5.7 Air Quality

5.7.1 Introduction

This section of the Environmental Assessment Certificate (EAC) Application/Environmental Impact Statement (EIS) (hereafter referred to as the EAC Application/EIS) has been prepared by Golder Associates Ltd. (Golder). It addresses the effects of the Proposed BURNCO Aggregate Project (hereafter referred to as the 'Proposed Project') identified in the construction, operation, reclamation and closure phases on VCs related to air quality. Consideration has been given to mitigation measures proposed to mitigate any identified effects to acceptable levels and any residual effects have been characterized. Additionally consideration has also been given to cumulative effects of other reasonable foreseeable future projects in combination with the residual effects of the Proposed Project.

This section should be read in conjunction with the following technical baseline report(s) provided in Volume 4, Part G – Section 22.0:

- Appendix 5.7-A Emission Estimation;
- Appendix 5.7-B Dispersion Meteorology;
- Appendix 5.7-C Dispersion Methodology;
- Appendix 5.7-D Air Quality and Meteorology Baseline Report; and
- Appendix 5.7-E BURNCO Air Dispersion Modelling Detailed Model Plan (Approved January 21, 2015).

5.7.2 Regulatory and Policy Setting

This section provides a summary of the regulatory and policy setting of the Proposed Project as it relates to air quality.

The air pollutant of greatest concern with regard to gravel extraction is typically particulate matter (PM). From an air permitting perspective particulate matter is generally defined into three size fractions as follows:

- Total suspended particulates (TSP);
- Particulates with a nominal aerodynamic diameter of 10 microns (µm) or less are referred to as PM_{10}; and
- Particulates with a nominal aerodynamic diameter of 2.5 µm or less are referred to as $PM_{2.5}$.

Exposure to respirable (PM_{10}) and fine particulate matter ($PM_{2.5}$) aggravates a number of respiratory illnesses. Smaller particles are generally thought to be of greater concern to human health than larger particles.

In addition combustion emissions from tug boats, hauling barges of mined aggregate from the facility may be a human health concern. Exhaust from the tug boats, as a result of marine diesel combustion may contain substances of interest including nitrogen dioxide (NO_2) and sulphur dioxide (SO_2).

British Columbia (BC) and the Federal government have established ambient air quality objectives and standards that were developed by environmental and health authorities for environmental protection. These objectives and standards are based on scientific studies that consider the effects of the contaminant on receptors such as humans, wildlife, vegetation, as well as aesthetic qualities including visibility. Federal and provincial air quality objectives and standards for criteria air contaminants are listed in Table 5.7-1.

Table 5.7-1: Ambient Air Quality Objectives and Standards for Criteria Air Contaminants

Contaminant	Averaging Period	Criteria (µg/m^3)					
		Federal			British Columbia		
		Maximum Desirable	Maximum Acceptable	Maximum Tolerable	Level A	Level B	Level C
TSP	24-hour	—	120	400	120	200	260
	Annual	60	70	—	60	70	75
PM_{10}	24-hour	—			50		
$PM_{2.5}$	24-hour	28[(b)]			25[(a)]		
	Annual	—			8		
NO_2	1-hour	—			188[(a)(c)]		
	Annual	—			60[(c)]		
SO_2	1-hour	—			200[(c)(d)]		

Notes:
(a) Compliance based on annual 98th percentile value.
(b) Compliance based on annual 98th percentile value, averaged over three consecutive years.
(c) Interim provincial air quality objective.
(d) Compliance based on annual 99th percentile value.
"--"signifies that no air quality criteria is available.
µg/m^3 – micrograms per cubic metre.

The BC Ministry of Environment (MoE) has defined three levels (A, B, C) of air quality objectives, based on the National Ambient Air Quality Objectives (NAAQO). The three levels and the equivalent NAAQO levels are summarized in British Columbia Ambient Air Quality Objective (BC MoE 2016).

The most stringent, Level A criteria and the equivalent NAAQO maximum desirable levels have been used in the assessment.

The Proposed Project is located in the sea to sky corridor. The air-shed is managed through the Sea-to-Sky air quality management plan (SSAQMP) and an implementation framework (The Sheltair Group 2007, 2008). The SSAQMP is a regional collaboration action plan for protecting the air quality in the air-shed (The Sheltair Group 2007). The SSAQMP promotes actions in the air-shed which can be programs, policies and bylaws that can be implemented to manage air quality and Green House Gas (GHG) emissions. Action items from the SSAQMP that may impact the Proposed Project include:

- Promote the use of best available technology and practise for construction and related equipment;
- Implement a public education and outreach campaign;

- Coordinate air quality initiatives with other organizations; and
- Incorporate the AQMP vision into other planning process.

The BC MoE has established guidelines for undertaking air dispersion modelling projects in the Province of BC (BC MoE 2008). These guidelines outlines recommended procedures and options for many elements throughout the modelling process including terrain and land use processing, handling of missing meteorological data, model selection, model switch selection, etc. To facilitate the model selection, emission source identification and the meteorological processing the BC MoE (2008) recommends the submission of a conceptual and detailed model plan. The conceptual model plan is a tool used to facility early communication between the proponent and the MoE and assists in avoiding errors, misdirected focus, rejection of modelled results and project delays. The detailed model plan provides detailed information on the anticipated approach and is used to determine different sources, meteorological and geophysical data, the corresponding data treatments, and the different outputs (BC MoE 2008). For the Proposed Project both a detailed and conceptual model plan has been submitted to the BC MoE (Golder 2013, 2015).

5.7.3 Assessment Methodology

This section provides a description of the assessment methodology used in preparing the EA related to air quality.

Please refer to Volume 2, Part B - Section 4.0: Assessment Methods for full description of the assessment methodology and scope including: selection of value components, establishing boundaries, describing existing conditions, identification of Proposed Project VC interactions, identifying mitigation measures, evaluating residual effects and assessing cumulative effects.

5.7.3.1 Value Component (VC) Selection and Rationale

This section describes the VCs and measureable indicators identified for this assessment related to air quality. The VCs identified reflect issues and guidelines, potential Aboriginal concerns, issues identified by BC EAO and the CEA Agency, other stakeholders, professional judgment and key sensitive resources, species or social and heritage values. All identified candidate air quality VCs were carried forward in the effects assessment (e.g. no air quality VCs were excluded from the assessment). Additional details regarding the methods used to select VCs is provided in Part B, Volume 2 – Section 4.2.4.

The selected VCs for air quality are the Air Quality Indicators for the BC Ambient Air Quality Objectives (AAQO) and NAAQO for TSP, PM_{10}, $PM_{2.5}$, NO_2 and SO_2 (BC MoE 2016). Proposed Project related air quality impacts were predicted using an air dispersion model and were compared against the AAQO and NAAQO. Cumulative impacts combined Proposed Project related contributions with background conditions and the cumulative concentration was compared against the AAQO and NAAQO. The AAQO and NAAQO are consistent with indicators and targets specified in the Sea-to-Sky Air Quality Management Plan (SSAQMP).

Table 5.7-2 provides a summary of identified VCs, rationale for their inclusion in the assessment, and Measurable Indicators that were considered.

Table 5.7-2: Value Components and Measurable Indicators: Air Quality

Value Component	Rationale	Measurable Indicators
Air Quality Indicators	Regulatory requirement. BC Ambient Air Quality Objectives (AAQO) and National Ambient Air Quality Objectives (NAAQO) for TSP, PM_{10}, $PM_{2.5}$, NO_2 and SO_2 where applicable; and relevant air quality indicators and targets specified in the Sea-to-Sky Air Quality Management Plan (SSAQMP).	Proposed Project and cumulative downwind concentrations will be compared against the objectives to determine compliance.

5.7.3.2 Assessment Boundaries

5.7.3.2.1 Spatial Boundaries

The spatial boundaries for the EA have been selected to take into account the physical extent of the Proposed Project, physical extent of Proposed Project-related effects and the physical extent of any key environmental systems. The specific study areas for air quality are provided in Table 5.7-3.

For a full description of the temporal boundaries of the Proposed Project please refer to Volume 1, Part A – Section 4.0.

Table 5.7-3: Spatial Boundaries: Air Quality

Study Area	Description
Local Study Area (LSA)	The LSA is 20 by 20 km, centered on the Proposed Project. The LSA extends along the barge route corridor, 1 km on either side of the corridor to the edge of the RSA. This is currently anticipated to be the area within which air quality effects can be predicted or measured with reasonable certainty (refer to Figure 5.7-1).
Regional Study Area (RSA)	The RSA corresponds to the wider area that will be used for the dispersion modelling domain, approximately 80 by 80 km centered on the Proposed Project.

5.7.3.2.2 Temporal Boundaries

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

- Project construction – up to 2 years;
- Project operations – 16 years; and
- Project reclamation and closure – on-going and 1 year beyond operations.

Air quality impacts during construction are expected to be limited; air emissions will be limited to land and marine vehicle exhaust emissions and fugitive particulate emissions. Proposed Project construction will require a total of four months of effort. The construction phase can be broken down into these overlapping stages:

- Dock and existing barge ramp upgrade;

- Road, warehouse and facilities upgrade and construction including substation and transmission;
- Processing plant area clearing and site clearing at the same time;
- Preload processing plant area, construction of processing plant facilities;
- Barge load jetty and new dock facilities Including pile driving;
- Initial dry excavation of pit using excavators;
- Installation of floating clamshell dredge and conveyor; and
- Construction of the McNab Creek Flood Protection Dyke.

Emissions are expected to be intermittent in nature throughout the construction period, depending on the schedule of activities. The emission activities that would occur during the construction phase of the Proposed Project would be land clearing of the material processing area and land clearing for year one of the aggregate pit. However, the pit will be expanded progressively over the operational life of the Proposed Project and each year land will need to be cleared to accommodate the pit growth. Emission activities associated with the annual land clearing to expand the pit are incorporated in the operation phase's emission activities.

It is expected that the Proposed Project operation phase would result in the largest air quality impacts from the three phases. Impacts to air quality would be based on on-site activities which would include land and marine vehicle exhaust and particulate emission from material handling, crushing, and screening activities.

Air emissions during the reclamation and closure phase are expected to be similar to those during the construction phase. It is difficult to know what kind of technologies and associated emissions rates can be expected as far into the future as the decommissioning would occur.

Due to the fact that intermittent nature of emissions associated with the construction and reclamation and closure phases of the Proposed Project, due to the fact that annual land clearing activities associated with pit expansion are incorporated in the operation phase's emission activities, and due to the nature of aggregate mining activities (material extraction, crushing and screening operations) the air assessment temporal boundaries were limited to the Proposed Project's operational phase. More specifically it is expected that the mining emissions will correlate closely with the amount of aggregate being processed each year; therefore the air quality assessment was undertaken for Year 12 of the mine's operation. Emission from the operations phase would have the highest (i.e., bounding) quantity on air emissions from the construction and reclamation and closure phases.

For a full description of the temporal boundaries of the Proposed Project please refer to Volume 1, Part A – Section 4.0.

5.7.3.2.3 Administrative Boundaries

The Proposed Project is located in the Howe Sound, BC outside the administrative boundaries of Metro Vancouver. Therefore the Metro Vancouver ambient air quality criteria were not used in the assessment, rather the BC ambient air quality criteria were used in the assessment.

5.7.3.2.4 Technical Boundaries

The technical boundaries for the assessment of the atmospheric environment VC are based on the accuracy of the air quality and the meteorological monitoring data used to evaluate the local and regional airshed. The selection of the technical assessment boundaries, including meteorological data domain, dispersion modeling domain, LSA, and RSA, was based on inputs from MoE.

5.7.3.3 Assessment Methods

The air quality assessment uses dispersion modeling to predict the potential concentrations of indicator compounds resulting from the air emissions at the Proposed Project. In calculating the air emissions that were used as inputs to the dispersion model, consideration was given to the Proposed Project design elements that reduce emissions, as well as in-design mitigation. Therefore, the predicted effects (i.e., concentrations of indicator compounds) represent the residual effects of the Proposed Project. The general approach used in the air quality assessment includes the following steps:

- Identify suitable air quality indicators to use for evaluating the effects of the Proposed Project on air quality (refer to Section 5.7.2). These indicators represent compounds that will be emitted in measureable amounts and for which relevant air quality criteria are available. In addition to the air quality indicators, identify the other compounds for which no criteria are available, but that are important from the perspective of other disciplines (e.g., human health).
- Identify the existing air quality conditions for the indicator compounds in the vicinity of the Proposed Project (Section 5.7.3.3.3.1 and Volume 4, Part G – Section 22.0: Appendix 5.7-A).
- Evaluate the potential air quality effects of the Proposed Project using the following steps:
  - Estimate the air emissions from the Proposed Project for the phase of activity (i.e., construction, operations, and closure and reclamation) assessed to have the highest (i.e., bounding) quantity of air emissions.
  - Predict the concentrations of indicator compounds released from the bounding phase of the Proposed Project dispersion modelling.
  - Use dispersion modelling to predict the concentration and deposition rates required as inputs to other disciplines affected by changes in air quality (e.g., human health).
  - Compare the predicted indicator compound concentrations to available criteria and standards, and assess the relevant significance of these effects.
  - Prepare monitoring, mitigation, and adaptive management strategies that reflect the nature of the Proposed Project, in the area where the Proposed Project is situated and the predicted air impacts.

5.7.3.3.1 Existing Conditions

Existing air quality has been described using data from a monitoring campaign on November 6 and 8, 2013, and available historical regional air quality monitoring data archived on a BC MoE website (BC MoE 2014b). Existing

meteorological conditions were characterised using data from Environment and Climate Change Canada's (ECCC; formerly Environment Canada) Port Mellon monitoring stations; the meteorological data was used to validate the air dispersion meteorology which was executed in no-observation mode.

Existing PM_{10} and $PM_{2.5}$ ambient concentrations were derived from hourly continuous monitoring data archived by BC MoE and collected at Langdale Elementary, Squamish and Horseshoe Bay between 2010 and 2013 calendar years (BC MoE 2014b).

Based on conversations with BC MoE (Golder 2015) it is expected that the air quality surrounding the Proposed Project and within the LSA will be similar to that monitored at Langdale Elementary; however, data from Langdale Elementary may not result in the most conservative background concentration (i.e., using the average of the Langdale Elementary, Squamish and Horseshoe Bay may result in a more conservative background concentration). Therefore, concentrations observed at Langdale Elementary were compared against the average concentrations at Langdale Elementary, Squamish and Horseshoe Bay and the more conservative of the two values were chosen.

Data for $PM_{10,}$ which met with BC MoE (2008) data completeness guidelines were available from Langdale Elementary and Squamish for 2010. Data for $PM_{2.5,}$ that meet BC MoE data completeness guidelines and which produced the most conservative background concentration were available from Langdale Elementary, Squamish and Horseshoe Bay for 2013. Total suspended particulate monitoring records were not available from the three air quality monitoring stations. Therefore, PM_{10}/TSP ratios for 24-hour and annual averages were obtained from *Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate or PM_{10} Data* (US EPA 1986). Background concentrations were calculated by taking the average 98th percentile value from the aforementioned stations.

The on-site monitoring in November 2013 was completed to support the technical assessment for other disciplines; specifically to provide other technical disciplines with baseline metal concentration and particulate deposition rates. Monitoring was undertaken for TSP, PM_{10}, ambient metals concentrations and particulate deposition. Metal composition was determined from a metal assay of the TSP concentration data, measured using a mini-vol sampler.

5.7.3.3.2 Identifying Project Interactions

A preliminary evaluation of identified interactions between the various physical works and activities and the selected VCs across all spatial and temporal phases of the Proposed Project was undertaken to characterize interactions as:

a) Positive, none or negligible, requiring no further consideration; or

b) Potential effect requiring further consideration and possibly additional mitigation.

This evaluation is presented in Section 5.7.5. Rationale is provided for all determinations that there is no or negligible interaction and that no further consideration is required. For those Proposed Project-VC interactions that may result in a potential effects requiring further consideration, the nature of the effects (both adverse and positive) arising from those interactions is described. Potential effects include direct, indirect and induced effects.

5.7.3.3.3 Evaluating Residual Effects

Potential Proposed Project-related residual effects were characterized as the basis for determining the significance of potential residual adverse effects for each VC. The characterization of effects was undertaken following application of appropriate mitigation measures.

Potential residual effects were characterized using the following standard residual effects criteria:

- **Context** – the current and future sensitivity and resilience of the VC to change caused by the Proposed Project;
- **Magnitude** – the expected size or severity of the residual effect;
- **Extent** – the spatial scale over which the residual physical, biological and/or social effect is expected to occur;
- **Duration** – the length of time the residual effect persists;
- **Reversibility** – indicating whether the effect is fully reversible, partially reversible or irreversible; and
- **Frequency** – how often the residual effect occurs.

