m^2, was recorded on June 21, 2011. On average, the lowest and highest mean daily solar radiation occurs during the winter and summer, respectively. This is because the sun is lowest on the horizon during the winter and highest during the summer. All hourly average solar radiation values recorded during night time hours were 0 W/m^2. None of the MSC climate stations reported solar radiation.

6.5.3 Greenhouse Gas Emissions

6.5.3.1 Data Sources

Desk based research was carried out to provide baseline GHG levels. Total CO_2e emissions for sector, provincial, federal, and international levels were obtained from Environment Canada's National Emissions Inventory (EC 2014b) and the International Energy Agency (2012).

6.5.3.2 Characterization of GHG Baseline Condition

Table 6.5-11 shows emissions on a sector, regional, national and global level.

Table 6.5-11. GHG Emissions on a Regional, National, and Global Scale

	GHG Emissions (Mt CO_2e /year)
Coal mining in Canada[a]	1
Mining in Canada[a]	8
British Columbia[a]	60.1
Canada[a]	699
Global[b]	31,600

[a] *Source: Environment Canada (2014b). Based on 2012 data.*
[b] *Source: International Energy Agency (2012)*

6.6 ESTABLISHING THE SCOPE OF THE EFFECTS ASSESSMENT FOR AIR QUALITY

This section includes a description of the scoping process used to identify potentially affected Valued Components (VCs), select assessment boundaries, and identify the potential effects of the Project that are likely to arise from the Project's interaction with a VC. Scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects. The scoping process for the assessment of air quality consisted of the following steps:

- *Step 1:* conducting a desk-based review of available scientific data, technical reports, and other Project examples to compile a list of potentially affected VCs in the vicinity of the Project;
- *Step 2:* carrying out detailed field baseline studies to fill information gaps and confirm presence/absence of VCs;
- *Step 3:* considering feedback from the EA Working Group on the proposed list of VCs included in the AIR and the EIS Guidelines;
- *Step 4:* defining assessment boundaries for each VC; and
- *Step 5:* identifying key potential effects on VCs.

6.6.1 Selecting Valued Components

Valued components (VCs) are components of the natural and human environment that are considered to be of scientific, ecological, economic, social, cultural, or heritage importance. To be included in the EA, there must be a perceived likelihood that the VC will be affected by the proposed Project. Valued components are scoped into the environmental assessment based on issues raised during consultation on the AIR and EIS Guidelines with Aboriginal communities, government agencies, the public and stakeholders. Consideration of certain VCs may also be a legislated requirement, or known to be a concern because of previous project experience.

6.6.1.1 Summary of Valued Components Selected for Assessment

The scope of air quality concerns was identified based on consultation with regulatory agencies, regulatory considerations and professional judgment. Table 6.6-1 presents the identification and rationale for selecting air quality as a valued component.

Table 6.6-1. Air Quality Valued Components Included in the Effects Assessment

Valued Components	Identified by*			Rationale for Inclusion
	AG	G	P/S	
Air Quality	X	X	X	Ambient air quality is a concern in general for human health as well as effects to the environment. Measureable parameters are selected to help define the effects of the Project activities on the environment. Air and climate issues were identified by the First Nations during a community consultation event.

**AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder*

The preliminary VC is Air Quality; specific pollutants to be modelled and assessed include:

- CACs:
  - nitrogen oxides,
  - sulphur oxides,
  - carbon monoxide,
  - total suspended particulate (TSP) matter,
  - particulate matter (PM_{10}), and
  - respirable particulate matter ($PM_{2.5}$);
- dust deposition; and
- GHGs.

Other 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 NOx and VOCs. The short section of proposed natural gas pipeline (approximately 800 m), may result in VOC emissions, however based on experience from other projects and professional knowledge, the emissions are expected to be minimal. VOC emissions associated with combustion of fuels and the processing of coal are also expected to be minimal. There are also currently no established BC or federal criteria for ambient VOC. Due to the minimal emissions, complex chemistry and the lack of ambient air quality criteria for these species, these pollutants are not considered further.

6.6.2 Selecting Assessment Boundaries

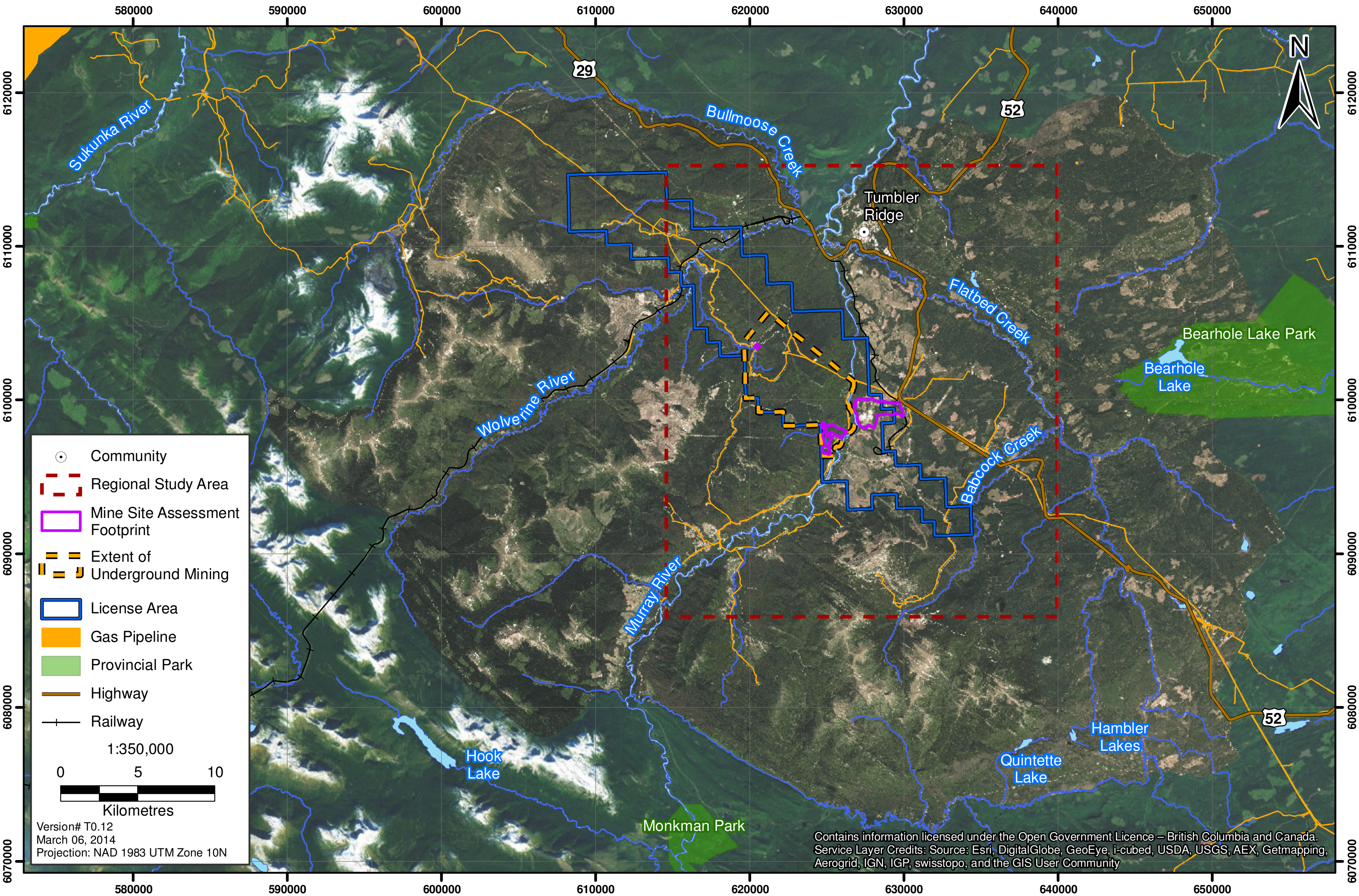
Assessment boundaries define the maximum limit within which the effects assessment is conducted. They encompass the areas within, and times during which, the Project is expected to interact with the VCs. The definition of these assessment boundaries is an integral part in scoping for air quality, and encompasses possible direct, indirect, and induced effects of the Project on air quality, as well as the trends in processes that may be relevant.

