5.2 Air Quality

5.2.1 Introduction

Air quality is defined as a measure of the condition of air relative to any human need or purpose. The atmosphere is an important pathway for the transport of contaminants to freshwater, terrestrial, and human environments. Air quality is a valued component (VC) because of its intrinsic importance to the health and well-being of people, wildlife, vegetation, and other biota that comprise ecosystems.

5.2.2 Scope of Assessment

The scope of the air quality assessment deviates from the AIR, and is limited to the consideration of criteria air contaminants (CACs); substances for which there are applicable regulatory criteria (called ambient air quality objectives [AAQOs]). Acidic deposition, fogging, and icing were modelled by the air quality team and are described in the Air Quality TDR (Stantec 2014). However, because these measurable parameters are not adequately addressed by comparison against regulatory criteria for ambient air quality, these topics are considered in sections where appropriate criteria exist as per the following:

- predicted concentrations of substances in air at specific locations of interest due to the presence of human or ecological receptors are addressed under Human Health (Section 9.2)
- potential effects of acidifying emissions on ecosystems are assessed under Vegetation Resources (Section 5.5) and Surface Water Quality (Section 5.9), and
- potential effects of pure water vapour emitted by cooling towers (which is not a pollutant) are assessed under Visual Quality (Section 7.3) and Accidents or Malfunctions (Section 10).

5.2.2.1 Regulatory and Policy Setting

There are seven substances of interest (SOI) listed in the AIR (Section 4.1, Table 4.1-2): sulphur dioxide (SO_2), oxides of nitrogen (NO_X), carbon monoxide (CO), respirable particulate matter ($PM_{2.5}$), hydrogen sulphide (H_2S), volatile organic compounds (VOCs), and ozone (O_3). Air quality is quantitatively assessed by comparing predicted ground-level concentrations from dispersion modelling to applicable AAQO and standards developed by regulatory agencies. Regulatory objectives for criteria air contaminants (CACs) include the BC Ambient Air Quality Objectives (BCAAQO), the National Ambient Air Quality Objectives (NAAQO), and the Canadian Council of Ministers of the Environment Canadian Ambient Air Quality Standards (CAAQS).

Ozone was raised as a potential concern by stakeholders. Ozone is not emitted by the Project directly, but can under specific circumstances result from chemical interactions in the atmosphere between precursor substances (i.e., NO_2 and VOCs), which are emitted by the Project. Emissions from the Project might also have the effect of consuming O_3 in the reaction of $NO \rightarrow NO_2$. In two Technical Memoranda (Stantec 2013b, 2013c), it was demonstrated that the Kitimat region displays little evidence of enhanced O_3 production. This conclusion was based on detailed analyses of local O_3 data, analyses of historical and future precursor emission quantities, and recommendations by the United States Environmental Protection Agency (US EPA). The incremental addition of precursor emissions attributable to the Project is unlikely to materially alter this condition. In the interests of focusing the assessment on relevant issues and concerns (e.g., the direct effects of emissions of CACs and the deposition of acidifying emissions), the potential for enhanced O_3 production is not assessed further.

The applicable AAQO for CACs are detailed in the Air Quality TDR (Stantec 2014; Section 4.1) and are summarized in Table 5.2-1. The most stringent of the BCAAQO, NAAQO, and CAAQS are used in this assessment.

Table 5.2-1: Ambient Air Quality Objectives for Criteria Air Contaminants

Substance	Averaging Period	BC Objective ($\mu g/m^3$)			Canada Objective ($\mu g/m^3$)		
		Level A	Level B	Level C	Maximum Desirable	Maximum Acceptable	Maximum Tolerable
SO_2	1-hour	**450**	900	900–1,300	450	900	N/A
	3-hour	**375**	665	N/A	N/A	N/A	N/A
	24-hour	160	260	360	**150**	300	800
	Annual	**25**	50	80	30	60	N/A
NO_2	1-hour	N/A	N/A	N/A	N/A	**400**	1,000
	24-hour	N/A	N/A	N/A	N/A	**200**	300
	Annual	N/A	N/A	N/A	**60**	100	N/A
CO	1-hour	**14,300**	28,000	35,000	15,000	35,000	N/A
	8-hour	**5,500**	11,000	14,300	6,000	15,000	20,000
$PM_{2.5}$	24-hour	**25** [a]			28 (27) [c]		
	Annual	**8** (6) [b]			10 (8.8) [d]		
H_2S [e]	1-hour	**7**	28	N/A	N/A	N/A	N/A
	24-hour	**3**	6	N/A	N/A	N/A	N/A

NOTES:

[a] Based on the 98th percentile value for one year

[b] The BCAAQO for $PM_{2.5}$ defines a planning goal of 6 $\mu g/m^3$ (annual average) intended as a voluntary target to guide airshed planning efforts. The objective is 8 $\mu g/m^3$ (BCMOE 2013a).

[c] The CAAQS for 24-hour $PM_{2.5}$ is referenced to the annual 98th percentile of daily 24-hour average concentrations, averaged over three years. The first CAAQS is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).

[d] The CAAQS for annual $PM_{2.5}$ is referenced to the three-year mean of annual average concentrations. The first CAAQS shown is the standard effective in 2015; the new standard proposed for 2020 is given in brackets (Environment Canada 2013).

[e] BCAAQO for total reduced sulphur measured as H_2S (BCMOE 2013a). This supersedes previous objectives specific to H_2S.

N/A – Not applicable.

Canada Objectives includes both the NAAQO and (for $PM_{2.5}$ only) the CAAQS.

Values in **bold** are the most stringent applicable criteria.

Sources: Health Canada (1998); CCME (2012); BCMOE (2013a); Environment Canada (2013)

Of the seven SOI listed in the AIR (Section 4.1, Table 4.1–2), six are commonly known as CACs. The seventh SOI, VOCs, is a mixture of volatile non-methane hydrocarbons and is not a CAC. No federal or provincial objectives or standards exist for the assessment of exposures to VOCs. However, an analysis of the relative proportions of benzene, toluene, ethylbenzene, and xylene (BTEX) in VOCs shows it to be small, and benzene itself is a small proportion of BTEX. Therefore, a preliminary comparison of predicted 1-hour VOCs concentrations to an applicable ambient air quality objective or standard for benzene is a conservative approach to preliminarily assess the predicted 1-hour concentrations of VOCs and determine if a more detailed assessment of individual VOC species is warranted. Because there is no standard for benzene in BC, the Alberta AAQO of 30 $\mu g/m^3$ is used.

BC has recently announced the development of new AAQO for SO_2 and NO_2, expected to be released in 2014. In the interim, MOE has recommended that proponents use U.S. EPA and WHO objectives. This assessment will reference the AAQO presented in Table 5.2-1 and the BC interim objectives presented in Table 5.2-2.

Table 5.2-2: Interim Objectives for Sulphur Dioxide and Nitrogen Dioxide

Substance	Averaging Period	Supplemental Objectives	
		Ppb	($\mu g/m^3$)
SO_2	1-hour [a]	75	200
NO_2	1-hour [b]	100	188
	Annual [c]	21	40

NOTES:

MOE has not specified criteria for the 24-hour SO_2 or NO_2, or annual average criterion for SO_2.

All conversions between ppb and $\mu g/m^3$ were performed by MOE and are referenced to 101.325 kPa and 25°C.

[a] The US EPA metric for SO_2 references the annual 99th percentile of daily 1-hour maximum, averaged over three consecutive years. This requires extracting the highest 1-hour value for each day followed by calculating the 99th percentile of those 365 values at each receptor modelled, and then averaging this value over three consecutive years.

[b] The US EPA metric for NO_2 references the annual 98th percentile of daily 1-hour maximum, averaged over three consecutive years. This requires extracting the highest 1-hour value for each day followed by calculating the 98th percentile of those 365 values at each receptor modelled, and then averaging this value over three consecutive years.

[c] The World Health Organization objective for NO_2 considers the first highest annual average value.

The air quality dispersion modelling that underpins many of the conclusions presented in this assessment is based on the requirements of the *Guidelines for Air Quality Dispersion Modelling in British Columbia* (hereafter, the Guidelines) (BC MOE 2008).

Emissions of NO_x from gas turbines are the subject of emission criteria from both the Province of BC (BC MOE 1992) and nationally from the Canadian Council of Ministers of Environment (CCME 1992).

BC has recently announced a plan to replace the existing *Emission Criteria for Gas Turbines* (BC MOE 1992). The new criteria are expected to include limits for NO_x, CO, and ammonia (NH_3). While the MOE announced in late 2013 that the existing criteria are presently rescinded, in the absence of new guidance, the MOE allows that the existing criteria apply to new sources in the intervening period. In the absence of approved alternative criteria, the rescinded *Emission Criteria for Gas Turbines* (1992) will determine the selection of the NO_X emission rate for the Project's combustion turbine drives. Further details are included in the Air Quality TDR (Stantec 2014).

5.2.2.2 Consultations' Influence on the Identification of Issues and the Assessment Process

LNG Canada has consulted with the CEA Agency, EAO, the Working Group, and Aboriginal Groups throughout Project development and planning. The following consultation activities have influenced the air quality assessment.

Consistent with the Guidelines (BCMOE 2008), LNG Canada developed a Detailed Modelling Plan (Stantec 2013), and following discussions with regulators, delivered it in final form to the MOE on December 18, 2013. The MOE requested expansion of the assessment to include acidification effects, to expand the assessment areas, and to model three full years of meteorological data instead of one, as required by the Guidelines (BCMOE 2008).

Consultation with potentially affected Aboriginal Groups resulted in assessment of vessel air emissions extending along the entire marine access route through inclusion of a shipping LSA and shipping RSA.

At the request of potentially affected Aboriginal Groups, LNG Canada engaged in an extensive assessment of background air quality in the traditional territories of six Aboriginal Groups. Thirteen passive ambient monitoring stations were established in 2013 and were serviced monthly. The assessment of background air quality is detailed in the Air Quality TDR (Stantec 2014; Section 3.2.3 and Appendix B) and is summarized in Section 5.2.3.