Table 5.7-4: Criteria for Characterizing Potential Residual Effects: Air Quality VC – Air Quality Indicators

VC	Context	Magnitude	Geographic Extent	Duration	Reversibility	Frequency
Air Quality Indicators	**Disturbed:** effect takes place within an area with human activity. Area has been substantially previously disturbed by human development or human development is still present; **Somewhat Disturbed**: effect takes place within an area has been relatively disturbed by human development or human development; or **Undisturbed:** effect takes place within an area that is relatively unaffected or not adversely affected by human development.	**Negligible:** Proposed Project effects are less than 25% of air quality objectives; **Low:** Proposed Project effects are between 25 and 50% of air quality objectives; **Medium:** Proposed Project effects are between 50 and 100% of the air quality objective; or **High:** Proposed Project effects are greater than the air quality criteria.	**Local:** Effect restricted to LSA; **Regional:** Effect extends beyond the LSA into the RSA; or **Beyond Regional:** Effect extends beyond the RSA.	**Short-term**: Conditions causing effect are short-term and evident during the construction or decommissioning and reclamation phases; **Medium-term**: Conditions causing effect are evident for an extended period, and last throughout the operational phase; or **Long-term**: Conditions causing effect extend over several Proposed Project phases, and extend into the decommissioning and reclamation phase.	**Fully reversible:** Effect reversible with reclamation and/or over time; **Partially Reversible:** Effect can be reversed partially; or **Irreversible:** Effect irreversible and cannot be reversed with reclamation and/or over time.	**Low:** Conditions or phenomena causing the effect occur infrequently; **Medium:** Conditions or phenomena causing the effect occur at regular, although infrequent intervals; or **High:** Conditions or phenomena causing the effect occur at regular and frequent intervals.

The criteria defined in Table 5.7-4 have been used to characterise and determine the significance of potential effects of the air quality VCs.

Where possible, definitions have taken into account the technical guidance that has been produced. The following documents are considered to be relevant to air quality:

- Guidelines for Air Quality Dispersion Modelling in British Columbia (BC MoE 2008);
- Canadian Ambient Air Quality Standards (Government of Canada 2013); and
- B.C. Ambient Air Quality Objectives (BC MoE 2016).

Please refer to Volume 2, Part B - Section 4.0: Assessment Methods of this EA. for a description of the criteria used to characterise potential effects for all disciplines.

The likelihood of potential residual effects occurring was also characterized for each VC using appropriate quantitative or qualitative terms. To derive a likelihood rating that indicates the probability of a certain effect to occur, implementation of mitigation measures were considered. For example, the likelihood of a certain effect is low, if there is a low potential of the event leading to the effect to occur, or if there are effective controls in place that can eliminate or reduce the magnitude or frequency of the effect. The following criteria were used to define likelihood:

- Low - likelihood of occurrence (0 to 40%) – Residual effect is possible but unlikely;
- Medium - likelihood of occurrence (41 to 80%) - Residual effect may occur, but is not certain to occur; and
- High - Likelihood of occurrence (81% to 100%) - Residual effect is likely to occur or is certain to occur.

For the purposes of the assessment of air quality, for the criteria of context, all predicted effects are assumed to be of a negative direction. For the criteria of reversibility, all effects are considered to be fully reversible, as air quality will return to background conditions once emissions from the Proposed Project cease.

In assigning magnitude for air quality, consideration is given to the maximum prediction outside the Proposed Project's footprint. Table 5.7-5 presents the criteria for assigning magnitude to the predicted air quality effects. If the predicted maximum concentrations exceeded the recommended criteria defined in Section 5.7.2, the effect was considered to be of high magnitude. A moderate magnitude is assigned when the maximum prediction was between 50% and the relevant criteria. A low magnitude is assigned when the maximum concentration was between 25% and 50% of the relevant criteria. The threshold for 'negligible' was set at 25% of the relevant criteria.

Table 5.7-5: Air Quality Magnitude Criteria

Indicator	Magnitude Level Definition (µg/m³)[(a)]			
	Negligible	Low	Moderate	High
TSP – 24-hour	<30	≤60	≤120	>120
TSP- Annual	<15	≤30	≤60	>60
PM_{10} – 24-hour	<12.5	≤25	≤50	>50
$PM_{2.5}$ – 24-hour	<6.25	≤12.5	≤25	>25

Indicator	Magnitude Level Definition (µg/m³)[a]			
	Negligible	Low	Moderate	High
$PM_{2.5}$ – Annual	<2	≤4	≤8	>8
NO_2- 1-hour	<47	≤94	≤188	>188
NO_2- Annual	<15	≤30	≤60	>60
SO2- 1 hour	<50	≤100	≤200	>200

Notes:

a) The threshold between negligible and low was set at 25% of the relevant criteria and the threshold between low and moderate was set at 50% of the relevant criteria.

5.7.3.3.3.1 Measurable Indicator Compounds

The assessment of air quality focused on predicting changes in the concentrations of selected indicator compounds. These indicator compounds represent compounds that are expected to be emitted from the Proposed Project, are generally accepted as indicative in changing air quality, and may be compounds for which relevant air quality criteria exist refer to Section 5.7.2). These indicator compounds fall into the following three (3) general categories:

- **Particulate matter:** total suspended particulate (TSP), particles nominally smaller than 10 micrometres (µm) in diameter (PM_{10}), and particles nominally smaller than 2.5 µm in diameter ($PM_{2.5}$). Particulate matter emissions will be estimated and Proposed Project effects will be assessed using an air dispersion model.
- **Combustion gases**: nitrogen dioxide (NO_2), and sulphur dioxide (SO_2). Combustion gases effects will be assessed using an air dispersion model and based on comparing results from the Proposed Project inventory to existing regional inventories.
- **Additional compounds**: Proposed Project activities will result in metals emissions entrained within fugitive particulate emissions. Downwind air quality concentrations for metals will be predicted using an air dispersion model. Model results will be supplied to the human health technical discipline; the effects associated with downwind metal concentrations will be assessed within the human health EA section (Volume 2, Part B - Section 9.1).

Due to the availability of electric power on site, combustion equipment (both mobile and stationary) associated with the Proposed Project operations will be limited. Major mining equipment such as the dredger, screens and crusher will be powered electrically. Quarried and processed material will be transferred around the Proposed Project Area using a network of conveyors instead of using haul vehicles. During normal operating conditions there are expected to only be three internal combustion engine vehicles onsite, with a maximum operating time of 10-12 hours per day comprising of a pick-up truck (F150), forklift and a loader. Due to the fact that exhaust emissions will be limited at the facility, it is expected that emissions of SO_2 and NO_2 from the Proposed Project will be minimal and will not contribute significantly to the ambient air quality. This will be confirmed through quantification of SO_2 and NO_2 emissions.

There is expected to be one tug movement per day to drop off and pick up a barge. Seaspan Marine is the anticipated operator of the tugs for the duration of the Proposed Project. Tugs will not have engines running while

docked. Compared to current shipping activities in the region, the addition of one tug movement per day is considered to be minimal and will not contribute significantly to the ambient air quality. This will be confirmed through quantification of SO_2 and NO_2 emissions associated with Proposed Project related tug movements, and comparison to total published shipping emissions within the Lower Fraser Valley. Furthermore NO_2, SO_2, PM_{10} and $PM_{2.5}$ emissions from tugboats will be modelled to determine the effect the maneuvering tug boats will have only at sensitive receptors within the RSA.

Metal compounds may be entrained in fugitive particulate emissions. Proposed Project related metal emission rates will be modelled and results will be provided to the human health technical discipline. Effects of metal air emissions will be assessed in the human health effects report.

5.7.3.3.3.2 Emission Methods

The methods used for calculating and quantifying the air emissions are as follows:

- **Identify emissions sources**: The identification of emission sources were based on information provided by BURNCO.
- **Calculate emission rates:** Air emission rates were calculated using accepted methods, such as emission factors, and were based on the activity data and detailed information provided by BURNCO.
- **Summarise overall emissions:** The calculated emissions were summarised by activity type.

Details of the specific emission calculation methods and resulting emissions are provided in Volume 4, Part G – Section 22.0: Appendix 5.7-B.

5.7.3.3.3.3 Dispersion Modelling Methods

An air dispersion model was used to predict concentrations associated with the Proposed Project emissions for the air quality assessment. The same models were used in predicting concentrations of indicator compounds as was used in predicting concentrations and deposition rates of non-indicator compounds (those compounds used by other disciplines in assessing the indirect effects of air quality). Specifically, the fully capable CALPUFF dispersion model (i.e., run in dynamic [3-D] mode with a fine resolution meteorological data set) was used in predicting concentrations and deposition rates. This model was selected for the following reasons:

- It is one of BC MoE's recommended core models for detailed air quality impact assessments (BC MoE 2008);
- It is capable of using a meteorological data that varies from one (1) area to another (i.e., 3-D or dynamic meteorology). This is important given the rugged and varied topography in and around the Proposed Project.
- It can be used to accurately predict concentrations and deposition rates at distances as small as 10s of metres and extending out far enough to enclose the entire modelling domain (i.e., 378×80 km).
- It is capable of simulating both wet and dry deposition of gaseous and particulate compounds.

To use the full capabilities of the CALPUFF model, a dynamic (3-D) meteorological data set must be developed covering the area where predictions are required (the LSA and RSA). This 3-D dispersion meteorological data set allows the meteorological conditions to vary across the modelling domain for each hour that is modelled. The data file is generated using the CALMET pre-processor. A meteorological dataset for 2012 was generated for the Proposed Project; for a detailed description on the generation and validation of the 3-D dataset please refer to Volume 4, Part G – Section 22.0: Appendix 5.7-C.

The assessment of effects looked at the highest predicted concentrations for (TSP, PM_{10},and $PM_{2.5}$) for all averaging periods except for 24-hour $PM_{2.5}$ where the BC air quality objective is for the 98th percentile value, The assessment of effects for NO_2 and SO_2 looked at the annual model predictions at sensitive receptors and the 1-hour averaging period looked at the 98th percentile for NO_2 and the 99th percentile for SO_2 for comparison against the BC interim air quality objectives (BC MoE 2016).

Details of the specific dispersion modelling methods are provided in Volume 4, Part G – Section 22.0: Appendix 5.7-D.

5.7.3.3.4 Evaluating Significance of Residual Effects

The significance of potential residual adverse effects was determined for each VC based on the residual effects criteria and the likelihood of a potential residual effect occurring (Section 5.7.3.3.3), a review of background information and available field study results, consultation with government agencies and other experts, and professional judgement.

The rationale and determination of the significance of potential residual effects on VCs are provided in Section 5.7.5.

5.7.3.3.5 Level of Confidence

The level of confidence for each predicted effect is discussed to characterize the level of uncertainty associated with both the significance and likelihood determinations. Level of confidence is typically based on expert judgement and is characterized as:

- Low: Limited evidence is available, models and calculations are highly uncertain, and/or evidence about potential effects is contradictory.
- Moderate: Sufficient evidence is available and generally supports the prediction.
- High: Sufficient evidence is available and most or all available evidence supports the prediction.

Conservatism will be incorporated into various stages to the assessment. Emission estimates will be calculated using emission factors and conservative assumptions will be made to complete the emission inventory. The air dispersion model will be executed based on the worst case daily emissions rates and will emit the worst case day every day of the year.

5.7.4 Baseline Conditions

The information and methods used in this assessment for baseline characterisation of air quality assessment have been obtained from those sources listed below.

Characterization of the existing environment serves as the background condition for which the effects of the Proposed Project are to be predicted and assessed. This section includes a description of the relevant existing air quality, along with a discussion of meteorology for context.

Indicator compounds, PM_{10} and $PM_{2.5}$ were measured at three air quality stations located in the RSA. These stations are:

- **Langdale Elementary** - operated by Howe Sound Pulp and Paper and located approximately 16 km to southwest;
- **Horseshoe Bay** - operated by Metro Vancouver and located approximately 23 km to southeast; and
- **Squamish** - operated by BC MoE & National Air Pollution Surveillance (NAPS) and located approximately 23 km to northeast.

Data collected from the three stations were analyzed based on the recommendations outlined in BC MoE (2008). These recommendations were taken from BC MoE (2008) and include:

- The use of the most recent monitoring data from the last year with 75% data availability from each quarter;
- Set the background level not lower than the 98^{th} percentile;
- Select background levels for the same averaging period to correspond to the model predictions (2012 calendar year); and
- In the case where there are more than one representative monitoring site, apply the same approach for each sites and taking the arithmetic average to set the background concentration.

Within the RSA no reliable air quality stations measured TSP. The Squamish station is also a NAPS station and NAPS stopped publishing daily TSP records in 2002. Therefore a literature review on the relationship between TSP and PM_{10} was undertaken. The United States Environmental Protection Agency (US EPA) published *Procedures for Estimating Probability of Nonattainment of a PM_{10} NAAQS Using Total Suspended Particulate or PM_{10} Data* (US EPA 1986) was used to establish the TSP value. The 24-hour and the annual average of PM_{10} concentration values for 2010 will be used to calculate the 24 hour average and annual TSP background concentrations along with a TSP: PM10 ratio provided in US EPA (1986).

Table 5.7-6 summarizes the background particulate matter concentrations for the RSA and the RSA. Background concentrations will be combined with Proposed Project dispersion model results which will result in the cumulative impact of the Proposed Project on the local and regional air quality.

Table 5.7-6: BC Ambient Air Quality Objectives and Baseline Particulate Matter Concentrations

Pollutant	Averaging Period	Ambient Air Quality Objective (µg/m^3)	Baseline Concentration (µg/m^3)
$PM_{2.5}$	24-hour	25	14.3
	Annual	8	6.2
PM_{10}	24-hour	50	26.2
TSP	24-hour	120	54.8
	Annual	60	20.7
NO_2	1-hour	188	41.4
	Annual	60	9.6
SO_2	1-hour	200	34.3

Within the air quality assessment, the air dispersion model will be executed in no-observation mode using one year's worth of mesoscale meteorological data to drive the dispersion model meteorological predictions; which is consistent with BC MoE (2008) recommendations. Therefore, the meteorological station data, within the Proposed Project domain, will be used to validate the dispersion model's meteorological data as well as providing an understanding of the local weather conditions.

Port Mellon (10U 465015 5485006), located approximately 9 km southwest of the Proposed Project is an ECCC meteorological station and used to validate the dispersion meteorological data set as well as contextualize the local meteorology. Temperature averages measured at Port Mellon shows the highest readings in the summer months of approximately 18°C. The monthly average temperature for year to year shows that there is little temperature variation. The relative humidity and precipitation decrease in the late spring and summer months. The predominant wind direction at Port Mellon is from the north-northwest, with a high level of calms. Port Mellon wind roses show that the majority of wind speeds occur in the wind speed class of 3 to 5 m/s or less, and this region is expected to have relatively calm winds. This is likely due to the valley terrain features surrounding the Port Mellon station.

Please refer to Volume 4, Part G – Section 22.0: Appendix 5.7-A for the air quality technical baseline reports for the Proposed Project site.

5.7.5 Effects Assessment

5.7.5.1 Project-VC Interactions

A preliminary evaluation of identified interactions between the various physical works and activities and the selected VCs across all spatial and temporal phases of the Proposed is presented in Table 5.7-7. Potential Project-VC interactions are characterized as:

a) Positive, none or negligible, requiring no further consideration; or

b) Potential effect requiring further consideration and possibly additional mitigation.

Rationale is provided for all determinations that there is no or negligible interaction and that no further consideration is required.

For those Proposed Project-VC interactions that may result in a potential direct, indirect and induced effects requiring further consideration, the nature of the effects (both adverse and positive) arising from those interactions is described in Section 5.7.5.2 below.