6.6.2.1 Spatial Boundaries

A single spatial boundary was used for the air quality assessment to represent both the local study area (LSA) and regional study area (RSA). The extent of the modelling domain used for the air dispersion model was used as this boundary. The spatial boundary was based on the "zone of influence" beyond which the potential residual effects of the Project are expected to diminish to a negligible state. Based on baseline studies, consultation, and expert knowledge, it was concluded that the potential impacts of the Project could extend 10 km from the site. The town of Tumbler Ridge lies outside the 10 km buffer; therefore, as a conservative approach, the northerly extent of the LSA was extended to include the town of Tumbler Ridge. The boundary, shown in Figure 6.6-1, 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). The results of the model (Appendix 6-B) confirmed that this boundary was adequate to assess the air quality zone of influence.

ERM

Figure 6.6-1
Spatial Boundaries for Assessment of Air Quality Effects



6.6.2.2 *Temporal Boundaries*

The temporal boundaries used for the air quality assessment are aligned with the Project phases and are defined as follows:

- **Construction**: 3 years;
- **Operation**: 25-year run-of-mine life;
- **Decommissioning and Reclamation**: 3 years (includes project decommissioning, abandonment and reclamation activities, as well as temporary closure, and care and maintenance); and
- **Post Closure**: 30 years (includes ongoing reclamation activities and post-closure monitoring).

A temporal boundary is the period of time when the Project has an effect on the environment. All of the Project phases could potentially interact with air quality; however, a 12-month period representative of conditions during the peak Operation of the proposed Project was included in the air quality modelling study since the majority of emissions will occur during this phase. By determining the effects of the year with the highest emissions, it can be assumed that if the effects during this year are found to be not significant, the potential effect for the entirety of the Project should also be not significant. It is anticipated that emission sources during Construction, Decommissioning and Reclamation, and Post Closure phase will be significantly lower than during Operation. Further rationale for the temporal boundaries is discussed in the Air Quality Modelling Report (Appendix 6-B).

6.6.3 Identifying Potential Effects on Air Quality

Potential interactions were identified using professional judgement and experience at other similar projects in BC, and was based on a matrix of Project activities. Table 6.6-2 presents the Project phases along with the nature of the potential interaction with each of the indicators. The identified interactions are characterized below.

6.6.3.1 *Summary of Potential Effects to be Assessed for Air Quality*

<u>Construction</u>

As shown in Table 6.6-2, the majority of Project activities during Construction interact with each of the indicators. As discussed in Section 6.6.2.2, the air quality modelling study included the year with the highest emissions. The emissions associated with Construction are expected to be significantly less than those during the year with the highest emissions. It has been assumed that if the effects during the worst case years are found to be Not Significant, the potential effects for Construction of the Project will also be Not Significant.

Table 6.6-2. Ranking Potential Effects on Air Quality

	Project Activities	Potential Effects on Air Quality: Increase in CACs	Increase in Dust Deposition	Increase in GHGs
Construction	**Underground Mine**			
	Construction of Production Decline (2 headings - surface and underground)	M	M	M
	Haul of waste rock from Production Decline portal to Shaft Site	M	M	M
	Ventilation during construction	M	M	M
	Development mining of underground service bays, sumps, conveyor headings, etc.	M	M	M
	Construct underground conveyor system	M	M	M
	Coal Processing Site			
	Surface Preparation			
	Establish site drainage and water management	L	L	L
	Site clearing and stripping (CPP site, CCR North)	M	M	M
	Soil salvage for reclamation	M	M	M
	Upgrade access roads, parking and laydown areas	M	M	M
	Heavy machinery use	M	M	M
	Buildings and Services			
	Install domestic water system	L	L	L
	Install sanitary sewer system	L	L	L
	Install natural gas and electricity distribution network	L	L	L
	Construct main fuel station	M	M	M
	Construct buildings (e.g., maintenance, administration, warehouse)	M	M	M
	Construct raw coal and clean coal stockpile areas	M	M	M
	Construct coal preparation plant buildings and install/commission equipment	M	M	M
	Construct surface conveyor system	M	M	M
	Construct rail load-out facilities	M	M	M
	Shaft Site			
	Upgrades to infrastructure within existing site	L	L	L
	Addition of waste rock within existing storage area	M	M	M
	Management of runoff from waste rock pile and release to receiving environment (M20 Creek)	L	L	L
	Decline Site			
	Upgrades to infrastructure within existing site	L	L	L
	Management of water from underground activities and release by exfiltration to ground	L	L	L

(continued)

Table 6.6-2. Ranking Potential Effects on Air Quality (continued)

	Project Activities	Potential Effects on Air Quality: Increase in CACs	Increase in Dust Deposition	Increase in GHGs
Construction (*cont'd*)	**Traffic and Transportation**			
	Transportation of materials to and from site	M	M	M
	Recycling and solid waste disposal	M	M	M
	Shuttling workforce to and from site	M	M	M
	Workforce and Administration			
	Hiring and management of workforce	L	L	L
	Taxes, contracts, and purchases	L	L	L
Operation	**Underground Mine**			
	Longwall panel mining, and development mining	M	M	M
	Ventilation from underground	M	M	M
	Methane management	M	M	M
	Secondary shaft construction	L	L	L
	Underground seepage collection and water management	L	L	L
	Surface subsidence	L	L	L
	Coal Processing Site			
	Coal Processing Plant			
	Stockpiles of raw coal	M	M	M
	Operation of coal preparation plant and conveyor system	M	M	M
	Stockpiles of clean coal and middlings	M	M	M
	Operation of rail loadout	M	M	M
	CCR			
	CCR Pile development	M	M	M
	Site clearing and stripping (expansion of CCR North, construction of CCR South)	M	M	M
	Seepage collection system	L	L	L
	Water Management			
	Management of water brought to surface from underground	L	L	L
	Management of seepage from CCR	L	L	L
	Management of other site contact water	L	L	L
	Maintenance of site ditching and water management infrastructure	L	L	L
	Release of excess contact water to receiving environment	L	L	L
	Shaft Site			
	Maintenance of infrastructure within existing site	L	L	L
	Progressive reclamation of waste rock pile	M	M	M

(continued)

Table 6.6-2. Ranking Potential Effects on Air Quality (continued)

	Project Activities	Potential Effects on Air Quality: Increase in CACs	Increase in Dust Deposition	Increase in GHGs
Operation *(cont'd)*	**Shaft Site** ***(cont'd)***			
	Management of runoff from waste rock pile and release to receiving environment (M20 Creek)	L	L	L
	Decline Site			
	Maintenance of infrastructure within existing site	L	L	L
	Secondary Shafts Site			
	Site preparation and construction of shafts	M	M	M
	Maintenance of infrastructure within existing site	L	L	L
	Utilities, Power, and Waste Handling			
	Electrical power use	M	M	M
	Natural gas use	M	M	M
	Domestic water use	L	L	L
	Domestic sewage handling	L	L	L
	Recycling and solid waste disposal	L	L	L
	Heavy Machinery, Traffic, and Transportation			
	Shuttling workforce to and from site	M	M	M
	Transportation of materials to and from site	M	M	M
	Surface mobile equipment use	M	M	M
	Road maintenance	M	M	M
	Fuel storage	M	M	M
	Workforce and Administration			
	Hiring and management of workforce	L	L	L
	Taxes, contracts, and purchases	L	L	L
Decommissioning and Reclamation	**Infrastructure Removal and Site Reclamation**			
	Facility tear down and removal	M	M	M
	Reclamation of plant site	M	M	M
	Reclamation of on-site roads and rail lines	M	M	M
	Recycling and solid waste disposal	M	M	M
	Heavy Machinery, Traffic, and Transportation			
	Shuttling workforce to and from site	M	M	M
	Transportation of materials to and from site	M	M	M
	Surface mobile equipment use	M	M	M
	Fuel storage	L	L	L
	CCR			
	Reclamation of CCR	M	M	M

(continued)

Table 6.6-2. Ranking Potential Effects on Air Quality (completed)

	Project Activities	Potential Effects on Air Quality: Increase in CACs	Increase in Dust Deposition	Increase in GHGs
Decommissioning and Reclamation	**CCR** ***(cont'd)***			
	Seepage collection system	L	L	L
	Site water management and discharge to receiving environment	L	L	L
	Underground Mine			
	Infrastructure tear down and removal	M	M	M
	Geotechnical and hydrogeological assessment and bulkhead installation	L	L	L
	Groundwater monitoring	L	L	L
	Workforce and Administration			
	Hiring and management of workforce	L	L	L
	Taxes, contracts, and purchases	L	L	L
Post Closure	**Shaft Site**			
	Waste rock pile seepage monitoring	L	L	L
	CCR			
	Seepage collection system	L	L	L
	Site water management and discharge to receiving environment	L	L	L
	Underground Mine			
	Groundwater monitoring	L	L	L

L	*Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

Operation

As shown in Table 6.6-2, the majority of Project activities during Operation interact with each of the indicators. Emissions associated with Operation were calculated and input into the air quality model to determine air quality indicator concentrations (see Appendix 6-B). The following sources were included in the air quality model and the emissions predictions:

- stack emissions, such as boilers and coal dryer;
- equipment exhaust emissions from vehicles such as dozers, graders, and haul trucks;
- shaft emissions from underground mining;
- rail idling emissions;

- fugitive dust from vehicles travelling on onsite unpaved roads ;
- fugitive dust from stockpiles and material handling; and
- fugitive dust emissions from mining activities such as bulldozing and grading.

