2 AIR QUALITY

2.1 Introduction

2.1.1 Focus

The project will produce airborne emissions that will increase ambient concentrations of certain compounds in the airshed. The air quality assessment predicts emissions from project operations and predicts ground-level concentrations of selected compounds emitted by project equipment.

The assessment also predicts acid deposition. Acidification potential is important in the Mackenzie Valley where ecosystems are subjected to a harsh climate and short growing season.

The focus of the air assessment is therefore on predicting changes in air concentrations and acid deposition rates. The effects these changes might have on the receiving environment will be dealt with in other sections of this volume, e.g., Section 6, Water Quality and Section 9, Vegetation.

Climate change, including the effect of climate change on the biophysical baseline, is addressed in Section 11, Climate Change.

Key issues for the air quality assessment were developed through stakeholder consultations and an understanding of the operational details of the proposed project. Following are the key air quality issues, followed by detailed assessments.

2.1.2 Summary of Findings

2.1.2.1 Changes in Air Quality

The following sections provide detailed results of the predicted air quality changes in the production area, gathering system, pipeline corridor and at the NGTL interconnect facility.

The following conclusions were reached regarding air quality effects:

- ground-level concentrations of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 2.5 µm in diameter ($PM_{2.5}$) and selected volatile organic compounds (VOCs) are all below applicable federal and territorial guideline levels at all locations in the production area and pipeline corridor

- ground-level concentrations in selected communities and at other receptors of importance to communities are below applicable guideline levels

- the potential acid input (PAI) levels predicted over the project areas are below threshold for the most sensitive ecosystems

2.1.2.2 Greenhouse Gas Emissions

Greenhouse gas emissions from the project will be about 720 kt/a ECO_2 (i.e., equivalent carbon dioxide values) in the production area, about 550 kt/a ECO_2 at the Inuvik area facility, and about 465 kt/a ECO_2 in the pipeline corridor.

2.1.3 Traditional Knowledge

Volume 1, Section 3, Traditional Knowledge, outlines the status of the traditional knowledge studies that communities near the project are undertaking. Because these studies are in progress, the proponents used existing published traditional knowledge in this EIS. There is no published traditional knowledge information on air in the reference data.

2.2 Assessment Approach

Volume 1, Section 2, Assessment Method, provides a description of the general assessment approach. The approach for air quality included the following steps:

1. Identify project-related activities and associated physical and chemical changes that might affect air quality and greenhouse gas emissions, i.e., key issues.

2. Identify key indicators (KIs) for measuring potential changes in valued components (VCs) resulting from project activities. In this assessment, air quality is the VC.

3. Identify the potential effects and illustrate the linkages between project activities and effects in the form of an effect pathway diagram.

4. Identify mitigation that will be implemented to reduce or prevent potential effects.

5. Evaluate the applicability of each pathway, after accounting for mitigation measures.

6. Predict changes in air quality and greenhouse gas emissions for the applicable pathways.

7. Evaluate and classify the predicted effects based on results of analysis and comparison with regulatory guideline values and established thresholds.

8. Identify the monitoring programs required to verify effect predictions and to comply with commitments described in Volume 7, Environmental Management.

2.2.1 Key Issues

The key air quality issues for the project were identified through community input, including regional technical workshops and community-level meetings. These issues were grouped into three categories:

- existing air quality, climate and meteorological conditions
- emissions during construction and operations
- effects of emissions on the environment and traditional land use

Volume 3, Section 2, Air Quality provides a complete description of the existing air quality, climate and meteorological conditions. The air quality assessment focused on effects from project emissions at peak operations, when emissions and

effects would be at a maximum. Effects associated with construction activities are not addressed in this assessment because they:

- will be lower magnitude than those of peak operations
- will be localized
- will occur over a brief period

2.2.2 Valued Components and Key Indicators

2.2.2.1 Selection Process

Air quality is the VC for this assessment. Key indicators provide a means of practically measuring and assessing changes in air quality. Key indicators for air quality were selected based on likely constituents of project emissions and typical regulatory requirements for projects of this type. The KIs in this assessment are:

- ambient concentrations of SO_2
- ambient concentrations of NO_2, which result from emissions of oxides of nitrogen (NO_X)
- ambient concentrations of CO
- ambient concentrations of $PM_{2.5}$, i.e., airborne particles that have an aerodynamic diameter smaller than 2.5 μm
- ambient concentrations of VOCs, specifically benzene and BTEX, i.e., benzene, toluene, ethylbenzene and xylene
- potential acid input, which measures the potential deposition of acid-forming compounds
- ice fog
- emissions of a group of gases collectively referred to as greenhouse gases (GHGs), which primarily include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)

Table 2-1 is a summary of the key indicators and how they relate to the various selection criteria applicable to this project.

Sulphur Dioxide

The natural gas produced by the project, and used as fuel at the facilities, is sweet gas that is effectively free of sulphur compounds. Therefore, project SO_2 emissions will be very low. Despite these low SO_2 emissions, the air quality assessment has included this key indicator to ensure regulator and stakeholder concerns are addressed.

Table 2-1: Selection Criteria for Key Indicators

Key Indicator	Regulatory Status	Stakeholder Concerns	Ecological Vulnerability	Importance to Local Communities	Precedence in Other Assessments
Sulphur dioxide (SO_2)	●	●	N/A	●	●
Nitrogen dioxide (NO_2)	●	N/A	N/A	N/A	●
Carbon monoxide (CO)	●	N/A	N/A	N/A	●
Fine particulate matter ($PM_{2.5}$)	●	●	N/A	●	●
Benzene and BTEX (benzene, toluene, ethylbenzene, xylene)	●	●	N/A	●	●
Potential acid input	N/A	●	N/A	●	●
Ice fog	N/A	●	N/A	●	N/A
Greenhouse gases (GHGs)	●	●	N/A	●	●

NOTES:
● = indicates that selection criteria apply to the VC mentioned in this row
N/A = not applicable
Key indicators are used in lieu of VCs because of the nature of the air quality assessment

Nitrogen Dioxide

Nitrogen dioxide (NO_2) and nitric oxide (NO) are the primary NO_X emitted from the combustion sources at the facilities. The NO emissions can undergo chemical reactions in the atmosphere to form additional NO_2. Nitrogen dioxide was selected as a key indicator because it is the only oxide of nitrogen that is regulated in Canada. However, the assessment does present predicted NO_X concentrations as these are required to determine the NO_2 concentrations. There are no air quality guideline values or objectives for NO_X.

Carbon Monoxide

Carbon monoxide (CO) was identified as a key indicator because it can result from the incomplete combustion of fuels used at the facilities. It is also a regulated compound.

Fine Particulate Matter

Fine particulate matter can include:

- particles small enough to be inhaled, i.e., nominally smaller than 10 μm in diameter and referred to as PM_{10}

- particles small enough to be drawn deeply into the respiratory tract during breathing, i.e., nominally smaller than 2.5 μm in diameter and referred to as $PM_{2.5}$

The PM_{10} also includes all of the smaller $PM_{2.5}$ particles. Most airborne particles emitted from facilities during peak operations will be in the smallest size ranges. Therefore, they will be assessed using $PM_{2.5}$ as an indicator.

Benzene and BTEX

Volatile organic compounds can be released in small quantities from the incomplete combustion of fuel at facilities. Of the VOCs that could be released, this assessment focused specifically on benzene and BTEX, i.e., the combination of benzene, toluene, ethylbenzene and xylene. Benzene and BTEX concentrations were included as a key indicator because of the perceived association between oil and gas operations and benzene and BTEX levels in the air.

Potential Acid Input

Emissions of SO_2 and NO_X have the potential to react in the atmosphere and cause acid deposition in the environment. Acid deposition is important to consider not only because it has been raised by regulators and stakeholders, but also because of the potentially sensitive nature of the receiving environment, such as vegetation sensitive to acidic conditions. The key indicator used to evaluate acid deposition is PAI, as it includes the wet and dry deposition of sulphur and nitrogen compounds.

Ice Fog

Ice fog forms in calm conditions when there is excess moisture in the air and conditions are cold enough for the moisture to freeze. These conditions are familiar to residents of communities such as Inuvik. The formation of ice fog in communities is aggravated by local emission sources such as idling vehicles. Although ice fog tends to be a local phenomenon, there is a potential for some changes in ice fog conditions because of the project. Therefore, ice fog is included as a key indicator.

Greenhouse Gas Emissions

The project greenhouse gas emissions have been selected as a key indicator because of regulatory, stakeholder and regional concerns. Greenhouse gas emissions primarily include emissions of CO_2, CH_4 and N_2O.

2.2.2.2 Rejected Key Indicators

Ground-level ozone (O_3) concentrations were not included as a key indicator. When meteorological conditions are suited to photochemical ozone formation,

project emissions of NO_X and VOCs could contribute to higher ground-level O_3 concentrations. Such conditions are rare in northern Canada, and it is more likely that NO_X emissions from the project activities will reduce ground-level O_3 concentrations because of their scavenging effect on ozone. Therefore, it is difficult to predict how and to what extent ground-level O_3 concentrations might change. The background ozone levels are presented in the air assessment because they are used to determine the amount of NO_X that gets converted to NO_2 in the atmosphere.

Another key indicator raised by the public includes the formation of Arctic haze. Arctic haze is a large-scale phenomenon caused by continental movements of fine airborne particles and aerosols, e.g., water vapour, sulphates and nitrates, and dominated by large Arctic weather systems. As the project will not influence these systems, Arctic haze was rejected as a key indicator.

2.2.3 Key Questions and Effect Pathway Diagrams

Air quality issues were summarized by two key questions:

- How will the project affect air quality?
- How will the project contribute to potential greenhouse gas emissions?

Table 2-2 shows the relationship between key questions, issues and the key indicators used in the air quality assessment. Effect pathway diagrams were prepared that illustrate the various paths by which project activities could affect air quality or greenhouse gas emissions. The effect pathway diagrams are presented along with each key question in subsequent sections.

Table 2-2: Key Questions, Related Issues and Key Indicators

Key Question	Related Key Issue	Potentially Affected Key Indicators
How will the project affect air quality?	• Emissions from the construction and operations of the project • Effects of emissions on the environment and traditional land use	• Ambient sulphur dioxide (SO_2) concentrations • Ambient nitrogen dioxide (NO_2) concentrations • Ambient carbon monoxide (CO) concentrations • Ambient fine particulate matter ($PM_{2.5}$) concentrations • Ambient benzene and BTEX concentrations • Potential acid input (PAI) levels • Ice fog
How will the project contribute to potential greenhouse gas emissions?	• Emissions from the construction and operations of the project	• Greenhouse gas emissions (GHG)

2.2.4 Effect Descriptions

The project's effects on air quality are described using a series of effect attributes (see Table 2-3):

- direction
- magnitude
- geographic extent
- duration

Table 2-3: Definitions of Effect Attributes for Air Quality

Attribute	Definition
Direction	
Adverse	The project is predicted to increase the key indicator value
Neutral	The project is predicted to have no effect on the key indicator value
Positive	The project is predicted to decrease the key indicator value
Magnitude	
No effect	The project will not change the key indicator
Low	The project will affect the key indicator, but this effect is unlikely to be detectable, i.e., <5% of established guideline levels or standards for that indicator
Moderate	The project will have a detectable effect on the key indicator, i.e., >5% of guideline values and standards, but the predicted effect is within established guideline levels or standards for that indicator
High	The project will affect the key indicator such that it will exceed its established guideline levels or standards
Geographic Extent	
Local	Effects are restricted to the local study area selected for each of the operating facilities
Regional	Effects are restricted to the regional study area
Beyond regional	Effects extend beyond the regional study area
National	Effects extend into southern Canada and possibly beyond the jurisdiction of the decision-making authority for the project
Duration	
Short term	Effects on the key indicator are limited to <1 year
Medium term	Effects on the key indicator occur from 1 to 4 years
Long term	Effects on the key indicator last more than 4 years but do not extend beyond 30 years after decommissioning and abandonment
Far future	Effects on the key indicator extend more than 30 years after decommissioning and abandonment

The combination of these effect attributes is used to determine if an effect is significant.

2.2.4.1 Direction

Direction describes the trend of the effect. For air quality, an adverse effect is one that increases the ambient concentration predicted for a key indicator. The direction is neutral if the project has no effect on a key indicator, and the direction is positive if the project decreases the value predicted for a key indicator.

2.2.4.2 Magnitude

Magnitude describes the severity or intensity of an effect. It is measured as changes in air concentrations, atmospheric deposition and emissions. Governments and regulators have established criteria to define maximum ambient air concentrations to ensure protection for humans, animals, vegetation, soil and water. These criteria are used to define the high-magnitude thresholds of air effects for the project, as levels below the criteria should have no adverse effects. Effects are assigned a moderate magnitude if their predicted value exceeds 5% of the criteria for most key indicators.

When assigning magnitudes for greenhouse gas emissions, project emissions were compared with the territorial and national emissions. When the greenhouse gas emissions exceed 1% of the projected 2010 territorial emissions, the effects are assigned a moderate magnitude. The greenhouse gas emissions are assigned a high magnitude when they exceed 1% of the forecasted 2010 national emissions.

Table 2-4 provides the basis of the magnitude ratings. As shown in the table, some of the eight key indicators identified in Table 2-1, shown previously, are assessed for different periods (i.e., one hour, 24 hour and annual). For simplicity, each of these assessed values will also be referred to as key indicators.

The magnitude determination criteria are based on available air quality standards. Northwest Territories Ambient Air Standards, which were updated at the end of 2002 (RWED 2002), have been used wherever possible. When they were not available, criteria were selected, in order of preference, from:

- federal criteria
- criteria from western Canadian jurisdictions
- criteria from eastern Canadian jurisdictions
- criteria from other North American jurisdictions

Table 2-5 is a summary of the air quality criteria referred to in the air assessment. However, other criteria might be used in sections that deal specifically with the effects of air emissions on the receiving environment, e.g., Section 6, Water Quality and Section 9, Vegetation.

Table 2-4: Magnitude Determination for Air Quality Effects

Key Indicator	Maximum Prediction			
1-hour sulphur dioxide (SO_2)[1] (µg/m³)	No change	<22.5[a]	<450	>450
24-hour SO_2[1] (µg/m³)	No change	<7.5[a]	<150	>150
Annual SO_2[1] (µg/m³)	No change	<2[a]	<30	>30
1-hour nitrogen dioxide (NO_2)[2] (µg/m³)	No change	<20[a]	<400	>400
24-hour NO_2[2] (µg/m³)	No change	<10[a]	<200	>200
Annual NO_2[2] (µg/m³)	No change	<5[a]	<100	>100
1-hour carbon monoxide CO[3] (µg/m³)	No change	<750[a]	<15,000	>15,000
8-hour CO[3] (µg/m³)	No change	<300[a]	<6,000	>6,000
24-hour fine particulate matter ($PM_{2.5}$)[1] (µg/m³)	No change	<2[a]	<30	>30
1-hour benzene[4] (µg/m³)	No change	<2[a]	<30	>30
1-hour total BTEX[5] (µg/m³)	No change	<2[a]	<30	>30
Potential acid input (keq/ha/a)	No change	<0.17[b]	<0.25[c]	>0.25[c]
Greenhouse gas emissions (kt/a)	No change	<17[d]	<7,640[e]	>7,640[e]
Magnitude	No Effect	Low	Moderate	High

NOTES:
a This value is about 5% of the available criteria used to determine a high magnitude
b Based on the Clean Air Strategic Alliance monitoring load value for sensitive ecosystems (CASA 1999)
c Based on the Clean Air Strategic Alliance critical load value for sensitive ecosystems (CASA 1999)
d Based on 1% of the 2010 GHG emission forecast (1,672 kt ECO_2/a) for the Northwest Territories (RWED 2001)
e Based on 1% of the 2010 GHG emission forecast (764,000 kt ECO_2/a) for Canada (Environment Canada 1999)
1 Based on the Northwest Territories Ambient Air Standards (RWED 2002)
2 Based on the acceptable Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981). Although NO_X predictions have been provided in the assessment, there are no regulatory guideline values for NO_X
3 Based on the desirable Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
4 Based on the Alberta Ambient Air Quality Guidelines (AENV 2000)
5 The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX as it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene

Emissions of SO_2 and NO_X have the potential to cause acid deposition in the environment. Potential acid input, the indicator used to evaluate the deposition of acid-forming compounds, includes the wet and dry deposition of sulphur and nitrogen species. Because PAI combines several chemical species, it is expressed in units of keq/ha/a, where keq refers to the number of equivalent hydrogen ions, i.e., 1 keq = 1 kmol H^+. Each molecule of sulphur is equivalent to two hydrogen ions, and each molecule of nitrogen is equivalent to one hydrogen ion. The assessment also shows the expected sulphate and nitrate deposition rates, which are not key air quality indicators. The potential effects of acid deposition are used by other disciplines that assess effects of air emissions on the environment, e.g., Section 9, Vegetation.