Table 5.7-7: Project-VC Interaction Table: Air Quality VC – Air Quality Indicators

Project Activities	Description	Air Quality Indicators	
		Potential Interaction[(a)]	Potential Effect / Rationale for Exclusion
Construction			
1. Crew and equipment transport	▪ Daily water taxi ▪ Tug and barge transport of machinery/materials (est. 8 loads) ▪ Barge household and industrial solid waste barged off-site	O	Construction activities (which will be intermittent) will result in air emissions that may cause short-term changes in air concentrations. Fuel combustion from construction vehicles and marine vessels will result in air emissions. **Minor source of Proposed Project emissions** (construction emissions will be bounded by operation effects)**.** **Mitigation practices** will help to control or limit the downwind impact of construction activities. Theses fugitive dust best management practices would include watering of exposed material, postponing work during high wind events, maintaining vehicle speed. Compared to the current rate of marine traffic in the Howe Sound the additional water taxing to transport crew and material are expected to be minimal to the current level of marine traffic in the region.
2. Site preparation, including construction of the berms and dyke	▪ Logging, clearing and grubbing ▪ Grading ▪ Construction of the berms and dyke ▪ Compaction and laying of gravel base ▪ Limited improvements to existing on-site road infrastructure	●	
3. Processing area installation, including conveyors and materials handling system)	▪ Installation and use of portable concrete batch plant for construction ▪ Installation of concrete foundations ▪ Installation of screens, crushers, wash plant, conveyor system and automated materials-handling system (i.e., reclaim tunnels) ▪ Installation of groundwater well as a source of make-up water for the wash plant	●	
4. Substation construction and connection	▪ Construct electrical substation adjacent to existing BC Hydro transmission line ▪ Construct outdoor switchyard, electric building, and 100 m transmission line	●	
5. Marine loading facility installation	▪ Remove existing mooring dolphins ▪ Steel pile installation ▪ Installation of conveyor, barge movement winch and mooring dolphins	●	
6. Pit development	▪ Dry excavation to remove overburden/topsoil ▪ Installation of clamshell and floating conveyor	●	

Project Activities	Description	Air Quality Indicators	
		Potential Interaction[(a)]	Potential Effect / Rationale for Exclusion
7. Other ancillary land-based construction works	▪ Temporary construction infrastructure set up (trailers, temporary power, etc.) ▪ Upgrades to the existing heavy equipment maintenance shop and warehouse ▪ Upgrades to the existing fuelling facility for the storage of diesel and gasoline for on-site equipment ▪ Construct site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility and helipad ▪ Install contained washroom facilities ▪ Construct pump room for well/stream intake water distribution and fire-fighting	●	
8. Other ancillary marine construction works	▪ Removal of existing small craft dock; install temporary dock for worker access ▪ Construct new floating small craft dock, the with tie-up area for a float plane, serviced with 30 amp (A) 125 volt (V) shore power ▪ Barge household and industrial solid waste off-site	●	
Operations			
9. Crew transport	▪ Daily water taxi	O	Proposed Project activities will result in air emissions, which may cause changes in air concentrations and atmospheric deposition rates. Fuel combustion will result in air emissions. **Primary source of Proposed Project emissions.** Combustion emissions as a result of marine traffic (water taxis and tug boats) are expected to be emitted but will be minimal when compared to the current marine traffic in the Howe Sound. In addition, Seaspan Marine is an ISO 14001 certified company and a member of the Green
10. Aggregate mining	▪ Use of electric powered floating clamshell dredge ▪ Primary screening and conveyance of extracted material to processing area ▪ Install channel plug in WC 2	●	
11. Processing (screening, crushing, washing)	▪ Screening to separate aggregate sizes ▪ Oversized gravels crushed ▪ Operation of wash plant fed using recycled water from two large storage tanks, supplemented with make-up water by a groundwater well. ▪ Drying and storage of fines and silt	●	

Project Activities	Description	Air Quality Indicators	
		Potential Interaction[(a)]	Potential Effect / Rationale for Exclusion
12. Progressive reclamation	▪ Ongoing earth works (including site clearing, surface material removal) ▪ Fines and silt mixed with organic overburden material and used for infilling, re-vegetation and landscaping	●	Marine Environmental Program. Their commitment to environmental stewardship includes an emission reduction strategy for their entire fleet of vessels (Seaspan 2014).
13. Stockpile storage	▪ Processed sand and gravel conveyed to stockpile area ▪ Storage of processed materials in stockpiles	●	
14. Marine loading	▪ Transfer of stored material using marine conveyor system ▪ Barge loading ▪ Site and navigational lighting	●	
15. Shipping	▪ Barge traffic (delivery/collection) in Howe Sound, Ramillies Channel, Thornbrough Channel, and Queen Charlotte Channel ▪ Tug and barge transport of fuel and consumables ▪ Navigational lighting	O	
16. Refueling and maintenance	▪ Refueling and maintenance of on-site equipment	O	

Project Activities	Description	Air Quality Indicators	
		Potential Interaction[(a)]	Potential Effect / Rationale for Exclusion
Reclamation and Closure			
17. Crew and equipment transport	▪ Daily water taxi movements ▪ Tug and barge transport of machinery/materials ▪ Barge household and industrial solid waste barged off-site	O	Decommissioning activities result in air emissions, which may cause short-term changes in air concentrations. Fuel combustion will result in air emissions. **Minor source of Proposed Project emissions** (reclamation and closure emissions will be bounded by operation effects). **Mitigation practices** will help to control or limit the downwind impact of reclamation and closure activities. Theses fugitive dust best management practices would include watering of exposed material, postponing work during high wind events, maintaining vehicle speed.
18. Removal of land-based infrastructure	▪ Remove surface facilities, including clamshell dredge, conveyor system, screens, crushers, wash plant, automated materials-handling system, heavy equipment maintenance shop and warehouse, fuelling facility, site office, communications building, workers lunch/dry room, caretaker's cabin, first aid facility, helipad and contained washroom facilities	●	
19. Removal of marine infrastructure	▪ Remove marine facilities, in marine load out facility, jetty, conveyors and piles	O	
20. Site reclamation	▪ Final completion of the pit lake, landscaping and re-vegetation to develop a functional ecosystem in the freshwater pit ▪ Landscaping and re-vegetation of processing area, berms and dyke	●	

Notes:
O = Potential effect of Proposed Project activity on VC is positive, none or negligible; no further consideration warranted.
● = Potential effect of Proposed Project activity on VC that may require mitigation/benefit enhancement; warrants further consideration

5.7.5.2 Potential Project-Related Effects

5.7.5.2.1 Air Quality Indicators

Effects related to air quality indicators are discussed in the sections below.

5.7.5.2.1.1 Construction

Effects on air quality during the construction phases of the Proposed Project were identified as minor potential interaction. Construction activities, land clearing to expand the pit, will occur progressively trough-out the operations phase of the Proposed Project; emissions associated with pit expansions are incorporated into the operations phases. Therefore construction effects would be bounded by the effects during operations.

5.7.5.2.1.2 Operations

Due to the availability of power on site, combustion equipment (both mobile and stationary) associated with the Proposed Project operations will be limited. Major mining equipment such as the dredger, screens and crusher will be powered electrically. Extracted and processed material will be transferred around the Proposed Project site using a network of conveyors instead of haul vehicles. During normal operating conditions there are expected to only be three internal combustion engine vehicles onsite, with a maximum operating time of 10-12 hours per day comprising of a pick-up truck (model F150), forklift and a loader. Due to the fact that exhaust emissions will be limited at the facility, it is expected that emissions of sulphur dioxide (SO_2) and nitrogen dioxides (NO_2) from the Proposed Project will be minimal and will not contribute significantly to the ambient air quality. This will be confirmed through quantification of SO_2 and NO_2 emissions.

There is expected to be one tug movement per day to drop off and pick up a barge. Tugs will not have engines running while docked. Seaspan Marine is the anticipated operator of the tugs for the duration of the Proposed Project and is an ISO 14001 certified company and a member of the Green Marine Environmental Program. Their commitment to environmental stewardship includes an emission reduction strategy for their entire fleet of vessels (Seaspan 2014). Compared to current shipping activities in the region, the addition of one tug movement per day is considered to be minimal and will not contribute significantly to the ambient air quality. This will be confirmed through quantification and modelling of SO_2 and NO_2 emissions associated with Proposed Project related tug movements. Emissions from the tug movements will be compared to total published shipping emissions within the Lower Fraser Valley.

The direct effects on air quality of the Proposed Project activities focused on the operating phase in year 12 of the Proposed Project, when emissions and activities were identified as being at their highest. The assessment explicitly considered the effects associated with the following activities:

- **Land Clearing**- During each operational year the excavation pit will be expanded; land will therefore need to be cleared to accommodate the expansion. Land clearing will occur at most over 30 days each year and will be conducted using a dozer and excavator. Emissions associated with land clearing include fugitive emissions of TSP, PM_{10} and $PM_{2.5}$ and vehicle combustion particulate emissions. The annual emissions, associated with expanding the pit, allows the operations phase effects to bind the construction phase effects.

- **Aggregate Extraction and Initial Processing**– The wet extraction process will consist of a flooded aggregate pit area below existing groundwater levels. Sand and gravel will be extracted from the pit using an electrically powered floating clamshell dredge, equipped with a primary crusher and a floating conveyor system. The wet extraction technique will act as a fugitive dust and particulate control technique thus eliminating the potential for fugitive particulate emissions. The crushed and screened material will also be wet which will also act a fugitive particulate emission control. Emissions associated with aggregate extraction will include fugitive emissions of TSP, PM_{10} and $PM_{2.5}$.
- **Conveying from Pit and Processing** – Material from the dredged will be conveyed to the processing plant, using over water conveyors and an underground conveyor from the pit lake to the processing plant area. Once at the processing plant the material will be crushed and screened, and sorted into piles of different size fractions. Emissions associated with conveying and processing will include fugitive emissions of TSP, PM_{10} and $PM_{2.5}$ and combustion particulates from onsite vehicles, and a propane powered welding unit.
- **Transfer to Barge** – Material will be transport from underground conveyors and loaded onto the Barge. Emissions associated with barge loading will include fugitive emissions of TSP, PM_{10} and $PM_{2.5}$.
- **Tug Transport**- A tug boat will transport the barges from the Proposed Project to existing aggregate handling activities in the lower mainland. It is expected that effects from the tug boat transportation will be minor. Emissions associated with tug boat transportation would include combustion of emissions of particulates, NO_2 and SO_2.

Proposed Project emissions were quantified for the expected maximum year of emissions, which correlated to the year 12 of operation. The annual emissions for indicator compounds are summarised in Table 5.7-8.

Table 5.7-8: Indicator Compound Emission Rates (tonnes/year) – Mine Operational Phase

Emission Activity	Indicator and non-indicator compounds (tonne/year)				
	$PM_{2.5}$	PM_{10}	TSP	SO_2	NO_2
Land Clearing	0.3	0.8	2.9	0.0	1.3
Aggregate Extraction and Initial Processing	0.1	1.2	3.5	n/a	n/a
Conveying from Pit and Processing	1	7.5	19.9	0.02	3.65
Transfer to Barge	0.4	2.6	5.4	n/a	n/a
Tug Transport	0.9	1.0	1	0.03	80.96
Total Operational	2.69	13.05	32.66	0.05	85.95

Notes:
n/a – not applicable

Details of the emissions calculations are provided in Volume 4, Part G – Section 22.0: Appendix 5.7-A.

Emission rates were feed into CALPUFF, the selected air dispersion model (refer to Volume 4, Part G – Section 22.0: Appendix 5.6-D). The maximum off-site particulate concentrations ($PM_{2.5}$, PM_{10} and TSP) predicted (within the RSA) with and without background concentration added for each air quality indicator, for the relevant averaging period, are summarised in Table 5.7-9.

Table 5.7-9: Predicted Air Concentrations for Indicator Compounds

Indicator Compound	Averaging Period	Air Quality Standard (µg/m³)[a]	Jurisdiction	Maximum Offsite (µg/m³)	Maximum Offsite with Baseline (µg/m³)
$PM_{2.5}$	24-hour [b]	25	BC	60.8	75.1
	Annual	8	BC	31.2	37.4
PM_{10}	24-hour	50	BC	145.3	171.5
TSP	24-hour	120	Canada	595.5	650.3
	Annual	60	BC	260.0	280.7

[a] All ambient air quality measurements will be referenced to standard conditions of 25°C and 101.3 kilopascal (kPa).
[b] Achievement based on annual 98th percentile value.

Contour plots (i.e., isopleth plots) of the predicted emission concentrations for each indicator compound and averaging period are provided in Figure 5.7-2 through Figure 5.7-6.

As demonstrated by the contour plots, all the potentially significant impacts are located within the Local Study Area (LSA) and are along the facility fence line.

Model results predict concentrations above air quality objectives at fence line receptors, as observed in Table 5.7-9 and Figure 5.7-2 through Figure 5.7-6, model results were not above air quality objectives at locations where people currently live. These locations were entered into the dispersion model as sensitive receptors and include seasonal residences (15 in total), where some are within 0.37 km of the Proposed Project's fence line, and a recreational area (campsite) located >3 km from the Proposed Project on Gambier Island near Ekins Point. Table 5.7-10 summarizes the maximum predictions for indicator compounds at sensitive receptors including background levels.

Table 5.7-10: Maximum Model Predictions, Including Background at Sensitive Receptor Locations

Receptor	GPS Location (UTM 10U)		Model Prediction Concentrations Including Background (µg/m³)							
			$PM_{2.5}$		PM_{10}	TSP		NO_2		SO_2
	Easting	Northing	24-h	Annual	24-h	24-h	Annual	1-h	Annual	1-h
Residence 1	472492	5490163	16.3	6.7	36.7	88.2	26.7	42.2	9.8	34.3
Residence 2	472473	5490134	16.5	6.8	37.0	88.7	27.0	42.3	9.8	34.3
Residence 3	472502	5490113	16.3	6.7	36.4	86.3	26.5	42.2	9.8	34.3
Residence 4	472514	5490093	16.2	6.7	36.2	85.2	26.3	42.2	9.7	34.3
Residence 5	472526	5490064	16.2	6.7	36.0	84.2	26.1	42.2	9.7	34.3

Receptor	GPS Location (UTM 10U)		Model Prediction Concentrations Including Background (µg/m³)							
			$PM_{2.5}$		PM_{10}	TSP		NO_2		SO_2
	Easting	Northing	24-h	Annual	24-h	24-h	Annual	1-h	Annual	1-h
Residence 6	472512	5490043	16.2	6.7	36.3	84.7	26.3	42.2	9.7	34.3
Residence 7	472517	5490024	16.1	6.7	36.3	84.4	26.2	42.2	9.7	34.3
Residence 8	472553	5490032	16.1	6.6	36.0	83.3	25.9	42.2	9.7	34.3
Residence 9	472530	5489996	16.1	6.7	36.4	83.9	26.1	42.2	9.7	34.3
Residence 10	472561	5490005	16.0	6.6	36.0	82.8	25.8	42.1	9.7	34.3
Residence 11	472545	5489970	16.1	6.6	36.2	83.0	25.9	42.2	9.7	34.3
Residence 12	472580	5489941	16.0	6.6	35.8	81.3	25.4	42.1	9.7	34.3
Residence 13	472604	5489898	15.9	6.6	35.8	80.8	25.2	42.1	9.7	34.3
Residence 14	472604	5489883	15.9	6.6	36.0	81.0	25.2	42.0	9.7	34.3
Residence 15	469764	5490065	14.4	6.2	27.3	58.1	20.9	41.5	9.6	34.3
Ekins Point	472345	5486912	14.9	6.3	31.8	69.4	22.3	41.8	9.6	34.3
McNab upstream	471594	5491495	14.8	6.3	29.4	64.8	22.3	41.7	9.6	34.3
Anvil Island	477888	5484737	14.3	6.2	26.5	55.8	20.8	41.4	9.6	34.3
Camp Artaban	474374	5480622	14.3	6.2	26.3	55.2	20.7	41.4	9.6	34.3
KAIKALAHUN 25	464260	5484988	14.3	6.2	26.4	55.3	20.8	41.5	9.6	34.3
KWUM KWUM	479401	5491810	14.3	6.2	26.5	55.6	20.8	41.5	9.6	34.3

On an annual basis tug boats will barge in and out of the BURNCO facility 300 times per year (1 barge trip per operational day). On an annually basis the fuel combustion associated with the tugboat will release would result in 0.030 tonnes of SO2 and 80.96 tonnes of NO2 emitted. The emission estimation method for tugboat exhaust can be found in Volume 4, Part G – Section 22.0: Appendix 5.6-A Emission Estimates. The tugboats will be travelling on existing barging routes. For context fuel consumption by marine traffic (bulk vessels, containership, cruise ship, general cargo, miscellaneous ships, motor vehicle carriers and tankers) in the Lower Fraser Valley is estimated to be approximately 65,654 tonnes of heavy duty fuel oil, 3,407 tonnes of distillate fuel oil and 8,349 tonnes of marine gas oil each year (The Chamber of Shipping 2007). The combustion of these fuels in the Lower Fraser Valley results in roughly 3,508 tonnes of SO2 and 4,022 tonnes of NO2 in annual emissions. The additional traffic of the tugboat within the lower mainland will increase marine traffic SO2 emissions by under 0.001% and NO2 emissions by 2.0%.

5.7.5.2.1.3 Reclamation and Closure

Effects on air quality during the reclamation and closure phases of the Proposed Project were identified as minor potential interaction whose effects would be bounded by the effects during operations.

5.7.5.2.2 Qualitative Assessment of the Potential of Visual Degradation

The formation of photochemical smog (smog) is generally associated with visual degradation. Smog is formed by the interaction of sunlight with specific chemical compounds the primary compound being ground level ozone. Ground level ozone is formed by the interaction between CO, NO_X and VOCs and sunlight.

The Proposed Project is not a significant source of CO and VOCs demonstrated by the fact that they are not included in the air quality technical assessment as indicator compounds (air quality indicators). Emissions of NO_X are small since the majority of the gravel extraction equipment is electronically powered. Proposed Project related emissions of NO_X are combustion sources; during Project operation the only combustion sources will be vehicular emissions associated with land clearing (which will only last for a maximum of 30 days per year), tug boat emissions (one tug boat visit per day maneuvering the barge in and out of the facility, the tugboat will not dock at the facility), and a very small amount of propane combustion associated with welding. All other equipment (dredgers, crushers, screens, conveyors, etc.) will be powered electrically.

Therefore the Proposed Project is not considered to contribute to visual degradation as a result of photochemical smog because combustion emission sources will be limited. Visual degradation has not been carried forward to the residual effects assessment nor the cumulative effects assessment.

5.7.5.3 Mitigation

This section provides a description of the proposed mitigation measures specifically related to Proposed Project effects on VCs for air quality. The following mitigation is presented to mitigate potential Project-related effects to air quality. The suite of measures proposed to mitigation potential air quality effects is presented in Table 5.7-11.