Decommissioning and Reclamation, and Post Closure

As shown in Table 6.6-2, Project activities during the Decommissioning and Reclamation interact with each of the indicators. There are minimal interactions during Post Closure. As discussed in Section 6.6.2.2, the air quality model included the year with the highest emissions. There will be limited emission sources during Decommissioning and Reclamation and therefore the air quality impacts are expected to be significantly less than those during the year with the highest emissions. It has been assumed that if the effects during the worst case years are found to be Not Significant, the potential effects for Decommissioning and Reclamation, and Post Closure of the Project will also be Not Significant.

6.7 EFFECTS ASSESSMENT AND MITIGATION FOR AIR QUALITY AND GREENHOUSE GAS

6.7.1 Key Effects on Air Quality and Greenhouse Gas

The activities associated with the Project have the potential to generate CACs, dust deposition, and greenhouse gases.

To assess the potential impact of CACs and dust deposition on air quality, a modelling study was conducted. The study comprised of an emission inventory for Project activities and a model scenario, aimed at characterizing the highest concentrations to be expected from the Project over its lifetime. The results were then compared to relevant standards and objectives.

In order to assess the potential GHG emissions an emission inventory was created, aimed at characterizing the highest levels to be expected from the Project over its lifetime. Current scientific knowledge does not allow for the effects of any individual project on climate change to be assessed due to the global scale, uncertainty, and complexity of assessing effects of collective anthropogenic GHG emissions on climate. The Project is therefore assessed in terms of CO_2e produced and compared with sector, provincial, federal, and international levels, consistent with guidance by the CEA Agency (2003).

6.7.1.1 Criteria Air Contaminants and Dust Deposition

The potential for effects has been assessed using a quantitative modelling approach. The air quality modelling study (Appendix 6-B) contains a detailed description of the model assumptions, inputs and results, as well as discussions of the uncertainties.

All model assumptions and inputs were chosen to represent a reasonably conservative scenario. For example, the maximum hourly emission rates for material handling were applied in the model.

The following sections characterize the effects of the Project on air quality for each of the pollutants. The emissions inventory can be found in Appendix 6-B. The maximum model results are presented in Table 6.7-1.

Table 6.7-1. 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.*

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.

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 μg/m³ is 17% of the objective, the maximum predicted 24-hour concentration of 23 μg/m³ is 11.5% of the objective and the maximum predicted annual concentration of 3.9 μg/m³ is 6.5% of the objective.

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 µg/m^3, which includes a background of 232 µg/m^3, is 2.4% of the objective and the maximum predicted 8-hour concentration of 297 µg/m^3, which includes a background of 232 µg/m^3, is 5.4% of the objective.

TSP

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

Maximum 24-hour average TSP concentrations exceeded the standard outside of the mine site. 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. Other mine sites in the area also predicted exceedances of 24-hour average TSP concentrations (Stantec 2012).

To examine the nature of the predicted exceedances, a frequency analysis was completed. It was predicted that 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 could 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 6.7-2 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 reduce the amount of unpaved road dust by 75% (US EPA 2006b). Other means of emission control are described in the Air Quality Management Plan.

Table 6.7-2. TSP Sources

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

[a] Predicted maximum concentrations will occur at different locations, therefore the sum of the maximum non-fugitive and fugitive concentrations does not equal the total.

PM_{10}

Maximum 24-hour average PM_{10} concentrations exceeded the standard outside of the mine site, however, the exceedances were well within the modelling domain. 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. Other mine sites in the area also predicted exceedances of 24-hour average PM_{10} concentrations (Stantec 2012).

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 6.7-3 shows the exceedances outside of the site area were from fugitive sources; primarily 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 2006b). Other means of emission control are described in the Air Quality Management Plan.

Table 6.7-3. PM_{10} Sources

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

[a] Predicted maximum concentrations will occur at different locations, therefore the sum of the maximum non-fugitive and fugitive concentrations does not equal the total.

$PM_{2.5}$

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 µg/m^3, which includes a background of 10.9 µg/m^3, is 72% of the objective and the maximum predicted annual concentration of 5.2 µg/m^3, which includes a background of 3.3 µg/m^3, is 65% of the objective.

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, 1.2 mg/dm^2/day of which is attributed to the background dustfall.

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 due to the fact that 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 2006b). Other means of emission control are described in the Air Quality Management Plan.

6.7.1.2 Greenhouse Gases

In order to calculate the emissions associated with the Project, the Mining Association of Canada's (2009) categorization of GHG emissions has been adopted:

- Scope 1 emissions - Direct emissions by equipment owned or controlled by the company;
- Scope 2 emissions - Emissions from purchased electricity; and
- Scope 3 emissions - Indirect emission source arising from the activities of third parties.

Fuel combustion and methane liberation are categorized as Scope 1 emissions (i.e., direct GHG emissions occurring from sources owned or controlled by the company), whereas emissions generated through the consumption of purchased electricity emissions are defined as Scope 2. Scope 3 emission sources, those indirect GHG emission source arising from the activities of third parties contracted by the Project, are not included in this assessment.

As a worst case approach the assessment focuses on emissions during Operation. During Construction there will be emissions associated with activities on site, however they will be significantly less than those during Operation. There will be methane emissions associated with Decommissioning and Post Closure; however they are likely to be minimal.

The GHG emissions associated with land use change are not considered significant as there will be no deforestation and the Project footprint is minimal.

All emissions are shown in CO_2 equivalent (CO_2e). CO_2 equivalent emissions are the amount of CO_2 emissions that would cause the same time-integrated radiative forcing, over a given time horizon, as an emitted amount of a long-lived GHG or a mixture of GHGs (IPCC 2007). The equivalent CO_2 emission is obtained by multiplying the emission of a GHG by its Global Warming Potential (GWP). For a mix of GHGs it is obtained by summing the equivalent CO_2 emissions of each gas. The GWP values have been taken from the IPCC Second Assessment Report, this is consistent with those used in the National Inventory Report (EC 2014b)[2]. The GWPs used are 1 for CO_2, 21 for CH_4 and 310 for N_2O (EC 2014b).

<u>Scope 1</u>

There are two sources of scope one emissions associated with the project, fuel use (diesel and natural gas) and methane liberation.

Fuel Use

Diesel will be required to power underground and surface vehicles and equipment. Total fuel consumption figures are very reliable upper estimates, because storage capacities will have to be designed according to estimated maximum fuel needs. Maximum fuel consumption values were used in order to carry out a worst case assessment.

GHG emissions from diesel fuel combustion are calculated by multiplying the estimated annual fuel needs by the associated combined emission factor for diesel fuel. Emission factors for diesel were available from the *Canada National Inventory Report* 1990-2011 (EC 2014b). CO_2 emissions from diesel combustion are assumed to equal 2.8 kgCO_2e per litre of diesel.

GHG emissions from natural gas usage were calculated by multiplying the estimated annual gas usage by the associated combined emission factor for natural gas. Emission factors for natural gas were available from the *Canada National Inventory Report* 1990-2014 (EC 2014b). CO_2 emissions from natural gas are assumed to equal 2.1 kgCO_2e/m^3. The emissions associated with fuel use are shown in Table 6.7-4.

Table 6.7-4. Total Fuel Use Emissions

Source	Fuel Consumption	GHG (tonnesCO_2e/yr)
Diesel	420,000 L/yr	1,172
Natural Gas	20,000,000 m^3/yr	43,240

Methane Liberation

Coalbed Gas (CBG, or Coal Bed Methane, coal mine methane), is a form of natural gas composed of methane, higher hydrocarbons, nitrogen and other gases contained predominantly within coal beds (seams) and to a lesser extent within coal bearing rocks. The gas is liberated when the pressure above or surrounding the containing seams and rocks is reduced. The release of the gas from the mined coal continues at a decreasing rate through mining, transportation, processing and shipment to the customer.