Table 2-5: Ambient Air Quality Guideline Values

Parameter	Northwest Territories Standards[1] (µg/m³)	Federal Air Quality Objectives[2]			Other Criteria (µg/m³)
		Desirable (µg/m³)	Acceptable (µg/m³)	Tolerable (µg/m³)	
Sulphur dioxide (SO_2)					
1-hour	450	450	900	N/A[3]	N/A
24-hour	150	150	300	800	N/A
Annual	30	30	60	N/A	N/A
Nitrogen dioxide (NO_2)					
1-hour	N/A	N/A	400	1,000	N/A
24-hour	N/A	N/A	200	300	N/A
Annual	N/A	60	100	N/A	N/A
Carbon monoxide (CO)					
1-hour	N/A	15,000	35,000	N/A	N/A
8-hour	N/A	6,000	15,000	20	N/A
Fine particulate matter ($PM_{2.5}$)					
24-hour	30	N/A	N/A	N/A	N/A
Benzene					
1-hour[3]	N/A	N/A	N/A	N/A	30
Toluene					
1-hour[4]	N/A	N/A	N/A	N/A	1,880
Ethylbenzene					
1-hour[5]	N/A	N/A	N/A	N/A	4,000
Xylene					
1-hour[4]	N/A	N/A	N/A	N/A	2,079

NOTES:
N/A = not applicable
1 Ambient Air Standards in the Northwest Territories (RWED 2002)
2 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
3 Alberta Ambient Air Quality Guidelines (AENV 2000)
4 Texas Natural Resources Conservation Commission Environmental Screening Levels (TNRCC 2000)
5 Ontario Point of Impingement Limit (Ontario Ministry of the Environment 2001)

Regional stakeholders identified the project's potential effects on acid deposition in the North as an important air quality issue. The critical load system, which combines acid deposition and the sensitivity of the receiving environment, has been used to evaluate the project's effects on acid deposition. The Clean Air Strategic Alliance (CASA) in Alberta has defined critical and monitoring loads as follows (CASA 1999):

- *the critical load is the highest level of deposition that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological system*
- *the target load is the level of deposition that provides long-term protection from adverse ecological consequences, and is practically and politically achievable*
- *the monitoring load is the level of acid deposition that should trigger monitoring and, or, research action*

Table 2-6 is a summary of the critical and monitoring loads developed by CASA for managing acid forming compounds in Alberta.

Table 2-6: Acid Deposition Criteria Used for the Air Quality Assessment

Sensitivity Level[1]	Critical Load[2] (keq/ha/a)	Target Load[2] (keq/ha/a)	Monitoring Load[2] (keq/ha/a)
High	0.25	0.22	0.17
Moderate	0.50	0.45	0.45
Low	1.00	0.90	0.70
NOTES: 1 Sensitivity of ecosystem receptors, for example soils and waterbodies 2 Loads are determined over map grid cells that are 1º latitude by 1º longitude			
SOURCE: CASA 1999			

The management numbers were not developed to manage PAI on a local scale. It is the view of CASA that the application of these targets should only be done on a 1° by 1° basis and that these levels should not be used when trying to manage on a smaller scale. This position was supported in a world-class science colloquium held in March of 2000 and re-affirmed by CASA and Alberta Environment in a workshop held in April of 2003. As local or maximum PAI values can be much higher than PAI predictions averaged over grid cells 1° by 1° in size, care must be taken when evaluating the potential environmental effects. For example, a maximum PAI prediction that appears to exceed a critical load value locally might be much lower than the critical load when averaged over a 1° by 1° area.

The PAI levels integrated over the local study areas (LSAs) are conservative estimates of gridded PAI levels because the LSAs are only 40,000 ha. This area is

much smaller than 1° by 1° grid cells that are at least 500,000 ha in size at these latitudes.

A conservative methodology was applied to determine the magnitude of project effects of PAI. An area PAI was calculated by averaging the PAI predictions over the LSA. The area PAI predictions were then compared with the CASA monitoring and critical load values for ecosystems with a high sensitivity, even though some of the areas affected could have low sensitivity. An evaluation of the effects of PAI on the receiving environment is presented in Section 6, Water Quality, Section 8, Soils, Landforms and Permafrost, and Section 9, Vegetation.

2.2.4.3 Geographic Extent

The geographic extent describes the area within which effects on key indicators are likely to occur. The geographic extent is local if effects are restricted to the LSA or regional if the effects are restricted to the regional study area (RSA). The local and regional study areas used in this assessment are detailed in Section 2.2.5, Study Areas and Boundaries. If an effect extends beyond the RSAs but is restricted to regions north of 60° and northwestern Alberta, the geographic extent is beyond regional. The geographic extent is national if the effects extend into southern Canada.

2.2.4.4 Duration

Duration describes the period in which an effect occurs, or how long a key indicator will take to return to pre-project conditions. If the effect and recovery are restricted to less than one year, the duration is short term. A duration of medium term is assigned if the effect lasts for more than a year but for less than four years, e.g., for effects that last throughout the construction phase. When the effect lasts more than four years but recovery is expected within 30 years of decommissioning and abandonment, the duration is long term. A duration of far future is assigned if the effects extend beyond 30 years after decommissioning and abandonment.

2.2.5 Study Areas and Boundaries

The air quality assessment uses dispersion models to predict changes in ambient concentrations and atmospheric deposition resulting from the project. Because of the large spatial extent of the project, it was necessary to define more than one airshed. These airsheds defined the area over which model predictions were made, and within which emissions from different facilities could interact. Emissions from one airshed are not expected to interact with emissions from the other airsheds.

2.2.5.1 Regional Study Areas

Three airsheds were identified from information about the location and type of facilities, regional meteorology and topography. The airsheds, which were the RSAs for the air assessment, were defined as follows:

- The northern airshed is a 150 by 200 km area that includes Niglintgak, Taglu and Parsons Lake, gathering pipelines, the Storm Hills pigging station and the Inuvik area facility (see Figure 2-1).

- The central airshed is a 250 by 375 km area that covers the northern part of the pipeline, including the Little Chicago compressor station and the Norman Wells compressor station (see Figure 2-2). There is a small gap between this airshed and both the northern and southern airsheds. However, there are no emission sources in these gap regions and, as mentioned previously, the extent of each airshed encompasses the air effects of emission sources within it.

- The southern airshed is a 300 by 500 km area that covers the southern part of the pipeline and includes the Blackwater River and Trail River compressor stations, the Trout River heater station and the NOVA Gas Transmission Ltd. (NGTL) interconnect facility (see Figure 2-3).

2.2.5.2 Local Study Areas

Local study areas were identified near each of the anchor fields and pipeline facilities. These define the areas where any effects are likely to occur. Each LSA is 20 by 20 km and is centred on a facility. The exception is the LSA for the Inuvik area facility, which was extended to the west to enclose the town of Inuvik. This LSA measures 32 km east to west and 20 km north to south.

2.2.5.3 Specific Sites

In addition to predictions made for the local and regional study areas, the air quality assessment also made predictions for:

- communities
- locations of importance to communities, e.g., fishing and hunting camps
- potentially sensitive lakes near the anchor fields and pipeline facilities

Table 2-7 lists the 19 communities for which predictions were made. Predictions were also made for an additional 57 locations where prolonged exposure could occur, such as fishing and hunting camps. These predictions were considered in the assessment of possible effects of air emissions on people living, hunting and trapping in the region (see Volume 6, Section 5.4, Human Health Risks).

Figure 2.1 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.2 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.3 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Table 2-7: Communities for Which Air Quality Predictions Were Made

Region	Community
Inuvialuit Settlement Region	Aklavik[1]
	Inuvik[1]
	Tuktoyaktuk
Gwich'in Settlement Area	Aklavik[1]
	Inuvik[1]
	Fort McPherson
	Tsiigehtchic
Sahtu Settlement Area	Colville
	Deline
	Fort Good Hope
	Little Chicago
	Norman Wells
	Tulita
Deh Cho Region	Fort Liard
	Fort Providence
	Fort Simpson
	Jean-Marie River
	Kakisa
	Nahanni Butte
	Trout Lake
	Wrigley

NOTE:
1 The communities of Aklavik and Inuvik are beside the boundary between the Inuvialuit Settlement Region and the Gwich'in Settlement Area and so have been shown in both regions

The results of PAI predictions made for 25 lakes in the production area are used in Section 6, Water Quality, to evaluate the effects of air emissions on surface water.

2.2.6 Analytical Approach

Two analytical techniques were used to evaluate project air quality:

- emission calculations
- dispersion modelling

2.2.6.1 Emissions Calculations

Emission rates were established for each project source as inputs to the dispersion models. Emission estimates for the project were developed using a combination of emission factor and mass balance calculations:

- Mass balance calculations account for materials entering and leaving a process, the reaction that occurs in the system and the residual atmospheric release.

- Emission factor calculations use accepted constants from the literature to identify an emission rate for a process based on energy input, power output or process flow. The constants represent average emission rates derived from multiple tests.

Several references were consulted to obtain the most current emission factors, with the primary resource being the AP-42 document published by the U.S. Environmental Protection Agency (U.S. EPA 1995). The AP-42 emission factors are the most widely recognized source of credible emission factors in the industry. If available, proposed emission standards by the Canadian Council of Ministers of the Environment (CCME) were used to estimate emissions. Whereas modern equipment might be able to meet or even exceed the current CCME standards, these values were used as a realistic but conservative estimate of NO_X emission rates for external combustion sources, i.e., heaters and gas-fired turbines. The Alberta *Code of Practice for Compressor and Pumping Stations and Sweet gas Processing Plants* (AEP 1996) was consulted to determine NO_X emission rates for reciprocating engines. Mass balance calculations were used to estimate SO_2 emissions from all sources.

In each case, an attempt has been made to provide a conservative and reasonable estimate of emissions from the sources identified. Conservative assumptions include the equipment running consistently at full capacity and the presence of 4 ppm (parts per million) sulphur in the fuel gas.

2.2.6.2 Dispersion Modelling

Air dispersion models simulate the atmospheric dispersion processes and atmospheric chemistry that link air emissions to changes in air quality and atmospheric deposition. These models were used to predict the transport, dispersion and chemical transformation of emissions from the facility in various meteorological conditions.

The CALPUFF dispersion model in 2-D mode was used for this air quality assessment. This model is widely used in similar assessments and is effective for evaluating ground-level concentrations and acid deposition. CALPUFF is one of the few models available that can complete the atmospheric chemistry and wet

and dry deposition necessary to predict PAI. CALPUFF is also suitable for evaluating concentration and deposition values close to the facilities and several hundred kilometres away, which is an important capability given the size of the project area. Although simpler models could have been used to assess some of the key indicators, CALPUFF is the only model that provides a consistent approach for all key indicators.

The CALPUFF model results were then used to determine the maximum short-term (1-hour), medium-term, (8-hour or 24-hour, depending on the key indicator), and long-term (annual) predictions in each LSA and at each of the selected locations discussed in Section 2.2.5, Study Areas and Boundaries. For each LSA, the maximum short-, medium- and long-term predictions can occur at different locations, as identified in the results tables. The number of times and areal extent where the short-, medium- and long-term predictions are expected to be over the applicable criteria are also listed.

The dispersion models use meteorological data as a key input to predict the transport, dispersion and chemical transformation of project emissions. Where practical, regulatory guidance suggests using at least one full year, i.e., 8,760 hours, of on-site data as input to the models. However, the size of the study areas in this air quality assessment makes this approach inappropriate. The alternative approach adopted in this assessment is to use five years, i.e., 43,824 hours, of hourly meteorological data from a regional station operated by the Meteorological Services of Canada. This approach is consistent with the Air Quality Code of Practice for the Upstream Oil and Gas Industry, Consultation Draft, produced by the GNWT (2002). This air quality assessment used three sources of meteorological data, one for each of the three airsheds, as follows:

- northern airshed – Inuvik, 1994 through 1998
- central airshed – Norman Wells, 1997 through 2001
- southern airshed – Fort Simpson, 1997 through 2001

2.3 Effects on Air Quality

2.3.1 Effect Pathways

The effect pathway diagram (see Figure 2-4) shows the key pathways and their intermediate pathways, e.g., white boxes, indicating how the project could potentially affect air quality VCs and KIs.

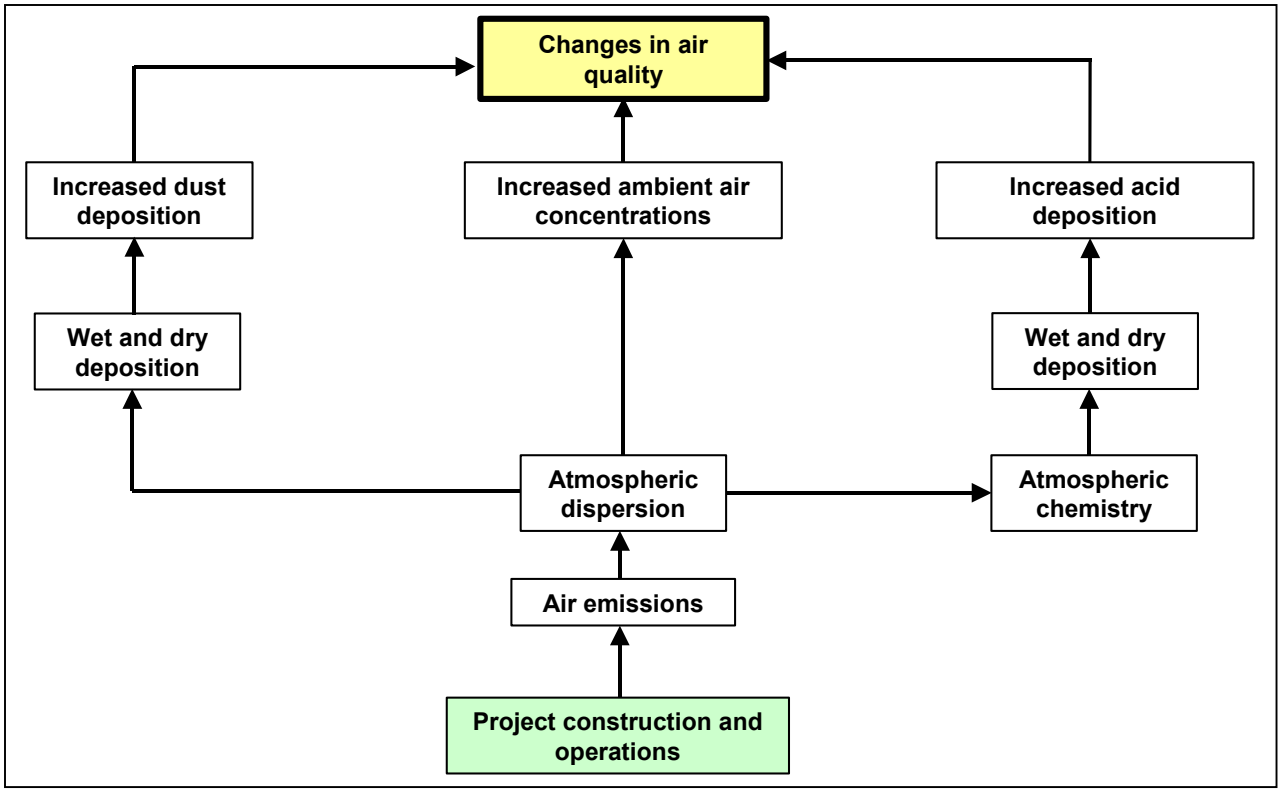

Figure 2-4: Effect Pathways – Air Quality

Each pathway was evaluated to determine if it would be applicable, given the mitigation planned for the project. A pathway was considered inapplicable if mitigation would eliminate the potential for effects on air quality. The pathways considered applicable for the air quality assessment are shown in Table 2-8. Each pathway, whether it is applicable or not, is discussed in the following sections.

Several project activities have the potential to contribute to air emissions. During construction these include facility and pipeline construction, operation of construction camps and movement of construction vehicles and aircraft during construction. During operations, potential emission sources include facility operations, well test flaring, process venting, fugitive emissions and vehicle movement.

Table 2-8: Applicable Pathways for Project Effects on Air Quality

Pathway	Applicable
Increased dust deposition	●[a]
Increased ambient air concentrations	●
Increased acid deposition	●

NOTES:
● = indicates that the pathway is considered valid
a Although the increased dust deposition pathway was considered applicable, it was not directly assessed as part of air quality, as discussed in Section 2.3.1.1, Increased Ambient Concentrations

The air emissions during construction were not quantified or assessed because they were determined to be small compared with the emissions during peak operations. The primary construction emissions will be dust generated from borrow sites, pipeline construction and vehicle movements along unpaved roadways. Such emissions are intermittent and likely to have effects that will be highly localized, short duration and low magnitude. Construction camps will also be potential sources of air emissions from space heating and from the incinerators used to manage wastes. Air effects from these sources would be limited to the immediate vicinity of the camps and of lower magnitude than effects during peak operations.

Finally, construction traffic will be a potential source of air emissions that will have an intermittent and temporary affect on air quality in the immediate vicinity of the roads. Given that traffic will not be stationary but travelling along the roadways, it is highly unlikely that the emissions will have any measurable effect on ambient air quality. Any changes in air quality because of traffic will be small compared with the effects expected near the stationary facilities during peak operating conditions.

During peak operations, the majority of air emissions will occur in the vicinity of the major project facilities. Therefore, much of the air assessment has focused on evaluating the effects associated with these operations. However, throughout the development and operations of the producing fields, it will be necessary to drill, complete and test wells. During testing, gas will be safely disposed of by flaring. Flaring during well tests can also contribute air emissions and has been assessed accordingly.

During the life of the project, there might be periods when facilities will need to relieve pressure by releasing gas to the atmosphere. The project proposes to use controlled venting to safely relieve pressure during these extreme events. Venting is considered a safe and reliable way of relieving pressure because this is a sweet gas project and is free of hydrogen sulphide. As venting does not include any combustion sources or emissions of hydrogen sulphide, no quantification of effects was completed. There is also the potential for small volumes of gases to be

released from valves and fittings during project operations. As such fugitive emissions are usually restricted to older operations and are expected to be very small given the modern design and configuration of this project, fugitive emissions were not quantified in the air assessment.

Although vehicle movements during operations might contribute to the project emissions, these will be minor compared with the operating facilities and are not considered in this assessment.