In addition, through LNG Canada's consultation program, potentially affected Aboriginal Groups have identified issues and concerns with respect to air quality, which are assessed in the relevant sections in Part B, as well as in Part C, as they relate to potential adverse effects on Aboriginal Interests (Section 14) or Other Matters of Concern to Aboriginal Groups (Section 16).

5.2.2.3 Traditional Knowledge and Traditional Use Incorporation

Review and consideration of TK and TU studies during the preparation of the Application (Section 14, Section 15, and Section 16) has helped inform the air quality assessment, including extending the shipping LSA and shipping RSA for vessel air emissions and the addition of passive ambient monitoring stations at locations identified through consultation.

5.2.2.4 Selection of Effects

Project CAC emissions might result in adverse effects on air quality. The key potential effect addressed in the air quality assessment is the increase in CAC ground-level concentrations due to facility emissions or due to Project shipping emissions.

5.2.2.5 Selection of Measurable Parameters

Measurable parameters facilitate qualitative or quantitative measurement of Project and cumulative effects, and provide a means to determine the change in air quality. The measurable parameters for the air quality assessment are provided in Table 5.2-3. Although VOCs are not CACs, they are assessed as outlined in Section 5.2.2.1. Deviations from the effects and measurable parameters presented in the AIR are outlined in Section 5.2.2

Table 5.2-3: Potential Project Effects on Air Quality and Measurable Parameters

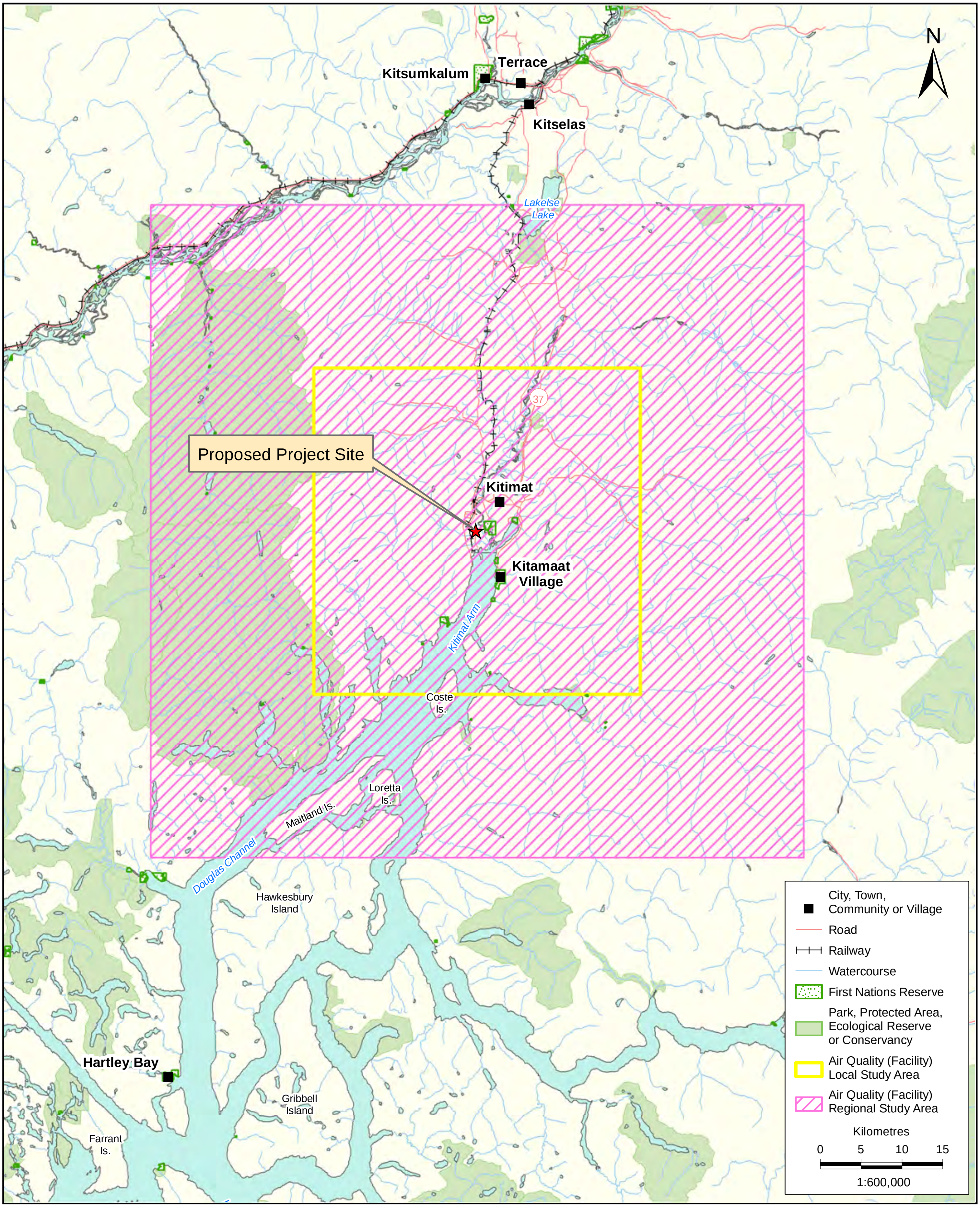
Potential Adverse Project Effects	Measurable Parameters
Change in ambient air quality in the Kitimat airshed	Estimate levels of CACs (SO_2, NO_2, CO, $PM_{2.5}$, and H_2S) and VOC
Change in ambient air quality along the marine access route	Estimate levels of CACs (SO_2, NO_2, CO, $PM_{2.5}$, and H_2S) and VOC

NOTE:
Hereafter, RSA is used to denote "airshed" for purposes of the assessment.

5.2.2.6 Boundaries

5.2.2.6.1 Spatial Boundaries

The Guidelines (BCMOE 2008) provide recommendations on selecting an appropriate spatial boundary for an air quality dispersion assessment. The Guidelines specify that Project and cumulative effects representing 10% of the AAQOs should be captured within the modelling domain. LNG Canada has chosen an assessment area sized to capture a more stringent level approximately equal to a measurement minimum detection limit—which is approximately 1 ppb for gases and 1 $\mu g/m^3$ for particulates. Figure 5.2-1 and Figure 5.2-2 illustrate the spatial boundaries for the air quality VC for both the LNG facility and shipping.



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LNG CANADA
Opportunity for British Columbia. Energy for the world

AIR QUALITY ENVIRONMENTAL EFFECTS ASSESSMENT

AIR QUALITY (FACILITY)
LOCAL AND REGIONAL STUDY AREAS

LNG CANADA EXPORT TERMINAL
KITIMAT, BRITISH COLUMBIA

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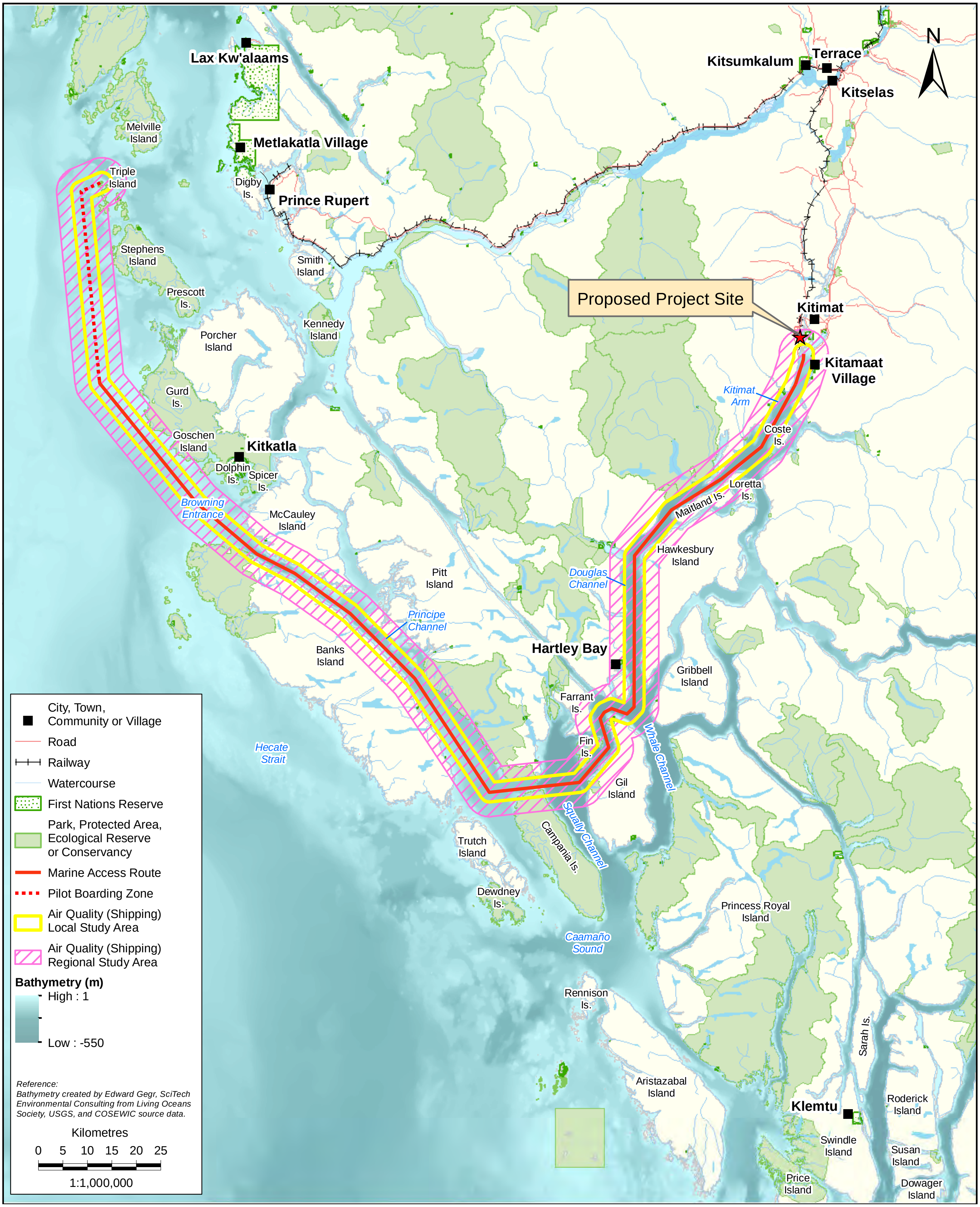

Stantec

LNG CANADA
Opportunity for British Columbia. Energy for the world

AIR QUALITY ENVIRONMENTAL EFFECTS ASSESSMENT

AIR QUALITY (SHIPPING)
LOCAL AND REGIONAL STUDY AREAS

LNG CANADA EXPORT TERMINAL
KITIMAT, BRITISH COLUMBIA

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The specific LSAs are as follows:

- **facility LSA** for the assessment of the facility CAC emissions, an LSA measuring 40 km by 40 km centered on the LNG facility footprint is used
- **shipping LSA** for the assessment of marine vessel air emissions extending along the entire marine access route, an LSA of 2 km on either side of the marine access route is used.