Exploration drilling results show that the coal seams of the Project contains CBG. CBG must be actively managed within the mine, as it presents a safety hazard otherwise. The specific approach to managing CBG will be adaptive and site specific, as it will depend on actual conditions observed underground. However, in general, CBG management will employ an inter-connected drainage system to collect CBG and vent it to the surface via the ventilation shaft. Depending on the volume of methane released, HD Mining may consider other options such as catalytic oxidation, flaring or capture and use.

There is significant uncertainty associated with predicting methane emissions associated with underground coal mining. The amount of methane released during coal mining depends on a number of factors, the most important of which are coal rank, coal seam depth, and method of mining. Underground coal mining releases more methane than surface or open-pit mining due to the higher gas content of deeper seams, however, the methane can be captured and mitigated, which is not possible with open pit mines. In longwall mines, the zone of disturbance can be large. It is estimated the zone of disturbance may extend up to 160 m into the roof rock and 40 m below the seam being worked, however, multiple seams within this depth will be mined (Kirchgessner et al. 2000).

In order to calculate the CO_2e emissions associated with methane liberation a methane emission factor (m^3/tonne of coal) is multiplied by the raw coal production (tonnes) and converted to tonnes of methane using a conversion factor (tonne/m^3). This is then converted to CO_2e using the methane GWP. Total emissions from coal mining are calculated as the sum of emissions from underground mining (ventilation systems plus degasification systems) and post-mining activities (emissions during subsequent handling, processing and transportation of coal), minus emissions avoided due to recovery. Emissions can also arise from low temperature oxidation, however, this source is usually insignificant when compared with the total emissions from underground coal mines and consequently, no methods have been developed to estimate it (IPCC 2006).

A number of different methods of calculating emissions factors for underground coal mining have been proposed. The British Columbia Reporting Regulation Methodology Manual states a value of 25 m^3/tonne for mines depths greater than 400 m. Environment Canada (2014b) suggests calculating an emission factor based on the King methodology (1994). Using the site specific depth of 500 m, a mining emission factor of 15.6 m^3/tonne and a post-mining emission factor of 0.9 m^3/tonne, was calculated. Site specific methane monitoring has also been carried out and the values range from 6.6 to 17.9 m^3/tonne (see Chapter 3). Coal seam J is the major workable coal seam and therefore the average value (11.3 m^3/tonne) for the tests from this seam were used. For longwall mining, the amount of gas released comes from the coal being extracted and from any other gas-bearing strata that are located around the mined seam, estimates suggest this would double the in-situ emissions, however multiple nearby seams will be mined, therefore doubling the emissions would lead to double counting. It is not possible to measure the post-mining methane content and therefore the Environment Canada recommended average value of 0.9 m^3/tonne was used. The values used in the calculations are shown in Table 6.7-5.

Table 6.7-5. Methane Liberation Factors

ROM Output (Mt)[a]	Mine Depth (m)	Methane Emission Factor (m^3/tonne)			Conversion Factor (tonne/m^3)	Methane GWP[b]
		BC Methodology	EC Methodology	Site Specific		
6	500	25	16.5[c]	12.2[d]	0.00067	21

[a] *The Project has a design capacity of approximately 6.0 Mtpa ROM coal per annum (4.8 million tonnes of saleable coal).*
[b] *The GWP values used are taken from the IPCC Second Assessment Report, this is consistent with those used in the National Inventory Report (EC 2014b).*
[c] *Emission factor of 15.6 m^3/tonne for mining and 0.9 m^3/tonne for post mining emissions.*
[d] *Emission factor of 11.3 m^3/tonne for mining and 0.9 m^3/tonne for post mining emissions.*

There is limited data available to compare these values to other underground coal mines. Environment Canada (2014b) provides emission factors for methane liberation from coal mining. There is, however, only one operating underground coal mine in British Columbia and one in Alberta. Both mines are drift mines (access to the seams is from or close to outcrop) operating close to the surface and therefore unrepresentative of deep coal mining as proposed at Murray River. The emissions factors from the two drift mines, are significantly lower (2.78 and 1.69 m^3/tonne respectively) than for deep mines. The only emission factor available for a deep Canadian underground mine, 14.49 m^3/tonne, was from a mine in Nova Scotia which is now closed. The IPCC (2006) default emission factors range from 10 to 25 m^3/tonne depending on depth. The guidance states that the low end of the range should be chosen for average mining depths of <200 m, and for depths of > 400 m the high value is appropriate (IPCC 2006). These values are consistent with those calculated for the Project.

In order to assess the quantities of methane released from the mine, HD Mining will carry out monitoring at the site once construction begins. Depending on the volume of methane emitted, mitigation measures will be put in place to ensure methane emissions are minimised. Possible mitigation measures include flaring, catalytic oxidiser systems, or capture and use. The volume of methane available for mitigation would depend on the efficiency of the drainage system. Good practice post-drainage techniques can typically capture 50% to 80% of the total gas from a longwall district (UN 2010). The IPCC Guidelines for National Greenhouse Gas Inventories (2006) provides a methodology to calculate emissions associated with flaring and catalytic oxidisation. Emissions associated with flaring, catalytic oxidiser systems and capture and use would vary depending on the system in place. If the methane was utilised on site as an energy source the resulting emissions would be accounted for in Scope 2, natural gas use. The total emissions assuming no mitigation, flaring, catalytic oxidisation and capture and use are shown in Table 6.7-6.

Table 6.7-6. Methane Emissions

Methodology	Methane (tonnes/yr)	Methane (tonnes/kt coal)	GHG (tonnes CO_2e/yr)		
			No Mitigation	Flaring/Catalytic Oxidiser[a]	Capture and Use[a]
British Columbia	100,500	16.8	2,110,500	672,546	422,100
Environment Canada	66,330	11.1	1,392,930	534,716	339,368
Site Specific	41,041	6.8	861,862	408,206	266,731

[a] *Assuming 80% capture rate.*

The total CO_2e associated with methane liberation before mitigation ranged from 861,862 to 2,110,500 tonnes, equivalent to 6.8 to 16.8 kg of methane per tonne of coal mined. This is similar to 2012 average underground coal mine methane emission rates from the US (12.5 kg/t coal), Australia (7.7 kg/t coal) and the UK (10.6 kg/t coal; US EPA 2014; Commonwealth of Australia 2014; Webb 2014).

If the methane emissions were flared or a catalytic oxidiser was used, the CO_2e emissions would be reduced by approximately 63%. The methane emissions would be further reduced if the methane was captured and used. The median values (Environment Canada), assuming mitigation was in place, have been used for the remainder of the assessment.

Summary

The total GHG emissions from Scope 1 emission sources are shown in Table 6.7-7 below.

Table 6.7-7. Total Scope 1 Emissions

Source	GHG (tonnes CO_2e/yr)
Diesel Use	1,172
Natural gas usage	43,240
Methane Liberation	339,368 - 534,716
Total	**383,780 – 579,128**

Scope 2

An electricity usage emission rate of 14 tCO_2e/GWh, based on electricity from BC Hydro was adopted (BC MOE 2013b). The estimated electricity usage for the project is 95 GWh per year. The total GHG emissions from Scope 2 emission sources are shown in Table 6.7-8 below.

Table 6.7-8. Total Scope 2 Emissions

Source	Electricity Usage (GWh/year)	GHG (tonnes CO_2e/yr)
Electricity usage	95	1,330

Summary

Table 6.7-9 shows a summary of all Project-related GHG emisisons. The total annual emissions for the Murray River Project ranges from 0.4 to 0.6 Mt CO_2e. The annual average value is expected to be lower than this worst-case scenario.

Table 6.7-9. Summary of Project-related GHG Emissions

Source	GHG (tonnes CO_2e/yr)
Scope 1	
Fuel use	1,172
Natural gas usage	43,034
Methane liberation	339,368 - 534,716
Total	**383,780 – 579,128**
Scope 2	
Electricity usage	1,330
Scope 1 and 2	
Total	**385,110 – 580,458**

The GHG emissions exceed 50,000 t CO_2e annually, therefore it is expected that HD Mining will be required to report their GHG emissions to EC, and also report to BC MOE and have their results verified. The annual average emissions during Construction and Decomissioning, when there is limited site operations and methane liberation, is expected to be significantly lower. However, if the Project emissions do exceed 50,000 t annually during Construction and Decommissioning, HD Mining will be required to report their GHG emissions to EC and the BC MOE.

Table 6.7-10 shows a comparision between emissions from the Murray River Project compared to those from other mines in the area. The methane liberation emissions at the Murray River Project account for 57 to 89 tCO_2/kt coal. The estimated emissions for the Murray River Project are similar to other mines in the area.