In summary, the primary source of project emissions will be caused by continuous operation of emission producing equipment at:

- gas conditioning facilities in the production area
- the Inuvik area facility
- compressor stations along the pipeline corridor
- Trail River heater station
- NGTL interconnect facility

Emission producing equipment includes turbines, power generators and heaters.

Air emissions from the operating facilities undergo the following processes, (see Figure 2-4, as shown previously):

- atmospheric dispersion – the physical process that transports and disperses air emissions, resulting in increased ground-level concentrations and direct effects on air quality

- atmospheric chemistry – the processes that transform emissions as they are dispersed in the atmosphere, resulting in increased acid deposition

- atmospheric deposition – the process associated with removal of emissions dispersed in the atmosphere and their deposition onto the ground, e.g., dust deposition and acid deposition

These processes will cause three possible changes in air quality:

- increased ambient concentrations
- increased acid deposition
- increased dust deposition

2.3.1.1 Increased Ambient Concentrations

Air emissions from facility operations and well test flaring might increase ambient concentrations of key indicators. The degree to which ambient air quality will change has been evaluated using the CALPUFF dispersion model described in Section 2.2.6, Analytical Approach.

2.3.1.2 Increased Acid Deposition

Emissions of SO_2 and NO_X from facility operations have the potential to react in the atmosphere to form acid compounds that could affect the environment when deposited on soils, vegetation or waterbodies. Potential increase in acid deposition because of the project has been evaluated using the CALPUFF dispersion model to determine sulphate and nitrate deposition, and from that, area PAI. The potential effect of acid deposition on the environment is discussed in Section 6, Water Quality, Sections 8, Soils, Landforms and Permafrost and Section 9, Vegetation.

2.3.1.3 Increased Dust Deposition

Increased dust deposition, mostly during construction and operations, would result from dust emissions caused by:

- facilities and rights-of-way construction
- extraction of borrow materials used during construction
- vehicle movement along unpaved roadways

In all cases, dust deposition would be a localized effect, as the larger dust particles will be deposited quickly and near their sources. Smaller particles, i.e., $PM_{2.5}$, will tend to remain airborne for longer periods and will not measurably contribute to dust deposition. The potential effects of increased dust deposition have been qualitatively incorporated into the vegetation effect assessment, i.e., Section 9, Vegetation.

2.3.2 Overview of Project Design and Mitigation

This section provides an overview of project design features and mitigation relevant to potential effects on air quality. The project design features are detailed in Volume 2, Project Description. Potential effects from the project will be reduced through best management practices during design, construction and operations, and decommissioning and abandonment.

Mitigation strategies for air quality will help reduce the magnitude or severity of the potential effects of the project via the pathways discussed previously in Section 2.3.1, Effect Pathways. The following sections describe these mitigation measures for construction and operations. Project mitigation measures are incorporated into the assessment of effects.

Table 2-9 summarizes proposed strategies to mitigate possible effects on air quality. These will reduce some short-term localized air quality effects.

Table 2-9: Air Quality Mitigation Strategies During Construction and Operations

Pathway	Primary Mitigation Strategy
Increased ambient air concentrations during operations Increased acid deposition during operations	Use equipment that meets with relevant standards including Northwest Territories regulations, CCME standards and Alberta standards (where regulations do not exist in the Northwest Territories) Consider efficiency in equipment selection Manage the need for and duration of flaring Ensure flare stack design requirements and flare performance standards are consistent with EUB Guide 60 and its amendments Use flare stacks of sufficient height to ensure proper dispersion
Increased ambient air concentrations during construction and operations	Apply best management practices to reduce fuel use Avoid idling vehicles except under extremely cold conditions
Increased dust deposition during construction and operations	Apply good site management practices for dust suppression to avoid community impacts

2.3.3 Niglintgak

Niglintgak will have:

- three well pads (north, south, central)
- six to twelve production wells
- a gas conditioning facility
- a disposal well
- above-ground flow lines
- a remote drilling sump
- supporting infrastructure

Two options are being considered for the Niglintgak gas conditioning facility:

- placing it on a barge in a side channel of Kumak Channel, adjacent to Kumak Island

- placing it on land east of the Kumak Channel

While two options are being considered for the Niglintgak gas conditioning facility, only the air modelling results for the land-based option have been presented in the EIS. These results are considered representative of both options because comparable equipment will be used at either site. In addition, there is little or no topography that could result in differences in predicted concentrations for either site. The stack locations of the two options are close enough that any differences in modelling results would be barely detectable.

2.3.3.1 Baseline Conditions

Niglintgak is distant from current sources of industrial air emissions, so background levels of combustion products, e.g., SO_2, NO_2, CO and $PM_{2.5}$, are low. Detectable levels of ozone are expected because ozone levels in northern Canada are naturally high. Background levels of VOCs are expected because organic compounds are released naturally by vegetation and decaying plant material. Background PAI, from long-range transport of acid-forming compounds emitted by large industrial facilities elsewhere in the northern hemisphere, is deposited by precipitation in the region.

Table 2-10 summarizes background concentrations of the key indicator compounds in Niglintgak. For additional background data, see Volume 3, Section 2, Air Quality.

Table 2-10: Baseline Air Conditions for Niglintgak

Parameter	Niglintgak
Sulphur dioxide (SO_2)[1] (µg/m³)	0.5
Nitrogen dioxide (NO_2)[1] (µg/m³)	0.8
Carbon monoxide (CO)[2] (µg/m³)	0.0
Fine particulate matter ($PM_{2.5}$)[2] (µg/m³)	0.0
Benzene (µg/m³)	3.0[a]
Total BTEX[3] (µg/m³)	4.9[a]
Potential acid input[4] (keq/ha/a)	0.03
Sulphate deposition[4] (kg/ha/a)	0.96
Nitrate deposition[4] (kg/ha/a)	0.62
Ozone (O_3)[1, 5] (µg/m³)	46.5

NOTES:
a SUMMA canister results for Taglu were applied to Niglintgak
1 Results based on passive monitoring data from Inuvik
2 Results assumed to be zero
3 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and was converted to µg/m³ assuming the molecular weight of benzene
4 Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories (Golder and Conor Pacific 1998)
5 Background ozone concentrations were not selected as a key indicator but are important in determining the quantity of NO_X emissions that are converted to NO_2 in the atmosphere

2.3.3.2 Niglintgak Effects

Table 2-11 shows the direction, magnitude, geographic extent and duration of air quality changes resulting from operations at their peak level. The direction is adverse for the 12 key indicators in the table, but the magnitude is low for seven of them because their predicted concentrations would not be detectable. Detectable is nominally defined as more than 5% of criteria. Moderate magnitude

was assigned to the 1-hour NO_2, 24-hour NO_2, 1-hour CO, 8-hour CO and 24-hour $PM_{2.5}$ concentrations, but their maximums were below the applicable objectives and standards. The duration was classified as long term because the effects will continue for the life of project operations.

Table 2-11: Effects on Air Quality at Niglintgak

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Low	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Moderate	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Project Emissions

Table 2-12 is a summary of project emission estimates for well test flaring and maximum operating conditions. Although Niglintgak produces sweet gas, SO_2 emissions were calculated assuming a nominal 4 ppm of sulphur compounds occur. This value is higher than the expected sulphur concentration in gas from the anchor fields. All sources will release very low levels of SO_2 because they will be powered by sweet natural gas. Some of the remaining compounds, i.e., $PM_{2.5}$, benzene and BTEX, will be released.

The following are the results of the air quality assessment for each key indicator at Niglintgak. The air quality assessment represents the combined effects of project sources in the northern airshed.

Table 2-12: Emissions from Niglintgak

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Niglintgak (well test flaring)	Full production[1]	0.74	0.69	–[a]	–[a]	–[a]	–[a]
Niglintgak (gas conditioning facility)	Compression	0.00	0.41	0.23	0.02	0.000	0.00
	Power generation	0.00	0.15	0.08	0.01	0.000	0.00
	Process equipment	0.00	0.07	0.08	0.01	0.000	0.00
	Total	0.00	0.63	0.38	0.03	0.000	0.00

NOTES:
SO_2 = sulphur dioxide
NO_X = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
a Emissions of other compounds from well testing were negligible and not quantified
1 Full production corresponds to a flaring rate of 700,000 m³/d
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might appear to add up to different values than the totals

Sulphur Dioxide

Table 2-13 summarizes the predicted ground-level SO_2 concentrations in Niglintgak. All maximum 1-hour, 24-hour and annual SO_2 predictions are below the Northwest Territories standards. The highest 1-hour SO_2 prediction is less than 0.09% of the Northwest Territories standard. Modelling results have not been shown in a figure because of the low levels of predicted SO_2.

Nitrogen Dioxide

Table 2-14 summarizes the predicted maximum ground-level NO_2 and NO_X concentrations in Niglintgak during well testing and during normal operations. It should be noted that NO_2 represents only a fraction of the NO_X concentrations for which there are no established guideline values or standards. During both activities, all NO_2 concentrations are below federal objectives. Modelling results have not been shown in a figure because of the low levels of predicted NO_2.

Carbon Monoxide

Combustion emissions at Niglintgak will affect ground-level CO concentrations. Predicted maximum ground-level CO concentrations (see Table 2-15) are much lower than the 1-hour and 8-hour federal objectives. Modelling results have not been shown in a figure because of the low levels of predicted CO.

Table 2-13: Sulphur Dioxide Predictions at Niglintgak

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Niglintgak (well test flaring)[1]	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	7.2	0.6	–[b]
	Distance to maximum[2] (km)	10.3	5.4	–[b]
	Direction to maximum[2]	WNW	WSW	–[b]
	Expected occurrences exceeding standard[3]	0.0	0.0	–[b]
	Area exceeding standard[4] (ha)	0	0	–[b]
Niglintgak (gas conditioning facility)	Maximum SO_2 concentration (µg/m³)	6.2	1.5	0.1
	Distance to maximum[2] (km)	0.1	0.1	0.1
	Direction to maximum[2]	SSW	SSW	SSW
	Expected occurrences exceeding standard[3]	0.0	0.0	0.0
	Area exceeding standard[4] (ha)	0	0	0
SO_2 standards[5] (µg/m³)		450	150	30

NOTES:
WNW = west-northwest
WSW = west-southwest
SSW = south-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond to the full production rate for Niglintgak
2 Distance and direction are relative to the centre of the Niglintgak production well pad
3 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations *exceeding* the applicable standards. It is the average of five years of modelling data, so it might not be a whole number
4 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
5 Ambient Air Standards in the Northwest Territories (RWED 2002)

Table 2-14: Nitrogen Dioxide and Oxides of Nitrogen Predictions at Niglintgak

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Niglintgak (well test flaring)[1]	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	6.7	0.5	–[b]
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	6.7	0.5	–[b]
	Distance to maximum[2] (km)	10.3	5.4	–[b]
	Direction to maximum[2]	WNW	WSW	–[b]
	Expected occurrences exceeding objective[3]	0.0	0.0	–[b]
	Area exceeding objective[4] (ha)	0	0	–[b]

Table 2-14: Nitrogen Dioxide and Oxides of Nitrogen Predictions at Niglintgak (cont'd)

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Niglintgak (gas conditioning facility)	Maximum NO_X concentration (µg/m³)	1,431.4	327.7	30.5
	Maximum NO_2 concentration (µg/m³)	147.2	33.6	3.9
	Distance to maximum[2] (km)	0.1	0.1	0.1
	Direction to maximum[2]	SSW	SSW	SSW
	Expected occurrences exceeding objective[3]	0.0	0.0	0.0
	Area exceeding objective[4] (ha)	0	0	0
NO_2 objectives[5, 6] (µg/m³)		400	200	100

NOTES:
SSW = south-southwest
WNW = west-northwest
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond to the full production rate for Niglintgak
2 Distance and direction are relative to the centre of the Niglintgak production well pad
3 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number
4 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
5 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
6 There are no Northwest Territories standards for NO_2

Table 2-15: Carbon Monoxide Predictions at Niglintgak

Area	Parameter	Averaging Period Predictions[a]	
		1-hour	8-hour
Niglintgak (gas conditioning facility)	Maximum carbon monoxide (CO) concentration (µg/m³)	777.4	315.0
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SSW	SSW
	Expected occurrences exceeding objective[2]	0.0	0.0
	Area exceeding objective[3] (ha)	0	0
CO objectives[4, 5] (µg/m³)		15,000	6,000

NOTES:
SSW = south-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to centre of the Niglintgak production well pad
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Fine Particulate Matter

Table 2-16 shows predicted maximum ground-level $PM_{2.5}$ concentrations. The maximum 24-hour concentrations are below the standard. Modelling results have not been shown in a figure because of the low levels of predicted $PM_{2.5}$.

Table 2-16: Fine Particulate Matter Predictions at Niglintgak

Area	Parameter	Averaging Period Predictions[a]	
		24-hour	Annual
Niglintgak (gas conditioning facility)	Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	9.9	1.5
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SSW	SSW
	Expected occurrences exceeding standard[2]	0.0	N/A
	Area exceeding standard[3] (ha)	0	N/A
$PM_{2.5}$ standards[4] (µg/m³)		30	N/A

NOTES:
N/A = not applicable
SSW = south-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the centre of the Niglintgak production well pad
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Ambient Air Standards in the Northwest Territories (RWED 2002)

Benzene and BTEX Compounds

Operation of the facilities at Niglintgak could result in the release of VOCs, including benzene, toluene, ethylbenzene and xylene, which are collectively referred to as BTEX. Table 2-17 summarizes the predicted ground-level concentrations of benzene and total BTEX at Niglintgak. Results are below criteria in all cases.

Potential Acid Input

Table 2-18 summarizes the PAI values predicted at Niglintgak. The area PAI value is much lower than the CASA critical load value (see Table 2-6, shown previously) and is a more appropriate value to compare with the CASA loading criteria. When spread over a full grid cell, the predicted PAI levels including the area PAI value would be considerably lower than presented in the table.

Modelling results have not been shown in a figure because of the low levels of predicted PAI.

Table 2-17: Benzene and BTEX Predictions at Niglintgak

Area	Parameter	Predicted Maximum Concentrations[a]	
		Benzene	BTEX
Niglintgak (gas conditioning facility)	Maximum 1-hour concentration (µg/m³)	0.1	2.3
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SSW	SSW
	Expected occurrences exceeding criteria[2]	0.0	0.0
	Area exceeding criteria[3] (ha)	0	0
Available criteria[4] (µg/m³)		30[b]	30[c]

NOTES:
SSW = south-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX as it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the centre of the Niglintgak production well pad
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Table 2-18: Potential Acid Input Predictions at Niglintgak

Area	Parameter	Results[a]
Niglintgak (gas conditioning facility)	Maximum potential acid input (PAI) (keq/ha/a)	0.18
	Area PAI (keq/ha/a)[1]	0.006
	Maximum sulphate deposition (kg/ha/a)	0.07
	Maximum nitrate deposition (kg/ha/a)	11.31
	Area with PAI >0.17 keq/ha/a[b] (ha)	<1
	Area with PAI >0.25 keq/ha/a[c] (ha)	0

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

Ice Fog

Ice fog conditions are typically associated with extremely cold temperatures, i.e., less than -30°C. During the winter months there could be times when temperatures are below -30°C and winds are calm. Under these conditions it is possible that the combustion sources at the Niglintgak facilities would result in a small amount of ice fog formation directly adjacent to the operation. The extent of ice fog conditions is generally limited to a region within 500 m of the source.

2.3.4 Taglu

Field development at Taglu will include:

- one well pad
- 10 to 15 production wells
- a gas conditioning facility
- above-ground flow lines
- one to two disposal wells
- supporting infrastructure, including airstrip

The initial field development will involve drilling five to seven production wells from a single well pad. Field development will require drilling an additional three to eight production wells from the same well pad within 10 years of start-up.

2.3.4.1 Baseline Conditions

Like Niglintgak, Taglu is far from current industrial air emission sources, so background levels of combustion products, e.g., SO_2, NO_2, CO and $PM_{2.5}$, are low. Detectable levels of ozone are expected because ozone levels in northern Canada are naturally high. Background levels of VOCs are expected because organic compounds are released naturally by vegetation and decaying plant material. Background PAI, from long-range transport of acid-forming compounds emitted by large industrial facilities elsewhere in the northern hemisphere, is deposited by precipitation in the region.

Table 2-19 summarizes background concentrations of the key indicator compounds in Taglu. Volume 3, Section 2, Air Quality provides additional background data.

2.3.4.2 Taglu Effects

Table 2-20 shows the attributes of the predicted air quality effects in Taglu. The direction for all 12 key indicators was adverse, with magnitude ranging from low for six indicators, to moderate for six indicators. Moderate magnitude was assigned to the 1-hour, 24-hour and annual NO_2, the 1-hour and 8-hour CO, and the 24-hour $PM_{2.5}$ concentrations. The maximum values associated with these

averaging periods are likley to be measurable but still below the applicable objectives and standards. The duration was classified as long term because the effects will continue for the life of project operations.