The specific RSAs are as follows:

- **facility RSA** for the assessment of the facility CAC emissions, an RSA measuring 78 km by 78 km centered on the LNG facility footprint is used
- **shipping RSA** for the assessment of marine vessel air emissions extending along the entire marine access route, an RSA of 5 km on either side of the marine access route is used.

Dispersion modelling was completed to support the vegetation (Section 5.5), surface water quality (Section 5.9) and human health (Section 9.2) assessments. The spatial boundaries used for the assessment of potential effects from acidifying emissions include an LSA/RSA measuring 125 km by 40 km around the LNG facility. These spatial boundaries are discussed further in those individual sections.

5.2.2.6.2 Temporal Boundaries

Based on the current Project schedule, the temporal boundaries are:

- construction, Phase 1 (trains 1 and 2) to be completed approximately five to six years following issuance of permits, the subsequent phase(s) (trains 3, 4) to be determined based on market demand
- operation, minimum of 25 years after commissioning, and
- decommissioning, approximately two years at the end of the Project life.

5.2.2.6.3 Administrative and Technical Boundaries

Federal, provincial, regional, municipal, and Aboriginal Groups' administrative boundaries played no immediate role in determining the assessment methodology aside from those noted above for spatial boundaries.

Potential effects of the facility construction and operation on air quality are generally known and have predictable effects. The modelling of air quality in this assessment is accomplished through use of the CALPUFF modelling system, following guidance available in the Guidelines (BCMOE 2008). There are no technical limitations on the ability to predict potential Project effects on air quality.

5.2.2.7 Residual Effects Description Criteria

Table 5.2-4 lists residual effects description criteria used in the air quality assessment.

5.2.2.8 Significance Thresholds for Residual Effects

Significance of effects on air quality is determined using both dispersion modelling and professional judgment.

An effect is considered significant if ambient concentrations of air contaminants will exceed relevant regulatory criteria (i.e., are high in magnitude) and are of concern relative to the geographic extent of predicted exceedances, their frequency of occurrence, and the presence of potentially susceptible receptors (e.g., human, wildlife, vegetation, soils, or water bodies) that uptake ambient air.

The significance determination is based on a comparison of Project emissions with existing emissions in the RSA. The characteristics of the emission (mass, rate, location, frequency) and the setting into which the emissions are introduced were determined and studied. Where professional judgment alone is insufficient to arrive at a conclusion, a dispersion modelling exercise is undertaken. In all instances, the background levels of the substances of interest are considered.

A predicted concentration that is greater than the applicable AAQO and the interim objectives does not imply that the Project’s effect on air quality is significant. Dispersion models often produce results that are highly conservative (see Stantec 2014; Section 8). As such, dispersion models should be used primarily as tools to understand the interaction of the emission sources with meteorology, terrain, and receptors. Professional judgment and the consideration of aspects such as magnitude, geographic extent, frequency, and reversibility are important considerations in determining significance.

Air quality effects that are assessed as significant warrant a comprehensive human health risk assessment for the affected receptors. See Section 9.2 for an assessment of air emissions effects on human health.

Table 5.2-4: Characterization of Residual Effects for Air Quality

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Characterization of Residual Effects		
Magnitude	The expected size or severity of effect. Low-magnitude effects may have negligible to little effect, while high-magnitude effects may have a substantial effect.	**Negligible**—no measurable change **Low**—within normal variability of baseline conditions **Moderate**—increase or decrease with regard to baseline but within regulatory levels and objectives **High**—singly or as a substantial contribution in combination with other sources causing exceedances of objectives beyond the Project boundaries
Geographic Extent	The spatial scale over which the residual effects of the Project are expected to occur. The geographic extent of effects can be local or regional. Local effects may have a lower effect than regional effects.	**Project footprint**—effects are restricted to the Project footprint **LSA**—effects extend into the LSA **RSA**—effects extend into the RSA
Duration	The length of time the residual effect persists. The duration of an effect can be short term or longer term.	**Short-term**—effects are measurable for less than 1 month. **Medium-term**—effects are measurable for greater than 1 month but less than 2 years **Long-term**—effects are measurable for between 2 years and the life of the Project (approximately 25 years)
Frequency	How often the effect occurs. The frequency of an effect can be frequent or infrequent. Short-term and/or infrequent effects may have a lower effect than long-term and/or frequent effects.	**Single event**—occurs once **Multiple irregular event (no set schedule)**—occurs at sporadic intervals **Multiple regular event**—occurs regularly and at regular intervals **Continuous**—occurs continuously
Reversibility	Whether or not the residual effect on the VC can be reversed once the physical work or activity causing the disturbance ceases. Effects can be reversible or permanent. Reversible effects may have a lower effect than irreversible or permanent effects.	**Reversible**—recovery occurs after Project closure and reclamation **Irreversible**—permanent
Context	Refers primarily to the sensitivity and resilience of the VC. Consideration of context draws heavily on the description of existing conditions of the VC, which reflect cumulative effects of other projects and activities that have been carried out, and information about the impact of natural and human-caused trends on the condition of the VC. Project effects may have a higher effect if they occur in areas or regions that have already been adversely affected by human activities (i.e., disturbed or undisturbed) or are ecologically fragile and have little resilience to imposed stresses (i.e., fragile).	**Low resilience**—low capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance. **Moderate resilience**—moderate capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance. **High resilience**—high capacity for the VC to recover from a perturbation, with consideration of the baseline level of disturbance.

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Likelihood of Residual Effects		
Likelihood	Whether or not a residual effect is likely to occur	**Low**—low likelihood that there will be a residual effect. **Medium**—moderate likelihood that there will be a residual effect. **High**—high likelihood that there will be a residual effect.

5.2.3 Baseline Conditions

A description of existing baseline conditions near the Project allows a characterization of the interaction between the Project and the atmospheric environment, and places Project effects into context with atmospheric environmental conditions in the region.

Two distinct subcomponents characterize the atmospheric environment baseline: climate and air quality. Physical attributes of the atmosphere that comprise climate (e.g., temperature, precipitation, humidity, winds, pressure, and solar radiation) are important because they govern the dispersion of Project emissions and determine their ultimate disposition in the environment. Existing air quality is important because it is the context into which the Project's emissions are added (e.g., a near-pristine environment or an urbanized or industrialized airshed).

This section briefly summarizes a full assessment of baseline conditions presented in the Air Quality TDR (Stantec 2014; Section 3, Appendix A and Appendix B). This includes a review of previous works, a description of regional climatic conditions, and descriptions of air quality in Kitimat and the North Coast. Note that Appendix E in the TDR (Stantec 2014) contains a detailed description of the CALMET meteorological input files that drives the CALPUFF dispersion model. It is not summarized in this section.

5.2.3.1 Baseline Data Sources

The review of previous works comprises relevant environmental assessments. Specifically the Applications filed in support of the Kitimat LNG Project, the Enbridge Northern Gateway Project, the Rio Tinto Alcan's *Sulphur Dioxide Technical Assessment Report* (RTA STAR), and the 2014 MOE Kitimat Airshed Emissions Effects Assessment.

The description of regional climatic conditions and the description of air quality in Kitimat were taken from existing sources of climate and air quality data collected by the Governments of Canada and BC. The description of air quality on the north coast is developed from data collected on behalf of LNG Canada by Stantec at 13 passive ambient air quality monitoring stations. Details are described in Section 4 of the Air Quality TDR (Stantec 2014; Section 4).

5.2.3.2 Baseline Overview

5.2.3.2.1 Literature Review

Section 4.1 of the Air Quality TDR (Stantec 2014) contains a literature review that briefly describes four substantial analyses of air quality in the Kitimat region. This includes (in chronological order): the 2005 Kitimat LNG Environmental Assessment, the 2010 Enbridge Northern Gateway Environmental Assessment, the 2013 RTA STAR and the 2014 MOE Kitimat Airshed Emissions Effects Assessment.

The Kitimat LNG Environmental Assessment (2005) and Enbridge Northern Gateway Environmental Assessment (2010) share one common element—marine vessel emissions as a main concern. Both those assessments were completed before the International Marine Organization declaration of the North American Emission Control Area for marine vessels. Given the 96% reduction in marine vessel SO_2 emissions both of these assessment findings are outdated. Since that time, it has also been determined that the actions required to achieve the required reductions in SO_2 (fuel switching) have the co-benefit of reducing emissions of NO_X and $PM_{2.5}$. In essence, the subject of these assessments—deleterious effects of SO_2 near the jetty—have been fully mitigated and are no longer of concern.

The RTA STAR work (2013) is relevant in that it presents an assessment of present-day and future SO_2 emissions from the largest source of that substance in the Kitimat region. The study concludes that despite the estimated 56% increase in SO_2 emissions, the near-field effects are largely unchanged from the present-day effects. This is achieved by improved dispersion of emissions from the modernized facility compared with the poor dispersion experienced with the circa-1950 facility design. Despite this, offsite effects frequently exceed provincial and other objectives for air quality on a hillside to the west, and to a lesser extent in populated areas.