Table 6.7-11 shows emissions from the Murray River Project compared to those on a regional, national and global level. This assessment includes a global comparison, as this is considered to be more representative of the global GHG atmospheric scale involved. The GHG emissions account for approximately 6% of emissions associated with mining in Canada and 0.8% of emissions in BC. On a national level, the emissions from the Project are very small, and compared with global emissions they are considered insignificant.

Table 6.7-10. Summary of Other Mines GHG Emissions

	Location	Type	Capacity (Mtpa)	GHG Emissions (tonnes CO_2e /year)	GHG Emissions (tonnes CO_2e /kt coal)
Murray River	Tumbler Ridge, BC	Underground	6	385,110 – 580,458	64 – 97
Roman Mine[a]	Tumbler Ridge, BC	Open pit	3	181,393	60
Quinttete[b]	Tumbler Ridge, BC	Open pit	4	28,306[c]	7[c]
Trend[b]	Tumbler Ridge, BC	Open pit	2	60,287	30
Wolverine[b]	Tumbler Ridge, BC	Open pit	2.4	100,872	42
Willow Creek[d]	Chetwynd, BC	Open pit	0.9	74,874	83
Dillon/Brule[d]	Chetwynd, BC	Open pit	1.2	115,035	95

[a] *PRC (2010)*
[b] *Stantec (2012)*
[c] *Methane emissions not taken into account*
[d] *EC (2014a)*

Table 6.7-11. Comparison on a Regional, National and Global Scale

	GHG Emissions (Mt CO_2e /year)	Murray River Project Emissions Comparison (%)
Coal mining in Canada[a]	1	38.5 – 58.0
Mining in Canada[a]	8	4.8 – 7.3
British Columbia[a]	60.1	0.6 – 1.0
Canada[a]	699	0.06 – 0.1
Global[b]	31,600	0.0012 – 0.0018

[a] *Source: Environment Canada (2014b). Based on 2012 data.*
[b] *Source: International Energy Agency (2012). Based on 2011 data.*

6.7.2 Mitigation Measures for Air Quality and Greenhouse Gases

The following section details mitigation and management measures designed to reduce or eliminate adverse Project effects. Mitigation measures involve taking a tangible action to avoid, minimize, restore on-site, or offset Project effects. Mitigation measures that are recommended to reduce an adverse effect are technically, environmentally, and economically feasible, and aim to avoid, reduce, control, eliminate, offset, or compensate for potential project effects.

The Project has been designed to reduce adverse effects by optimizing alternatives, incorporating specific design changes, following best practices, and enhancing project benefits. Further details can be found in the Air Quality and Dust Management Plan (Section 24.2).

There are two main types of mitigation and management measures that will be put in place in order to reduce air quality impacts associated with the Project: emission reduction measures and fugitive dust reduction measures. The majority of measures will be relevant for all phases of the Project and for all pollutants. Emission reduction methods include implementing energy efficiency measures, installing emission control systems (e.g., wet scrubbers) on stacks and on relevant ventilation systems, and ensuring proper equipment maintenance. Fugitive dust suppression measures include wetting work areas, roads, and storage piles, installing covers on equipment and loads carried by vehicles, installing windbreaks or fences, and using dust hoods and shields.

Mitigation and management measures that will be put in place in order to reduce GHG impacts associated with the Project include implementing energy efficiency measures and minimising methane emissions from mining and post mining activities.

6.8 RESIDUAL EFFECTS ON AIR QUALITY

Predicted changes or residual effects are those adverse effects remaining after the implementation of mitigation measures, and are therefore the potential consequences of the Project on the air quality. After the application of mitigation measures, the following residual effects are predicted to occur for the VC air quality:

- TSP, PM_{10} and $PM_{2.5}$ emissions;
- dust deposition; and
- GHG emissions.

After the application of mitigation measures, there are not predicted to be any residual effects for NOx, SOx, and CO. Table 6.8-1 shows a summary of the residual effects on air quality.

Table 6.8-1. Summary of Residual Effects on Air Quality

Residual Effect	Project Phase (timing of effect)	Project Component / Physical Activity	Description of Cause-Effect	Description of Mitigation Measure(s)	Description of Residual Effect
Increase in TSP, PM_{10}, $PM_{2.5}$, and Dust Deposition	All phases	• Underground Mine • Coal Processing Site • Shaft Site • Secondary Shafts Site • Heavy Machinery, Traffic and Transportation	• Emission sources • Fugitive dust sources	• Emission reduction measures • Fugitive dust reduction measures	• TSP, PM_{10} and $PM_{2.5}$ emissions • Dust deposition
Increase in GHGs	All phases		• Emission sources	• Emission reduction measures	• GHG emissions

6.9 CHARACTERIZING RESIDUAL EFFECTS, SIGNIFICANCE, LIKELIHOOD AND CONFIDENCE ON AIR QUALITY

Residual effects are characterized using standard criteria (i.e., the magnitude, geographic extent, duration, frequency, reversibility, resiliency, and ecological context). Standard ratings (e.g., major, moderate, minor/low, medium, and high) for these characterization criteria are provided in the methodology chapter (Chapter 5); however, Table 6.9-1 provides a summary of definitions for each characterization criterion, specific to air quality.

Table 6.9-1. Definitions of Characterization Criteria for Residual Effects on Air Quality

Magnitude	Duration	Frequency	Geographic Extent	Reversibility	Ecological Context	Likelihood	Confidence Level
Low: differing from the average value for baseline conditions to a small degree, but within the range of natural variation and well below threshold value [a] (Table 6.2-1). *Moderate*: differing from the average value for baseline conditions and approaching the limits of natural variation, but below or equal to threshold value [a] (Table 6.2-1). *High*: differing from baseline conditions and exceeding threshold values [a] so that there will be a detectable change beyond the range of natural variation (Table 6.2-1).	*Short-term*: an effect that lasts approximately 1 to 5 years. *Medium-term*: an effect that lasts between 6 and 25 years. *Long-term*: an effect that lasts between 26 and 50 years. *Far Future*: an effect that lasts more than 50 years.	*Once:* an effect that occurs once during any phase of the Project. *Sporadic*: an effect that occurs at sporadic or intermittent intervals during any phase of the Project. *Regular*: an effect that occurs regularly during any phase of the Project. *Continuous*: an effect that occurs constantly during any phase of the Project.	*Local*: an effect is limited to the Project footprint. *Landscape*: an effect extends beyond the Project footprint but within the modelling domain. *Regional*: an effect extends across the broader region. *Beyond Regional*: an effect that extends possibly across or beyond the province of BC.	*Reversible Short-term*: an effect that can be reversed relatively quickly. *Reversible Long-term*: an effect that can be reversed after many years. *Irreversible*: an effect cannot be reversed (i.e., is permanent).	*Low*: background air quality is considered poor. *Neutral*: background air quality is considered average. *High*: background air quality is considered pristine.	*Low*: an effect that is unlikely, but could occur. *Medium*: an effect that is likely, but may not occur. *High:* an effect that is highly likely to occur.	*Low* (< 50% confidence): The cause-effect relationship(s) between the Project and its interaction with the environment is poorly understood and/or data for the Project area or scientific analyses are incomplete, leading to a high degree of uncertainty. *Medium* (50 to 80% confidence): The cause-effect relationship(s) between the Project and its interaction with the environment is not fully understood, and/or data for the Project area or scientific analyses are incomplete, leading to a moderate degree of uncertainty. *High* (> 80% confidence): The cause-effect relationship(s) between the Project and its interaction with the environment is well understood, and/or data for the Project area or scientific analyses are complete, leading to a low degree of uncertainty.

[a] No threshold values are available for GHG, therefore it is not possible to quantitatively determine significance. GHG were assessed qualitatively by comparing project emissions with sector, provincial, federal, and international levels, consistent with guidance by the CEA Agency (2003).

6.9.1 Residual Effects Characterization for Air Quality

Potential residual effects that could affect air quality include CAC emissions, dust deposition and GHG emissions. Characterization of residual effects, significance, confidence, and likelihood are presented in Table 6.9-2. The assessment considered results of baseline studies, regulatory considerations, air quality modelling, and scientific literature.

6.9.1.1 Characterizing Residual Effects

CACs and Dust Deposition

The residual effects for TSP, PM_{10}, and dust deposition, are predicted to have a high magnitude as the modelled results are over the relevant objectives. The residual effects for $PM_{2.5}$ are predicted to have a moderate magnitude as the modelled results are below the relevant objectives. For all pollutants the duration is classed as medium term as they will occur throughout the life of the Project and the frequency of the effects is considered continuous. Air quality concentrations will be lower than the predicted levels for much of the time, however, as a worst case approach, residual effects are considered to be continuous and at peak levels for the entire Project duration. The geographic extent of CAC emissions is landscape as the effects are contained within the modelling domain. The effects are reversible short term as the concentrations will return to baseline levels as soon as the pollutant sources are removed. The ecological context is considered neutral as the air quality in the air area is considered pristine, with localised areas of poor air quality around industrial areas.