Table 2-19: Baseline Air Conditions for Taglu

Parameter	Taglu
Sulphur dioxide (SO_2)[1] (µg/m³)	0.5
Nitrogen dioxide (NO_2)[1] (µg/m³)	0.8
Carbon monoxide (CO)[2] (µg/m³)	0.0
Fine particulate matter ($PM_{2.5}$)[2] (µg/m³)	0.0
Benzene (µg/m³)	3.0
Total BTEX[3] (µg/m³)	4.9
Potential acid input[4] (keq/ha/a)	0.03
Sulphate deposition[4] (kg/ha/a)	0.96
Nitrate deposition[4] (kg/ha/a)	0.62
Ozone (O_3)[1, 5] (µg/m³)	46.5

NOTES:
1 Results based on passive monitoring data from Inuvik
2 Results assumed to be zero
3 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and was converted to µg/m³ assuming the molecular weight of benzene
4 Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories (Golder and Conor Pacific 1998)
5 Background ozone concentrations were not selected as a key indicator, but are important in determining the quantity of NO_X emissions converted to NO_2 in the atmosphere

Project Emissions

Table 2-21 is a summary of project emission estimates during well testing and for maximum operating conditions at Taglu. Although Taglu produces sweet gas, SO_2 emissions were calculated, assuming a nominal 4 ppm of sulphur compounds occur. This value is higher than the expected sulphur concentrations in gas from the anchor fields. All sources will release very low levels of SO_2 because they will be powered by sweet natural gas.

The following are the results of the air quality assessment for each key indicator in Taglu. The air quality assessment represents the combined effects of project sources in the northern airshed.

Table 2-20: Effects on Air Quality at Taglu

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Moderate	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Moderate	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-21: Emissions from Taglu

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Taglu (well test flaring)	Full production[1]	1.48	1.58	–[a]	–[a]	–[a]	–[a]
Taglu (operations)	Compression	0.00	0.91	0.52	0.04	0.000	0.00
	Power generation	0.00	0.58	0.34	0.01	0.000	0.00
	Process equipment	0.00	0.15	0.10	0.01	0.000	0.00
	Total	0.01	1.63	0.96	0.06	0.000	0.00

NOTES:
SO_2 = sulphur dioxide
NO_X = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
a Emissions of other compounds from well testing were negligible and not quantified
1 Full production corresponds to a flaring rate of 1,397,260 m³/d
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals

Sulphur Dioxide

Table 2-22 summarizes the predicted ground-level SO_2 concentrations in Taglu. During well testing and normal operations, all maximum 1-hour, 24-hour and annual SO_2 predictions are below the Northwest Territories standards. Modelling results are not shown in a figure because of the low levels of predicted SO_2.

Table 2-22: Sulphur Dioxide Predictions at Taglu

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Taglu (well test flaring)[1]	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	7.6	0.5	–[b]
	Distance to maximum[2] (km)	1.3	5.1	–[b]
	Direction to maximum[2]	NNE	ESE	–[b]
	Expected occurrences exceeding standard[3]	0.0	0.0	–[b]
	Area exceeding standard[4] (ha)	0	0	–[b]
Taglu (operations)	Maximum SO_2 concentration (µg/m³)	2.2	0.4	0.0
	Distance to maximum[2] (km)	0.1	0.1	0.1
	Direction to maximum[2]	SSE	SE	ESE
	Expected occurrences exceeding standard[3]	0.0	0.0	0.0
	Area exceeding standard[4] (ha)	0	0	0
SO_2 standards[5] (µg/m³)		450	150	30

NOTES:
ESE = east-southeast
NNE = north-northeast
SE = southeast
SSE = south-southeast
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond at 100% of the production rate for Taglu
2 Distance and direction are relative to the centre of the Taglu production well pad
3 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
4 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
5 Ambient Air Standards in the Northwest Territories (RWED 2002)

Nitrogen Dioxide

Table 2-23 summarizes the predicted maximum ground-level NO_2 and NO_X concentrations in Taglu. During well testing and normal operations, all ground-

level NO_2 concentrations are below federal objectives. Modelling results have not been shown in a figure because of the low levels of predicted NO_2.

Table 2-23: Nitrogen Dioxide and Oxides of Nitrogen Predictions at Taglu

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Taglu (well test flaring)[1]	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	8.0	0.5	–[b]
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	8.0	0.5	–[b]
	Distance to maximum[2] (km)	1.3	5.1	–[b]
	Direction to maximum[2]	NNE	ESE	–[b]
	Expected occurrences exceeding objective[3]	0.0	0.0	–[b]
	Area exceeding objective[4] (ha)	0	0	–[b]
Taglu (operations)	Maximum NO_X concentration (µg/m³)	1,275.6	399.0	12.3
	Maximum NO_2 concentration (µg/m³)	158.0	54.5	2.7
	Distance to maximum[2] (km)	8.9	1.1	1.2
	Direction to maximum[2]	E	ESE	W
	Expected occurrences exceeding objective[3]	0.0	0.0	0.0
	Area exceeding objective[4] (ha)	0	0	0
NO_2 objectives[5, 6] (µg/m³)		400	200	100

NOTES:
E = east
ESE = east-southeast
NNE = north-northeast
W = west
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond at 100% of the production rate for Taglu
2 Distance and direction are relative to the centre of the Taglu production well pad
3 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations *exceeding* the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number
4 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
5 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
6 There are no Northwest Territories standards for NO_2

Carbon Monoxide

Combustion emission sources at Taglu will affect ground-level CO concentrations. Predicted maximum ground-level CO concentrations (see Table 2-24) are much lower than the 1-hour and 8-hour federal objectives.

Modelling results have not been shown in a figure because of the low levels of predicted CO.

Table 2-24: Carbon Monoxide Predictions at Taglu

Area	Parameter	Averaging Period Predictions[a]	
		1-hour	8-hour
Taglu	Maximum carbon monoxide (CO) concentration (µg/m³)	752.9	333.8
	Distance to maximum[1] (km)	0.1	0.2
	Direction to maximum[1]	WSW	SW
	Expected occurrences exceeding objective[2]	0.0	0.0
	Area exceeding objective[3] (ha)	0	0
CO objectives[4, 5] (µg/m³)		15,000	6,000

NOTES:
SW = southwest
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the centre of the Taglu production well pad
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Fine Particulate Matter

Table 2-25 shows predicted maximum ground-level $PM_{2.5}$ concentrations. The maximum 24-hour concentration is below the standard. Modelling results have not been shown in a figure because of the low levels of predicted $PM_{2.5}$.

Benzene and BTEX Compounds

Table 2-26 summarizes the predicted ground-level concentrations of benzene and total BTEX at Taglu. All predicted maximum ground-level concentrations are below the relevant criteria.

Potential Acid Input

Table 2-27 summarizes the PAI values predicted at Taglu. The area PAI value (see Table 2-6, as shown previously) is much lower than the CASA monitoring load and critical load value. No figure of modelling results is provided because of the low predicted PAI values.

Table 2-25: Fine Particulate Matter Predictions at Taglu

Area	Parameter	Averaging Period Predictions[a]	
		24-hour	Annual
Taglu	Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	1.5	0.3
	Distance to maximum[1] (km)	0.2	0.1
	Direction to maximum[1]	N	ESE
	Expected occurrences exceeding standard[2]	0.0	–
	Area exceeding standard[3] (ha)	0	–
$PM_{2.5}$ standard[4] (µg/m³)		30	N/A

NOTES:
ESE = east-southeast
N= north
N/A = not applicable
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the centre of the Taglu production well pad
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Ambient Air Standards in the Northwest Territories (RWED 2002)

Table 2-26: Benzene and BTEX Predictions at Taglu

Area	Parameter	Predicted Maximum Concentrations[a]	
		Benzene	BTEX
Taglu	Maximum 1-hour concentration (µg/m³)	0.6	1.4
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	WSW	WSW
	Expected occurrences exceeding criteria[2]	0.0	0.0
	Area exceeding criteria[3] (ha)	0	0
Available criteria[4] (µg/m³)		30[b]	30[c]

NOTES:
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX as it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the centre of the Taglu production well pad
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Table 2-27: Potential Acid Input Predictions at Taglu

Area	Parameter	Results[a]
Taglu	Maximum potential acid input (PAI) (keq/ha/a)	0.05
	Area PAI (keq/ha/a)[1]	0.005
	Maximum sulphate deposition (kg/ha/a)	0.05
	Maximum nitrate deposition (kg/ha/a)	3.35
	Area with PAI >0.17 keq/ha/a[b] (ha)	0
	Area with PAI >0.25 keq/ha/a[c] (ha)	0

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

Ice Fog

Because of the proximity of Taglu to Niglintgak, the same conclusions can be drawn about the likelihood and extent of ice fog conditions at Taglu. As discussed previously, the extent of ice fog conditions is generally limited to a region within 500 m of the source.

2.3.5 Parsons Lake

Development at Parsons Lake will include:

- a north pad consisting of:
  - nine to 19 production wells
  - two disposal wells
  - a gas conditioning facility
- a south pad consisting of three to seven production wells
- above-ground flow lines on the north pad and from the south pad to the north pad
- supporting infrastructure, including an airstrip

The initial field development will involve drilling nine wells from the proposed north pad. Up to ten contingent wells might be drilled at the north pad. Three wells will be drilled at the south pad seven to 10 years after the initial phase. Up to four contingent wells might be drilled at the south pad.

2.3.5.1 Baseline Conditions

Table 2-28 summarizes background concentrations of the key indicator compounds for the Parsons Lake field. As conditions at Parsons Lake are similar to those at Niglintgak and Taglu, background levels of combustion products, e.g., SO_2, NO_2, CO and $PM_{2.5}$, are low. Detectable levels of ozone are expected because ozone levels in northern Canada are naturally high. Background levels of VOCs are also expected because organic compounds are released naturally by vegetation and decaying plant material. Background PAI, from long-range transport of acid-forming compounds emitted by large industrial facilities elsewhere in the northern hemisphere, is deposited by precipitation in the region.

Table 2-28: Baseline Air Conditions for Parsons Lake

Parameter	Parsons Lake
Sulphur dioxide (SO_2)[1] (µg/m³)	0.5
Nitrogen dioxide (NO_2)[1] (µg/m³)	0.8
Carbon monoxide (CO)[2] (µg/m³)	0.0
Fine particulate matter ($PM_{2.5}$)[2] (µg/m³)	0.0
Benzene[3] (µg/m³)	2.6
Total BTEX[3, 4] (µg/m³)	3.7
Potential acid input[5] (keq/ha/a)	0.03
Sulphate deposition[5] (kg/ha/a)	0.96
Nitrate deposition[5] (kg/ha/a)	0.62
Ozone (O_3)[1, 6] (µg/m³)	46.5

NOTES:
1 Results based on passive monitoring from Inuvik
2 Results assumed to be zero
3 Results based on SUMMA canister data from Parsons Lake
4 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and converted to µg/m³ assuming the molecular weight of benzene
5 Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories (Golder and Conor Pacific 1998)
6 Background ozone concentrations were not selected as a key indicator, but are important in determining the quantity of NO_X emissions that are converted to NO_2 in the atmosphere

Background sulphate and nitrate deposition data helps estimate how much PAI is from nitrate and how much is from sulphate. The soils and aquatics disciplines require this information to determine PAI effects.

2.3.5.2 Parsons Lake Effects

Table 2-29 shows the direction, magnitude, geographic extent and duration of the changes in the key indicators of air quality.

Table 2-29: Effects on Air Quality at Parsons Lake

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Low	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

The direction of all 12 indicators is adverse. Eight of the indicators are low magnitude and the 1-hour and 24-hour NO_2, 8-hour CO and 24-hour $PM_{2.5}$ are moderate magnitude. The duration was classified as long term because the effects will continue for the life of project operations.

2.3.5.3 Project Emissions

Table 2-30 is a summary of project emissions during well testing and for maximum operating conditions. Although the Parsons Lake field produces sweet gas, SO_2 emissions were calculated assuming a nominal 4 ppm of sulphur compounds exists in the gas. This value is higher than the expected sulphur concentrations in gas from the anchor fields.

Sulphur Dioxide

Table 2-31 summarizes the predicted ground-level SO_2 concentrations at the Parsons Lake field. None of the maximum 1-hour, 24-hour or annual SO_2 predictions exceeds the Northwest Territories standards. Modelling results have not been shown in a figure because of the low levels of predicted SO_2.

Table 2-30: Emissions from Parsons Lake

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Parsons Lake (well test flaring)	Full production[1]	0.80	0.81	–[a]	–[a]	–[a]	–[a]
Parsons Lake (operations)	Compression	0.00	0.61	0.28	0.02	0.000	0.00
	Power generation	0.00	0.89	0.39	0.01	0.000	0.00
	Process equipment	0.00	0.04	0.05	0.00	0.000	0.00
	Total	0.00	1.53	0.72	0.03	0.000	0.00

NOTES:
SO_2 = sulphur dioxide
NO_X = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
a Emissions of other compounds from well testing were negligible and not quantified
1 Full production corresponds to a flaring rate of 750,000 m³/d
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Nitrogen Dioxide

Table 2-32 summarizes the predicted maximum ground-level NO_2 and NO_X concentrations at the Parsons Lake field. None of the predicted concentrations during either well testing or normal operations are over the Northwest Territories standards. Modelling results have not been shown in a figure because of the low levels of predicted NO_2.

Carbon Monoxide

Combustion emissions at Parsons Lake could affect ground-level CO concentrations. The predicted maximum ground-level CO concentrations (see Table 2-33) are much lower than the objectives. Modelling results have not been shown in a figure because of the low levels of predicted CO.

Fine Particulate Matter

Table 2-34 shows predicted maximum ground-level $PM_{2.5}$ concentrations for Parsons Lake. All are below the Northwest Territories standard. Modelling results have not been shown in a figure because of the low levels of predicted $PM_{2.5}$.

Table 2-31: Sulphur Dioxide Predictions at Parsons Lake

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Parsons Lake (well test flaring)[1]	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	6.4	0.6	–[b]
	Distance to maximum[2] (km)	9.4	5.1	–[b]
	Direction to maximum[2]	WNW	WSW	–[b]
	Expected occurrences exceeding standard[3]	0.0	0.0	–[b]
	Area exceeding standard[4] (ha)	0	0	–[b]
Parsons Lake (operations)	Maximum SO_2 concentration (µg/m³)	10.3	3.3	0.1
	Distance to maximum[2] (km)	0.3	0.3	0.3
Parsons Lake (operations) (cont'd)	Direction to maximum[2]	WSW	WSW	WSW
	Expected occurrences exceeding standard[3]	0.0	0.0	0.0
	Area exceeding standard[4] (ha)	0	0	0
SO_2 standards[5] (µg/m³)		450	150	30

NOTES:
WNW = west-northwest
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond at 100% of the production rate for Parsons Lake
2 Distance and direction are relative to the centre of the Parsons Lake production well pad
3 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number
4 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards.
5 Ambient Air Standards in the Northwest Territories (RWED 2002)

Table 2-32: Nitrogen Dioxide and Oxides of Nitrogen Predictions at Parsons Lake

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Parsons Lake (well test flaring)[1]	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	6.5	0.6	–[b]
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	6.5	0.6	–[b]
	Distance to maximum[2] (km)	9.4	5.1	–[b]
	Direction to maximum[2]	WNW	WSW	–[b]
	Expected occurrences exceeding objective[3]	0.0	0.0	–[b]
	Area exceeding objective[4] (ha)	0	0	–[b]
Parsons Lake (operations)	Maximum NO_X concentration (µg/m³)	2,785.5	894.1	26.8
	Maximum NO_2 concentration (µg/m³)	285.3	92.1	4.5
	Distance to maximum[2] (km)	0.3	0.3	0.3

Table 2-32: Nitrogen Dioxide and Oxides of Nitrogen Predictions at Parsons Lake (cont'd)

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Parsons Lake (operations) (cont'd)	Direction to maximum[2]	WSW	WSW	WSW
	Expected occurrences exceeding objective[3]	0.0	0.0	0.0
	Area exceeding objective[4] (ha)	0	0	0
NO_2 objectives[5, 6] (µg/m³)		400	200	100

NOTES:
WNW = west-northwest
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Because of the short duration (24 hours) of well test flaring, annual concentrations were not calculated
1 The modelling results correspond at 100% of the production rate for Parsons Lake
2 Distance and direction are relative to the centre of the Parsons Lake production well pad
3 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
4 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
5 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
6 There are no Northwest Territories standards for NO_2

Table 2-33: Carbon Monoxide Predictions at Parsons Lake

Parameter	Averaging Period Predictions[a]	
	1-hour	8-hour
Maximum carbon monoxide (CO) concentration (µg/m³)	1,290.0	813.4
Distance to maximum[1] (km)	0.3	0.3
Direction to maximum[1]	WSW	WSW
Expected occurrences exceeding objective[2]	0.0	0.0
Area exceeding objective[3] (ha)	0	0
CO objectives[4, 5] (µg/m³)	15,000	6,000

NOTES:
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the centre of the Parsons Lake production well pad
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Table 2-34: Fine Particulate Matter Predictions at Parsons Lake

Parameter	Averaging Period Predictions[a]	
	24-hour	Annual
Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	8.6	0.9
Distance to maximum[1] (km)	0.3	0.3
Direction to maximum[1]	WSW	WSW
Expected occurrences exceeding standard[2]	0	N/A
Area exceeding standard[3] (ha)	0	N/A
$PM_{2.5}$ standards[4] (µg/m³)	30	N/A

NOTES:
WSW = west-southwest
N/A = not applicable
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the centre of the Parsons Lake production well
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Benzene and BTEX Compounds

Table 2-35 summarizes the predicted maximum ground-level concentrations of benzene and total BTEX in Parsons Lake. Both are well below criteria.

Potential Acid Input

Table 2-36 shows that the area PAI value for Parsons Lake is below both the critical and monitoring loads. Modelling results have not been shown in a figure because of the low levels of predicted PAI.

Ice Fog

Although Parsons Lake is farther inland than Niglintgak and Taglu, it is subject to similar climatic conditions. Therefore, the same conclusions for ice fog can also be applied to Parsons Lake. The likelihood of ice fog conditions resulting from the Parsons Lake facilities is therefore quite low and the extent quite localized.