One outcome of the improved dispersion of the emissions from the modernized facility compared to that of the present-day facility is the increased acidification effects in the far field. Acidification effects that were previously confined near Kitimat are now dispersed farther north up the Kitimat River valley. The result is acid deposition to the north that is predicted to be greater than previously experienced.

The Kitimat Airshed Emissions Effects Assessment (2014) commissioned by the MOE presents an assessment of twelve scenarios based on a range of existing and proposed facilities with various levels of emissions treatments for NO_2 and SO_2 in the Kitimat Airshed. One scenario (G_76.2) resembles the application case emissions and sources considered in this assessment. NO_2 and SO_2 emissions considered in that scenario are approximately 73% and 20% higher, respectively, than those considered in this assessment. Given these discrepancies and other differences in dispersion modelling treatment, these results are not comparable to LNG Canada Project's application case results. The predicted concentrations of NO_2 and SO_2 in the Kitimat Airshed Emissions Effects Assessment resemble generally the findings of this assessment and the RTA STAR work; however, a more detailed comparison of predictions is of limited value.

5.2.3.2.2 Regional Climate

The BC north coast is a region of temperate rainforest and rugged coastal terrain with high annual precipitation amounts throughout the region. The moderating influence of the ocean limits the seasonal temperature ranges, resulting in relatively mild winters and cool summers.

The climate baseline is developed based on data from two Canadian Climate Normals Stations (Environment Canada 2014) in Kitimat and Terrace (1981 to 2010). Section 4.2.1 of the Air Quality TDR (Stantec 2014; Section 4.2.1 and Appendix A) describes in detail patterns of temperature, precipitation, and wind. Appendix A in the TDR contains the detailed Canadian Climate Normals data for these two stations.

5.2.3.2.3 Baseline Air Quality, Kitimat

Kitimat has a long history of industrial development and a long record of continuous monitoring for SOI at five continuous monitoring stations, four of which are still operating. Air quality monitoring is conducted in both the industrial areas on the west side of Kitimat River and in the residential areas on the east side. Substances of interest historically collected in Kitimat include SO_2, NO_2, $PM_{2.5}$, and H_2S. Data on CO and VOCs have not been collected in the region. The CO baseline is developed from information collected at a representative site outside the Kitimat region. Data on O_3 was collected briefly at two sites in Kitimat for a total of 291 days. As noted in Section 5.2.2 the assessment of O_3 is not considered necessary in this assessment.

Data from monitoring stations in both the industrial and residential neighbourhoods of Kitimat indicate that air quality is good, with few instances of observed concentrations exceeding the most stringent BC and federal objectives for some substances. Historically, there have been exceedances of the 1-hour and 24-hour objectives for H_2S, but those measurements were taken while a pulp mill was still operating in Kitimat.

Table 5.2-5 provides a summary of baseline concentrations. These values were determined by taking 98th percentile data from the station with the highest observed concentrations for each SOI. The resulting values for all substances and averaging periods are well within the applicable objectives (Table 5.2-1). The Air Quality TDR (Stantec 2014; Section 4.2.2 and Appendix B) describes in detail the baseline air quality in Kitimat. Appendix B in the TDR contains detailed air quality data for Kitimat.

Table 5.2-5: Summary of Baseline Air Quality in the Kitimat Area

Substance	Averaging Period	Concentration [a] (µg/m³)	Most Stringent AAQO (µg/m³) [b]
SO_2 [c]	1-hour	54.7	450 (200)
	24-hour	31.8	150
	Annual	6.9	25
NO_2 [d]	1-hour	19.8	400 (188)
	24-hour	12.1	200
	Annual	3.9	60 (40)
CO [e]	1-hour	970.0	14,300
	8-hour	931.0	5,500
$PM_{2.5}$ [d]	24-hour	12.5	25
	Annual	3.5	8
H_2S [d]	1-hour	4.9	7
	24-hour	2.6	3

NOTES:

[a] Representative values for each category are based on the most recent three years of monitoring data available from the station with the highest observed concentrations of the substance of interest. Values are the 98th percentile of monitored concentrations (except annual averages, which are the mean values of the 1-h average concentrations).

[b] See Table 5.2-1 and (for values in parentheses) Table 5.2-2.

[c] SO_2 values are from the Kitimat Haul Road monitoring station.

[d] NO_2, $PM_{2.5}$, and H_2S values are from the Kitimat Rail monitoring station.

[e] Ambient CO data are not measured locally. Suitable baseline data were obtained from the nearest, most representative station: Smithers St. Josephs.

Air Quality Data Source: BCMOE (2013b)

5.2.3.2.4 Baseline Air Quality, North Coast

A Project-specific passive ambient monitoring network was established on the north coast to cover areas not sampled by the existing Kitimat network. Thirteen stations were installed at various locations in the Kitimat region, along Douglas Channel, and in Hecate Strait.

Monthly average concentrations for a suite of gaseous contaminants were obtained from each station. The following substances were measured: SO_2, NO_2, NO_X, H_2S, O_3, and VOCs. Measurements of NO_X are not included as there are no AAQO for NO_X. Measurements of VOC and O_3 are not shown because they are being recalculated. In general, concentrations of the three substances presented are low relative to the annual AAQO—a conservative metric for comparison (Table 5.2-1 and Table 5.2-2). Some variability between settled/industrial locations and remote/rural stations was noted. In some instances, small seasonal fluctuations were noted. Results are recorded as average concentrations for each observation period (approximately one month). Average concentrations for three of six substances measured are presented in Table 5.2-6. Section 4.2.3 and Appendix B of the Air Quality TDR (Stantec 2014) describes in detail the baseline air quality on the north coast.

Table 5.2-6: Summary of Baseline Air Quality Results on the North Coast

Station Number	Station Name	Average Concentrations (ppb)		
		SO_2	NO_2	H_2S
1	Lakelse Lake	0.83	3.93	0.12
2	Kitimat Haul Road	9.88	8.12	0.92
3	Kitamaat Village	2.05	2.92	0.48
4	Terrace 1	0.46	4.41	0.14
5	Old Town	1.62	2.56	0.24
6	Gil Island	0.71	2.38	0.14
7	Promise Island	1.27	3.76	0.18
8	Terrace 2	0.54	5.32	0.12
9	Gitaus	0.46	3.13	0.11
10	Metlakatla	0.81	3.90	0.14
11	McCauley Island	0.55	1.30	0.14
12	Dolphin Island	0.63	1.43	0.11
13	Kitsumkalum Lake	0.41	1.18	0.14

NOTES:

The average values presented are representative of between 9 and 14 months average, depending on when sampling was initiated. Station start-up varied between August 2013 and April 2014. Sampling in this table is representative through to July 2014.

Some average values exclude missing data and data removed from the record owing to uncertainty in the analytical results. Further details are included in the Air Quality Technical Data Report and Appendices (Stantec 2014).

Average concentrations for SO_2, NO_2, and H_2S are presented in Table 5.2-6. Concentrations for NO_X are not presented because there are no AAQO for NO_X. Ozone and VOCs are not shown because they are being reanalyzed. They will be made available upon request.

Data recorded as below the minimum detection limit are conservatively assumed to be present at the minimum detection limit.

5.2.3.3 Baseline Conclusions

The literature review provides a good overview of past works and their findings. The climatic and meteorological baseline data are detailed and suitable for the stated purpose of understanding the atmosphere's role in dispersing emitted substances. The baseline air quality in Kitimat and on the north coast are adequately characterized and help place the LNG facility emissions in context, as well as those from Project-related vessels along the marine access route

5.2.4 Project Interactions

Table 4.4–1 (Section 4) identifies potential interactions of concern between Project activities and each of the selected VCs that are carried forward in the assessment. The potential effects identified in Section 5.2.2.4 that may result from interactions with Project activities are assessed. The extent to which these interactions are considered is ranked in Table 5.2-7. The ranking categories (i.e., 0, 1, or 2) in Table 5.2-7 are defined in a footnote to the table.

A conservative approach is taken in assigning a rank of 1, whereby interactions with a meaningful degree of uncertainty will be assigned a rank of 2 so that a detailed effects assessment is conducted.

Table 5.2-7: Potential Project Effects on Air Quality

Project Activities and Physical Works	Potential Effects	
	Change in ambient air quality in the Kitimat airshed	Change in ambient air quality along the marine access route
Facility Activities and Works		
Construction		
Site preparation (clearing, grubbing, grading, levelling, and set-up of temporary facilities)	1	0
Onshore construction (installation of LNG facility, utilities, ancillary support facilities, access roads) and includes hydrotesting	1	0
Dredging (includes disposal)	1	0
Marine terminal construction (modifications to existing wharf, installation of sheet piling, material offloading and laydown areas, transfer piping and electrical installations)	1	0
Vehicle and rail traffic (haul road upgrades, road use, vehicle traffic)	1	0
Commissioning and start-up	1	0
Operation		
LNG production (including natural gas treatment, condensate extraction, storage in tanks, and transfer onto rail cars,) and LNG storage and loading	2	0
Decommissioning		
Dismantling of land-based and marine infrastructure	1	0
Remediation and reclamation of the site	1	0

Project Activities and Physical Works	Potential Effects	
	Change in ambient air quality in the Kitimat airshed	Change in ambient air quality along the marine access route
Shipping Activities		
Construction		
Shipping equipment and materials	0	1
Operation		
LNG shipping	0	2
Decommissioning		
Shipping equipment and materials	0	1

KEY:
0 = No interaction.
1 = Potential adverse effect requiring mitigation, but further consideration determines that any residual adverse effects will be eliminated or reduced to negligible levels by existing codified practices, proven mitigation measures, or BMPs.
2 = Interaction may occur and the resulting effect may exceed negligible or acceptable levels without implementation of Project-specific mitigation. Further assessment is warranted.
NOTE: Only activities with an interaction of 1 or 2 for at least one effect are shown.

5.2.4.1 Justification of Interaction Rankings

For the change in ambient air quality in the facility RSA, Project activities associated with waste management, disposal, and post-closure monitoring and follow-up are not expected to generate a quantity of emissions that will affect the existing atmospheric environment. They are not considered because the quantities are small and emitted intermittently, or they are so distant as to exclude the possibility that overlapping effects occur. These activities are ranked as 0.