GHGs

The Project GHG emissions will enter the global atmospheric pool where, after mixing, there will be no measurable difference to global GHGs as a result of the Project. GHG emissions are predicted have a low magnitude as the emissions are low in comparison to global GHG emissions. The duration is classed as medium term as they will occur throughout the life of the Project and the frequency of the effects is considered continuous. GHG emissions will be lower than the predicted levels for much of the time, however, as a worst case approach, residual effects are considered to be continuous and at peak levels for the entire Project duration. The geographic extent of the GHG emissions is considered global, however the GHG levels measured in the global atmosphere will not be able to detect the increase in GHGs as a result of the Project. The effects are considered reversible long term as GHG in the atmosphere is removed by natural sinks. The ecological context is considered neutral.

6.9.1.2 Significance of Residual Effects on Air Quality

Residual effects on air quality are expected, however they are considered Not Significant.

The residual effects for TSP, PM_{10}, $PM_{2.5}$, and dust deposition are considered Not Significant (moderate) as the effects are of a high magnitude, of a medium duration, albeit continuous, and will be within the range of natural variation at a landscape level scale. The effects are also fully reversible in the short- to long-term.

Table 6.9-2. Characterization of Residual Effects, Significance, Confidence and Likelihood on Air Quality

Residual Effects	**Residual Effects Characterization Criteria**						**Significance of Adverse Residual Effects**	**Likelihood and Confidence**	
	Magnitude *(low, moderate, high)*	**Duration** *(short, medium, long, far future)*	**Frequency** *(once, sporadic, regular, continuous)*	**Geographic Extent** *(local, landscape, regional, beyond regional)*	**Reversibility** *(reversible short-term; reversible long-term; irreversible)*	**Context** *(low, neutral, high)*	**Not significant** *(minor, moderate); Significant (major)*	**Probability** *(low, medium, high)*	**Confidence** *(low, medium, high)*
Increase in TSP, PM_{10};, $PM_{2.5}$, and Dust Deposition	High	Medium	Continuous	Landscape	Reversible short-term	Neutral	Not Significant (moderate)	High	Medium
Increase in GHGs	Low	Medium	Continuous	Global	Reversible long-term	Neutral	Not Significant (minor)	High	Medium

The residual effects for GHG emissions are considered Not Significant (minor) as the effects are of a low magnitude, of a medium duration, albeit continuous, on a global scale. The effects are also reversible in the long-term.

6.9.1.3 Characterization of Likelihood and Confidence for Residual Effects Conclusions on Air Quality

To determine the potential for the Project to cause residual effects, the likelihood of a residual effect occurring can be expressed as a measure of probability. The likelihood of a residual effect does not influence the determination of significance, rather it influences the risk of an effect occurring.

Likelihood criteria are provided in Table 6.9-1. The probability of residual effects to air quality and greenhouse gas emissions is high as the effect is highly likely to occur if the Project is developed. Uncertainty exists in every prediction of future change, however, the approach used to assess the effects on air quality was developed to incorporate quantitative data from baseline reports and air quality modelling, therefore providing a robust, transparent, and defensible approach to the effects assessment. The confidence in the magnitude of the residual air quality effects is therefore high. The methodology used to calculate greenhouse gas emissions was taken from provincial and federal documentation and scientific papers, however, there are uncertainties associated with estimating methane liberation values. The confidence in the magnitude of the residual effect is therefore medium.

6.10 SUMMARY OF RESIDUAL EFFECTS ASSESSMENT AND SIGNIFICANCE FOR AIR QUALITY

The residual effects for TSP, PM_{10}, $PM_{2.5}$ and dust deposition are considered Not Significant (moderate) during Operation as the effects are of a medium to high magnitude, of a medium duration, albeit continuous, and will be within the range of natural variation at a landscape level scale. The effects are also fully reversible in the short-term. The residual effects are considered Not Significant (minor) during Construction, Decommissioning and Reclamation, Post Closure as the emissions are expected to be significantly lower than those during operation. The residual effects for GHG emissions are considered Not Significant (minor) as the effects are of a low magnitude, of a medium duration, albeit continuous, on a global scale. The effects are also reversible in the long-term. Table 6.10-1 shows a summary of the residual effects and significance for air quality.

The TSP, PM_{10}, $PM_{2.5}$, and dust deposition residual effects have been carried forward into a cumulative impact assessment. A cumulative effects assessment for GHG emissions was not completed as the contribution of an individual project to climate change cannot be measured and climate change is a global and not a local issue.

Table 6.10-1. Summary of Residual Effects, Mitigation, and Significance on Air Quality

Residual Effects	Project Phase	Mitigation Measures	Significance
Increase in TSP, PM_{10}, $PM_{2.5}$, and Dust Deposition	Operation	• Emission reduction measures. • Fugitive dust reduction measures.	Not Significant (moderate)
	Construction, Decommissioning and Reclamation, Post-closure	• Emission reduction measures. • Fugitive dust reduction measures.	Not Significant (minor)
Increase in GHGs	All phases	• Emission reduction measures and methane liberation reduction measures.	Not Significant (minor)

6.11 CUMULATIVE EFFECTS ASSESSMENT

6.11.1 Introduction

Cumulative effects are the result of a project-related effect interacting with the effects of other human actions (i.e., anthropogenic developments, projects, or activities) to produce a combined effect. A cumulative effects assessment is a requirement of the AIR and the EIS Guidelines, and is necessary for the proponent to comply with the *Canadian Environmental Assessment Act* (2012) and the BC *Environmental Assessment Act (2002)*.

The method for assessing cumulative effects generally follows the same steps as the Project-specific effects assessment:

1. scoping and identification of potential effects;
2. description of potential effects and mitigation measures, with subsequent identification of residual cumulative effects; and
3. characterization of residual cumulative effects.

However, because of the broader scope and greater uncertainties inherent in CEA (e.g., data limitations associated with some human actions, particularly future actions), there is greater dependency on qualitative methods and expert judgement. This method for assessing cumulative effects is tailored to how much information is available and facilitates comparison between the project-specific assessment and the cumulative effects assessment. It also facilitates comparison between assessment categories.

6.11.2 Establishing the Scope of the Cumulative Effects Assessment

The scoping process involves identifying those activities for which residual effects on air quality are predicted, defining the spatial and temporal boundaries of the assessment, and examining the relationship between the residual effects of the Project and those of other projects and activities.

The following two criteria for the relevance of evidence pertaining to other human actions are considered in the scoping of the CEA:

1. A residual effect of the Project must be demonstrated to operate cumulatively with the effects of another human action; and
2. The other human action must be known to have been carried out, or it must be probable (using best professional judgement) that it *will be* carried out.

6.11.2.1 Spatial Boundaries

The cumulative effects assessment spatial boundary is intended to encompass an area beyond which effects of the Project would not cumulatively interact with effects of other Projects. The same study area used in the project-specific effects assessment was selected as a suitable boundary for the cumulative effects assessment as it encompasses the regional setting for the Project and other relevant regionally important projects. The study area was based on the "zone of influence" beyond which potential residual effects of the Project are expected to diminish to a negligible state, therefore the effects of any projects outside this area are not expected to interact cumulatively.

6.11.2.2 Temporal Boundaries

The temporal boundaries for the CEA go beyond the phases of the Project, beginning before major human actions were undertaken in the region, and extending into the future. While precisely forecasting which other human actions will occur at the end of the Project's Post Closure phase would be pure conjecture, an extrapolation of a likely future development scenario for the next several decades—based on information available today—is attempted.

The following temporal periods are evaluated as part of the CEA: past (1940-2010), present (2010 to 2014) and future. Effects on air quality from past projects are unlikely to overlap with potential effects from the Project.

6.11.2.3 Identification of Potential Cumulative Effects

Residual effects carried forward from the Project-specific assessment are considered in combination with the residual effects of past, present, and future human actions, where some spatial and temporal overlap occurs. The locations of other human actions near the Murray River Project are shown in Figure 6.11-1.

The results are presented in an impact matrix, as shown in Table 6.11-1.

The Quintette (Babcock) Mine is located within the study area, however as a past project there are unlikely to be any emissions to overlap with potential effects from the Project. No further consideration is warranted.