2.3.6 Gathering Pipelines and Associated Facilities

The gathering pipelines and associated facilities connect the three production fields to the Inuvik area facility near Inuvik (see Volume 2, Project Description). For this assessment the gathering system includes the Niglintgak lateral, the Taglu

lateral, the Parsons Lake lateral, the Storm Hills lateral, and the Inuvik area facility, the Storm Hills pigging facility, two intermediate block valves, and pads for the trenchless installation at the East Channel of the Mackenzie River.

Table 2-35: Benzene and Total BTEX Predictions at Parsons Lake

Parameter	Predicted Maximum Concentrations[a]	
	Benzene	BTEX
Maximum 1-hour concentration (µg/m³)	0.9	3.7
Distance to maximum[1] (km)	0.3	0.3
Direction to maximum[1]	W	WSW
Expected occurrences exceeding criteria[2]	0	0
Area exceeding criteria[3] (ha)	0	0
Available criteria[4] (µg/m³)	30[b]	30[c]

NOTES:
W = west
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX as it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the centre of the Parsons Lake production well pad
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Table 2-36: Potential Acid Input Predictions at Parsons Lake

Parameter	Results[a]
Maximum potential acid input (PAI) (keq/ha/a)	0.13
Area PAI (keq/ha/a)[1]	0.006
Maximum sulphate deposition (kg/ha/a)	0.05
Maximum nitrate deposition (kg/ha/a)	7.88
Area with PAI >0.17 keq/ha/a[b] (ha)	0
Area with PAI >0.25 keq/ha/a[c] (ha)	0

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

2.3.6.1 Baseline Conditions

Table 2-37 summarizes background concentrations of the key indicator compounds for the gathering pipelines and associated facilities. Volume 3, Section 2, Air Quality, provides additional background data.

Table 2-37: Baseline Air Conditions for the Gathering Pipelines and Associated Facilities

Parameter	Storm Hills Pigging Facility	Inuvik Area Facility
Sulphur dioxide (SO_2)[1] (µg/m³)	0.5	0.5
Nitrogen dioxide (NO_2)[1] (µg/m³)	0.8	0.8[a]
Carbon monoxide (CO)[2] (µg/m³)	0.0	0.0
Fine particulate matter ($PM_{2.5}$)[2] (µg/m³)	0.0	0.0
Benzene[3] (µg/m³)	2.6	2.6
Total BTEX[3, 4] (µg/m³)	3.7	3.7
Potential acid input[5] (keq/ha/a)	0.03	0.03
Sulphate deposition[5] (kg/ha/a)	0.96	0.96
Nitrate deposition[5] (kg/ha/a)	0.62	0.62
Ozone (O_3)[1, 6] (µg/m³)	46.5	46.5

NOTES:
1 Results based on passive monitoring from Inuvik
2 Results assumed to be zero
3 Results based on SUMMA canister data from Parsons Lake
4 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and converted to µg/m³ assuming the molecular weight of benzene
5 Results based on wet deposition monitoring data for Snare Rapids, Northwest Territories (Golder and Conor Pacific 1998)
6 Background ozone concentrations were not selected as a key indicator, but are important in determining the quantity of NO_X emissions converted to NO_2 in the atmosphere

2.3.6.2 Gathering Pipelines and Associated Facilities Effects

Because of the low levels of emissions from the Storm Hills pigging facility, facility emissions were not modelled and resulting effect attributes were not determined. However, emissions from the facility were included with the collective project emissions used when modelling the northern airshed. Therefore, the focus of modelling for the gathering pipelines and associated facilities is the Inuvik area facility.

Table 2-38 summarizes the attributes of air quality effects at the Inuvik area facility LSA. The direction for all the assessed 12 indicators was classified as adverse, with nine having low-magnitude effects and three having moderate-magnitude effects. No predicted maximum ground-level concentrations

of the key air quality indicators exceeded the standards, guideline levels or objectives. As the effects will continue for the life of project operations, the duration was classified as long term.

Table 2-38: Effects on Air Quality at the Inuvik Area Facility

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Low	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Low	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	N/A	N/A

NOTE:
N/A = not applicable

2.3.6.3 Project Emissions

Table 2-39 summarizes project emissions during maximum operating conditions. The only emission sources in the gathering pipelines and associated facilities are the Storm Hills pigging facility and the Inuvik area facility. The Storm Hills pigging facility will be located about 28 km southwest of the Parsons Lake facility and about 51 km north of the Inuvik area facility. The emissions from the Storm Hills pigging facility would be few and limited to power generation and process equipment.

Sulphur Dioxide

Table 2-40 summarizes ground-level SO_2 predictions for the Inuvik area facility. All of the predicted 1-hour, 24-hour and annual SO_2 concentrations were below

Northwest Territories standards. Modelling results have not been shown in a figure because of the low levels of predicted SO_2.

Table 2-39: Emissions from the Gathering Pipelines and Associated Facilities

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Storm Hills pigging facility	Power generation	0.00	0.06	0.01	0.00	0.000	0.00
	Process equipment	0.00	0.00	0.00	0.00	0.000	0.00
	Subtotal	0.00	0.06	0.01	0.00	0.000	0.00
Inuvik area facility	Compression	0.01	0.88	0.81	0.07	0.000	0.00
	Power generation	0.00	0.16	0.09	0.01	0.000	0.00
	Process equipment	0.00	0.27	0.24	0.02	0.000	0.00
	Subtotal	0.01	1.31	1.15	0.09	0.000	0.00
Total		0.01	1.37	1.15	0.09	0.000	0.00

NOTES:
SO_2 = sulphur dioxide
NO_X = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
Numbers in this table have been rounded for presentation purposes. The sum of the numbers might add up to values different than the totals.

Table 2-40: Sulphur Dioxide Predictions at the Inuvik Area Facility

Parameter	Averaging Period Predictions[a]		
	1-hour	24-hour	Annual
Maximum sulphur dioxide (SO_2) concentration (µg/m³)	5.5	1.7	0.2
Distance to maximum[1] (km)	0.1	0.1	0.1
Direction to maximum[1]	WNW	WNW	WNW
Expected occurrences exceeding standard[2]	0.0	0.0	0.0
Area exceeding standard[3] (ha)	0.0	0.0	0.0
SO_2 standards[4] (µg/m³)	450	150	30

NOTES:
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the Inuvik area facility
2 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Nitrogen Dioxide

Table 2-41 summarizes the NO_X and NO_2 concentrations predicted in the Inuvik area facility LSA. None of the maximum 1-hour, 24-hour or annual NO_2 predictions exceeds objectives. Modelling results have not been shown in a figure because of the low levels of predicted NO_2.

Table 2-41: Nitrogen Dioxide and Oxides of Nitrogen Predictions at the Inuvik Area Facility

Parameter	Averaging Period Predictions[a]		
	1-hour	24-hour	Annual
Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	686.8	159.6	17.7
Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	227.2	38.9	2.5
Distance to maximum[1] (km)	5.2	1.6	0.1
Direction to maximum[1]	NW	WNW	WNW
Expected occurrences exceeding objective[2]	0.0	0.0	0.0
Area exceeding objective[3] (ha)	0.0	0.0	0.0
NO_2 objectives[4, 5] (µg/m³)	400	200	100

NOTES:
NW = northwest
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the Inuvik area facility
2 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for NO_2

Carbon Monoxide

Table 2-42 summarizes the predicted ground-level CO concentrations for the Inuvik area facility. None of the predicted 1-hour and 8-hour CO concentrations exceeds the objectives.

Fine Particulate Matter

Table 2-43 shows predicted maximum ground-level $PM_{2.5}$ concentrations for the Inuvik area facility. All values are below the Northwest Territories standard.

Table 2-42: Carbon Monoxide Predictions at the Inuvik Area Facility

Parameter	Averaging Period Predictions[a]	
	1-hour	8-hour
Maximum carbon monoxide (CO) concentration (µg/m³)	705.9	269.7
Distance to maximum[1] (km)	0.1	0.1
Direction to maximum[1]	WNW	WNW
Expected occurrences exceeding objective[2]	0.0	0.0
Area exceeding objective[3] (ha)	0.0	0.0
CO objectives[4, 5] (µg/m³)	15,000	6,000

NOTES:
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the Inuvik area facility
2 The *expected occurrences exceeding the objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Table 2-43: Fine Particulate Matter Predictions at the Inuvik Area Facility

Parameter	Averaging Period Predictions[a]	
	24-hour	Annual
Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	12.3	2.0
Distance to maximum[1] (km)	0.1	0.1
Direction to maximum[1]	WNW	WNW
Expected occurrences exceeding standard[2]	0	N/A
Area exceeding standard[3] (ha)	0	N/A
$PM_{2.5}$ standards[4] (µg/m³)	30	N/A

NOTES:
WNW = west-northwest
N/A = not applicable
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
1 Distance and direction are relative to the Inuvik area facility
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Benzene and BTEX Compounds

Table 2-44 shows ground-level concentrations of benzene and total BTEX for the Inuvik area facility. None of the predicted benzene or BTEX concentrations exceed criteria.

Table 2-44: Benzene and Total BTEX Predictions at the Inuvik Area Facility

Parameter	Predicted Maximum Concentrations[a]	
	Benzene	BTEX
Maximum 1-hour concentration (µg/m³)	0.1	1.2
Distance to maximum[1] (km)	0.1	0.1
Direction to maximum[1]	WSW	WSW
Expected occurrences exceeding criteria[2]	0.0	0.0
Area exceeding criteria[3] (ha)	0.0	0.0
Available criteria[4] (µg/m³)	30[b]	30[b]

NOTES:
WSW = west-southwest
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX as it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the Inuvik area facility
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Potential Acid Input

Table 2-45 summarizes predicted PAI values associated with Inuvik area facility emissions. The area PAI are below the critical and monitoring loads.

Ice Fog

Similar to the production area facilities, there is a small likelihood of ice fog conditions resulting from the Inuvik area facility. These conditions would be localized and would likely be too far from the town of Inuvik to influence ice fog conditions that could also be occurring in the town at the same time. Ice fog in Inuvik is often influenced by vehicle activity and other combustion activities.

Table 2-45: Potential Acid Input Predictions at the Inuvik Area Facility

Parameter	Results[a]
Maximum potential acid input (PAI) (keq/ha/a)	0.1
Area PAI (keq/ha/a)[1]	0.004
Maximum sulphate deposition (kg/ha/a)	0.08
Maximum nitrate deposition (kg/ha/a)	6.06
Area with PAI >0.17 keq/ha/a[b] (ha)	0.0
Area with PAI >0.25 keq/ha/a[c] (ha)	0.0

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the northern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems as defined by CASA
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

2.3.7 Pipeline Corridor

For this assessment the pipeline corridor includes the gas pipeline, the natural gas liquid (NGL) pipeline and pipeline facilities including block valves, compressor stations and a heater station (see Volume 2, Project Description). The natural gas pipeline will transport sweet natural gas from the Inuvik area facility to the Northwest Territories boundary. The gas pipeline and the NGL pipeline will share a common right-of-way from the Inuvik area facility to a point near the Norman Wells compressor station.

2.3.7.1 Baseline Conditions

Background levels of combustion products, e.g., SO_2, NO_2, CO and $PM_{2.5}$, are low because, except for the Norman Wells compressor station, the pipeline facilities are far from other combustion sources. Baseline monitoring in Norman Wells indicated low concentrations of combustion products in that community. Ozone is present in measurable amounts at all pipeline facilities. Ozone levels are naturally high in northern Canada. Areas near the pipeline facilities are likely to have detectible amounts of VOCs that are emitted by vegetation and decaying plant materials. Background PAI near the pipeline facilities is caused by acid-forming compounds from industrial facilities elsewhere in the northern hemisphere, which are transported long-range and deposited in precipitation.

Table 2-46 summarizes the background concentrations of the key indicators for the pipeline corridor.

Table 2-46: Baseline Air Conditions for the Pipeline Corridor

Parameter	Little Chicago Compressor Station	Norman Wells Compressor Station	Blackwater River Compressor Station	Trail River Compressor Station	Trout River Heater Station
Sulphur dioxide (SO_2) (µg/m³)	0.5[b]	0.5[b]	0.5[a]	0.5[a]	0.5[a]
Nitrogen dioxide (NO_2) (µg/m³)	0.9[b]	0.9[b]	0.9[a]	0.9[a]	0.9[a]
Carbon monoxide (CO)[1] (µg/m³)	0.0	0.0	0.0	0.0	0.0
Fine particulate matter ($PM_{2.5}$)[1] (µg/m³)	0.0	0.0	0.0	0.0	0.0
Benzene[2] (µg/m³)	2.6	2.6	2.6	2.6	2.6
Total BTEX[2, 3] (µg/m³)	3.7	3.7	3.7	3.7	3.7
Potential acid input[4] (keq/ha/a)	0.03	0.03	0.03	0.03	0.03
Sulphate deposition[4] (kg/ha/a)	0.96	0.96	0.96	0.96	0.96
Nitrate deposition[4] (kg/ha/a)	0.62	0.62	0.62	0.62	0.62
Ozone (O_3)[5] (µg/m³)	45.7	45.7	45.7	45.7	45.7

NOTES:
a Results are based on passive monitoring data from Inuvik
b Results are based on continuous monitoring data from Norman Wells
1 Results assumed to be zero
2 Results are based on the SUMMA canister data for Parsons Lake
3 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and converted to µg/m³ assuming the molecular weight of benzene
4 Results are based on wet deposition monitoring for Snare Rapids, Northwest Territories (Golder and Connor Pacific 1998)
5 Background ozone concentrations were not selected as a key indicator but are important in determining the quantity of NO_X emissions that are converted to NO_2 in the atmosphere

2.3.7.2 Pipeline Corridor Effects

The air quality assessment included separate evaluations of each of the five major pipeline corridor facilities, i.e., the Little Chicago, Norman Wells, Blackwater River and Trail River compressor stations, and the Trout River heater station.

All 12 key indicators at the Little Chicago compressor station (see Table 2-47) were classified as adverse, with eight assigned a low magnitude and four a magnitude rating of moderate. The PAI levels averaged over the modelling LSA are conservative estimates of gridded PAI levels and were much lower than CASA critical loads. This is true for all pipeline corridor facilities.

Table 2-47: Effects on Air Quality at Little Chicago Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Moderate	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Low	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-48 describes the air quality effects at the Norman Wells compressor station. All 12 key indicators were classified as having an adverse direction, with seven classified as low magnitude and five classified as moderate magnitude.

Table 2-48: Effects on Air Quality at Norman Wells Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Moderate	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-49 shows the air quality effects for the Blackwater River compressor station. All 12 key indicators were classified as having an adverse direction, with seven classified as low magnitude and five classified as moderate magnitude.

Table 2-49: Effects on Air Quality at Blackwater River Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide ($NO_{2)}$	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Moderate	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-50 describes the air quality effects for the Trail River compressor station. All 12 key indicators were classified as having an adverse direction. Of these, six were classified as low and six were classified as moderate magnitude.

Table 2-51 shows the air quality effects for the Trout River heater station. The 12 key indicators were all classified as having an adverse direction. Nine were classified as low and three were classified as moderate magnitude.

2.3.7.3 Project Emissions

The pipeline corridor includes facilities in the central and southern airsheds introduced in Section 2.2.5, Study Areas and Boundaries. Table 2-52 shows emission levels from the Little Chicago and Norman Wells compressor stations in the central airshed.

Table 2-53 shows emissions from the pipeline facility LSAs in the southern airshed, i.e., the compressor stations at Blackwater River and Trail River and the heater station at Trout River.

Table 2-50: Effects on Air Quality at Trail River Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Moderate	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Moderate	Local	Long term
8-hour CO	Operations	Adverse	Moderate	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-51: Effects on Air Quality at Trout River Heater Station

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide ($SO_{2)}$	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Low	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Low	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-52: Emissions from Pipeline Corridor Facilities in the Central Airshed

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Little Chicago compressor station	Compression and pumping	0.00	0.40	0.19	0.01	0.000	0.00
	Power generation	0.00	0.13	0.06	0.00	0.000	0.00
	Process equipment	0.00	0.03	0.03	0.00	0.000	0.00
	Total	0.00	0.57	0.27	0.02	0.000	0.00
Norman Wells compressor station	Compression	0.00	0.40	0.19	0.01	0.000	0.00
	Power generation	0.00	0.13	0.06	0.00	0.000	0.00
	Process equipment	0.00	0.03	0.03	0.00	0.000	0.00
	Total	0.00	0.57	0.27	0.02	0.000	0.00
Central airshed total		0.00	1.14	0.54	0.04	0.000	0.00

NOTES:

SO_2 = sulphur dioxide
NO_x = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Table 2-53: Emissions from Pipeline Corridor Facilities in the Southern Airshed

Area	Activity	Emissions					
		SO_2 (t/d)	NO_X (t/d)	CO (t/d)	$PM_{2.5}$ (t/d)	Benzene (t/d)	BTEX (t/d)
Blackwater River compressor station	Compression	0.00	0.40	0.19	0.01	0.000	0.00
	Power generation	0.00	0.13	0.06	0.00	0.000	0.00
	Process equipment	0.00	0.03	0.03	0.00	0.000	0.00
	Total	0.00	0.57	0.27	0.02	0.000	0.00
Trail River compressor station	Compression	0.00	0.40	0.19	0.01	0.000	0.00
	Power generation	0.00	0.13	0.06	0.00	0.000	0.00
	Process equipment	0.00	0.03	0.03	0.00	0.000	0.00
	Total	0.00	0.57	0.27	0.02	0.000	0.00
Trout River heater station	Power generation	0.00	0.14	0.02	0.00	0.000	0.00
	Process equipment	0.00	0.05	0.07	0.01	0.000	0.00
	Total	0.00	0.19	0.09	0.01	0.000	0.00

NOTES:

SO_2 = sulphur dioxide
NO_x = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Sulphur Dioxide

Table 2-54 summarizes predicted ground-level SO_2 concentrations for central airshed pipeline facilities, and Table 2-55 shows concentrations for southern airshed pipeline facilities. All predicted 1-hour, 24-hour and annual SO_2 concentrations are below Northwest Territories standards. Modelling results have not been shown in a figure because of the low levels of predicted SO_2.