For the change in ambient air quality along the shipping RSA, all activities except for construction and operational shipping are ranked as 0. All Project activities in the marine environment near the facility are included in the facility RSA. Operation shipping is ranked as 2 along the shipping RSA.

The atmospheric effects from activities with interaction rankings of 1 can be managed to acceptable levels through the application of mitigation and best management practices. Interactions ranked as 1 include all construction activities except waste management, LNG loading in the operation phase, and all decommissioning activities except waste management and post-closure monitoring and follow-up.

Shipping activity in the facility RSA is ranked as 0 for all phases. All shipping activities, except berthing and hotelling, are included under changes in ambient air quality along the marine access route. Actvities associated with vessels while berthing and when at berth are included in facility activities and works.

All activities ranked as 1 and 2 are assessed by quantification of emissions and, where warranted (for items ranked 2), plume dispersion modelling is conducted to predict ground-level concentrations of measurable parameters. The modelling is only conducted for those activities that have the potential to cause significant adverse residual effects: specifically operational emissions of the LNG facility and operational shipping along the marine access route.

5.2.5 Assessment of Residual Effects from the LNG Facility

5.2.5.1 Analytical Methods

5.2.5.1.1 Analytical Assessment Techniques

Air dispersion modelling is used to estimate Project emissions in the facility RSA.

For activities that might result in a change in ambient air quality in the Kitimat airshed (defined here as the facility RSA, measuring 78 km by 78 km centered on the LNG facility footprint), four modelling scenarios are used:

- the base case, which considers emissions from existing sources in the facility RSA
- the Project-alone case, which considers the land-based and marine-based emissions in the facility RSA
- the application case, which combines the results of the base case and Project-alone cases, and
- the cumulative case, which combines the results of the application case with the effects of reasonably foreseeable future projects.

The significance determination for Project residual effects is based on the application case; however, results for the base and Project-alone cases inform the discussion of residual effects. The Project-alone case is important to consider as it determines the magnitude of effects attributed to the Project and if the Project singly or as a substantial contributor, in combination with other sources, causes exceedances.

Air dispersion modelling was performed using the CALPUFF modelling system. The CALPUFF dispersion model is a refined model that applies terrain and meteorological data, and uses improved plume rise, dispersion, and terrain algorithms. The CALPUFF model is a non-steady-state Gaussian puff dispersion model that incorporates simple chemical transformation mechanisms, complex terrain algorithms and building downwash. It is suitable for estimating ground-level air quality concentrations on local and regional scales, from tens of metres to hundreds of kilometres. The CALPUFF model system is recommended in the Guidelines (BCMOE 2008).

The CALPUFF dispersion modelling assessment follows a method consistent with both the Guidelines (BCMOE 2008) and the Detailed Air Quality Modelling Plan for the Proposed LNG Canada Project (Stantec 2013). CALPUFF dispersion modelling is described in detail in Section 6 and in Appendices C, D, E, and F of the Air Quality TDR (Stantec 2014).

5.2.5.1.2 Assumptions and the Conservative Approach

The ability of a plume dispersion model to predict ambient concentrations depends on the accuracies of the source and emission inventory, the meteorology, and the assumptions used to represent the atmospheric physics and chemistry processes. The US EPA (2005) indicates that the application of regulatory dispersion models is viewed as a “best estimate” approach and that this approach should be viewed as “acceptable to the decision maker.”

The application of CALPUFF in this assessment is consistent with best practices and the Guidelines (BCMOE 2008). Care and attention has been paid to conservatively estimate emission rates and emission parameters, and to execute the model. Atmospheric physics and chemistry are portrayed accurately. Quality control processes were applied to confirm the work is free from material error. There is a high degree of confidence that predicted concentrations in the assessment are conservative, which means Project effects are likely overpredicted.

Modelling methods and confidence in the assessment are described in detail in Section 6 and Section 8 of the Air Quality TDR (Stantec 2014).

5.2.5.2 Assessment of Change in Ambient Air Quality in the Kitimat Airshed

5.2.5.2.1 Description of Project Effect Mechanisms for Change in Ambient Air Quality in the Kitimat Airshed

In the construction phase, air emissions from activities such as site preparation, onshore construction, dredging, and marine construction will result in increases in the overall level of air emissions. The duration of Phase 1 construction is expected to be approximately five to six years.

In the operation phase, air emissions from the LNG processing facility, marine terminal, shipping (in proximity to the facility between Kitamaat Village and marine terminal), docking, and hoteling of the LNG tanker will result in increases to the overall level of existing regional air emissions. The operation phase is expected to last for a minimum duration of 25 years.

In the decommissioning phase, air emissions from the dismantling of the LNG facility will result in less air emissions than the construction phase. The potential effect from decommissioning is assessed qualitatively.

5.2.5.2.2 Mitigation for Change in Ambient Air Quality in the Kitimat Airshed

LNG Canada is committed to continuous improvement and will continue to evaluate opportunities to reduce facility emissions on an on-going basis. Throughout construction and operation, LNG Canada will control CAC emissions from Project activities by implementing the following mitigation measures:

- manage vehicle and equipment emissions by conducting regular maintenance on all machinery and equipment (Mitigation 5.2-1)
- control construction-related fugitive road dust, through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis (Mitigation 5.2-2)
- optimize timber salvage and offer available timber to local communities. (Mitigation 5.2-3)
- prohibit the open burning (or incineration) of accumulated waste materials from the workforce accommodation centre(s) (Mitigation 5.2-4)
- manage, through Project engineering design and operational procedures, the NO_X emissions associated with the gas turbine exhaust and incinerator exhaust to meet regulatory requirements (Mitigation 5.2-5)
- adhere to the Air Quality Management Plan (Mitigation 5.2-6)
- diesel fired equipment will be powered by low sulphur fuel (Mitigation 5.2-7)
- construction vessels, supporting tugs, and LNG carriers and assist tugs will use low-sulfur fuel in compliance with applicable marine emission standards (IMO, 2008) (Mitigation 5.2-8)

5.2.5.2.3 Characterization of Change in Ambient Air Quality in the Kitimat Airshed

In this section, the change in ambient air quality in the facility RSA is briefly summarized for the base case, Project-alone case, and application case. Emission quantities and dispersion modelling results for these cases are extensive and detailed in the Air Quality TDR (Stantec 2014). For the sake of avoiding repetition, these figures and tables are not reproduced here. The emissions quantities are presented in the Air Quality TDR (Stantec 2014: Section 5.1 and 5.3). The dispersion modelling results are presented in the Air Quality TDR (Stantec 2014: Section 7.1, 7.2, and 7.3).

The significance determination for Project residual effects is based on the application case; however, results for the base and Project-alone cases are used in the discussion of residual effects, particularly the magnitude of effects.

Base Case: Emissions and Dispersion Modelling Results

The base case modelling includes emissions from the RTA facility and Modernization Project and the Kitimat LNG facility (based on a gas turbine driver scenario) at Bish Cove, plus their associated marine-based emissions (ships at their respective jetties). These two facilities are the major sources of CAC emissions in the RSA before Project construction. The annual base case emissions are as follows: SO_2 = 15,317 tonnes; NO_X = 1,190 tonnes; CO = 1,092 tonnes; $PM_{2.5}$ = 578 tonnes; H_2S = 0 tonnes; and VOCs = 26.3 tonnes.

All predicted concentrations for NO_2, CO, and $PM_{2.5}$ are a small fraction of the most stringent applicable objective. Comparison with the BC interim objectives for NO_2 indicates that the predicted concentrations are also lower than these objectives. Predicted VOCs concentrations are well below any level of concern.

The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the base case are 3,390 $\mu g/m^3$, 2,170 $\mu g/m^3$, 573 $\mu g/m^3$, and 32.5 $\mu g/m^3$, respectively. These concentrations are well above the most stringent applicable AAQO. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also greater than these objectives. The predicted exceedance area, just to the west of the RTA facility, is almost entirely attributable to the RTA facility SO_2 emissions, which comprise 99.8% of the base case SO_2 emissions.

Project-alone Case: Emissions and Dispersion Modelling Results

The Project-alone case includes emissions from the LNG Canada facility and its associated marine-based emissions (ships at the jetty). This facility's emissions are a small incremental addition of CAC emissions to the facility RSA. The annual Project-alone case facility emissions are as follows: SO_2 = 752 tonnes; NO_X = 3,723 tonnes; CO = 3,047 tonnes; $PM_{2.5}$ = 224 tonnes; H_2S = 0.37 tonnes; and VOCs = 138 tonnes. See the Air Quality TDR for further details (Stantec 2014).

All predicted concentrations for NO_2, CO, $PM_{2.5}$, and H_2S are a small fraction of the most stringent applicable objective. Comparison with the BC interim objectives for NO_2 indicates that the predicted concentrations are also lower than these objectives. A comparison of predicted VOCs concentrations against the Alberta AAQO for benzene indicates the VOC concentrations are well below any level of concern. Therefore, a more detailed assessment of individual VOC species is not warranted.

The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the Project-alone case emissions are 188 $\mu g/m^3$, 129 $\mu g/m^3$, 30.5 $\mu g/m^3$, and 1.5 $\mu g/m^3$, respectively. These concentrations are well below the most stringent applicable AAQO. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also less than these objectives. The maximum predicted concentrations occur 1 km to 2 km to the north-northwest of the LNG facility, where the plume meets elevated terrain.

Three additional scenarios associated with facility emissions are investigated: high inlet total sulphur, non-routine flaring, and cooling tower-related fogging and icing.

The high inlet total sulphur scenario assumes the inlet gas total sulphur content increases to 30 mg/m^3 from its current normal level of 9 mg/m^3. The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the high inlet total sulphur scenario are 622 $\mu g/m^3$, 410 $\mu g/m^3$, 96.5 $\mu g/m^3$, and 5.56 $\mu g/m^3$, respectively. These results are higher than the most stringent applicable AAQOs for the 1-hour and 3-hour averaging times. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also greater than these objectives. Given this abnormal situation would not persist for more than a few hours to days, comparison against both the annual average and BC interim objective (which involves averaging over three years) is unwarranted. For the predicted exceedances to occur the high inlet gas scenario must coincide with worst-case meteorology—an unlikely occurrence.