Mitigation measures will be adopted throughout the three Proposed Project phases (construction, operation and reclamation and closure). Mitigation measures will primarily be used to control releases of fugitive particulate from onsite activity that result in downwind impacts of indicator compounds (TSP, PM_{10} and $PM_{2.5}$). Emission control practices will range from watering exposed areas, building McNab Creek Flood Protection Dyke, the Pit Lake Containment Berm and the Processing Area Dirt Berm, enclosing aggregate transfer points, and enclosing material processing equipment like the crusher and screens.

Mitigation processes will limit the emission rate from emission sources, where appropriate emission rates have been reduced to account for mitigation activities. The emission rate control efficiencies applied to emission sources were taken from widely used and acceptable literature sources that include WRAP Fugitive Dust Handbook (Countess Environmental 2004), and Pits and Quarries Guidance Chapter 8 (Environment Canada 2009). For further details regarding the control efficiencies applied to emission sources refer to Volume 4, Part G – Section 22.0: Appendix 5.7-A Emission Estimation. Mitigation due to the natural attenuation of precipitation and the onsite dyke and berms used to shelter the processing plant and the pit area were not included in inventory.

The mitigation strategy outlined below forms the basis for the commitments that the Proposed Project is making with respect to air quality. A detailed list of all commitments of the Proposed Project are provided in Volume 3, Part F – Section 19.

5.7.5.3.1 Construction

An Air Quality and Dust Control Management Plan (Volume 3, Part E - Section 16.0) will be established prior to the construction phase. The management plan will detail control measures that must be in place to control fugitive particulates.

Control of emissions during the construction phase will include the establishment of a continuous air quality and meteorological monitoring program. The program will be installed prior to the construction phase, this will allow data comparison between pre-construction and construction activities to better determine the impact of the construction activities. On-site meteorological monitored data may also be used to determine high wind conditions and construction activities will be discontinued during high wind events. Watering exposed area will be undertaken to control the entrainment of fugitive particulates in the atmosphere. Vehicle speed limits will be set so as limit the disturbance of surface material.

The proposed mitigation measures for the construction operation are widely used throughout industry and are effective in limiting the release of fugitive particulates from construction activities.

5.7.5.3.2 Operations

The dust control management will contain dust control management activities required for the operation phase of the Proposed Project.

These control measures will include a wet extraction technique, the Processing Area Dirt Berm along the eastern boarder of the processing plant which will act as a wind barrier, aggregate transfer points will be enclosed, two stock piles will be mist sprayed, high moisture content of the material being handled, crushers and screens at the processing plant will be enclosed and some of the conveying equipment will be underground.

Where appropriate emission reduction efficiencies have been applied to emission rates. Emission reduction efficiencies were taken from widely used literature values. The emission reduction efficiency for the following activities are listed below:

- 85% reduction efficiency for partially enclosed crushing units taken from Pits and Quarries Guidance Chapter 8, Section 8.5 - Crusher Emission Control Techniques (Environment Canada 2009).
- 50% reduction efficiency for wind erosion off the 10 mm Crushed Gravel and 20 mm Crushed Gravel Stockpiles taken from Environment Canada (2009).
- 50% reduction efficiency for partially enclosed the dry screening units were taken from Environment Canada (2009).
- A 100% emission reduction for wet screening was assumed since material will be saturated.
- 50 and 75% emission reductions were used for material handling processes that were enclosed or were enclosed with mist spray, reduction efficiency taken from Environment Canada (2009).
- For conveyor transfers the emission factors for controlled transfers were used in AP 42 Chapter 11.19.2 (US EPA 2004).

- 55% emission reductions were used for fugitive road particulate emissions based on watering at least twice a day, value provided in the Western Regional Air Partnership (WRAP) Fugitive Dust Handbook (2004).

Mitigation measures for fugitive barge emissions will include:

- Barges will only be travelling loaded in one direction;
- The barges will have 2.74 m boxwalls which will act as partial windscreens;
- The loaded aggregate material will be wet; and
- Five of the seven aggregate types will have material silt content less than 1.5%.

5.7.5.3.3 Reclamation and Closure

The dust control management will contain dust control management activities required for the reclamation and closure phase of the Proposed Project.

Control of emissions during the reclamation and closure phase will include many similar control measures as the construction phase. They would include. Watering exposed areas during dry periods will be undertaken to control the entrainment of fugitive particulates in the atmosphere. Vehicle speed limits will be set so as limit the disturbance of surface material.

The proposed mitigation measures for the reclamation and closure operation are widely used throughout industry and are effective in limiting the release of fugitive particulates from construction activities.

Table 5.7-11: Identified Mitigation Measures: Air Quality

Potential Effect	Mitigation	Anticipated effectiveness
Construction		
Fugitive particulate concentrations from construction activities: Bulldozing, material handling (material drops), fugitive road dust, and wind erosion from un-vegetated dyke and berms.	Develop and implement an Air Quality and Dust Control Management Plan	Compared to the Proposed Project operations phase emissions from the construction phase are expected to be short term and intermittent compared to the operation phase. Mitigation measures undertaken by BURNCO during the construction phase are consistent with industry practices in control.
	Establish an Air Quality and Meteorological Monitoring Program	
	Watering of unpaved roads and restricted speed limits within Proposed Project Area to reduce particulate emissions.	
Operations		
Fugitive particulate concentrations from onsite activities.	Establish an Air Quality and Meteorological Monitoring Program	Allows the Proposed Project to measure and compare operations phase effects to construction and pre-construction conditions. May be used in determining operational schedule (do not undertake some processes during high wind days).

Potential Effect	Mitigation	Anticipated effectiveness
Fugitive particulate concentrations processing plant crushing units.	Partial enclosure	85% taken from Pits and Quarries Guidance Chapter 8, Section 8.5 - Crusher Emission Control Techniques (Environment Canada 2009).
Fugitive particulate concentrations from wind erosion off the10 mm Crushed Gravel and 20 mm Crushed Gravel Stockpiles.	Watering	50% taken from Environment Canada (2009).
Fugitive particulate concentrations from processing plant dry screening units.	Partial enclosure	50% taken from Environment Canada (2009)
Fugitive particulate concentrations from processing plant wet screening.	Wet process	100% assumed since material will be saturated.
Fugitive particulate concentrations from material handling (material drops).	Partial enclosure	50% taken from Environment Canada (2009).
Fugitive particulate concentrations from material handling (material drops).	Partial enclosure and water (mist) spray	75% taken from Environment Canada (2009).
Fugitive particulate concentrations from fugitive road dust.	Watering	55% taken from WRAP Fugitive Dust Handbook (Countess Environmental 2004).
Reclamation and Closure		
Fugitive particulate concentrations from reclamation and closure activities: Bulldozing, material handling (material drops), fugitive road dust, and wind erosion from un-vegetated dyke and berms	Watering of unpaved roads and restricted speed limits within Proposed Project Area to reduce particulate emissions.	Compared to the facility operations phase emissions from the reclamation and closure phase are expected to be short term and intermittent compared to the operation phase. Mitigation measures undertaken by BURNCO during the construction phase are consistent with industry practices in control

5.7.5.4 Residual Effects Assessment

Potential Project-related residual effects have been characterized using the criteria for each VC identified Table 5.7-4. The characterization of potential residual effects (i.e., following application of appropriate mitigation measures) is described below and presented in Table 5.7-12.

Due to the nature of the air quality assessment and the fact that the in-design mitigation measures outlined in above are already incorporated into the assessment, all of the effects predicted by the dispersion modelling assessment were considered residual effects. Residual effects are considered those likely to remain after the implementation of mitigation measures.

5.7.5.4.1 Construction

Effects on air quality during the construction phase of the Proposed Project were identified as minor potential interaction whose effects would be bounded by the effects during operations; therefore, construction effects have not been assessed.

5.7.5.4.2 Operations

5.7.5.4.2.1 Project Effects: Indicator Compounds- Particulate Matter

Particulate matter ($PM_{2.5}$, PM_{10} and TSP) will be emitted from a variety of onsite activities during aggregate extraction operation. Impacts of $PM_{2.5}$, PM_{10} and TSP emissions from onsite sources were predicted using an air dispersion model. Model results are tabulated and illustrated in Section 5.7.5.2.1.2 show that for all particulates ($PM_{2.5}$, PM_{10} and TSP) and for all averaging periods (24-hour and annual) model predictions (coupled with their respective background concentrations) were greater than the air quality criteria in the immediate vicinity of the facility's fence-line (areas where the people would not dwell) but dropped below air quality objective limits at residences within 0.37 km of the fence-line.

Due to the fact that the air quality standards are for 24-hour and annual averaging (exposure) periods and due to the fact that the residences are the receptors nearest to the facility where people will be exposed to potential down-wind impacts from the Proposed Project over a 24-hour and annual period, the predictions at the residences were used to assess the magnitude of the effects.

For all particulates and averaging periods Proposed Project only predicted concentrations fall to below 1.2 $\mu g/m^3$, within the LSA; 1.2 $\mu g/m^3$ is the lower detection limit of the proposed air quality monitors that will be used onsite (E-BAM). Therefore, Proposed Project predicted concentrations fall below detection limits within the LSA and the extent of the effect was determined to be local. Emission activities assessed were conditions that may occur at any time during the mine operations therefore the duration was selected as medium-term. The frequency was selected as medium because the metrological conditions may occur at any time that would result in the maximum predictions.

5.7.5.4.2.2 Project Effect: Combustion Gas NO_2 and SO_2

The increase of one tugboat trip per day during the 300 operational days per year will minimally increase annual marine NO_2 and SO_2 emission rates within the Lower Fraser Valley (increase of 2.0% for NO_2 and less than 0.001% percent of SO_2).

As observed from Table 5.7-10 the 98th, maximum and 99th percentile predicted concentrations for NO_2 and SO_2, when coupled with background concentrations are less than 25% of the ambient air quality guidelines at sensitive receptors; therefore the magnitudes were determined to be negligible.

The tugs will transport the barges to existing facilities in Langley and Burnaby. Both barging routes and facilities are located beyond the RSA extents therefore the extent of the effect has been selected as "beyond regional". Tug boat transport part of normal operations of the facility therefore the duration and frequency of the effect were selected as medium-term and high.

Table 5.7-12: Characterization of Potential Project-Related Residual Effects: Air Quality VC – Air Quality Indicators

Project-Related Effect	Residual Effect Assessment Criteria						
	Context	Magnitude	Extent	Duration	Reversibility	Frequency
Construction						
Effects, will be bounded by operational effects, therefore assessment is conservatively assumed to be same as the operations phase.						
Operations						
Increase in $PM_{2.5}$ – 24-hour	Somewhat Disturbed	M	L	MT	FR	M
Increase in $PM_{2.5}$ – Annual	Somewhat Disturbed	M	L	MT	FR	M
Increase in PM_{10} – 24-hour	Somewhat Disturbed	M	L	MT	FR	M
Increase in TSP – 24-hour	Somewhat Disturbed	M	L	MT	FR	M
Increase in TSP – Annual	Somewhat Disturbed	L	L	MT	FR	M
Increase in NO_2- 1-hour, tug boats	Somewhat Disturbed	N	BR	MT	FR	H
Increase in NO_2- Annual, tug boats	Somewhat Disturbed	N	BR	MT	FR	H
Increase in SO_2- 1-hour, tug boats	Somewhat Disturbed	N	BR	MT	FR	H
Reclamation and Closure						
Effects, will be bounded by operational effects, therefore assessment is conservatively assumed to be same as the operations phase.						

Assessment Criteria:
Context- Disturbed, Somewhat Disturbed, Undisturbed
Magnitude: N – Negligible, L – Low, M – Medium, H – High;
Geographic Extent: L – Local, BL – Beyond Local;
Duration: ST – Short-tern, MT – Medium-term, LT – Long-term;
Reversibility: FR - Fully Reversible, Partially Reversible; IR - Irreversible;
Frequency: L – Low, M – Medium, H – High

5.7.5.4.3 Reclamation and Closure

Effects on air quality during the reclamation and closure phase of the Proposed Project were identified as minor potential interaction whose effects would be bounded by the effects during operations; therefore, reclamation and closure effects have not been assessed.

Table 5.7-13 Likelihood of Occurrence of Potential Residual Effects: Air Quality

Air Quality Indicator	Residual Effect	Likelihood	Rationale
Construction			
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects therefore assessment is conservatively assumed to be same or less than the operations phase		
Operations			
BC ambient air quality objectives and NAAQS	Increase in $PM_{2.5}$ – 24-hour	High	Normal aggregate operations will result in the emissions of particulate matter that would result in increased downwind ambient concentrations.
	Increase in $PM_{2.5}$ – Annual	High	
	Increase in PM_{10} – 24-hour	High	
	Increase in TSP – 24-hour	High	
	Increase in TSP – Annual	High	
	Increase in NO_2- 1-hour, tug boats	High	Daily tug boat operations will result in emissions of NO_2 and SO_2 that may result in increased ambient concentrations
	Increase in NO_2- Annual, tug boats	High	
	Increase in SO_2- 1-hourl, tug boats	High	
Reclamation and Closure			
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects therefore assessment is conservatively assumed to be same or less than the operations phase		

5.7.5.5 Significance of Residual Effects

The significance of potential residual adverse effects will be determined for each VC based on the residual effects criteria and the likelihood of a potential residual effect occurring, a review of background information and available field study results, consultation with government agencies, First Nations, and other experts, and professional judgement. A summary of significance determinations is presented in Table 5.7-14.

The determination of significance of residual adverse effects is rated as negligible-not-significant, not significant, or significant, which are generally defined as follows:

- Negligible-Not Significant: The basis for determining that effects are negligible will be provided in the Application for each VC. Negligible effects will not be carried forward to the cumulative effects assessment
- Not significant: Effects determined to be not significant are residual effects greater than negligible that do not meet the definition of significant. Residual effects that are not significant will be carried forward to the cumulative effects assessment.

- Significant: The basis for determining that a residual effect is significant will be provided in the Application for each VC. Significant residual effects will be carried forward to the cumulative effects assessment.

Detailed rationale for significance determinations is provided below.

5.7.5.5.1 Construction

Effects on air quality during the construction phase of the Proposed Project were identified as minor potential interaction whose effects would be bounded by the effects during operations. Construction effects will be bounded by operational effects therefore assessment is conservatively assumed to be same or less than the operations phase.

5.7.5.5.2 Operations

5.7.5.5.2.1 Residual Effect: Indicator Compounds- Particulate Matter

For all particulate matter ($PM_{2.5}$, PM_{10} and TSP) and for all averaging periods at locations where people live (residences less than 0.37 km form the facility fence-line) the air dispersion model predicted concentrations were less than the air quality standard but greater than 25% of the objective. Furthermore model predictions dropped to less than 1.2 ug/m^3 within the LSA, which is less than the detection limit of the proposed monitoring device. Furthermore the effect will be fully reversible since after the operation period the air quality conditions will return to pre-operation conditions. A significant effect would be deemed to be when the magnitude of the effect is high (greater than air quality criteria at residences) and an effect that is irreversible. Proposed Project based effects will not exceed ambient air quality criteria at the residences and the effects are fully reversible therefore the residual effect was deemed not significant.

5.7.5.5.2.2 Residual Effect: Indicator Compounds- Combustion Gases (SO_2 and NO_2)

Model results indicate that at their respective maximum and percentile model predictions, when coupled with background concentrations are negligible (less than 25% of the respective air quality objectives). As well, the result of an additional 1 tugboat trip per operational day (300 days per calendar year) on existing barging routes would result in an increase in SO_2 and NO_2 emission rates by less than 5% in the Lower Fraser Valley.

Due to the negligible modelling results and due to fact that the increase in marine traffic results in minimal increases to annual NO_2 and SO_2 emissions the effects were deemed negligible.

5.7.5.5.3 Reclamation and Closure

Effects on air quality during the reclamation and closure phase of the Proposed Project were identified as minor potential interaction whose effects would be bounded by the effects during operations. Reclamation

and closure effects will be bounded by operational effects therefore assessment is conservatively assumed to be same or less than the operations phase.

Table 5.7-14 Significance of Potential Residual Effects: Air Quality

Air Quality Indicator	Residual Effect	Significance	Rationale
Construction			
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects.		
Operations			
BC ambient air quality objectives and NAAQS	Increase in $PM_{2.5}$ – 24-hour	not significant	Proposed Project effects will not exceed ambient air quality criteria at residences and effects are fully reversible.
	Increase in $PM_{2.5}$ – Annual	not significant	
	Increase in PM_{10} – 24-hour	not significant	
	Increase in TSP – 24-hour	not significant	
	Increase in TSP – Annual	not significant	
	Increase in NO_2- 1-hour, tug boats	Negligible-not significant	Proposed Project effects will be negligible within the LSA. As well annual emission rates will result in a less than 5% increase in emission along shipping routes in the Lower Fraser Valley: therefore, it is expected to have not significant impact.
	Increase in NO_2- Annual, tug boats	Negligible-not significant	
	Increase in SO_2- 1-hour, tug boats	Negligible-not significant	
Reclamation and Closure			
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects.		

5.7.5.6 Level of Confidence

The level of confidence of predicted residual effects is provided in Table 5.7-15. The prediction confidence of the assessment on each VC is based on scientific information and statistical analysis, professional judgement and effectiveness of mitigation (rated as high, moderate, and low).