Nitrogen Dioxide

Table 2-56 shows the maximum NO_X and NO_2 predictions for facilities in the central airshed. Maximum NO_2 concentrations at both the Little Chicago and Norman Wells compressor stations are below federal objectives.

Table 2-54: Sulphur Dioxide Predictions in the Central Airshed

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Little Chicago compressor station	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	6.5	1.4	0.2
	Distance to maximum[1] (km)	0.1	0.1	0.1
	Direction to maximum[1]	S	S	SE
	Expected occurrences exceeding standard[2]	0.0	0.0	0.0
	Area exceeding standard[3] (ha)	0	0	0
Norman Wells compressor station	Maximum SO_2 concentration (µg/m³)	3.8	0.8	0.1
	Distance to maximum[4] (km)	0.1	0.1	0.1
	Direction to maximum[4]	W	SE	SE
	Expected occurrences exceeding standard[2]	0.0	0.0	0.0
	Area exceeding standard[3] (ha)	0	0	0
SO_2 standards[5] (µg/m³)		450	150	30

NOTES:
S = south
SE = southeast
W = west
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
1 Distance and direction are relative to the Little Chicago compressor station
2 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
4 Distance and direction are relative to the Norman Wells compressor station
5 Northwest Territories Ambient Air Standards (RWED 2002)

Table 2-55: Sulphur Dioxide Predictions in the Southern Airshed

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Blackwater River compressor station	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	3.8	1.2	0.2
	Distance to maximum[1] (km)	0.1	0.1	0.1
	Direction to maximum[1]	S	S	S
	Expected occurrences exceeding standard[2]	0	0	0
	Area exceeding standard[3] (ha)	0	0	0
Trail River compressor station	Maximum SO_2 concentration (µg/m³)	5.9	1.8	0.2
	Distance to maximum[1] (km)	0.1	0.1	0.1
	Direction to maximum[1]	W	W	W
	Expected occurrences exceeding standard[2]	0	0	0
	Area exceeding standard[3] (ha)	0	0	0
Trout River heater station	Maximum SO_2 concentration (µg/m³)	1.5	0.4	0.1
	Distance to maximum[1] (km)	0.2	0.1	0.3
Trout River heater station (cont'd)	Direction to maximum[1]	S	SE	SE
	Expected occurrences exceeding standard[2]	0	0	0
	Area exceeding standard[3] (ha)	0	0	0
SO_2 standards[4] (µg/m³)		450	150	30

NOTES:
S = south
SE = southeast
W = west
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Table 2-56: Nitrogen Dioxide and Oxides of Nitrogen Predictions in the Central Airshed

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Little Chicago compressor station	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	2,463.7	617.3	87.1
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	254.5	109.2	9.8
	Distance to maximum[1] (km)	0.1	1.3	0.1
	Direction to maximum[1]	SE	ENE	SE
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0	0	0
Norman Wells compressor station	Maximum NO_X concentration (µg/m³)	1,478.8	406.1	53.2
	Maximum NO_2 concentration (µg/m³)	151.9	47.3	6.2
	Distance to maximum[4] (km)	0.1	1.3	0.1
	Direction to maximum[4]	SE	WNW	SE
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0	0	0
NO_2 objectives[5, 6] (µg/m³)		400	200	100

NOTES:
ENE = east-northeast
WNW = west-northwest
SE = southeast
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
1 Distance and direction are relative to the Little Chicago compressor station
2 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
4 Distance and direction are relative to the Norman Wells compressor station
5 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
6 There are no Northwest Territories standards for NO_2

Table 2-57 shows the predicted maximum ground-level NO_X and NO_2 concentrations for facilities in the southern airshed. The maximum NO_2 predictions at all facilities are below the respective federal objectives. Modelling results have not been shown in a figure because of the low levels of the predicted NO_2 concentrations.

Carbon Monoxide

Table 2-58 shows the predicted ground-level CO concentrations for pipeline facilities in the central airshed. None of the predicted 1-hour or 8-hour CO concentrations exceeds the objectives.

Table 2-57: Nitrogen Dioxide and Oxides of Nitrogen Predictions in the Southern Airshed

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
Blackwater River compressor station	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	1,213.9	336.7	48.4
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	132.6	38.9	5.8
	Distance to maximum[1] (km)	7.2	1.4	0.1
	Direction to maximum[1]	SSW	SE	S
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0	0	0
Trail River compressor station	Maximum NO_X concentration (µg/m³)	1,468.6	336.8	45.5
	Maximum NO_2 concentration (µg/m³)	150.4	41.9	5.4
	Distance to maximum[1] (km)	6.7	1.5	0.1
	Direction to maximum[1]	NNE	NNW	S
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0	0	0
Trout River heater station	Maximum NO_X concentration (µg/m³)	305.7	135.8	21.6
	Maximum NO_2 concentration (µg/m³)	91.2	41.5	3.1
	Distance to maximum[1] (km)	5.2	1.4	0.3
	Direction to maximum[1]	SSE	SE	WNW
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0	0	0
NO_2 objectives[4, 5] (µg/m³)		400	200	100

NOTES:
NNE = north-northeast
NNW = north-northwest
S = south
SE = southeast
SSE = south-southeast
SSW = south-southwest
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for NO_2

Table 2-58: Carbon Monoxide Predictions at Pipeline Facilities in the Central Airshed

Area	Parameter	Averaging Period Predictions[a]	
		1-hour	8-hour
Little Chicago compressor station	Maximum carbon monoxide (CO) concentration (µg/m³)	483.7	121.0
	Distance to maximum[1] (km)	4.7	5.1
	Direction to maximum[1]	SSE	SSE
	Expected occurrences exceeding objective[2]	0	0
	Area exceeding objective[3] (ha)	0	0
Norman Wells compressor station	Maximum CO concentration (µg/m³)	699.2	300.1
	Distance to maximum[4] (km)	0.1	0.1
	Direction to maximum[4]	SE	SE
	Expected occurrences exceeding objective[2]	0	0
	Area exceeding objective[3] (ha)	0	0
CO objectives[5, 6] (µg/m³)		15,000	6,000

NOTES:
SE = southeast
SSE = south-southeast
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
1 Distance and direction are relative to the compressor station at Little Chicago
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Distance and direction are relative to the Norman Wells compressor station
5 Federal Ambient Air Quality Objective from *The Clean Air Act* (Environment Canada 1981)
6 There are no Northwest Territories standards for CO

Table 2-59 summarizes the ground-level CO predictions for pipeline facilities in the southern airshed. The predicted maximum 1-hour and 8-hour CO concentrations for these facilities are all below the objectives.

Modelling results have not been shown in a figure because of the low levels of predicted CO.

Fine Particulate Matter

Table 2-60 summarizes the predicted maximum ground-level $PM_{2.5}$ concentrations for pipeline facilities in the central airshed. All values are below the Northwest Territories standard.

Table 2-61 summarizes the predicted maximum ground-level $PM_{2.5}$ concentrations for pipeline facilities in the southern airshed. All values are below the Northwest Territories standard.

Table 2-59: Carbon Monoxide Predictions in the Southern Airshed

Area	Parameter	Averaging Period Predictions[a]	
		1-hour	8-hour
Blackwater River compressor station	Maximum carbon monoxide (CO) concentration (µg/m³)	585.0	316.2
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SE	SE
	Expected occurrences exceeding objective[2]	0	0
	Area exceeding objective[3] (ha)	0	0
Trail River compressor station	Maximum CO concentration (µg/m³)	751.3	368.6
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	W	W
	Expected occurrences exceeding objective[2]	0	0
	Area exceeding objective[3] (ha)	0	0
Trout River heater station	Maximum CO concentration (µg/m³)	197.2	83.2
	Distance to maximum[1] (km)	0.2	0.2
	Direction to maximum[1]	W	WNW
Trout River heater station (cont'd)	Expected occurrences exceeding objective[2]	0	0
	Area exceeding objective[3] (ha)	0	0
CO objectives[4, 5] (µg/m³)		15,000	6,000

NOTES:
SE = southeast
W = west
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Table 2-60: Fine Particulate Matter Predictions in the Central Airshed

Area	Parameter	Averaging Period Predictions[a]	
		24-hour	Annual
Little Chicago compressor station	Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	2.0	0.4
	Distance to maximum[1] (km)	5.0	5.0
	Direction to maximum[1]	S	S
	Expected occurrences exceeding standard[2]	0	N/A
	Area exceeding standard[3] (ha)	0	N/A
Norman Wells compressor station	Maximum $PM_{2.5}$ concentration (µg/m³)	6.7	1.6
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SE	SE
	Expected occurrences exceeding standard[2]	0	N/A
	Area exceeding standard[3] (ha)	0	N/A
$PM_{2.5}$ standards[4] (µg/m³)		30	N/A

NOTES:
S = south
SE = southeast
N/A = not applicable
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Table 2-61: Fine Particulate Matter Predictions in the Southern Airshed

Area	Parameter	Averaging Period Predictions[a]	
		24-hour	Annual
Blackwater River compressor station	Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	9.5	2.5
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	S	S
	Expected occurrences exceeding standard[2]	0.0	N/A
	Area exceeding standard[3] (ha)	0	N/A
Trail River compressor station	Maximum $PM_{2.5}$ concentration (µg/m³)	12.1	2.8
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	W	W
	Expected occurrences exceeding standard[2]	0	N/A
	Area exceeding standard[3] (ha)	0	N/A
Trout River heater station	Maximum $PM_{2.5}$ concentration (µg/m³)	2.8	0.7
	Distance to maximum[1] (km)	0.1	0.3
	Direction to maximum[1]	SE	SE
	Expected occurrences exceeding standard[2]	0	N/A
	Area exceeding standard[3] (ha)	0	N/A
$PM_{2.5}$ standards[4] (µg/m³)		30	N/A

NOTES:
N/A = not applicable
S = south
SE = southeast
W = west
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Benzene and BTEX Compounds

Table 2-62 shows the predicted maximum ground-level concentrations of benzene or BTEX at facilities in the central airshed. None of the predicted concentrations exceed the criteria.

Table 2-62: Benzene and Total BTEX Predictions in the Central Airshed

Area	Parameter	Predicted Maximum Concentrations[a]	
		Benzene	BTEX
Little Chicago compressor station	Maximum 1-hour concentration (µg/m³)	0.2	1.0
	Distance to maximum[1] (km)	4.6	4.3
	Direction to maximum[1]	SSE	SSE
	Expected occurrences exceeding criteria[2]	0	0
	Area exceeding criteria[3] (ha)	0	0
Norman Wells compressor station	Maximum 1-hour concentration (µg/m³)	0.5	1.2
	Distance to maximum[4] (km)	0.1	0.1
	Direction to maximum[4]	SE	SE
	Expected occurrences exceeding criteria[2]	0	0
	Area exceeding criteria[3] (ha)	0	0
Available criteria[5] (µg/m³)		30[b]	30[c]

NOTES:
SE = southeast
SSE = south-southeast
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX because it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the Little Chicago compressor station
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 Distance and direction are relative to the Norman Wells compressor station
5 There are no Northwest Territories standards for benzene or total BTEX

Table 2-63 is a summary of the predicted maximum ground-level concentrations of benzene or BTEX at pipeline facilities in the southern airshed. None of the predicted concentrations exceed the criteria.

Table 2-63: Benzene and Total BTEX Predictions in the Southern Airshed

Area	Parameter	Predicted Maximum Concentrations[a]	
		Benzene	BTEX
Blackwater River compressor station	Maximum 1-hour concentration (µg/m³)	0.4	1.0
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SE	SE
	Expected occurrences exceeding criteria[2]	0	0
	Area exceeding criteria[3] (ha)	0	0
Trail River compressor station	Maximum 1-hour concentration (µg/m³)	0.5	1.3
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	S	S
	Expected occurrences exceeding criteria[2]	0	0
	Area exceeding criteria[3] (ha)	0	0
Trout River heater station	Maximum 1-hour concentration (µg/m³)	0.0	0.1
	Distance to maximum[1] (km)	0.2	0.2
	Direction to maximum[1]	W	WNW
	Expected occurrences exceeding criteria[2]	0	0
	Area exceeding criteria[3] (ha)	0	0
Available criteria[4] (µg/m³)		30[b]	30[c]

NOTES:
S = south
SE = southeast
W = west
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX because it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Potential Acid Input

Table 2-64 is a summary of PAI predictions in the central airshed. Whereas the maximum PAI values are predicted to exceed the monitoring and critical load values recommended by CASA for sensitive ecosystems (see Table 2-6, shown previously), the area PAI predictions are well below both the critical and monitoring loads. Only 18 ha near the Little Chicago compressor station and 12 ha near the Norman Wells compressor station are predicted to experience PAI in excess of 0.25 keq/ha/a.

Table 2-64: Potential Acid Input Predictions in the Central Airshed

Area	Parameter	Results[a]
Little Chicago compressor station	Maximum potential acid input (PAI) (keq/ha/a)	2.21
	Area PAI (keq/ha/a)[1]	0.007
	Maximum sulphate deposition (kg/ha/a)	0.40
	Maximum nitrate deposition (kg/ha/a)	136.26
	Area with PAI >0.17 keq/ha/a[2] (ha)	45
	Area with PAI >0.25 keq/ha/a[3] (ha)	18
Norman Wells compressor station	Maximum PAI (keq/ha/a)	1.33
	Area PAI (keq/ha/a)[1]	0.008
	Maximum sulphate deposition (kg/ha/a)	0.26
	Maximum nitrate deposition (kg/ha/a)	82.12
	Area with PAI >0.17 keq/ha/a[b] (ha)	25
	Area with PAI >0.25 keq/ha/a[d] (ha)	12

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the central airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

Table 2-65 is a summary of PAI predictions at pipeline facilities in the southern airshed. Only 10 ha near the Blackwater River compressor station and 10 ha near the Trail River compressor station are predicted to experience PAI in excess of 0.25 keq/ha/a. The maximum PAI levels at the Trout River heater station are predicted to be 0.25 keq/ha/a over a 14 ha area.

The following figures provide graphical summaries of PAI predictions near Little Chicago (see Figure 2-5), Norman Wells (see Figure 2-6), Blackwater River (see Figure 2-7), Trail River (see Figure 2-8) and Trout River (see Figure 2-9) facilities.

Ice Fog

At all pipeline corridor facilities there is the potential for a localized increase in ice fog. However, all facilities are located at a sufficient distance from communities so any ice fog formation should not affect them.

Figure 2.5 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.6 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.7 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.8 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Figure 2.9 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Table 2-65: Potential Acid Input Predictions in the Southern Airshed

Area	Parameter	Results[a]
Blackwater River compressor station	Maximum potential acid input (PAI) (keq/ha/a)	1.20
	Area PAI (keq/ha/a)[1]	0.009
	Maximum sulphate deposition (kg/ha/a)	0.41
	Maximum nitrate deposition (kg/ha/a)	73.73
	Area with PAI >0.17 keq/ha/a[2] (ha)	23
	Area with PAI >0.25 keq/ha/a[3] (ha)	10
Trail River compressor station	Maximum PAI (keq/ha/a)	1.11
	Area PAI (keq/ha/a)[1]	0.008
	Maximum sulphate deposition (kg/ha/a)	0.46
	Maximum nitrate deposition (kg/ha/a)	68.05
	Area with PAI >0.17 keq/ha/a[2] (ha)	23
	Area with PAI >0.25 keq/ha/a[3] (ha)	10
Trout River heater station	Maximum PAI (keq/ha/a)	0.49
	Area PAI (keq/ha/a)[1]	0.006
	Maximum sulphate deposition (kg/ha/a)	0.10
	Maximum nitrate deposition (kg/ha/a)	30.39
	Area with PAI >0.17 keq/ha/a[b] (ha)	35
	Area with PAI >0.25 keq/ha/a[d] (ha)	14

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

2.3.8 Northwestern Alberta

2.3.8.1 Baseline Conditions

The NGTL interconnect facility is distant from current sources of industrial air emissions, so background levels of combustion products, e.g., SO_2, NO_2, CO and $PM_{2.5}$, are low. Detectable levels of ozone are expected, as ozone levels in northern Canada are naturally high. Background PAI, from long-range transport of acid-forming compounds emitted by large industrial facilities elsewhere in the northern hemisphere, is deposited by precipitation in the region.

Table 2-66 summarizes background concentrations of the key indicator compounds in Niglintgak. Volume 3, Section 2, Air Quality provides additional background data.