The worst-case flaring scenario assumed a gas flow to the flares at 400 kg/s and a natural gas total sulphur content of 30 mg/m^3. The sulphur oxidation efficiency is assumed to be 98%. The maximum predicted 1-hour average ground-level SO_2 concentration associated with this flaring is 11.2 $\mu g/m^3$. The maximum predicted 1-hour average ground-level H_2S concentration associated with this upset flaring scenario is 0.12 $\mu g/m^3$. The predicted 1-hour concentrations of SO_2 and H_2S are well below the most stringent applicable AAQO. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also lower than these objectives.

The CALPUFF model is used to forecast the extents and frequencies of fogging and icing attributable to the cooling tower emissions of water vapour. Periods when the relative humidity is greater than 98 percent were excluded from the simulation because fog is likely to occur naturally under these conditions. The highest frequency of fogging (19 hours per year) is predicted along the Project fenceline to the northeast of the cooling towers, while the highest frequencies of fogging outside the fenceline are approximately two to six hours per year. Icing is forecast to occur for two hours over three years on the Project fenceline to the southwest of the cooling towers. Further analysis of effects of fogging and icing on visual quality is discussed in Section 7.3.

Application Case: Emissions and Dispersion Modelling Results

The application case modelling scenario includes emissions from the base case added to the emissions for the Project-alone case.

All predicted concentrations for NO_2, CO, and $PM_{2.5}$ are a small fraction of the most stringent applicable objective. Comparison with the BC interim objectives for NO_2 indicates that the predicted concentrations are also lower than these objectives. A comparison of predicted VOCs concentrations against the Alberta

AAQO for benzene indicates the VOC concentrations are well below any level of concern. Therefore, a more detailed assessment of individual VOC species is not warranted.

The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the application case are 3,460 µg/m^3, 2,170 µg/m^3, 592 µg/m^3, and 33.4 µg/m^3, respectively. These concentrations are well above the most stringent applicable AAQO. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also greater than these objectives.

Isopleth maps in Appendix G of the Air Quality TDR (Stantec 2014) show the geographic extent of the predicted effects in the application case to be localized near the LNG facility and on isolated hillsides above and to the west of the facility. Areas farther removed from the LNG facility, including the city of Kitimat, are less affected. Adverse effects (high predicted concentrations) occur sporadically over time.

The predicted exceedance area in the application case lies just to the west of the RTA facility. It is almost entirely attributable to the base case SO_2 emissions. Emissions from the RTA facility comprise 95.3% of the application case SO_2 emissions. A supplemental assessment of model output shows the following:

- the base case contribution, for the same hour in the meteorological database, to the application case maximum predicted concentration at the application case point of maximum impingement accounts for 98% of the 1–hour average ground-level SO_2 concentration, and
- the base case contribution, for the same hour in the meteorological database, to the application case maximum predicted concentration at the Project-alone case point of maximum impingement accounts for 83% of the 1–hour average ground-level SO_2 concentration.

5.2.5.2.4 Determination of Significance for Change in Ambient Air Quality in the Kitimat Airshed

The residual effects of the Project are characterized as moderate in magnitude, confined largely to the LSA, long-term, and continuous over the operation phase. Residual adverse effects (high predicted concentrations) occur sporadically over time.

The Project's residual effects are of moderate magnitude because the Project is not responsible either singly or as a substantial contributor, in combination with other sources, for causing exceedances of AAQO beyond the Project boundaries. The residual effects occur in a moderately resilient environment; however, they are reversible after emissions decrease or cease. The atmospheric environment has a high degree of resilience to changes in air quality caused by the Project.

The magnitude of CAC emissions from the Project construction phase activities are lower than from the operation phase. As such, the characterizations of effects above for the operation phase apply to the construction phase, but to a lesser degree.

The emissions attributed to the Project decommissioning phase activities have lower emission intensities compared to construction. As such, the characterizations above for the construction phase apply to the decommissioning phase, but to a lesser degree.

With implementation of the mitigation and environmental protection measures, residual effects of the Project are assessed to be not significant.

5.2.5.3 Summary of Project Residual Effects from the LNG Facility

The changes in ambient air quality in the facility RSA are summarized in Table 5.2-8. Because emissions during operation are greater and of longer duration than any other phase, the increased CAC concentrations for the application case are assumed to characterize the Project's entire residual effects (i.e., construction and decommissioning have lesser residual effects).

With implementation of the mitigation and environmental protection measures, the residual effects of the Project are assessed to be not significant.

5.2.6 Assessment of Residual Effects from Shipping

5.2.6.1 Analytical Methods

5.2.6.1.1 Analytical Assessment Techniques

Plume dispersion modelling is used for water- and ground-level concentrations of measurable parameters associated with Project emissions within the shipping LSA and RSA along the marine access route.

For shipping activities that might result in a change in ambient air quality along the marine access route, one modelling scenario is considered: the Project-alone case, which considers the Project's marine-based emissions outside the facility RSA.

Plume dispersion modelling of marine emissions along the shipping LSA uses the SCREEN3 model consistent with the Guidelines (BCMOE 2008) and the Detailed Air Quality Modelling Plan for the Proposed LNG Canada Project (Stantec 2013). SCREEN3 is a single-source Gaussian plume model that provides maximum water- or ground-level concentration predictions for point, area, flare, and volume sources. SCREEN3 is able to account for a variety of effects including: building downwash for both near-wake and far-wake regions, cavity recirculation, and flare releases. Simple-area sources can be modelled with SCREEN3. This model can incorporate the effects of terrain below stack height on maximum concentrations and can also estimate 24-hour average concentrations due to point-source plume impaction for terrain above stack height. The SCREEN3 dispersion model uses combinations of wind speed and atmospheric stability class (a 54 case matrix) as an internal screening meteorological data set

(U.S. EPA, 1995). The SCREEN3 dispersion modelling method is described in detail in Section 6 of the Air Quality TDR (Stantec 2014).

5.2.6.1.2 Assumptions and the Conservative Approach

The ability of a plume dispersion model to predict ambient concentrations depends on the accuracies of the source and emission inventory, the meteorology, and the assumptions used to represent the atmospheric physics and chemistry processes. The U.S. EPA (2005) indicates that the application of regulatory dispersion models is viewed as a “best estimate” approach and that this approach should be viewed as "acceptable to the decision maker.”

The application of SCREEN3 in this assessment is consistent with best practices and the Guidelines (BCMOE 2008). Care has been paid to conservatively estimate emission rates and emission parameters. Atmospheric physics are conservatively portrayed. There is a high degree of confidence that predicted concentrations in the assessment are conservative; meaning Project effects are likely overpredicted.

The modelling method and confidence in the assessment are described in detail in the Air Quality TDR (Stantec 2014; Section 6 and 8).

5.2.6.2 Assessment of Change in Ambient Air Quality along the Marine Access Route

5.2.6.2.1 Description of Project Effect Mechanisms for Change in Ambient Air Quality along the Marine Access Route

In the operation phase, air emissions from marine vessels will result in increases to the overall regional air emissions. The operation phase is expected to last for a minimum duration of twenty-five years.

5.2.6.2.2 Mitigation for Change in Ambient Air Quality along the Marine Access Route

Throughout construction and operation, LNG Canada will control CAC emissions from marine vessels by implementing the following mitigation measure:

- construction vessels, supporting tugs, and LNG carriers will use low-sulfur fuel in compliance with applicable marine emission standards (IMO 2008)(Mitigation 5.2-8).

5.2.6.2.3 Characterization of Change in Ambient Air Quality along the Marine Access Route

The Project-alone case shipping modelling scenario considers only emissions from Project vessels in transit along the marine access route. Marine vessel emissions contribute a small incremental addition of CAC and VOCs emissions to the shipping RSA. The annual Project-alone case shipping emissions are as follows: SO_2 = 17.6 tonnes; NO_X = 465 tonnes; CO = 65.0 tonnes; $PM_{2.5}$ = 9.12 tonnes; H_2S = 0 tonnes; and VOCs = 27.0 tonnes.

All predicted concentrations for SO_2, NO_2, CO, and $PM_{2.5}$ at receptors along the shipping LSA are a small fraction of the most stringent applicable objective. Comparison with the BC interim objectives for SO_2 and NO_2 indicates that the predicted concentrations are also lower than these objectives. The predicted VOCs concentrations are well below any level of concern.

The maximum predicted 1-hour average ground-level SO_2 concentration associated with the Project-alone case marine emissions is 3.62 µg/m^3. This is predicted at Hartley Bay, the community closest to the marine access route (2 km). At Metlakatla Village, 27 km from the marine access route, the maximum predicted 1-hour average ground-level SO_2 concentration is 1.08 µg/m^3. These concentrations are well below the most stringent applicable AAQO. Given the limited amount of time that the marine vessels will spend in proximity to any given receptor along the marine access route, these exposures will not measurably elevate existing SO_2 levels.

5.2.6.2.4 Determination of Significance for Change in Ambient Air Quality along the Marine Access Route

All maximum predicted concentrations of SO_2, NO_2, CO, $PM_{2.5}$, and H_2S for the Project-alone case marine vessels are less than the most stringent applicable objectives and are less than the interim objectives for SO_2 and NO_2.

The residual effects of the Project-alone case within the shipping LSA are characterized as low in magnitude and confined largely to the LSA, long-term. The frequency is multiple and regular over the operation phase. The residual effects occur in a highly resilient environment; however, they are reversible after emissions decrease or cease. Residual adverse effects (high predicted concentrations) occur sporadically over time.

Section 7.2.1 of the Air Quality TDR (Stantec 2014) show that the geographic extent of the predicted effects is localized to near the LNG carriers and tugs. Areas further removed from the centre of the shipping LSA, including various communities and locations of interest, are less affected. Residual adverse effects occur only sporadically over time. The atmospheric environment has a high degree of resilience to changes in air quality caused by the Project.