Conservatism was built into the various aspects of the air quality assessment. Conservatism in the air assessment approach includes:

- The emission calculations represent maximum daily activity levels. The maximum daily emission rate was then applied to every hour of the day irrespective if the source was operational for only a portion of the day. For example screening, which will be operating for six to nine hours a day, were assumed to be emitting continuously during the assessment. Similarly, land clearing, which only will be operational for the maximum of 30 days over the entire year, were also modeled as continuous sources. The exception to this is bulldozing (used for land clearing) where bulldozing activities were assumed to only occur 80% of the time that the bulldozer was operational; however, the bulldozer activities were still distributed over the entire day; and

- The effect of precipitation in reducing fugitive emissions from unpaved roads and wind erosion from stockpiles was not considered.

Based on the conservatism of the emission inventory, the emission modelling and the addition of the 98th percentile value used to establish background concentrations it is unlikely that Proposed Project emissions and Proposed Project effects were underestimated. Therefore the level of confidence is considered high.

Table 5.7-15: Level of Confidence in Potential Residual Effect Predictions: Air Quality

Residual Effect	Level of Confidence (LOC) in Residual Effect Prediction	LOC Rationale
Construction		
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects.	
Operations		
Increase in $PM_{2.5}$ – 24-hour	High	Conservatism built into emission rate estimation (refer to Volume 4, Part G – Section 22.0: Appendix 5.6-A Emission Estimation) and modelling methods consistent with standard modelling methods per BC MoE (2008). The conservatism and the combination of Proposed Project effects and background concentrations (based in the 98th percentile) lends certainty to residual effect predictions.
Increase in $PM_{2.5}$ – Annual	High	
Increase in PM_{10} – 24-hour	High	
Increase in TSP – 24-hour	High	
Increase in TSP – Annual	High	
Increase in NO_2- 1-hour, tug boats	High	Quantification of tug boat emission rates based on 2005 - *2006 BC Ocean-Going Vessel Emissions Inventory* (The Chamber of Shipping 2007). Proposed Project effects and background concentrations (based in the 98th percentile) lends certainty to residual effect predictions.
Increase in NO_2- Annual, tug boats	High	
Increase in SO_2- 1-hour, tug boats	High	
Reclamation and Closure		
BC ambient air quality objectives and NAAQS	Effects will be bounded by operational effects.	

5.7.5.7 Cumulative Effects Assessment

The residual effects of the Project in combination with the effects of other projects and activities that have been carried out (past and present projects) are described in Section 5.7.5.4. The combination of these residual project effects with the effects of all other certain and reasonably foreseeable projects comprise the total future cumulative effects.

The potential cumulative effects for air quality were evaluated by using the following approach:

- Identify the existing air quality conditions for the indicator compounds in the vicinity of the Proposed Project. This will include contributions from existing emission sources.
- Estimate the air emissions from the Proposed Project for the phase of activity (i.e., construction, operations, and closure and reclamation) assessed to have the highest (i.e., bounding) quantity of air emissions.
- Predict the concentrations of indicator compounds released from the bounding phase of the Proposed Project dispersion modelling.
- Compare the predicted indicator compound concentrations plus background concentrations to available criteria and standards, and assess the relevant significance of these effects. The results of these first four bullets are summarized in Section 5.7.5.5. Residual effects that were determined to be not significant and significant were carried forward to the subsequent stages of cumulative effects assessment described in the following bullets.
- Identify certain and reasonably foreseeable projects that may interact with Project-related effects. For each certain and reasonably foreseeable project, identify which compounds would most-likely interact with compounds emitted from the Project.
- At certain and reasonably foreseeable project locations, establish project effects, as a percentage of background concentrations.
- Evaluate the magnitude and significance of the cumulative effects using the data from the previous two bullets.

5.7.5.7.1 Residual Effects Included in Cumulative Effects Assessment

All proposed Project-related residual effects identified in Section 5.7.5.5 were included in the cumulative effects assessment, with the exception of residual effects that were found to be negligible. Negligible residual effects were not carried through to the cumulative effects assessment as they are not considered measureable or are within a natural variability of the system are therefore unlikely to interact cumulatively with other certain and reasonably foreseeable projects. Residual effects that were included in the cumulative effects assessment are summarized in Table 5.7-16.

Table 5.7-16: Residual Effects Included in Cumulative Effects Assessment

Residual Effect	Included in Cumulative Effects Assessment	Rationale
Increase in $PM_{2.5}$ – 24-hour	Yes	Residual effects were assigned a significance level of not significant; therefore, residual effects will be considered as part of the cumulative effects assessment.
Increase in $PM_{2.5}$ – Annual	Yes	
Increase in PM_{10} – 24-hour	Yes	
Increase in TSP – 24-hour	Yes	
Increase in TSP – Annual	Yes	

5.7.5.7.2 Spatial and Temporal Boundaries

The spatial boundary of the cumulative effects assessment for Air Quality is defined as the LSA (Figure 4-5) since Project effects cannot be distinguished from background concentrations at the outer boundary of the LSA.

The temporal boundary is limited to the operational phase of the Proposed Project, the phase in which Project-related effects are likely to result in the highest overall change in air quality.

5.7.5.7.3 Effects of Other Projects and Activities

A list of certain and reasonably foreseeable projects and activities with potential effects that could interact temporally and/or spatially with Proposed Project-related residual effects are provided in Table 4-5 in Volume 2, Part B - Section 4.0. Of those, the certain and reasonably foreseeable Projects were determined to have the potential to have a potential incremental effect on air quality if:

- The certain and reasonably foreseeable Project is located within or along long the edge (within 15 km of the Proposed Project, since a number of certain and foreseeable projects are located just outside of the LSA) of the spatial boundaries of the cumulative effects assessment as described in Section 5.7.5.7.2; and
- The certain and reasonably foreseeable project is expected to be a source of the air quality indicators considered in the cumulative effects assessment, namely TSP, PM_{10}, and $PM_{2.5}$.

The certain and reasonably foreseeable projects that have a potential incremental effect on air quality are summarized in Table 5.7-17.

Table 5.7-17: Potential Incremental Effects of Other Projects and Activities on Air Quality

Project	Timeline	Phase of the project overlaps with the Proposed Project[1]	Project Description	Rationale
Reasonably Foreseeable Future Projects				
Box Canyon Hydro (Box Canyon Hydro Corp. (Sound Energy Inc.))	Proposed start in 2017.	Construction and Operations	▪ Temporary Use Permit issued in February of 2014 to construct concrete batch plant relating to the construction project. ▪ Planned future run-of-river hydroelectric project with a capacity of 15 MW and proposed start of 2017. ▪ Total project footprint will be 64.5 ha ▪ Electricity Purchase Agreement obtained from BC Hydro 2010 Clean Power Call ▪ Multiple water intakes in three McNab drainages: Box Canyon, Marty, and Cascara creeks are planned with total penstock length of 7,847 m. ▪ All intake water delivered to a powerhouse located on the Banks of McNab Creek ~1250 m upstream in existing cut block. ▪ A 2.8 km 138 kV timber pole overhead line will connect powerhouse to BC Hydro 1L31 138 kV transmission line along the McNab Ck FSR. ▪ Habitat compensation is planned for Box Canyon Creek (possibly Marty and Cascara) in the form of rearing habitat for juvenile Coho salmon and cutthroat trout ▪ Website: http://www.elementalenergy.ca/projects/	Construction phase is anticipated to result in emissions of TSP, PM_{10}, and $PM_{2.5}$. The operations phase is not expected to be a significant source of TSP, PM_{10}, and $PM_{2.5}$ emissions.

[1] When timelines are uncertain it was assumed that the Proposed Project would overlap with both construction and operations.

Project	Timeline	Phase of the project overlaps with the Proposed Project[1]	Project Description	Rationale
Woodfibre LNG (Woodfibre Natural Gas Ltd.)	Operations in the second quarter of 2017 Assumes permit issuance in 2015/early 2016	Operations	▪ Development of the former Western Forest Products Woodfibre Mill; an LNG facility has been proposed. ▪ Three to four times per month an LNG carrier will travel through well-established shipping lanes to the Woodfibre LNG terminal. Each carrier will travel at 8 to 10 knots in Howe Sound, be accompanied by at least three tugboats, at least one of which will be tethered to the carrier, and have two BC Coast Pilots on board, who are experts on BC's coast. ▪ Website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_408.html	Construction and operation phase are anticipated to result in emissions of TSP, PM_{10}, and $PM_{2.5}$
Porteau Cove Residential Development (Concord Pacific)	Unknown.	Assumed Construction and Operations.	▪ Under a partnership between Squamish Nation and Concord Pacific, this residential development proposes 1,400 homes, lots, and commercial space, located on the east side of Howe Sound, 12.3km south of the project. ▪ This work includes 6 water reservoirs, water source development/treatment, sewage treatment plant, ocean discharge, stormwater systems and Best Management Practices. ▪ The development includes 18km of roads including a new highway interchange. ▪ Website: http://www.pwlpartnership.com/our-portfolio/planning-urban-design/porteau-cove	Construction activities are anticipated to result in emissions of TSP, PM_{10}, and $PM_{2.5}$. The operations phase is not expected to be a significant source of TSP, PM_{10}, and $PM_{2.5}$ emissions.

5.7.5.7.4 Potential Interactions with Other Projects

The certain and reasonably foreseeable projects that have potential to interact with residual Project effects, and therefore were included in the cumulative effects assessment, are summarized in Table 5.7-18

Table 5.7-18: Other Projects or Activities and Potential Adverse Cumulative Interactions and Effects for Air Quality

Other Project / Activity	Potential Incremental Effect	Potential for Interaction Resulting in Cumulative Effect	Rationale for Potential Cumulative Effect
Increase in $PM_{2.5}$ (24-hour, Annual), PM_{10} (24-hour), and TSP (24-hour, Annual) Concentrations			
Box Canyon Hydro	Potential additive offsite indicator compound concentrations	Y	Offsite effects (indicator compound concentrations) from other projects or activities may have an additive effect as a result of the Project
Woodfibre LNG			
Porteau Cove Residential Development			

No interaction or not likely to interact cumulatively (N), Yes, Potential cumulative effect (Y),

5.7.5.7.5 Change in Levels of $PM_{2.5}$, PM_{10}, and TSP Off-Site

For the construction phases of Box Canyon Hydro, Porteau Cove Residential Development and Woodfibre LNG, fugitive particulate emissions are expected to be the primary concern. Fugitive particulate emission sources are generally intermittent, low-lying, and particles will deposit near to the source; therefore, particulate effects associated with the construction phases of the certain and reasonably foreseeable projects are expected to be localized to their project locations.

During the operational phase, Woodfibre LNG will emit particulate matter from stacks and flares with buoyancy, and therefore will be dispersed over a wider area than construction related particulate emissions.

The change in levels of $PM_{2.5}$, PM_{10} and TSP off site associated with the Proposed Project are summarized in Table 5.7-10.

5.7.5.7.6 Mitigation

Mitigation measures that will assist in minimizing interactions between Project effects and similar environmental effects from other reasonably foreseeable project activities are the same as those described in Table 5.7-11. Mitigation controls, including wet processes, watering and partial enclosures have been accounted for in the emission inventory and subsequent air dispersion modelling for Project-related effects; no additional mitigation is proposed.

5.7.5.7.7 Residual Cumulative Effects and their Significance

Residual cumulative effects and their significance were characterized using the same criteria that were used to characterize Proposed Project residual effects, summarized in Table 5.7-21.

The construction phase of Box Canyon, Porteau Cove Residential Development and Woodfibre LNG were identified to potentially interact with residual Proposed Project effects. However, fugitive particulate matter emissions from construction activities will be intermittent, short in duration and localized. The Proposed Project fugitive particulate matter emissions are similarly localized. To demonstrate the localized nature of Proposed Project residual effects Table 5.7-19 shows the contribution of Proposed Project particulate matter effects as a percent of background concentrations at the certain and reasonably foreseeable project locations. Particulate matter Proposed Project effects are at most 2.3% above background concentrations at certain and reasonably foreseeable project locations. Due to localized nature of fugitive particulate matter construction emissions associated with both the Proposed Project and the certain and foreseeable projects; it is expected that the construction phase of certain and foreseeable projects would negligibly interact with residual Proposed Project effects (i.e. Proposed Project maximum offsite predictions and predictions at sensitive receptors are expected to negligibly increase as result of certain and reasonably foreseeable project interactions).

Table 5.7-19: Project Effects as a Percentage above Background Concentration at Certain and Reasonably Foreseeable Project Locations

Parameter	Averaging Period	Background Concentration ($\mu g/m^3$)	Box Canyon Hydro	Porteau Cove Residential Development	Woodfibre LNG
PM2.5	24 Hour	14.3	0.8%	0.2%	0.2%
	Annual	6.2	0.2%	0.1%	0.0%
PM10	24 Hour	26.2	1.5%	0.5%	0.4%
TSP	24 Hour	54.8	2.3%	0.6%	0.5%
	Annual	20.7	0.6%	0.1%	0.1%

During the operational phase of Woodfibre LNG particulates will be emitted from stacks with buoyancy; therefore, there is a greater likelihood for interaction between Woodfibre LNG and the Proposed Project residual effects. However, Woodfibre LNG, located approximately 15 km north east of the Proposed Project, will be powered by electricity (Woodfibre LNG Limited 2015). Natural gas and natural gas products and bi-products may be flared (emergency operations), combusted on site in generators (emergency operations), oil heater (normal operations), and flare pilots (normal operations). Particulate matter is generally not a concern from natural gas combustion; therefore, the magnitude of the interaction is expected to be small. This is further confirmed by data provided within the Woodfibre air quality assessment undertaken to support the EA application (Woodfibre LNG 2015). Table 5.7-20 summarizes the incremental increase in particulate concentrations at the Proposed Project location as a result of the Woodfibre LNG Project. The incremental increase is shown as a percent of background concentration.

Table 5.7-20: Incremental Increase in Particulate Concentrations at Proposed Project Location as a Result of the Woodfibre LNG Project

Parameter	Averaging Period	Background Concentration (µg/m^3)	Increase in Background Concentration at the Proposed Project location due to Woodfibre LNG
PM2.5	24 Hour	14.3	0.2%
	Annual	6.2	<0.01%
PM10	24 Hour	26.2	0.1%
TSP	24 Hour	54.8	<0.01%
	Annual	20.7	<0.01%

Note: Particulate concentration data taken from Woodfibre LNG Limited 2015

It is observed that Woodfibre LNG effects would account for at most a 0.2% change in background concentrations at the Proposed Project Location Table 5.7-20).

The magnitude of cumulative effects were assigned as negligible since construction emissions from Box Canyon, Porteau Cove Residential Development and Woodfibre LNG are expected to negligibly interact with residual Proposed Project effects, and based on data presented in Table 5.7-20 above, emissions during the operational phase of Woodfibre LNG are also expected to negligibly interact with Proposed Project residual effects.

The duration of the cumulative effects will be assigned a duration of “medium-term” since construction phases of the certain and reasonably foreseeable projects and the Proposed Project’s operational phases may overlap. The cumulative effect will be fully reversible since after the closure of the Project air quality will return to pre-operation conditions. As well, the frequency was selected as medium because the metrological conditions may occur at any time over the year that would result in the maximum predictions.

A significant cumulative effect would be deemed to be when the magnitude of the effect is high and the cumulative effect that is irreversible. The cumulative effects are expected to have a magnitude of negligible and be fully reversible; therefore the cumulative residual effect was assigned as negligible.

The residual cumulative effect’s likelihood was assigned low since it will be unlikely that project effects from Box Canyon Hydro, Porteau Cove Residential Development and Woodfibre LNG will cumulatively interact with Project effects. Due to the uncertainty in the levels of particulates emitted from the other projects and activities, the level of confidence in the determination of the cumulative residual effects were considered moderate.

Table 5.7-21: Summary of Residual Cumulative Effects Characterization for Air Quality

Proposed Project-Related Effect	Residual Cumulative Effect Assessment Criteria								
	Context	Magnitude	Extent	Duration	Reversibility	Frequency	Significance	Likelihood	Level of Confidence
Construction									
Effects, will be bounded by operational effects, therefore assessment is conservatively assumed to be same as the operations phase.									
Operations									
Increase in $PM_{2.5}$ – 24-hour	Somewhat Disturbed	N	L	ST	FR	M	N	Low	M
Increase in $PM_{2.5}$ – Annual	Somewhat Disturbed	N	L	ST	FR	M	N	Low	M
Increase in PM_{10} – 24-hour	Somewhat Disturbed	N	L	ST	FR	M	N	Low	M
Increase in TSP – 24-hour	Somewhat Disturbed	N	L	ST	FR	M	N	Low	M
Increase in TSP – Annual	Somewhat Disturbed	N	L	ST	FR	M	N	Low	M
Reclamation and Closure									
Effects, will be bounded by operational effects, therefore assessment is conservatively assumed to be same as the operations phase.									