Table 2-66: Baseline Air Conditions – Northwestern Alberta

Parameter	NGTL
Sulphur dioxide (SO_2)[1] (µg/m³)	0.5[a]
Nitrogen dioxide (NO_2)[1] (µg/m³)	0.9[a]
Carbon monoxide (CO)[2] (µg/m³)	0.0
Fine particulate matter ($PM_{2.5}$)[2] (µg/m³)	0.0
Benzene (µg/m³)	2.6
Total BTEX[3] (µg/m³)	3.7
Potential acid input[4] (keq/ha/a)	0.03
Sulphate deposition[4] (kg/ha/a)	0.96
Nitrate deposition[4] (kg/ha/a)	0.62
Ozone (O_3)[1, 5] (µg/m³)	45.7

NOTES:
a Results are based on passive monitoring data from Inuvik
b Results are based on continuous monitoring data from Norman Wells
1 Results assumed to be zero
2 Results are based on the SUMMA canister data for Parsons Lake
3 Total BTEX was calculated as the sum of the benzene, toluene, ethylbenzene and xylene concentrations and converted to µg/m³ assuming the molecular weight of benzene
4 Results are based on wet deposition monitoring results for Snare Rapids, Northwest Territories (Golder and Connor Pacific 1998)
5 Background ozone concentrations were not selected as a key indicator but are important in determining the quantity of NO_X emissions that are converted to NO_2 in the atmosphere

2.3.8.2 Northwestern Alberta Effects

Table 2-67 shows the direction, magnitude, geographic extent and duration of air quality changes resulting from operations at their peak level. All 12 key indicators were classified as having an adverse direction. Of these, nine were classified as low magnitude and three were classified as moderate magnitude. The PAI levels integrated over the modelling LSA are conservative estimates of gridded PAI levels and were much lower than CASA critical loads.

2.3.8.3 Project Emissions

The NGTL interconnect facility is a metering station where the primary source of emissions is power generation. A summary of emissions from this facility is provided in Table 2-68.

Table 2-67: Effects on Air Quality – Northwestern Alberta

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term
24-hour SO_2	Operations	Adverse	Low	Local	Long term
Annual SO_2	Operations	Adverse	Low	Local	Long term
1-hour nitrogen dioxide ($NO_{2)}$	Operations	Adverse	Moderate	Local	Long term
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term
Annual NO_2	Operations	Adverse	Low	Local	Long term
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term
8-hour CO	Operations	Adverse	Low	Local	Long term
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term
1-hour benzene	Operations	Adverse	Low	Local	Long term
1-hour BTEX	Operations	Adverse	Low	Local	Long term
Area potential acid input	Operations	Adverse	Low	Local	Long term

Table 2-68: Emissions from the NGTL Interconnect Facility

Area	Activity	Emissions					
		SO_2 (t/d)	**NO_X** (t/d)	**CO** (t/d)	**$PM_{2.5}$** (t/d)	**Benzene** (t/d)	**BTEX** (t/d)
NGTL interconnect facility	Power generation	0.00	0.14	0.02	0.00	0.000	0.00
	Process equipment	0.00	0.13	0.17	0.02	0.000	0.00
	Total	0.00	0.27	0.19	0.02	0.000	0.00

NOTES:
SO_2 = sulphur dioxide
NO_X = oxides of nitrogen
CO = carbon monoxide
$PM_{2.5}$ = fine particulate matter
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Sulphur Dioxide

Table 2-69 summarizes predicted ground-level SO_2 concentrations at the NGTL interconnect facility. All predicted 1-hour, 24-hour and annual SO_2 concentrations are below Northwest Territories standards. Modelling results have not been shown in a figure because of the low levels of predicted SO_2.

Nitrogen Dioxide

Table 2-70 shows the maximum NO_X and NO_2 predictions for the NGTL interconnect facility. All predictions are below the federal objectives. Modelling results have not been shown in a figure because of the low levels of predicted NO_2.

Table 2-69: Sulphur Dioxide Predictions at the NGTL Interconnect Facility

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
NGTL interconnect facility	Maximum sulphur dioxide (SO_2) concentration (µg/m³)	2.1	0.5	0.1
	Distance to maximum[1] (km)	0.3[b]	0.1[b]	0.1[b]
	Direction to maximum[1]	W	SSE	SSE
	Expected occurrences exceeding standard[2]	0.0	0.0	0.0
	Area exceeding standard[3] (ha)	0	0	0
SO_2 standards[4] (µg/m³)		450	150	30

NOTES:
SSE = south-southeast
W = west
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
b The model predicted the locations of maximum SO_2 concentrations at the NGTL interconnect facility, though the magnitudes of these maximums were too low to appear in the table
1 Distance and direction are relative to the NGTL interconnect facility
2 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Table 2-70: Nitrogen Dioxide and Oxides of Nitrogen Predictions at the NGTL Interconnect Facility

Area	Parameter	Averaging Period Predictions[a]		
		1-hour	24-hour	Annual
NGTL interconnect facility	Maximum oxides of nitrogen (NO_X) concentration (µg/m³)	372.0	145.8	22.5
	Maximum nitrogen dioxide (NO_2) concentration (µg/m³)	126.6	51.1	3.4
	Distance to maximum[1] (km)	5.2	1.1	0.3
	Direction to maximum[1]	WNW	NNW	SSE
	Expected occurrences exceeding objective[2]	0.0	0.0	0.0
	Area exceeding objective[3] (ha)	0.0	0.0	0.0
NO_2 objectives[4, 5] (µg/m³)		400	200	100

NOTES:
NNW = north-northwest
SSE = south-southeast
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour, 24-hour or annual concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for NO_2

Carbon Monoxide

Table 2-71 shows the predicted ground-level CO concentrations for the NGTL interconnect facility. None of the predicted 1-hour or 8-hour CO concentrations exceeds the objectives. Modelling results have not been shown in a figure because of the low levels of predicted CO.

Table 2-71: Carbon Monoxide Predictions at the NGTL Interconnect Facility

Area	Parameter	Averaging Period Predictions[a]	
		1-hour	8–hour
NGTL interconnect facility	Maximum carbon monoxide (CO) concentration (µg/m³)	284.4	104.2
	Distance to maximum[1] (km)	0.3	0.4
	Direction to maximum[1]	W	WNW
	Expected occurrences exceeding objective[2]	0.0	0.0
	Area exceeding objective[3] (ha)	0.0	0.0
CO objectives[4, 5] (µg/m³)		15,000	6,000

NOTES:
W = west
WNW = west-northwest
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding objective* is the number of 1-hour or 8-hour periods with predicted concentrations exceeding the applicable objectives. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding objective* is the total area over which the predicted 1-hour or 8-hour concentrations exceeded the applicable objectives
4 Federal Ambient Air Quality Objectives from *The Clean Air Act* (Environment Canada 1981)
5 There are no Northwest Territories standards for CO

Fine Particulate Matter

Table 2-72 summarizes the predicted maximum ground-level $PM_{2.5}$ concentrations at the NGTL interconnect facility. All values are below the Northwest Territories standard.

Benzene and BTEX Compounds

Table 2-73 is a summary of the predicted maximum ground-level concentrations of benzene or BTEX at the NGTL interconnect facility. None of the predicted concentrations exceed the criteria.

Potential Acid Input

Table 2-74 is a summary of PAI predictions at the NGTL interconnect facility. The PAI levels integrated over the LSA are a conservative estimate of gridded PAI levels because the LSA is only 40,000 ha. This is much smaller than 1° by 1° grid cells that are at least 500,000 ha in size at these latitudes. The area PAI prediction is well below the CASA monitoring load for the most sensitive ecosystems. Figure 2-10 shows the local PAI results graphically.

Table 2-72: Fine Particulate Matter Predictions at the NGTL Interconnect Facility

Area	Parameter	Averaging Period Predictions[a]	
		24-hour	Annual
NGTL interconnect facility	Maximum fine particulate matter ($PM_{2.5}$) concentration (µg/m³)	3.1	0.7
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	SSE	SSE
	Expected occurrences exceeding standard[2]	0.0	N/A
	Area exceeding standard[3] (ha)	0.0	N/A
$PM_{2.5}$ standards[4] (µg/m³)		30	N/A

NOTES:
N/A = not applicable
SSE = south-southeast
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding standard* is the number of days or years with predicted concentrations exceeding the applicable standards. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding standard* is the total area over which the predicted 24-hour or annual concentrations exceeded the applicable standards
4 Northwest Territories Ambient Air Standards (RWED 2002)

Table 2-73: Benzene and Total BTEX Predictions at the NGTL Interconnect Facility

Area	Parameter	Predicted Maximum Concentrations[a]	
		Benzene	BTEX
NGTL interconnect facility	Maximum 1-hour concentration (µg/m³)	0.0	0.1
	Distance to maximum[1] (km)	0.1	0.1
	Direction to maximum[1]	W	W
	Expected occurrences exceeding criteria[2]	0.0	0.0
	Area exceeding criteria[3] (ha)	0	0
Available criteria[4] (µg/m³)		30[b]	30[c]

NOTES:
W = west
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
b Alberta Ambient Air Quality Guidelines (AENV 2000)
c The Alberta Ambient Air Quality Guidelines (AENV 2000) value for benzene was used for BTEX because it is the most stringent of the available criteria for benzene, toluene, ethylbenzene and xylene
1 Distance and direction are relative to the facilities
2 The *expected occurrences exceeding criteria* is the number of hours with predicted concentrations exceeding the applicable criteria. It is the average of five years of modelling data, so it might not be a whole number.
3 The *area exceeding criteria* is the total area over which the predicted 1-hour concentrations exceeded the applicable criteria
4 There are no Northwest Territories standards for benzene or total BTEX

Figure 2.10 has been removed for the purposes of reducing file size and can be viewed as a graphic separately. This document can be accessed through the link in the Table of Contents reference web page.

Table 2-74: Potential Acid Input Predictions at the NGTL Interconnect Facility

Area	Parameter	Results[a]
NGTL interconnect facility	Maximum potential acid input (PAI) (keq/ha/a)	0.49
	Area PAI (keq/ha/a)[1]	0.009
	Maximum sulphate deposition (kg/ha/a)	0.11
	Maximum nitrate deposition (kg/ha/a)	30.18
	Area with PAI >0.17 keq/ha/a[b] (ha)	43
	Area with PAI >0.25 keq/ha/a[d] (ha)	16

NOTES:
a The predictions in the table include the effects of combined emissions from project sources in the southern airshed
b 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
c 0.25 keq/ha/a represents the critical load value for sensitive ecosystems
1 Area PAI represents integrated PAI levels over the entire 40,000 ha LSA, which is considerably smaller than 1° by 1° grid cells that are more than 500,000 ha in size at this latitude

Ice Fog

The meteorological conditions necessary for the formation of ice fog are extremely rare in the region. Therefore, emissions from the NGTL interconnect facility are not expected to have any effect on ice fog formation.

2.3.9 Infrastructure

As discussed in Section 2.3.1, Effect Pathways, the project infrastructure is expected to have a limited and localized effect on air quality. Potential effects of activities such as vehicle movement and operation of camps, including waste incineration, are likely minor compared with potential effects of operating facilities and are therefore not assessed. This includes the construction camps that will be potential sources of air emissions from space heating and from the incinerators used to manage wastes. Air effects from these sources would be limited to the immediate vicinity of the camps and of lower magnitude than effects during peak operations.

2.3.10 Significance of Effects

In the previous sections, the characteristics of the residual effects of the project were described in terms of the effect's direction, magnitude, geographic extent, and duration. These characteristics are used to determine the significance of the effects on air quality.

Volume 1 provides a discussion about the rationale for determining significance. An adverse residual effect is considered significant if the effect is either:

- moderate or high magnitude and extends into the far future, i.e., more than 30 years after project decommissioning
- high magnitude and occurs outside the LSA at any time

In this section, the significance of the effects for each project component and the combined project is presented. Tables provide the results of the effect assessments and indicate if the effect is significant. The assessment was focused on effects during project operations when air emissions will be most pronounced. The magnitude of effects will be low or moderate and are confined to the LSAs. No significant effects on air quality are predicted.

2.3.10.1 Niglintgak

There are no significant air quality effects at Niglintgak (see Table 2-75). Of the 12 key indicators associated with increased ambient concentrations, seven were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour and 24-hour NO_2, 1-hour and 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

Table 2-75: Significance of Air Quality Effects for Operations at Niglintgak

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Low	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Moderate	Local	Long term	No
8-hour CO	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

The key indicator used to evaluate increased PAI was assigned a low magnitude because the area PAI predictions were lower than the critical or monitoring load values identified by CASA for sensitive ecosystems.

2.3.10.2 Taglu

There are no significant air quality effects at Taglu (see Table 2-76). Of the 12 key indicators with increased ambient concentrations, six were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour, 24-hour

and annual NO_2, 1-hour and 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards. Potential acid input, the key indicator of increased acid deposition, was assigned a low magnitude because the area PAI predictions were lower than the critical or monitoring load values identified by CASA for sensitive ecosystems.

Table 2-76: Significance of Air Quality Effects for Operations at Taglu

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Moderate	Local	Long term	No
1-hour carbon monoxide CO)	Operations	Adverse	Moderate	Local	Long term	No
8-hour CO	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

2.3.10.3 Parsons Lake

There are no significant air quality effects at Parsons Lake (see Table 2-77). Of the 12 key indicators with increased ambient concentrations, eight were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour and 24-hour NO_2, 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

Table 2-77: Significance of Air Quality Effects for Operations at Parsons Lake

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Low	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

The key indicator of PAI was assigned a low magnitude because the area PAI prediction was lower than the critical or monitoring load values identified by CASA for sensitive ecosystems.

2.3.10.4 Gathering Pipelines and Associated Facilities

A full air quality assessment within the gathering pipelines and associated facilities was completed for the Inuvik area facility only because the emissions from the Storm Hills pigging facility were considered too low to justify a separate modelling evaluation. The air quality assessment results for the Inuvik area facility indicated there would be no significant air quality effects (see Table 2-78).

Nine of the 12 key indicators of increased ambient concentrations were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour and 24-hour NO_2 and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

The key indicator of increased PAI was assigned a low magnitude because the area PAI prediction was lower than the critical or monitoring load values identified by CASA for sensitive ecosystems.

Table 2-78: Significance of Air Quality Effects for Operations at the Inuvik Area Facility

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Low	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Low	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

2.3.10.5 Pipeline Corridor

The air quality assessment included separate evaluations of each of the five major pipeline facilities. Significance has been determined for each one.

The air quality assessment results for the Little Chicago compressor station indicated there would be no significant air quality effects (see Table 2-79). Of the 12 key indicators of increased ambient concentrations, eight were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour, 24-hour and annual NO_2 and 24-hour $PM_{2.5}$ because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and the applicable objectives and standards.

The key indicator of increased PAI was assigned a low magnitude because the area PAI prediction was below the monitoring load value for 1° by 1° areas proposed by CASA for protecting sensitive ecosystems.

There are no significant air quality effects at the Norman Wells compressor station (see Table 2-80). Of the 12 key indicators of increased ambient concentrations, seven were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour, 24-hour and annual NO_2, 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

Table 2-79: Significance of Air Quality Effects for Operations at the Little Chicago Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Moderate	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Low	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

The PAI used to evaluate increased acid deposition was given a low magnitude because the area PAI prediction was below the monitoring load value for 1° by 1° areas proposed by CASA for protecting sensitive ecosystems.

There are no significant air quality effects at the Blackwater River compressor station (see Table 2-81). Of the 12 key indicators of increased ambient concentrations, seven were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour, 24-hour and annual NO_2, 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the maximum predicted concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

The key indicator of increased PAI was assigned a low magnitude because the area PAI prediction was below the monitoring load value for 1° by 1° areas proposed by CASA for protecting sensitive ecosystems.

Table 2-80: Significance of Air Quality Effects for Operations at the Norman Wells Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Moderate	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour (CO)	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

There are no significant air quality effects at the Trail River compressor station (see Table 2-82). Of the 12 key indicators of increased ambient concentrations, six were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour, 24-hour and annual NO_2, 1-hour and 8-hour CO and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

The key indicator of increased PAI was assigned a low magnitude because the area PAI prediction was below the monitoring load value for 1° by 1° areas proposed by CASA for protecting sensitive ecosystems.

There are no significant air quality effects at the Trout River heater station (see Table 2-83). Of the 12 key indicators of increased ambient concentrations, nine were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour and 24-hour NO_2 and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

Table 2-81: Significance of Air Quality Effects for Operations at the Blackwater River Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Moderate	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

Table 2-82: Significance of Air Quality Effects for Operations at the Trail River Compressor Station

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Moderate	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Moderate	Local	Long term	No
8-hour CO	Operations	Adverse	Moderate	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

Table 2-83: Significance of Air Quality Effects for Operations at the Trout River Heater Station

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Low	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Low	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

There are no significant air quality effects at the NGTL interconnect facility (see Table 2-84). Of the 12 key indicators of increased ambient concentrations nine were determined to have a low magnitude. Moderate magnitude was assigned to the 1-hour and 24-hour NO_2 and 24-hour $PM_{2.5}$ concentrations because the predicted maximum concentrations exceeded 5% of the relevant guideline levels and were below the applicable objectives and standards.

The key indicator of increased PAI was assigned a low magnitude because the area PAI prediction was below the monitoring load value for 1° by 1° areas proposed by CASA for protecting sensitive ecosystems.

2.3.10.6 Combined

It was assumed that emissions from individual project elements would act in a combined manner in each of the airsheds discussed in Section 2.2.5, Study Areas and Boundaries. This is because of the potential for transport and mixing of emitted constituents within an airshed.

Therefore, the significance determinations presented for each of the project components represent the combined air quality effects near each facility. The assessment results indicate no significant effects on air quality for all indicators at all sites assessed.