With the mitigation and environmental protection measures, the change in ambient air quality along the shipping LSA is assessed to be not significant.

5.2.6.3 Summary of Project Residual Effects from Shipping

The change in ambient air quality along the shipping LSA is summarized in Table 5.2-8. All emissions from shipping occur during the operation phase (e.g., does not include construction shipping). With implementation of the mitigation and environmental protection measures, the change in ambient air quality along the shipping LSA is assessed to be not significant.

5.2.7 Summary of Project Residual Effects

Because emissions during operation are greater and of longer duration than any other phase, increased CAC concentrations for the application case are assumed to characterize the entire Project's residual effects (i.e., construction and decommissioning have lesser residual effects).

With implementation of the mitigation and environmental protection measures, the residual effects of the Project in the facility LSA and shipping LSA are assessed to be not significant.

5.2.8 Assessment of Cumulative Effects

Cumulative effects are considered for each Project-specific residual effect. Three stages are involved: (1) establishing context by providing an overview of the cumulative effects of other projects and activities on the VC; (2) determining the potential for Project-specific residual effects to interact with the effects of other projects and activities; and if the Project does interact cumulatively with other actions, (3) assessing the significance of the resulting overall cumulative effect, and characterizing the Project's contribution to the change in cumulative effects.

5.2.8.1 Stage 1 – Cumulative Effects Context

Existing and reasonably foreseeable projects located in the RSA that interact cumulatively with Project residual effects are summarized below (see Table 5.2-9). The existing and approved projects include the RTA facility and Modernization Project and the Kitimat LNG Project (based on a gas turbine driver scenario). The planned and announced projects located in the RSA include Douglas Channel LNG Terminal (also known and BC LNG), Enbridge Northern Gateway Project, and Kitimat Clean West Coast Refinery (Kitimat Clean).

Of these, the Douglas Channel LNG Terminal is not considered in this assessment because there is no available information on record and no reasonably foreseeable starting date. The Project interacts cumulatively with existing and reasonably foreseeable projects; hence assessing the significance of the resulting overall cumulative effect is warranted.

Table 5.2-8: Summary of Project Residual Effects: Air Quality

Project Phase	Mitigation Measures	Residual Effects Rating Criteria: Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context	Likelihood of Residual Effects	Significance	Prediction Confidence	Follow-up and Monitoring
Facility Works and Activities											
Change in Ambient Air Quality in the Kitimat Airshed											
Construction	▪ Mitigation 5.2-1 ▪ Mitigation 5.2-2 ▪ Mitigation 5.2-3 ▪ Mitigation 5.2-4 ▪ Mitigation 5.2-6 ▪ Mitigation 5.2-7 ▪ Mitigation 5.2-8	L	LSA	LT	MR	R	M	H	N	H	No follow -up programs are proposed for air quality.
Operation	▪ Mitigation 5.2-5 ▪ Mitigation 5.2-6	M	LSA	LT	C	R	M	H	N	H	
Decommissioning	▪ Same as construction	L	LSA	MT	MR	R	M	H	N	H	
Residual effects for all phases		M	LSA	LT	C	R	M	H	N	H	
Shipping Activities											
Change in Ambient Air Quality along the Marine Access Route											
Operation	▪ Mitigation 5.2-8	L	LSA	LT	MR	R	H	H	N	H	No follow -up programs are proposed for air quality.
Residual effects for all phases		L	LSA	LT	MR	R	H	H	N	H	

KEY

MAGNITUDE:

N = Negligible—no measurable change

L = Low—within normal variability of baseline conditions

M = Moderate—increase/decrease with regard to baseline but within regulatory levels and objectives

H = High—singly or as a substantial contribution in combination with other sources causing exceedances of AAQO beyond the project boundaries

GEOGRAPHIC EXTENT:

PF = Project footprint—effects are restricted to the Project footprint

LSA—effects extend into the LSA
RSA—effects extend into the RSA

DURATION:

ST = Short-term—effects are measurable for less than 1 month

MT = Medium-term—effects are measurable for greater than 1 month but less than 2 years

LT = Long-term—effects are measurable for between 2 years and the life of the Project (approximately 25 years)

FREQUENCY:

S = Single event—occurs once

MI = Multiple irregular—occurs at sporadic intervals

MR = Multiple regular—occurs regularly and at regular intervals

C = Continuous—occurs continuously

REVERSIBILITY:

R = Reversible—recovery occurs after Project closure and reclamation

I = Irreversible—permanent

CONTEXT:

L = Low resilience: occurs in a fragile ecosystem and/or highly disturbed environment

M = Moderate resilience: occurs in a stable ecosystem and/or moderately disturbed environment

H = High resilience: occurs in viable ecosystem and/or undisturbed environment

SIGNIFICANCE:

S = Significant

N = Not Significant

PREDICTION CONFIDENCE:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made.

L = Low level of confidence

M = Moderate level of confidence

H = High level of confidence

LIKELIHOOD OF RESIDUAL EFFECT OCCURRING :

Based on professional judgment

L = Low likelihood that there will be a residual effect

M = Moderate likelihood that there will be a residual effect

H = High likelihood that there will be a residual effect

Table 5.2-9: Potential for Cumulative Effects on Air Quality

Other Projects and Activities with Potential for Cumulative Effects	Potential Cumulative Effects	
	Change in ambient air quality in the Kitimat airshed	Change in ambient air quality along the marine access route
Kitimat Area Project/Facility		
Douglas Channel LNG Project (also known as BC LNG)	✓	✓
Enbridge Northern Gateway Project	✓	✓
Kitimat Clean	✓	✓
Kitimat LNG Terminal Project	✓	✓
MK Bay Marina	✓	✓
Rio Tinto Alcan Facility and Modernization Project	✓	✓
Sandhill Materials – Aggregate Processing	✓	
Activity		
BC Ferries		✓
Cruise Ships		✓

NOTES:
✓ = those 'other projects and activities' whose effects have potential to interact cumulatively with the Project's residual effects.

5.2.8.2 Stage 2 – Determination of Potential Cumulative Interactions

5.2.8.2.1 LNG Facility

The Project plus existing and approved facilities are included in the application case. The Project plus existing and approved facilities (the application case) plus planned and announced projects are included in the cumulative case.

Existing and approved facilities located in the RSA include:

- RTA facility and Modernization Project, and
- Kitimat LNG (based on a gas turbine driver scenario).

Emissions information for the RTA facility and Modernization Project and the Kitimat LNG facility (based on a gas turbine driver scenario) comes from publicly available information sources and or from direction received from regulators. Of these, the RTA facility and Modernization Project has the greatest potential for cumulative interactions. The RTA facility and Modernization Project emits substantial quantities of two common SOIs (SO_2 and NO_X) from facilities and marine vessels at the RTA jetty. Because the RTA facility is immediately adjacent to the Project, these effects overlap with those of the Project. To a lesser extent there is potential for cumulative interactions with Kitimat LNG and marine vessels at the Kitimat LNG jetty. Kitimat LNG emits two common SOIs (SO_2 and NO_X); however, given a separation of 10 km, the potential that effects from Kitimat LNG may overlap with those of the Project are less than for RTA facility.

In addition to existing facilities, there are noted interactions in Table 5.2-9 with BC Ferries and cruise ships. These emissions are a small part of total emissions and have not been quantitatively assessed. Their omission has an immeasurably small effect on the overall predicted concentrations and does not materially affect the conclusions of the assessment.

Planned and announced projects located in the RSA include:

- Douglas Channel LNG Terminal (BC LNG)
- Enbridge Northern Gateway Project (ENGP), and
- Kitimat Clean.

Details on the BC LNG project are not publicly available; therefore, it is not considered. Emissions information for ENGP comes from publicly available information sources. The EAO, in cooperation with MOE, provided emissions information for the Kitimat Clean facility.

Both the ENGP and Kitimat Clean projects have a low potential for cumulative interactions. The ENGP and Kitimat Clean facilities emit small quantities of two common SOIs (SO_2 and NO_X) from facilities and marine vessels in Douglas Channel. ENGP is located 5 km away, and marine vessels at its jetty are the two main sources of SOIs. Kitimat Clean facility is located greater than 30 km to the north of the Project and promises state-of-the-art emission controls. The marine vessels associated with Kitimat Clean will have some emissions of SOI near the Project site; however, the location of its jetty is unknown. The MK Bay Marina and Sandhill Materials aggregate processing emissions are not considered because the quantities are small and emitted intermittently. Their inclusion would not materially affect the conclusions here.

5.2.8.2.2 Shipping

All of the other projects have a marine transportation component. Operationally, marine vessels maintain a high degree of separation in time and space while in transit and passing one another. This separation, combined with the discontinuous (mobile) nature of the emissions, precludes the possibility of meaningful cumulative effects.

Residual effects of the shipping associated with the Project are assessed to be not significant (Section 5.2.6.2). The SCREEN3 assessment demonstrated that even after making the highly conservative assumption that marine vessels are depicted as continuous, stationary sources, concentrations are a small fraction of the most stringent AAQO. By depicting the Project's marine vessels as continuous, stationary sources, the residual effects assessment anticipates the cumulative effect of multiple overlapping and mobile vessels adjacent to communities and locations of interest. Cumulative effects from shipping are therefore identical to the Project residual effects from shipping.

5.2.8.3 Stage 3 - Determining Significance of Cumulative Effects

There is a reasonable expectation that the contribution of the Project's residual effects will cause a change in cumulative effects that could affect the quality or sustainability of air quality. Accordingly, an assessment of cumulative effects follows, first of the application and base cases (to consider Project interactions with existing and approved facilities) and second, of the cumulative and base cases (to consider Project interactions with existing and approved facilities, plus planned and announced projects).

5.2.8.3.1 Cumulative Effects from Interactions between the Project and Planned and Announced Projects

Emission summaries and dispersion modelling results for the cumulative case are presented in this section. The cumulative case illustrates the effect of adding Project-alone emissions to the planned and announced projects emission sources. The significance determination for the Project and planned and announced projects are determined for the cumulative case and relies on comparisons between the cumulative case and the Project-alone case. Results of the Project-alone case are presented in Section 5.2.5.2.