Assessment Criteria:
Context- Disturbed, Somewhat Disturbed, Undisturbed
Magnitude: N – Negligible, L – Low, M – Medium, H – High;
Geographic Extent: L – Local, BL – Beyond Local;
Duration: ST – Short-tern, MT – Medium-term, LT – Long-term;
Reversibility: FR - Fully Reversible, Partially Reversible; IR - Irreversible;
Frequency: L – Low, M – Medium, H – High
Significance: N – Negligible- Not Significance, NS – Not Significant, S - Significant
Likelihood: Low, Medium, High
Level of Confidence: L- Low, M- Moderate, H- High.

5.7.6 Conclusions

The air quality assessment predicts that emission rates from the Proposed Project (when coupled with a background particulate concentration) would exceed ambient air quality objectives for particulate matter near the facility's fence-line. However, model predicted concentrations, coupled with background concentrations, at the nearest receptor where people live (less than 0.37 km from the facility's fence-line) show that particulate matter (TSP, PM_{10}, and $PM_{2.5}$) predicted concentrations do not exceed ambient air quality standards. These residual effects were not considered significant.

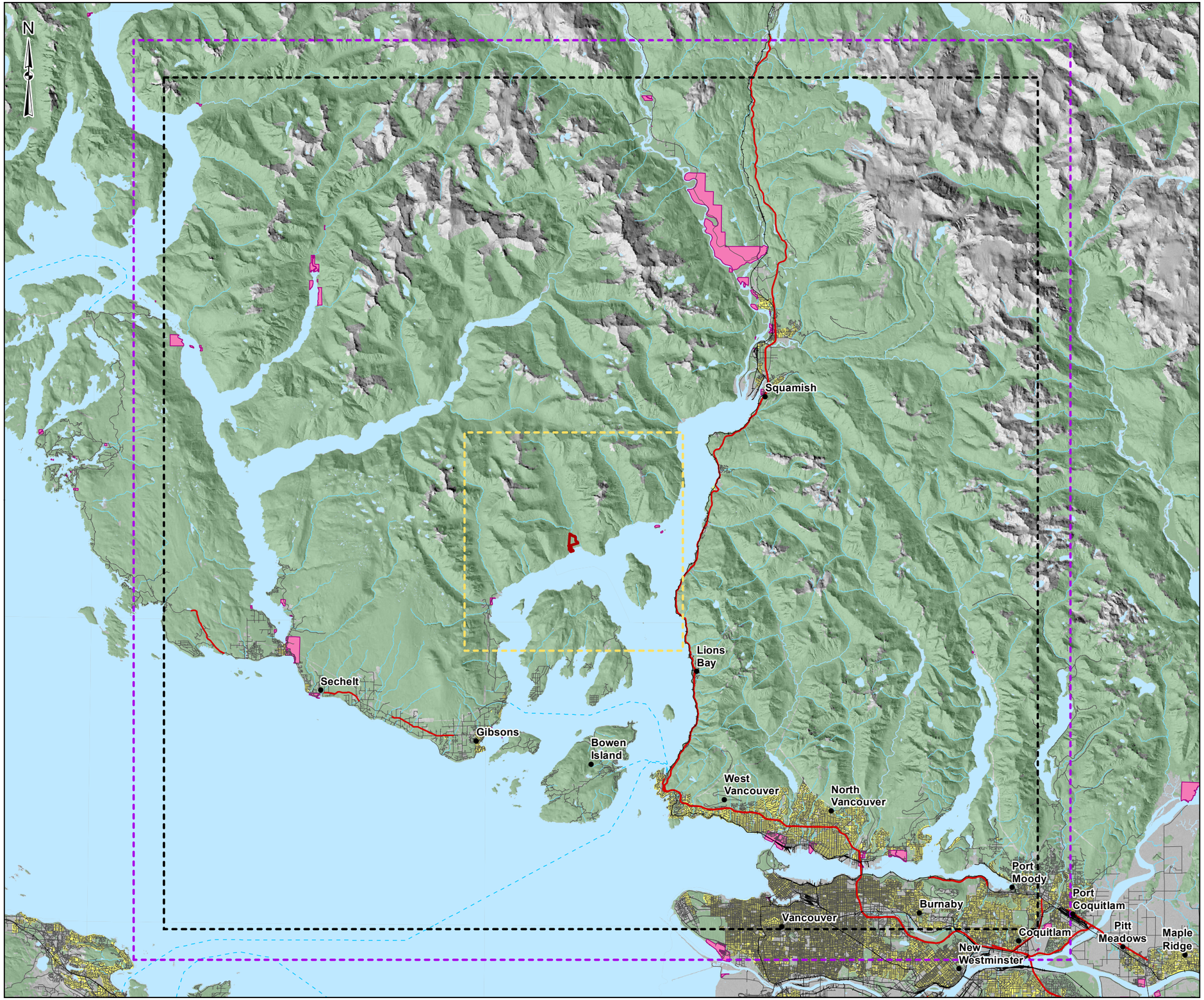
Predictions for NO_2 and SO_2, at sensitive receptors when coupled with background concentrations are negligible (less than 25% of the respective air quality objectives). As well, the result of an additional 1 tugboat trip per operational day (300 days per calendar year) on existing barging routes would result in an increase in SO_2 and NO_2 emission rates by less than 5% in the Lower Fraser Valley. Due to the negligible modelling results and due

to fact that the increase in marine traffic results in minimal increases to annual NO_2 and SO_2 emissions the effects were deemed negligible.

Particulate cumulative effects are expected to have a magnitude of negligible and be fully reversible; therefore the cumulative residual effect was deemed negligible.

Proposed mitigation practices such as enclosing material drop areas and mist sprays have been incorporated into the emission inventory and the air quality model. An Air Quality and Dust Control Management Plan will be established that will detail control measures, such as watering and speed controls that must be in place to limit fugitive particulates.

Conservatism has been built in to the air quality assessment. This includes the use of conservative assumptions in the emission inventory and modelling the maximum daily emission rates for every day of the year (regardless if they are being emitted every day of the year). Background concentrations were also established using the 98^{th} percentile value from observational data and were coupled with model predicted effects. Based on the conservatism in the assessment approach and the coupling of background and model predicted effects it is unlikely that Proposed Project air effects have been underestimated.



LEGEND

- Project Area
- Local Study Area CALPUFF
- Regional Study Area CALPUFF
- MM5 Extent
- Vegetation
- Residential Area
- Indian Reserve
- Highway
- Road
- Railway
- Ferry

REFERENCE

Elevation and indian reserves from Geobase. Base data from CanVec and the Province of British Columbia. DEM from British Columbia Imagery WMS.
Projection: UTM Zone 10 Datum: NAD 83

SCALE

10 0 10

SCALE 1:350,000 KILOMETRES

PROJECT

BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE

AIR QUALITY LOCAL AND REGIONAL STUDY AREA EXTENTS

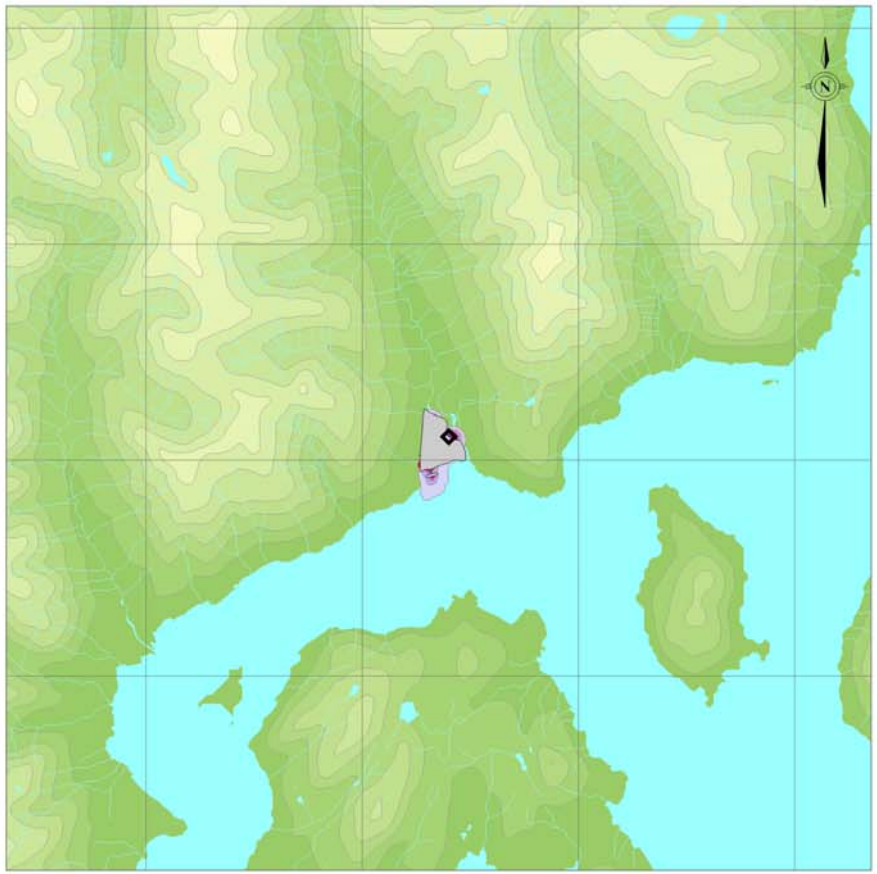
Golder Associates

PROJECT NO. 11-1422-0046			PHASE No. 4700	
DESIGN	TB	25 Nov. 2014	SCALE AS SHOWN	REV. 1
GIS	DL	08 Mar. 2016		
CHECK	JR	03 Mar. 2015		
REVIEW	SC	03 Mar. 2015		

FIGURE 5.7-1

Path: X:\Project Data\BC\McNab\Figures\MXD\Air Quality\BURNCO_AIR_Figure_5_7_1_Air_Quality_Study_Areas.mxd

Modelling Area

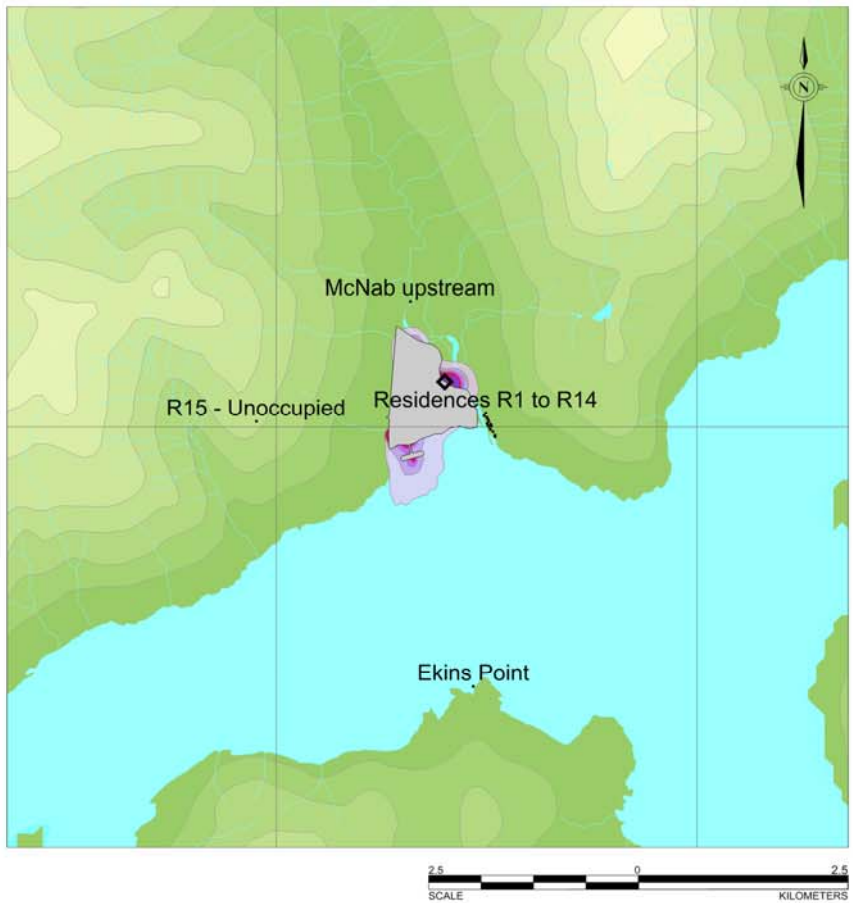


25.0
22.5
20.0
17.5
BLANK
14.3

Concentrations in µg/m³

Background $PM_{2.5}$ Concentration Taken as 14.3 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

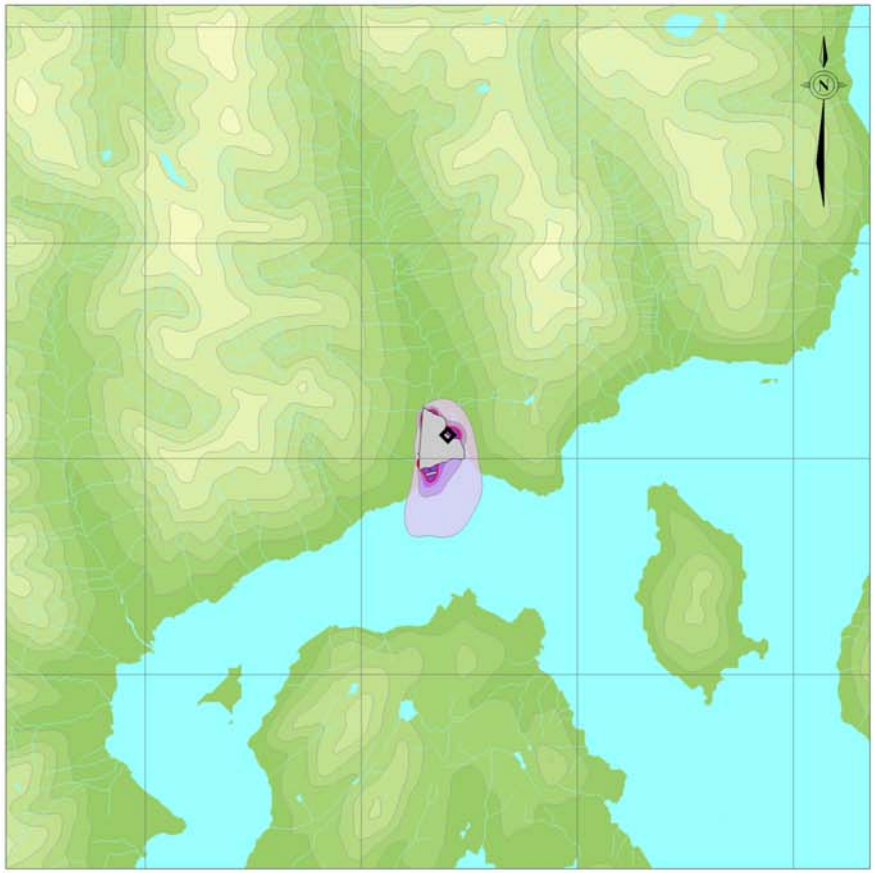
TITLE
24-HOUR FINE PARTICULATE MATTER ($PM_{2.5}$) PREDICTIONS

Golder Associates

PROJECT NO.	11-1422-0046	PHASE No.	4700	
DESIGN	TB	02 Aug. 13	SCALE AS SHOWN	REV. 0
AIR	TB	11 Dec. 14		
CHECK	JR	12 Dec. 14		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-2

Modelling Area

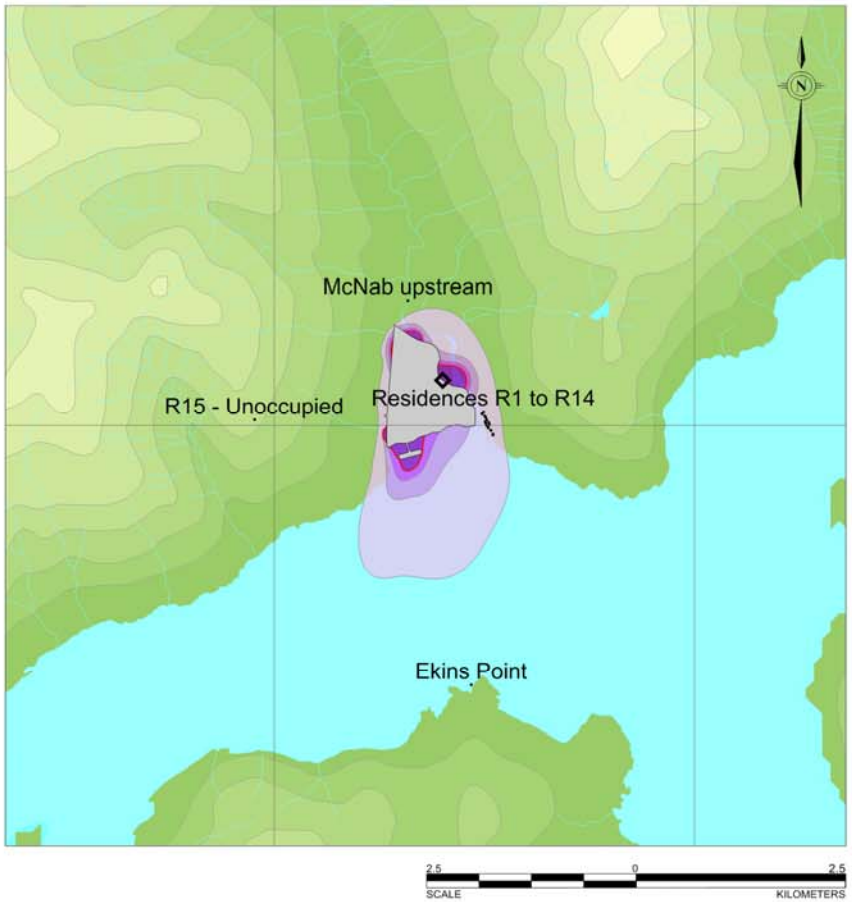


8.0
7.5
7.0
6.5
BLANK
6.2

Concentrations in µg/m³

Background $PM_{2.5}$ Concentration Taken as 6.2 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