Quality Wind Project and the Peace River Coal Loadout (Trend Mine Project) are the only present projects within the study area. It is unlikely there will be TSP, PM_{10} and $PM_{2.5}$ emissions associated with a wind project, therefore due to the nature of the project and the distance from the Murray River Project, it is not expected that there will be any cumulative effects associated with the project. No further consideration of the Quality Wind Project is warranted. The Peace River Coal Loadout (Trend Mine Project) is a source of TSP, PM_{10} and $PM_{2.5}$ emissions. The effects are considered moderate.

The Herman Mine, Quintette Mine and the Peace River Coal Loadout (Roman Mine Project) are likely to overlap spatially and temporally with the Project. Each of these projects is a source of TSP, PM_{10} and $PM_{2.5}$ emissions, however not an appreciable source of SO_2, CO, or NO_X. The effects are considered moderate.

Tumbler Ridge Wind Project and Babcock Creek Wind Project are the only other future projects which overlap spatially and temporally with the Project. It is unlikely there will be TSP, PM_{10} and $PM_{2.5}$ emissions associated with a wind project during operation; however, there may be emissions during construction. The emissions during construction are likely to be short lived and localised. Assuming standard mitigation and management measures are in place, the cumulative impacts are considered negligible. No further consideration is warranted.

Other land use activities that interact temporally with air quality include: forestry activities, agriculture activities, industrial roads, oil and gas exploration, coal and mineral resource exploration, and transportation. These activities will produce TSP, PM_{10}, $PM_{2.5}$ and dust, primarily due to traffic on unpaved roads. The emissions are likely to be short lived and localised. Assuming standard mitigation and management measures are in place, the cumulative impacts are considered negligible. No further consideration is warranted.

As in the Project-specific effects assessment, only potential adverse effects ranked as moderate or major (yellow or red) before active application of mitigation measures will be carried forward in the CEA.

6.11.3 Description of Potential Cumulative Effects and Mitigation

The potential effects identified as moderate are described in detail below. Where data are lacking, best professional judgement has been used, and specific data limitations encountered and assumptions made are documented.

The Peace River Coal Loadout (Trend Mine Project) is a source of TSP, PM_{10}, $PM_{2.5}$ and dust emissions. Emissions from the loadout will have been captured in the baseline monitoring and have therefore already been taken into account within the modelling.

Air quality modelling carried out for the Quintette Mine concluded that maximum predicted concentrations of TSP, PM_{10} and dustfall may be higher than the most stringent objectives for short durations on a 24-hour basis. All other predicted results are well below the most stringent objectives (Stantec 2012). The emissions are based on the peak operating year and it was assumed that all processes are occurring simultaneously; the emission estimates are therefore considered conservative. The episodes of PM concentrations above the applicable objectives are predicted to occur in relatively small areas south of the project boundary on the slopes of Mount Babcock and Mount Kostuik. Dustfall amounts decrease rapidly to amounts less than the objective 1 km south of the project boundary. There is likely to be overlap between the Murray River and Quintette Mine emissions, however, the timing of the peak emissions is unlikely to be the same for each project, and the wind will blow the emissions to different locations so the location of the maximum emissions from each project is unlikely to overlap. The likelihood of peak Quintette Mine effects occurring at the same place and time as maximum baseline and Murray River Project effects are therefore extremely small.

Figure 6.11-1
Air Quality Cumulative Effects Assessment Boundary and Other Human Actions near the Murray River Project

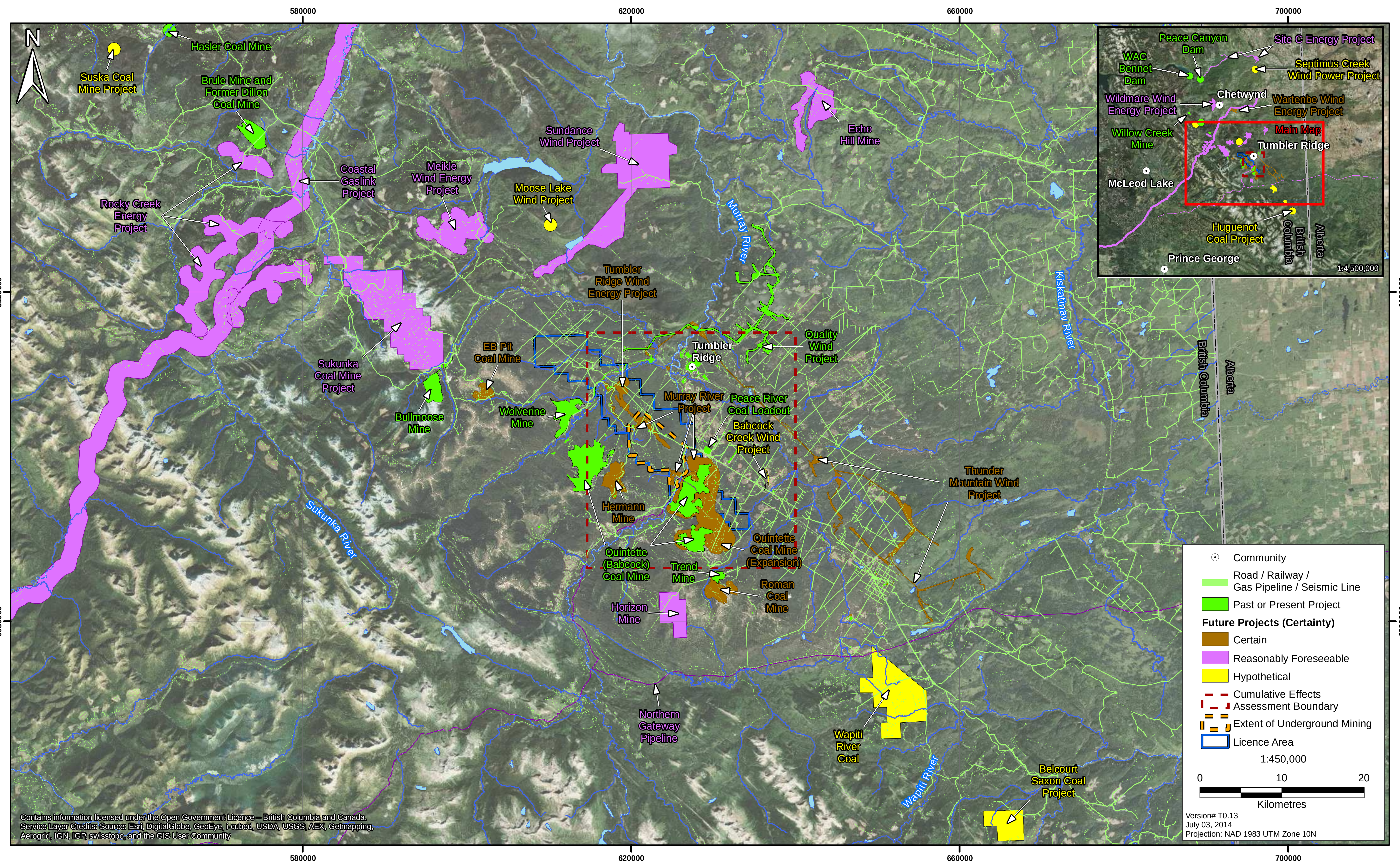


Table 6.11-1. Ranking Potential for Residual Effects to Interact Cumulatively with Effects of Other Human Actions on Air Quality

Murray River Coal Project Residual Effect	Potential for Cumulative Effect with Other Human Actions																	
	Time Frame																	
	Past						Present						Future					
	Historic		Recent										Certain					
	Hasler Coal Mine	Sukunka (Bullmoose) Mine	Bullmoose Mine	Dillon Coal Mine	Quintette (Babcock) Mine	Willow Creek Mine	Brule Mine	Trend Mine	Quality Wind Project	Peace Canyon Dam	Wolverine Mine (Perry Creek) and EB Pit	WAC Bennett Dam	Hermann Mine	Quintette Mine	Roman Mine Project	Thunder Mountain Wind Park	Tumbler Ridge Wind Project	Wartenbe Wind Project
TSP, PM_{10}, $PM_{2.5}$, and Dust Deposition	-	-	-	-	O	-	-	M	O	-	-	-	M	M	M	-	L	-