The annual cumulative case emissions are as follows: SO_2 = 16,957 tonnes; NO_X = 5,643 tonnes; CO = 4,708 tonnes; $PM_{2.5}$ = 1,023 tonnes; H_2S = 22.7 tonnes; and VOCs = 455 tonnes.

All predicted concentrations for NO_2, CO, and $PM_{2.5}$ are a small fraction of the most stringent applicable objective. Comparison with the BC interim objectives for NO_2 indicates that the predicted concentrations are also lower than these objectives. The predicted VOCs concentrations are well below any level of concern.

The maximum predicted 1-hour, 3-hour, 24-hour, and annual average ground-level SO_2 concentrations associated with the cumulative case are 3,460 $\mu g/m^3$, 2,170 $\mu g/m^3$, 592 $\mu g/m^3$, and 33.5 $\mu g/m^3$, respectively. These concentrations are well above the most stringent applicable AAQO. Comparison with the BC interim objectives for SO_2 indicates that the predicted concentrations are also greater than these objectives.

The maximum predicted SO_2 concentrations are unchanged from those presented in the application case despite the Kitimat Clean facility emitting 872 tonnes per year of SO_2. This is owing to the distance between the Kitimat Clean facility and the Project (30+ km).

Isopleth maps in Appendix G of the Air Quality TDR (Stantec 2014) show the geographic extent of predicted effects in the cumulative case to be localized near the LNG facility and on isolated hillsides above and to the west of the facility. Areas farther removed from the LNG facility, including the city of Kitimat, are less affected. Cumulative adverse effects occur sporadically.

The predicted exceedance area in the cumulative case lies just to the west of the RTA facility. It is almost entirely attributable to the base case SO_2 emissions. Emissions from RTA facility make up 90.3% of the cumulative case SO_2 emissions. A supplemental assessment of model output shows the following:

- the base case contribution to the cumulative case maximum predicted concentrations at the future case point of maximum impingement (paired in time) shows that the base case contributes 98% and 97% respectively to the 1–hour and annual average ground-level SO_2 concentrations, and
- the base case contribution to the cumulative case maximum predicted concentrations at the Project-alone case point of maximum impingement (paired in time) shows that the base case contributes 83% and 95% respectively to the 1–hour and annual average ground-level SO_2 concentrations.

5.2.8.4 Summary of Cumulative Effects

Cumulative effects are characterized as high in magnitude. The RTA facility is largely responsible for predicted exceedances of objectives beyond the Project boundaries, hence the high magnitude rating. Cumulative effects are confined largely to the RSA, long-term, and continuous over the operation phase (see Table 5.2-10). Cumulative adverse effects (high predicted concentrations) occur sporadically over time.

Cumulative effects are moderate in magnitude because the Project is not responsible either singly or as a substantial contributor in combination with other sources for causing exceedances of AAQO beyond the Project boundaries. The contribution from the Project to the overall cumulative effect is moderate in magnitude. The cumulative effects occur in a moderately resilient environment; however, they are reversible after emissions decrease or cease.

With implementation of the mitigation and environmental protection measures, the cumulative effects associated with the facility are assessed to be not significant.

Table 5.2-10: Summary of Cumulative Effects on Air Quality

Effects	Other Projects, Activities and Actions	Cumulative Effects Characterization					
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context
Facility Works and Activities							
Cumulative change in ambient air quality							
Cumulative effect with the Project and other projects, activities and actions ▪ Some modelled exceedances of AAQOs	▪ Rio Tinto Alcan Facility and Modernization Project ▪ Kitimat LNG Terminal Project ▪ Douglas Channel LNG Terminal (BC LNG) ▪ Enbridge Northern Gateway Project (ENGP) ▪ Kitimat Clean ▪ MK Bay Marina ▪ Sandhill Materials – Aggregate Processing	H	RSA	LT	C	R	M
Contribution from the Project to the overall cumulative effect ▪ Incremental increase in CACs within guidelines		M	LSA	LT	C	R	M
Shipping Activities							
Cumulative change in ambient air quality							
Cumulative effect with the Project and other projects, activities and actions ▪ Increase in CACs within regulatory guidelines	▪ Rio Tinto Alcan Facility and Modernization Project ▪ Kitimat LNG Terminal Project ▪ Douglas Channel LNG Terminal (BC LNG) ▪ Enbridge Northern Gateway Project (ENGP) ▪ MK Bay Marina	M	RSA	LT	MR	R	M
Contribution from the Project to the overall cumulative effect ▪ Incremental increase in CACs within regulatory guidelines		M	LSA	LT	MR	R	M

KEY

MAGNITUDE:

N = Negligible—no measurable change

L = Low—within normal variability of baseline conditions

M = Moderate—increase/decrease with regard to baseline but within regulatory levels and objectives

H = High—singly or as a substantial contribution in combination with other sources causing exceedances of AAQO beyond the project boundaries

GEOGRAPHIC EXTENT:

PF = Project footprint—effects are restricted to the Project footprint

LSA—effects extend into the LSA
RSA—effects extend into the RSA

DURATION:

ST = Short-term—effects are measurable for less than 1 month

MT = Medium-term—effects are measurable for greater than 1 month but less than 2 years

LT = Long-term—effects are measurable for between 2 years and the life of the Project (approximately 25 years)

FREQUENCY:

S = Single event—occurs once

MI = Multiple irregular—occurs at sporadic intervals

MR = Multiple regular—occurs regularly and at regular intervals

C = Continuous—occurs continuously

REVERSIBILITY:

R = Reversible—recovery occurs after Project closure and reclamation

I = Irreversible—permanent

CONTEXT:

L = Low resilience: occurs in a fragile ecosystem and/or highly disturbed environment

M = Moderate resilience: occurs in a stable ecosystem and/or moderately disturbed environment

H = High resilience: occurs in viable ecosystem and/or undisturbed environment

SIGNIFICANCE:

S = Significant

N = Not Significant

PREDICTION CONFIDENCE:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made.

L = Low level of confidence

M = Moderate level of confidence

H = High level of confidence

LIKELIHOOD OF RESIDUAL EFFECT OCCURRING :

Based on professional judgment

L = Low likelihood that there will be a residual effect

M = Moderate likelihood that there will be a residual effect

H = High likelihood that there will be a residual effect

The shipping cumulative effects are characterized as moderate in magnitude. Cumulative effects are confined largely to the RSA, long-term, and multiple regular over the operation phase (see Table 5.2-10). Cumulative adverse effects (high predicted concentrations) do not occur.

The shipping cumulative effects are moderate in magnitude because the Project is not responsible either singly or as a substantial contributor in combination with other sources for increasing existing levels of CACs. The contribution from the Project to the overall cumulative effect is moderate in magnitude. The cumulative effects occur in a moderately resilient environment; however, they are reversible after emissions decrease or cease.

With implementation of the mitigation and environmental protection measures, the cumulative effects from shipping are assessed to be not significant.

5.2.9 Prediction Confidence and Risk

The ability of a plume dispersion model to predict ambient concentrations depends on the accuracies of the source and emission inventory, the meteorology, and the assumptions used to represent the atmospheric physics and chemistry processes. The U.S. EPA (2005) indicates that the application of regulatory dispersion models is viewed as a “best estimate” approach and that this approach should be viewed as "acceptable to the decision maker.”

The application of CALPUFF in this assessment is consistent with best practices and the Guidelines (BCMOE 2008). Care has been paid to conservatively estimate emission rates and emission parameters. Atmospheric physics and chemistry are portrayed accurately. There is a high degree of confidence that predicted concentrations in the assessment are conservative; meaning Project effects are likely overpredicted.

The modelling method and confidence in the assessment are described in detail in Section 6 and Section 8 of the Air Quality TDR (Stantec 2014).

5.2.10 Follow-up Program and Compliance Monitoring

No follow-up programs are proposed for air quality. Compliance monitoring to be implemented through Environmental Management Plans is described in Section 12 and Section 21 (Table 21.3–1).

5.2.11 Summary of Mitigation Measures

LNG Canada commits to monitor and report emissions consistent with the monitoring and reporting requirements of its *Environmental Management Act* permit, once issued. Other reporting as required is similarly included as a commitment (e.g., National Pollutant Release Inventory).

The following mitigation measures will be implemented to address potential effects on air quality during construction, operation and decommissioning activities:

- manage vehicle and equipment emissions by conducting regular maintenance on all machinery and equipment (Mitigation 5.2-1)
- control construction-related fugitive road dust, through measures such as speed limits on Project-controlled gravel roads and road watering on an as-needed basis (Mitigation 5.2-2)
- optimize timber salvage and offer available timber to local communities. (Mitigation 5.2-3)
- prohibit the open burning (or incineration) of accumulated waste materials from the workforce accommodation centre(s) (Mitigation 5.2-4)
- manage, through Project engineering design and operational procedures, the NOX emissions associated with the gas turbine exhaust and incinerator exhaust to meet regulatory requirements (Mitigation 5.2-5)
- adhere to the Air Quality Management Plan (Mitigation 5.2-6)
- diesel fired equipment will be powered by low sulphur fuel (Mitigation 5.2-7), and
- construction vessels, supporting tugs, and LNG carriers and assist tugs will use low-sulfur fuel in compliance with applicable marine emission standards (IMO, 2008) (Mitigation 5.2-8).

5.2.12 Conclusion

Project emissions have a potential to interact with many other sources in the RSA that have a potential to result in changes in ambient air quality in the Kitimat airshed and changes in ambient air quality along the marine access route. After mitigation, which includes adherence to the Air Quality Management Plan, reduction of continuous NO_X emissions associated with gas turbine exhaust, and the use of low-sulphur fuel, the Project residual effects and cumulative effects are not significant. The Project is not, either singly or as a substantial contributor in combination with other sources, responsible for causing exceedances of AAQO beyond the Project site fenceline.

There is a high degree of confidence in the conclusions owing to the quantification of emissions, the conservative nature of plume dispersion modelling, and the emphasis placed on quality control of all components of the modelling procedures.