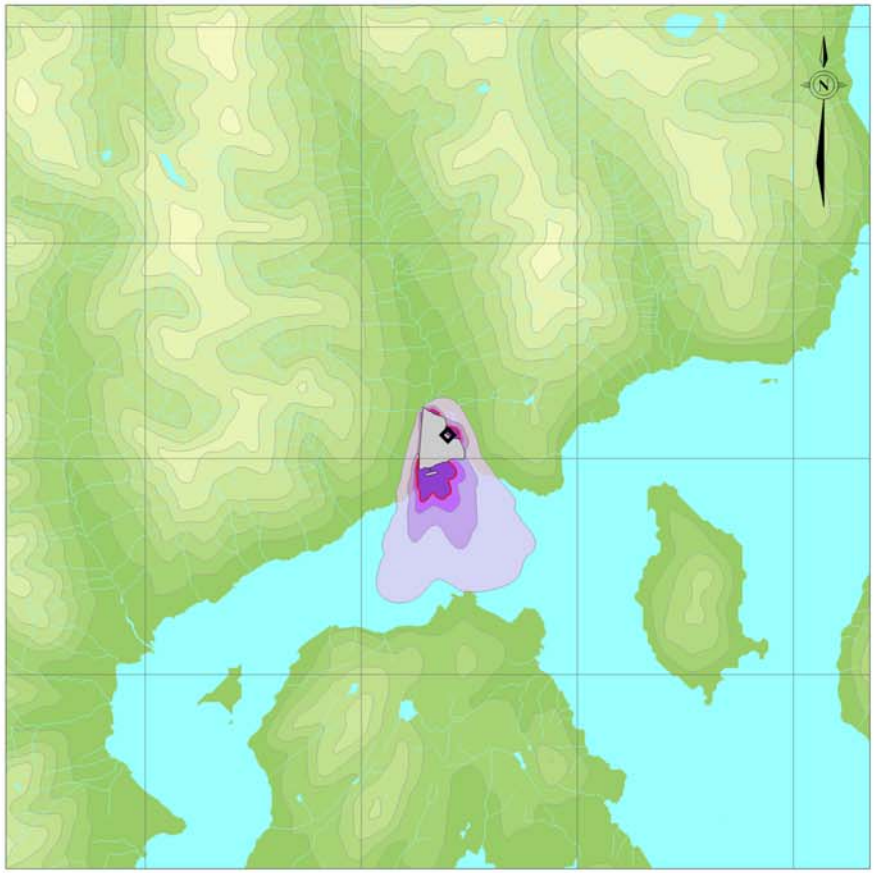
TITLE
ANNUAL FINE PARTICULATE MATTER ($PM_{2.5}$) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.4700	
DESIGN	TB	02 Aug. 13	SCALE AS SHOWN	REV. 0
AIR	TB	22 Dec. 14		
CHECK	JR	12 Dec. 13		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-3

Modelling Area

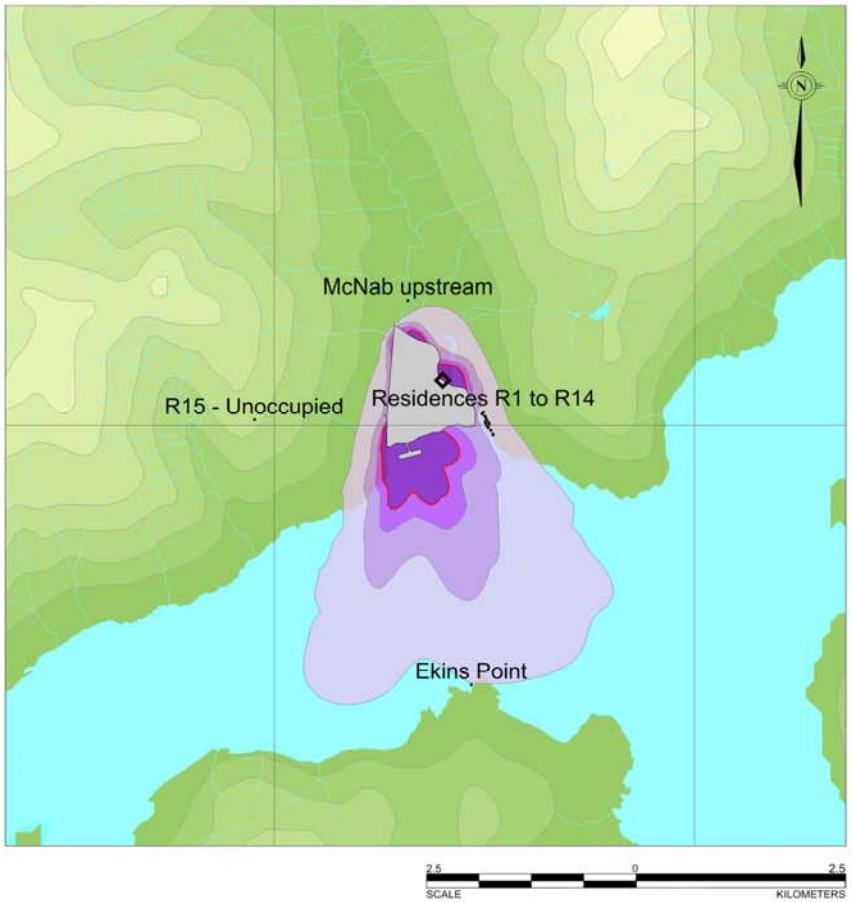


50.0
44.0
38.0
32.0
BLANK
26.2

Concentrations in µg/m³

Background PM_{10} Concentration Taken as 26.2 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

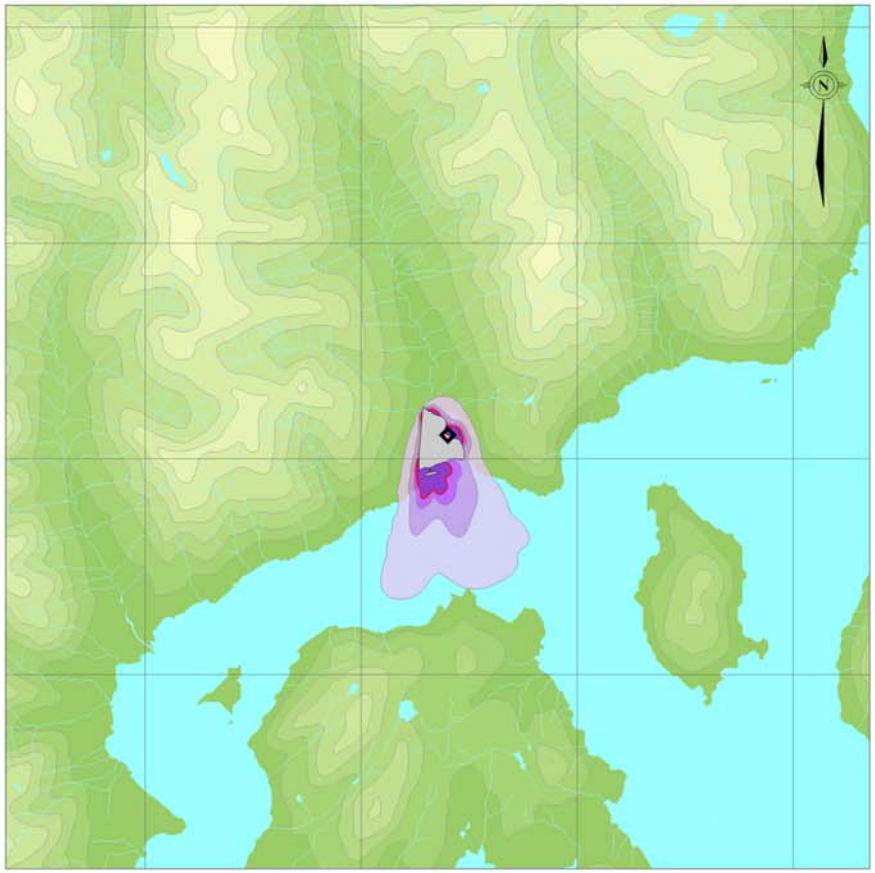
TITLE
24-HOUR COARSE PARTICULATE MATTER (PM_{10}) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No. 4700	
DESIGN	TB	02 Aug. 12	SCALE AS SHOWN	REV. 0
AIR	TB	11 Dec. 14		
CHECK	JR	12 Dec. 14		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-4

Modelling Area

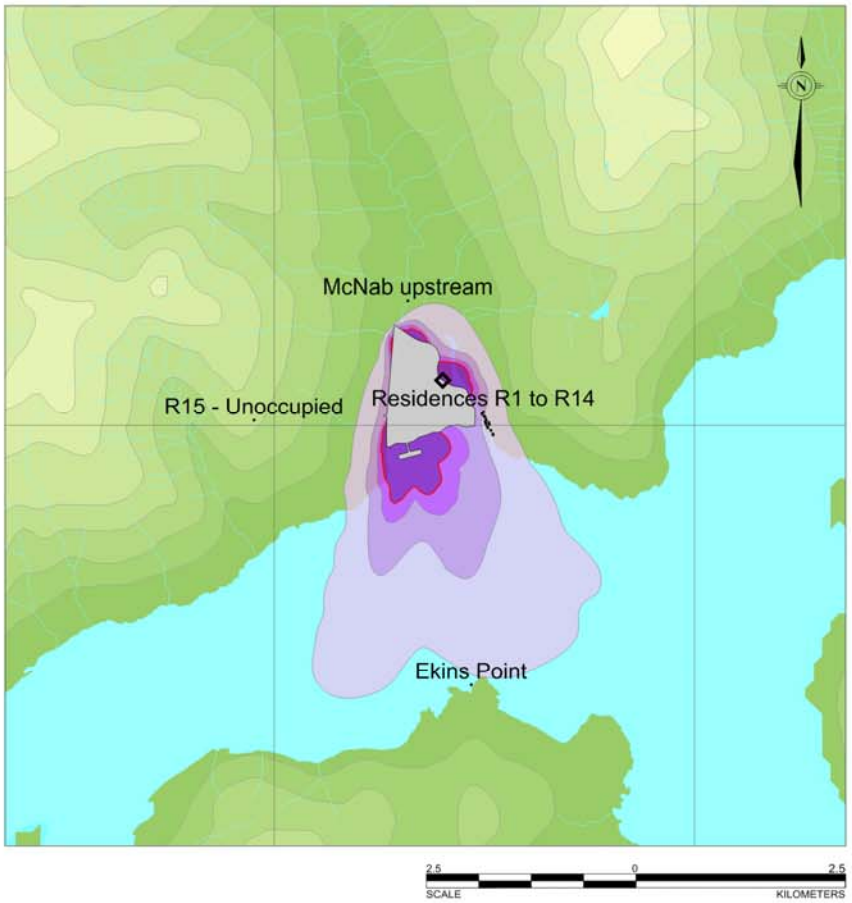


120.0
103.8
87.5
71.3
BLANK
54.8

Concentrations in µg/m³

Background TSP Concentration Taken as 54.8 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

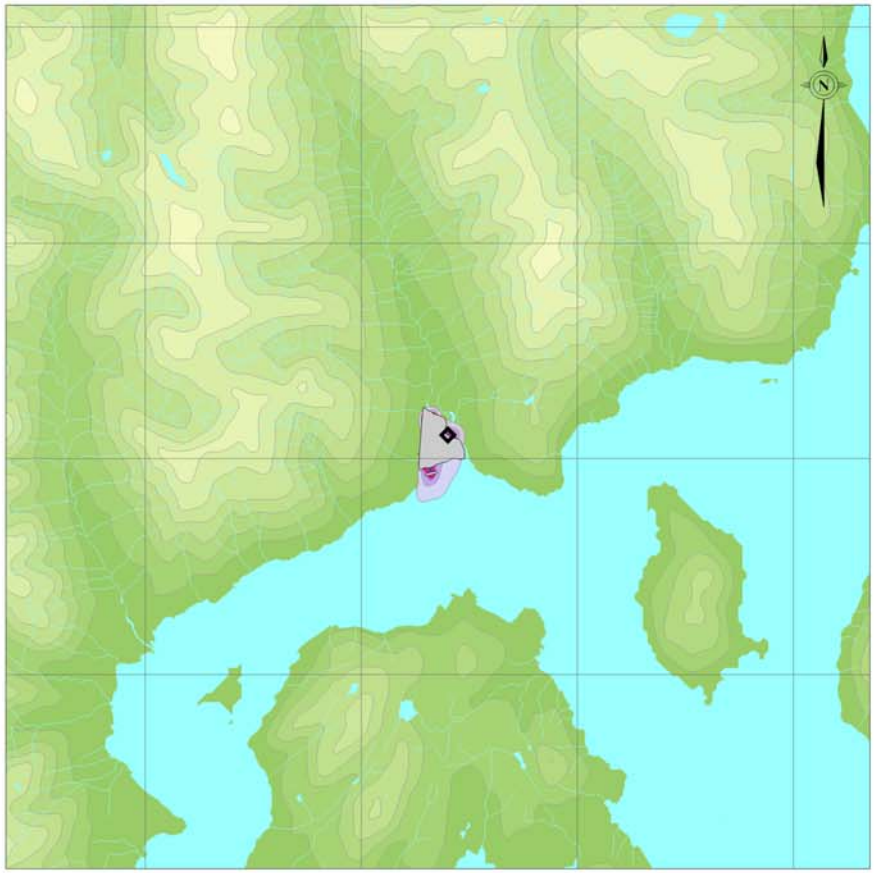
TITLE
24-HOUR TOTAL SUSPENDED PARTICULATE (TSP) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.4700	
DESIGN	TB	02 Aug. 13	SCALE AS SHOWN	REV. 0
AIR	TB	22 Apr. 14		
CHECK	JR	12 Dec. 14		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-5

Modelling Area

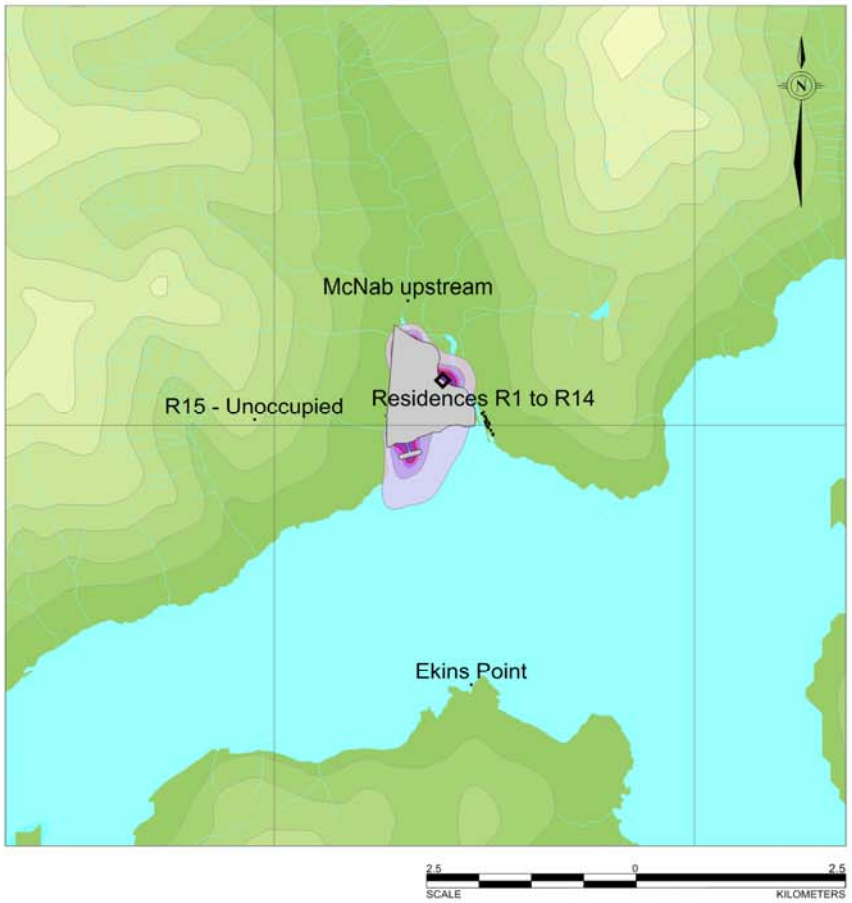


60.0
50.0
40.0
30.0
BLANK
20.7

Concentrations in µg/m³

Background TSP Concentration Taken as 20.7 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