Murray River Coal Project Residual Effect	Potential for Cumulative Effect with Other Human Actions *(cont'd)*																
	Time Frame *(cont'd)*																
	Future *(cont'd)*																
	Reasonably Foreseeable										Hypothetical						
	Echo Hill Mine	Coastal Gaslink Project	Horizon Mine	Meikle Wind Energy Project	Northern Gateway Pipeline	Rocky Creek Energy Project	Site C Clean Energy Project	Sukunka Coal Mine Project	Sundance Wind Project	Wildmare Wind Energy Project	Babcock Creek Wind Project	Belcourt Saxon Coal Project	Huguenot Mine	Moose Lake Wind Power	Septimus Creek Wind Power Project	Suska Mine	Wapiti River Coal Project
TSP, PM_{10}, $PM_{2.5}$, and Dust Deposition	-	-	-	-	-	-	-	-	-	-	L	-	-	-	-	-	-

Notes:

(-)	*No spatial or temporal overlap.*
O	*Spatial and temporal overlap, but no interaction is anticipated, no further consideration warranted.*
L	*Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
M	*Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*
H	*Key interaction resulting in potential significant major adverse effect or significant concern; warrants further consideration.*

Air quality modelling carried out for the Roman Mine concluded that maximum predicted concentrations of TSP and PM_{10} may be higher than the most stringent objectives on a 24-hour basis (PRC 2011). The highest concentrations are predicted just northeast of the rail load-out property boundary, with predicted concentrations decreasing rapidly with distance from the load-out property. Elevated concentrations are also predicted southwest of the property boundary, however, this is outside of the study area. There is likely to be overlap between the Murray River and Roman Project emissions, however, the timing of the peak emissions is unlikely to be the same for each project, and the wind will blow the emissions to different locations so the location of the maximum emissions from each project is unlikely to overlap. The likelihood of peak Roman Mine effects occurring at the same place and time as maximum baseline and Murray River Project effects are therefore extremely small.

The combined effects of the Roman Mine, Quintette Mine and Murray River Project are shown in Table 6.11-2. In order to carry out a worst-case assessment, the area where the maximum Roman mine concentration predictions (PRC 2011), found just northeast of the PRC rail load-out, was assessed. The Quintette Mine and Murray River Project concentration predictions for the same location, and the baseline concentrations, are presented. Exceedances of the TSP 24 hr, PM_{10} 24 hr and dustfall objectives are predicted.

Table 6.11-2. Cumulative Concentrations at the PRC Rail Load-out

Pollutant	Averaging Period	Objective	Baseline Concentrations[a] (μg/m³)	Roman Contribution (μg/m³)	Quintette Contribution (μg/m³)	Murray River Contribution (μg/m³)	Cumulative Concentration (μg/m³)
TSP	24-hour	120	45.2	73.6	1.7	45.9	**166.4**
	Annual	60	12.5	15.9	0.06	8.3	36.8
PM_{10}	24-hour	50	21.4	27	2.6	13.8	**64.8**
$PM_{2.5}$	24-hour	25	10.9	7.3	0.2	4.1	22.5
	Annual	8	3.3	1.5	0.4	0.8	6.0
Dust Deposition	30-day	1.7	1.2[b]	0.4	0.03	0.2	**1.8**

Note: Exceedances highlighted in bold.
[a] *Baseline monitoring will include emissions from existing activities, such as the Trend Coal Mine.*
[b] *Site specific monitoring (see Appendix 6-B)*

There is limited data available in order to assess the cumulative impacts of the Herman Mine on air quality. There will be TSP, PM_{10}, $PM_{2.5}$ and dustfall emissions associated with the project, however, the mine is located approximately 6 km from the Project area and emissions from the mine would likely have dispersed to low concentrations by the time they reach the Project area.

There are two main types of mitigation and management measures that will be put in place in order to reduce air quality impacts associated with cumulative effects, emission reduction measures and fugitive dust reduction measures. The most relevant mitigation measures will be fugitive dust suppression measures, particularly watering of roads and storage piles, and installing covers on equipment and loads carried by vehicles. The exceedances from the other mines are also likely to be due to unpaved road dust. Road watering is particularly effective, with a control efficiency of 75% (US EPA 2006b). Dustfall monitoring will also be carried out by each of the mines in order to assess the cumulative effects. If exceedances are identified then there is the opportunity for the mines to work together to manage the effects. Further details of mitigation measures are provided in the Air Quality Management Plan.

A summary of residual cumulative effects is presented in Table 6.11-3.

Table 6.11-3. Summary of Residual Cumulative Effects

Valued Component	Murray River Activity	Other Human Action Activity	Description of Potential Cumulative Effect	Description of Mitigation Measure(s)	Description of Residual Cumulative Effect
Air Quality	• Underground Mine • Coal Processing Site • Shaft Site • Secondary Shafts Site • Heavy Machinery, Traffic and Transportation	Trend Mine	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition	• Fugitive dust reduction measures • Emission reduction measures	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition
		Quintette Mine	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition	• Fugitive dust reduction measures • Emission reduction measures	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition
		Roman Mine	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition	• Fugitive dust reduction measures • Emission reduction measures	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition
		Hermann Mine	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition	• Fugitive dust reduction measures • Emission reduction measures	TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition

6.11.4 Characterization of Residual Cumulative Effects, Significance, Likelihood, and Confidence

The residual cumulative effects to air quality are characterized using the same criteria described in Section 6.9 (e.g., Magnitude, Geographic Extent, Duration, Frequency, Reversibility, Context). A summary of the assessment of residual cumulative effects is in Table 6.11-4.

Predicted maximum TSP, PM_{10}, and dustfall values associated with the Murray River Project are low to moderate at most receptors, with a possibility of high magnitude, short duration effects over a small area along the proposed access road. The residual effects for $PM_{2.5}$ are predicted to have a low to moderate magnitude. The episodes of high TSP, PM_{10}, $PM_{2.5}$ and dustfall are predicted to occur sporadically for the life of the Operation phase and are reversible. Hence, the residual effects are assumed to be not significant.

Table 6.11-4. Characterization of Residual Cumulative Effects, Significance, Confidence and Likelihood on Air Quality

Residual Cumulative Effects	Residual Effects Characterization Criteria						Significance of Adverse Residual Effects	Likelihood and Confidence	
	Magnitude *(low, moderate, high)*	**Duration** *(short, medium, long, far future)*	**Frequency** *(once, sporadic, regular, continuous)*	**Geographic Extent** *(local, landscape, regional, beyond regional)*	**Reversibility** *(reversible short-term; reversible long-term; irreversible)*	**Context** *(low, neutral, high)*	**Not significant** *(minor, moderate); Significant (major)*	**Probability** *(low, medium, high)*	**Confidence** *(low, medium, high)*
TSP, PM_{10}, $PM_{2.5}$ and Dust Deposition	High	Short	Sporadic	Landscape	Reversible short-term	Neutral	Not Significant (moderate)	High	Medium

The residual cumulative effects for TSP, PM_{10} and dust deposition are predicted have a high magnitude as the cumulative concentrations may exceed the relevant objectives. The residual effects for $PM_{2.5}$ are predicted to have a moderate magnitude as the cumulative effects are not expected to exceed the objectives. The duration is classed as short term and the frequency of the effects is considered sporadic. The geographic extent of emissions is landscape. The effects are reversible short term as the concentrations will return to baseline levels as soon as the emission sources are removed. The ecological context is considered neutral as the air quality in the air area is considered pristine, with localised areas of poor air quality around industrial areas.

6.12 Effects Assessment Conclusions for Air Quality and Greenhouse Gases

Project residual effects on air quality include the potential for increased CACs, dust deposition and GHG emissions. Dispersion modelling was used to determine the magnitude of the effect of Project operations on CAC emissions and dust deposition. The results were then compared to relevant standards and objectives. Effects of increased GHG emissions were assessed by comparing project GHG emissions with sector, provincial and federal emission totals. It was determined that the effects of increases in CACs, dust deposition and GHG emissions on air quality are considered to be not significant.

A cumulative assessment was carried out in order to assess the combined impacts of the Murray River Project with other projects in the area. Four projects were identified as potentially having a cumulative effect: Roman Mine, Quintette Mine, Trend Mine, and Herman Mine. The cumulative effects of increases in CACs and dust deposition on air quality are concluded to be not significant.

A summary of the residual Project and cumulative effects is provided in Table 6.12-1.

Table 6.12-1. Summary of Project and Cumulative Residual Effects, Mitigation, and Significance on Air Quality

			Significance of Residual Effects	
Residual Effects	Project Phase	Mitigation Measures	Project	Cumulative[a]
TSP, PM_{10}, $PM_{2.5}$, and Dust Deposition	All phases	Fugitive dust reduction measures	Not Significant (moderate)	Not Significant (moderate)
GHG	All phases	Emission reduction measures	Not Significant (minor)	n/a

Note: n/a = not applicable

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Definitions of the acronyms and abbreviations used in this reference list can be found in the Glossary and Abbreviations section.

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