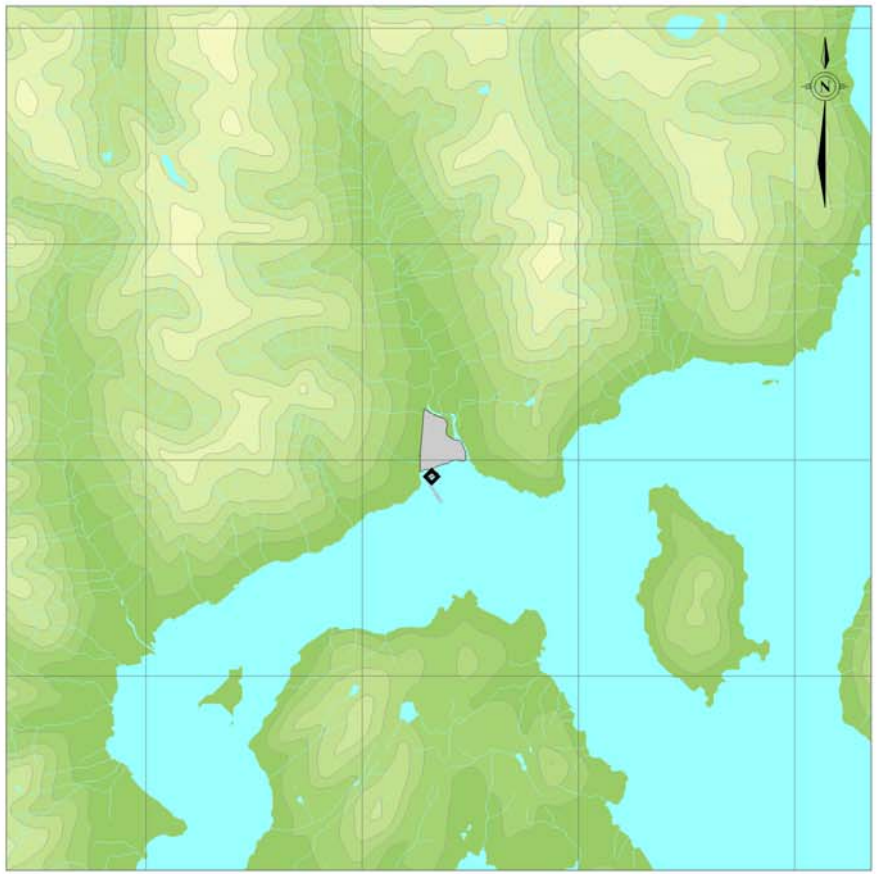
TITLE
ANNUAL TOTAL SUSPENDED PARTICULATE (TSP) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.4700	
DESIGN	TB	02 Aug. 12	SCALE AS SHOWN	REV. 0
AIR	TB	22 Apr. 14		
CHECK	JR	12 Dec. 14		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-6

Modelling Area



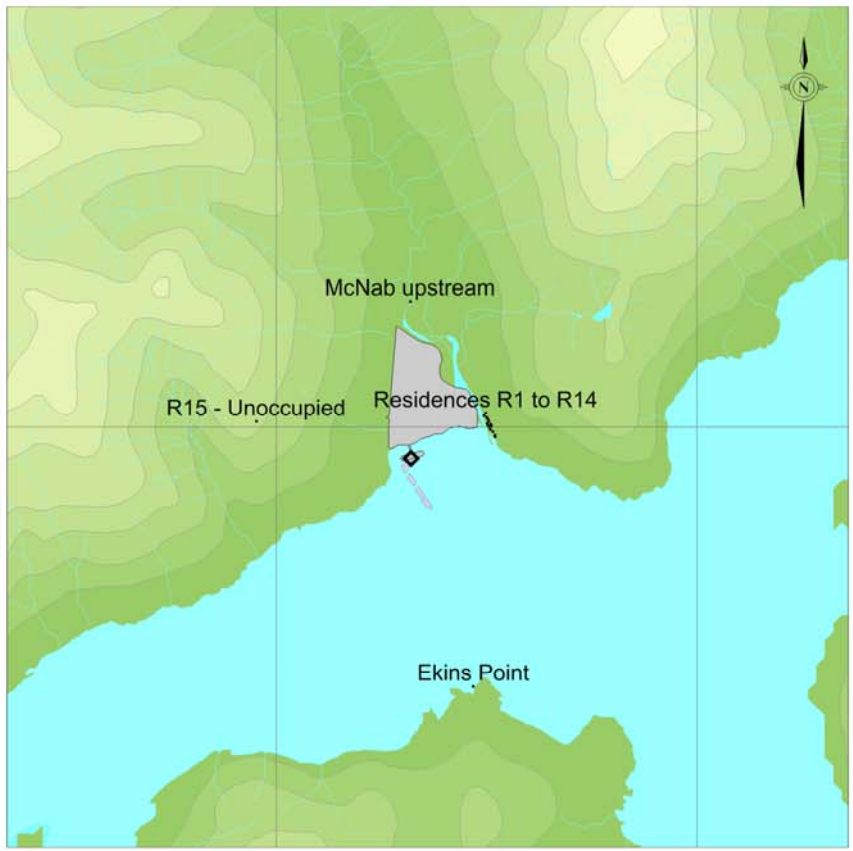
5 0 5
SCALE KILOMETERS

188.0
99.0
55.0
45.0
BLANK
41.4

Concentrations in µg/m³

Background NO_2 Concentration Taken as 41.4 µg/m³

Map Insert



2.5 0 2.5
SCALE KILOMETERS

LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

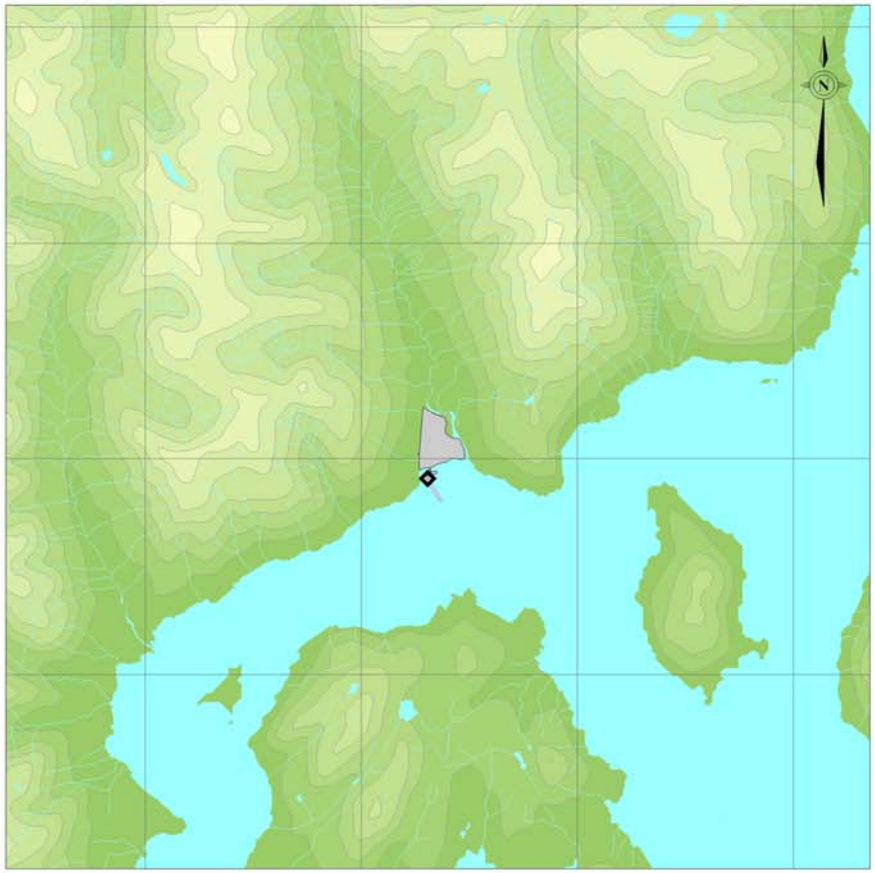
TITLE
1-HOUR NITROGEN DIOXIDE (NO_2) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.4700	
DESIGN	TB	02 Aug. 13	SCALE AS SHOWN	REV. 0
AIR	TB	12 Jan. 15		
CHECK	JR	23 Feb. 15		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-7

Modelling Area

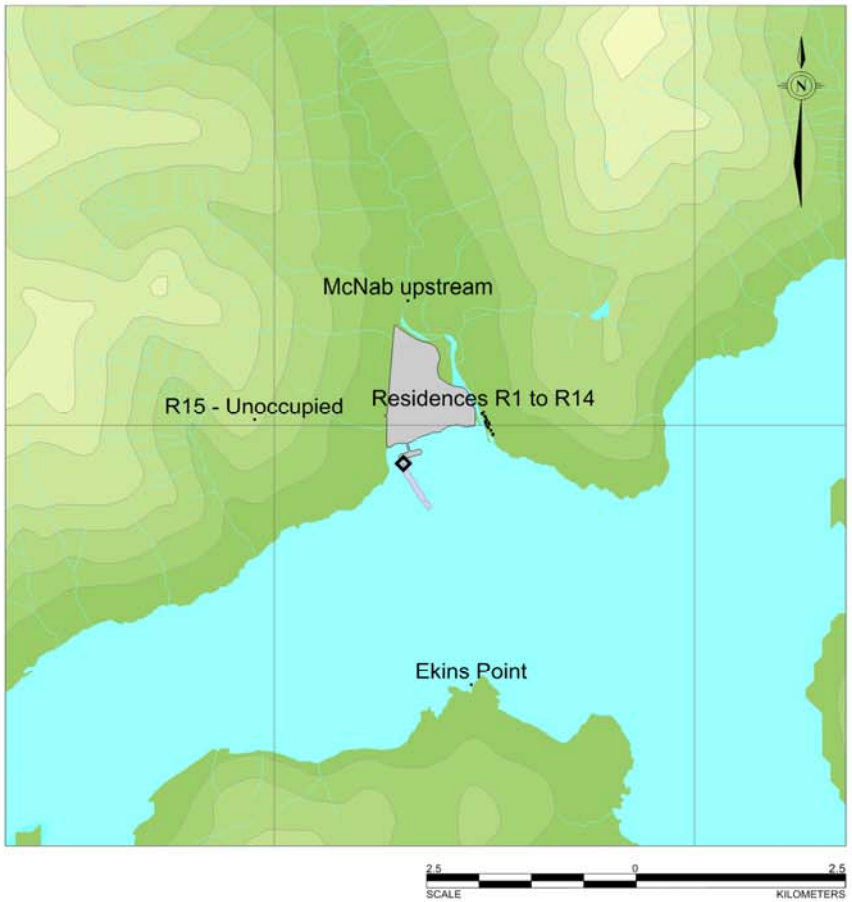


60.0
30.0
12.0
10.0
BLANK
9.6

Concentrations in µg/m³

Background NO_2 Concentration Taken as 9.6 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

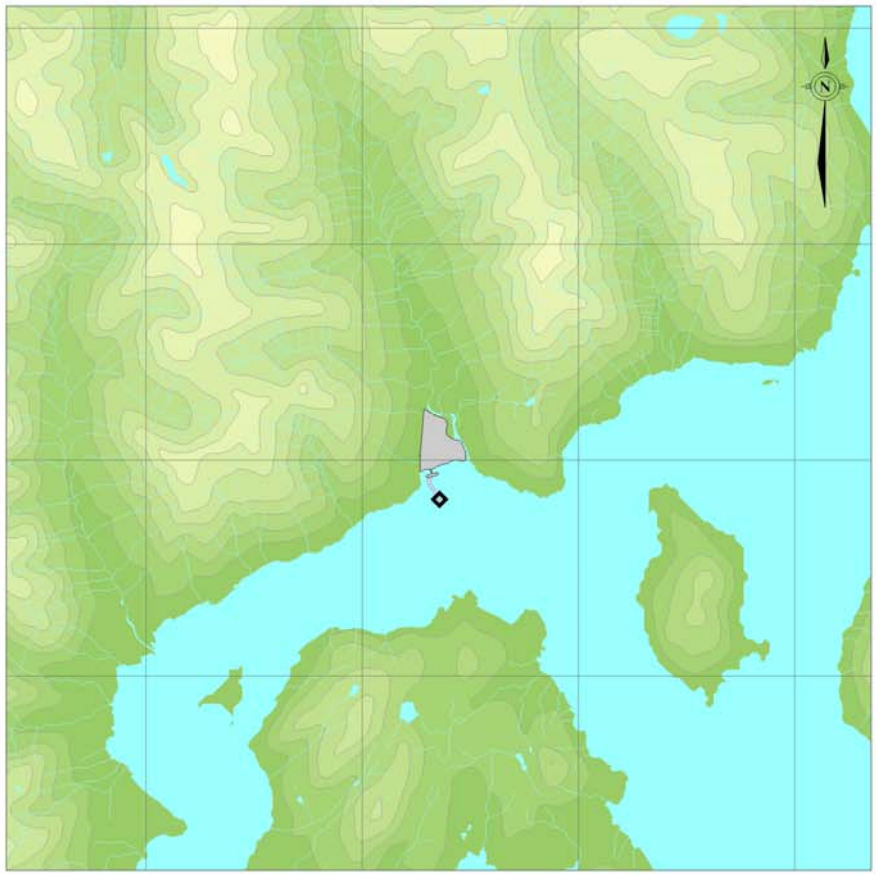
TITLE
ANNUAL NITROGEN DIOXIDE (NO_2) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No. 4700	
DESIGN	TB	02 Aug. 12	SCALE AS SHOWN	REV. 0
AIR	TB	12 Jan. 15		
CHECK	JR	23 Feb. 15		
REVIEW	SC	27 Feb. 15		

FIGURE: 5.7-8

Modelling Area

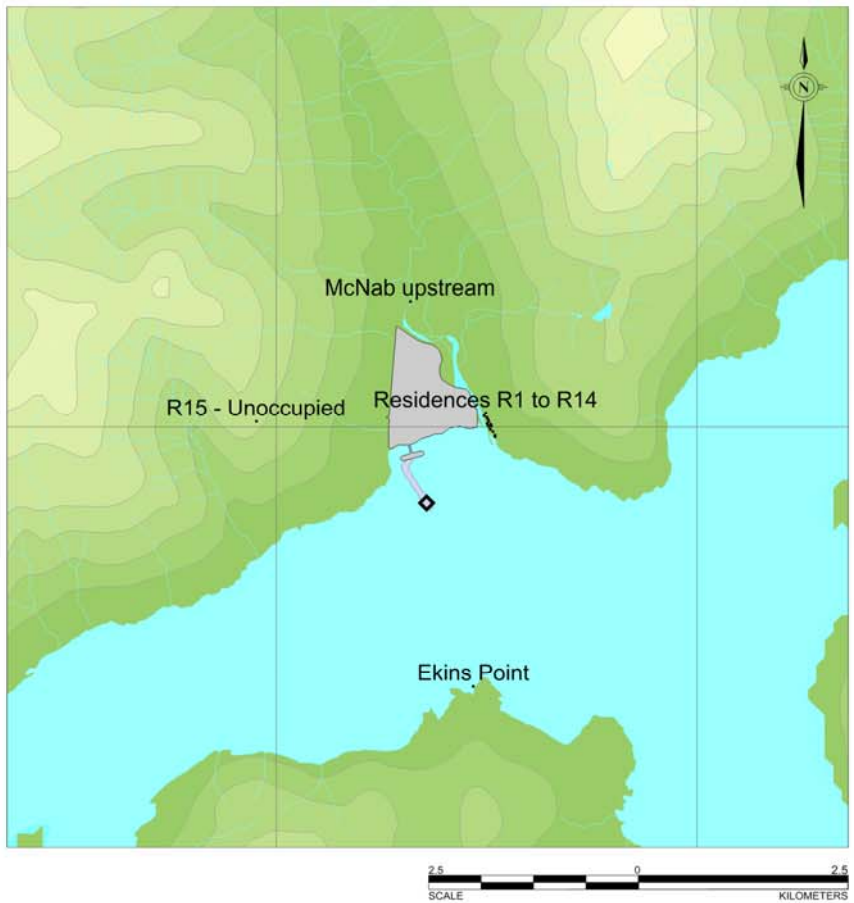


200.000
100.000
34.350
34.301
BLANK
34.300

Concentrations in µg/m³

Background SO_2 Concentration Taken as 34.3 µg/m³

Map Insert



LEGEND

- *Elevations are shown at 200 m contour intervals.*
- *BURNCO fenceline.*
- *Indicates maximum off site prediction.*
- *Sensitive receptors.*

REFERENCES

DEM provided by GeoBase
Projection: UTM Zone 10 Datum: NAD 83.

PROJECT
BURNCO ROCK PRODUCTS LTD.
BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

TITLE
1-HOUR SULPHUR DIOXIDE (SO_2) PREDICTIONS

Golder Associates

PROJECT NO. 11-1422-0046			PHASE No.4700
DESIGN	TB	02 Aug. 12	SCALE AS SHOWN REV. 0
AIR	TB	12 Jan. 15	
CHECK	JR	23 Feb. 15	**FIGURE: 5.7-9**
REVIEW	SC	27 Feb. 15	