Table 2-84: Significance of Air Quality Effects for Operations at the NGTL Interconnect Facility

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide (SO_2)	Operations	Adverse	Low	Local	Long term	No
24-hour SO_2	Operations	Adverse	Low	Local	Long term	No
Annual SO_2	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide (NO_2)	Operations	Adverse	Moderate	Local	Long term	No
24-hour NO_2	Operations	Adverse	Moderate	Local	Long term	No
Annual NO_2	Operations	Adverse	Low	Local	Long term	No
1-hour carbon monoxide (CO)	Operations	Adverse	Low	Local	Long term	No
8-hour CO	Operations	Adverse	Low	Local	Long term	No
24-hour fine particulate matter ($PM_{2.5}$)	Operations	Adverse	Moderate	Local	Long term	No
1-hour benzene	Operations	Adverse	Low	Local	Long term	No
1-hour BTEX	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No

NOTE:
Only the operations phase was assessed because effects during construction and decommissioning will be less.

2.3.10.7 Prediction Confidence

Available information and understanding of air quality are used to provide predictions of the effects of the project on air quality. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty.

In all cases, there is a high degree of confidence that effects will be less than predicted because, where data is uncertain, a conservative approach has been applied in developing the effect assessment. The high degree of confidence in the air predictions is because:

- 12 months of ambient monitoring data collected outside Inuvik and in Norman Wells confirmed earlier expectations of low background air concentrations in the production area and along the pipeline corridor

- modelling used three comprehensive five-year meteorological datasets, ensuring the range of meteorological conditions over the project area was represented

- emission values used in the models were calculated based on peak operations with all equipment operating at maximum capability. This conservative assumption ensures that actual emissions and expected effects would not be underestimated.

- dispersion modelling used the CALPUFF model to predict the parameters presented in this assessment. This model provides accurate predictions of ground-level concentrations and deposition values.

2.4 Effects on Greenhouse Gas Emissions

2.4.1 Effect Pathways

Figure 2-11 provides the effect pathway diagram for the question, *How will the project contribute to potential greenhouse gas emissions?* The figure shows that several project components during construction and operations will contribute to GHG emissions. Greenhouse gas emissions are mostly CO_2, CH_4 and N_2O, which can all be expressed as ECO_2, i.e., equivalent carbon dioxide values.

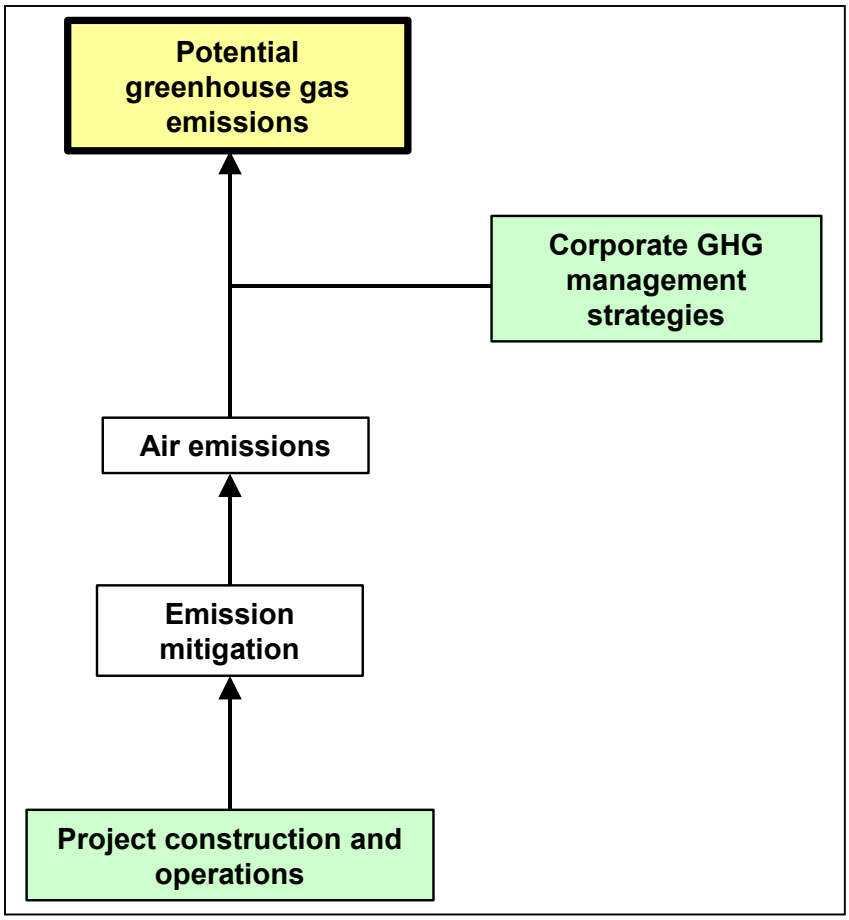

Figure 2-11: Effect Pathways – Greenhouse Gas Emissions

The effect pathway diagram indicates that during construction of facilities and pipelines, construction camp operations and vehicle and aircraft use will contribute to air emissions. Mitigation measures to control GHG emissions will include reducing fuel use and using efficient combustion sources. Greenhouse gas emissions from construction would be minor compared with the GHG emissions from peak operations and were not carried through the assessment.

Production facility and gathering pipelines and associated facilities operations and associated traffic will contribute to GHG emissions. To put project GHG emissions into perspective, current levels of emissions in the Northwest Territories and in Canada are used as a reference point. Table 2-85 shows the current national and territorial levels of GHG emissions and the projections for 2010.

Table 2-85: National and Northwest Territories Greenhouse Gas Emissions

Reporting Year	GHG Emissions	
	Canada (kt/a of ECO_2)[1]	**Northwest Territories** (kt/a of ECO_2)
1995	673,000[2]	1,538[3]
2000	730,000[2]	1,607[3]
2010	764,000[3]	1,672[4]

NOTES:
ECO_2 = equivalent carbon dioxide
1 ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
2 Canada's Greenhouse Gas Inventory, 1990–2001 (Environment Canada 2003)
3 Canada's Emissions Outlook (NRC 1999)
4 Northwest Territories Greenhouse Gas Strategy (RWED 2001)

Current GHG emission levels within the airsheds considered in the assessment (see Section 2.2.5, Study Areas and Boundaries) are included in the totals for the Northwest Territories and are listed in Table 2-86.

Table 2-86: Existing Greenhouse Gas Emissions in the Project Airsheds

Activity	Emissions			
	CO_2 (kt/a)	**CH_4** (kt/a)	**N_2O** (kt/a)	**ECO_2**[1] (kt/a)
Aviation	–	–	–	–
Marine	–	–	–	–
Community	60.47	0.00	0.00	60.54
Power and industrial	119.51	0.15	0.00	122.67
Total	179.98	0.15	0.00	183.21

NOTES:
– = not available
1 ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)

2.4.2 Overview of Project Design and Mitigation

This section provides an overview of project design features and mitigation relevant to the potential contribution of the project to greenhouse gas emissions.

The project design features are detailed in Volume 2, Project Description. Most potential effects from the project will be reduced through best management practices during drilling, construction, operations and decommissioning and abandonment.

Mitigation strategies for greenhouse gas emissions will help to reduce the magnitude of potential effects from the pathways discussed in Section 2.4.1, Effect Pathways.

Table 2-87 summarizes proposed strategies to mitigate the project's contribution of greenhouse gases.

Table 2-87: Mitigation Strategies During Construction for Greenhouse Gases

Pathway	Primary Mitigation Strategy
Increased greenhouse gas emissions	Use equipment that meets with relevant standards including Northwest Territories regulations, CCME standards and Alberta standards (where regulations do not exist in the Northwest Territories) Consider efficiency in equipment selection Manage the need for and duration of flaring Ensure flare stack design requirements and flare performance standards are consistent with EUB Guide 60 and its amendments Apply best management practices to reduce fuel use Avoid idling vehicles except under extremely cold conditions

2.4.3 Niglintgak

See Section 2.3.3 for a description of Niglintgak development.

2.4.3.1 Baseline Conditions

Although there could be existing GHG emissions within the RSA, there are currently no GHG emissions at Niglintgak.

2.4.3.2 Niglintgak Effects

Table 2-88 summarizes greenhouse gas emission effects from operations at Niglintgak. The direction is adverse and the magnitude moderate because emissions exceed 1% of the Northwest Territories GHG emissions but are less than 1% of the national emissions.

The annual GHG emissions during peak operations at Niglintgak are summarized in Table 2-89.

Table 2-88: Effects on Greenhouse Gas Emissions at Niglintgak

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

Table 2-89: Annual Greenhouse Gas Emissions at Niglintgak

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Niglintgak (land-based option for gas conditioning facility)	Compression	108.00	0.01	0.00	109.63
	Power generation	37.80	0.00	0.00	38.37
	Process equipment	38.90	0.00	0.00	39.13
	Total	184.69	0.01	0.01	187.13

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

2.4.4 Taglu

See Section 2.3.4 for a description of Taglu development.

2.4.4.1 Baseline Conditions

Although there could be existing GHG emissions within the RSA, there are currently no GHG emissions at Taglu.

2.4.4.2 Taglu Effects

Table 2-90 summarizes the effect attributes for greenhouse gas emissions from operations at Taglu. The direction is adverse and the magnitude is moderate because emissions exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-90: Attributes for Greenhouse Gas Emissions at Taglu

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

Table 2-91 shows annual GHG emissions during peak operations at Taglu.

Table 2-91: Annual Greenhouse Gas Emissions at Taglu

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Taglu	Compression	249.24	0.02	0.01	253.01
	Power generation	24.00	0.27	0.01	33.86
	Process equipment	50.42	0.00	0.00	50.91
	Total	323.65	0.29	0.03	337.78

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

2.4.5 Parsons Lake

See Section 2.3.5 for a description of Parsons Lake development.

2.4.5.1 Baseline Conditions

Although there could be existing GHG emissions within the RSA, there are currently no GHG emissions at Parsons Lake.

2.4.5.2 Parsons Lake Effects

Table 2-92 summarizes greenhouse gas emission effects from operations at Parsons Lake. The direction is adverse and the magnitude moderate because emissions exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-92: Effects on Greenhouse Gas Emissions at Parsons Lake

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

Table 2-93 shows annual GHG emissions from peak operations at Parsons Lake.

2.4.6 Gathering Pipelines and Associated Facilities

The gathering pipelines and associated facilities connect the three anchor fields to the Inuvik area facility (see Volume 2, Project Description). The pipelines and associated facilities include the Niglintgak lateral, the Taglu lateral, the Parsons Lake lateral, the Storm Hills lateral, the Storm Hills pigging facility, the Inuvik

area facility, two intermediate block valves, and pads for the trenchless installation at the East Channel of the Mackenzie River.

Table 2-93: Annual Greenhouse Gas Emissions at Parsons Lake

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Parsons Lake	Compression	133.72	0.01	0.01	135.75
	Power generation	27.72	0.31	0.02	39.11
	Process equipment	26.06	0.00	0.00	26.22
	Total	187.51	0.33	0.02	201.08

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)

2.4.6.1 Baseline Conditions

Although there could be existing GHG emissions within the RSA, there are currently no GHG emissions along the gathering pipeline route.

2.4.6.2 Gathering Pipelines and Associated Facilities Effects

Table 2-94 summarizes the effect attributes for greenhouse gas emissions from gathering pipelines and associated facilities operations, i.e., Storm Hills and Inuvik area facility. The direction is adverse and the magnitude moderate because emissions exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-94: Effects on Greenhouse Gas Emissions Along the Gathering Pipelines and Associated Facilities

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

Table 2-95 shows annual GHG emissions from the gathering pipelines and associated facilities.

2.4.7 Pipeline Corridor

See Section 2.3.7 for a description of pipeline corridor development.

Table 2-95: Annual Greenhouse Gas Emissions for the Gathering Pipelines and Associated Facilities

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Storm Hills pigging facility	Power generation	0.59	0.01	0.00	0.83
	Process equipment	0.19	0.00	0.00	0.19
	Subtotal	0.78	0.01	0.00	1.02
Inuvik area facility	Compression	379.92	0.03	0.02	385.67
	Power generation	43.96	0.00	0.00	44.62
	Process equipment	118.55	0.00	0.00	119.67
	Subtotal	542.43	0.04	0.02	549.96
Total		543.21	0.04	0.02	550.98

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

2.4.7.1 Baseline Conditions

Although there could be existing GHG emissions within the RSA, there are currently no GHG emissions at the pipeline corridor facilities.

2.4.7.2 Pipeline Corridor Effects

Table 2-96 summarizes the effect attributes for greenhouse gas emissions from pipeline corridor operations. The direction is adverse and the magnitude moderate because emissions exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-96: Effects on Greenhouse Gas Emissions Along the Pipeline Corridor

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

The pipeline corridor includes facilities in two of the airsheds. Table 2-97 shows GHG emissions from the Little Chicago and Norman Wells compressor stations in the central airshed.

Table 2-97: Greenhouse Gas Emissions in the Central Airshed

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Little Chicago compressor station	Compression	87.28	0.01	0.00	88.60
	Power generation	4.17	0.05	0.00	5.88
	Process equipment	13.08	0.00	0.00	13.16
	Total	104.53	0.05	0.01	107.64
Norman Wells compressor station	Compression	87.28	0.01	0.00	88.60
	Power generation	4.17	0.05	0.00	5.88
	Process equipment	13.08	0.00	0.00	13.16
	Total	104.53	0.05	0.01	107.65

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Table 2-98 shows GHG emissions from the pipeline facilities in the southern airshed. Table 2-99 is a summary of GHG emissions from all pipeline corridor operations.

2.4.8 Northwestern Alberta

2.4.8.1 Baseline Conditions

There are currently no project GHG contributors near the NGTL interconnect facility.

2.4.8.2 Northwestern Alberta Effects

Table 2-100 summarizes the effect attributes for greenhouse gas emissions from NGTL interconnect facility operations. The direction is adverse and the magnitude is moderate because emissions exceed 1% of Northwest Territories GHG emissions but do not exceed 1% of the national emissions.

The pipeline corridor includes facilities in two of the airsheds introduced in Section 2.2.5, Study Areas and Boundaries. Table 2-101 shows GHG emissions from the NGTL interconnect facility.

Table 2-98: Greenhouse Gas Emissions at Pipeline Facilities in the Southern Airshed

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Blackwater River compressor station	Compression	87.28	0.01	0.00	88.60
	Power generation	4.17	0.05	0.00	5.88
	Process equipment	13.08	0.00	0.00	13.16
	Total	104.53	0.05	0.01	107.64
Trail River compressor station	Compression	87.28	0.01	0.00	88.60
	Power generation	4.17	0.05	0.00	5.88
	Process equipment	13.08	0.00	0.00	13.16
	Total	104.53	0.05	0.01	107.64
Trout River heater station	Compression	–	–	–	–
	Power generation	1.36	0.02	0.00	1.92
	Process equipment	32.76	0.00	0.00	32.96
	Total	34.12	0.02	0.00	34.88

NOTES:
– = not available
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Table 2-99: Summary of Greenhouse Gas Emissions from the Pipeline Corridor

Airshed	Facility	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
Central	Little Chicago compressor station	104.53	0.05	0.01	107.64
	Norman Wells compressor station	104.53	0.05	0.01	107.65
Southern	Blackwater River compressor station	104.53	0.05	0.01	107.64
	Trail River compressor station	104.53	0.05	0.01	107.64
	Trout River heater station	34.12	0.02	0.00	34.88
Pipeline corridor totals		452.24	0.23	0.03	465.45

NOTES:
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Numbers in this table have been rounded for presentation purposes. Therefore, the sum of the presented numbers might add up to values different than the totals.

Table 2-100: Effects on Greenhouse Gas Emissions – Northwestern Alberta

Key Indicator	Phase When Impact Occurs	Effect Attribute			
		Direction	Magnitude	Geographic Extent	Duration
GHG emissions	Operations	Adverse	Moderate	National	Long term

Table 2-101: Greenhouse Gas Emissions from the NGTL Interconnect Facility

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[a] (kt/a)
NGTL interconnect facility	Compression	–	–	–	–
	Power generation	1.36	0.02	0.00	1.92
	Process equipment	85.48	0.00	0.00	86.00
	Total	86.84	0.02	0.00	87.92

NOTES:
– = not available
ECO_2 = equivalent carbon dioxide
a ECO_2 emissions were calculated using greenhouse potentials of one for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)

2.4.9 Infrastructure

As discussed previously in Section 2.4.1, Effect Pathways, the project infrastructure would be a minor contributor to GHG emissions compared with the operating facilities and is not considered in this assessment.

2.4.10 Significance of GHG Emissions

2.4.10.1 Niglintgak

GHG emissions from operations at Niglintgak are not significant (see Table 2-102). The GHG emissions were assigned a moderate magnitude because they exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-102: Significance of Greenhouse Gas Emission Effects at Niglintgak

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.2 Taglu

GHG emissions from operations at Taglu are not significant (see Table 2-103). The magnitude was set as moderate because the GHG emissions from Taglu exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-103: Significance of Greenhouse Gas Emission Effects at Taglu

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.3 Parsons Lake

GHG emissions from operations at Parsons Lake are not significant (see Table 2-104). The magnitude of the effects was determined to be moderate because the emissions exceed 1% of Northwest Territories GHG emissions but are less than 1% of national emissions.

Table 2-104: Significance of Greenhouse Gas Emission Effects at Parsons Lake

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.4 Gathering Pipelines and Associated Facilities

GHG emissions from the gathering system include the combined effects of the Inuvik area facility and the Storm Hills pigging facility. These emissions are not significant (see Table 2-105). GHG emissions were assigned a moderate magnitude because they exceed 1% of Northwest Territories totals but are less than 1% of national emissions.

Table 2-105: Significance of Greenhouse Gas Emission Effects for the Gathering Pipelines and Associated Facilities

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.5 Pipeline Corridor

GHG emissions from the pipeline corridor include the combined emissions from the Little Chicago, Norman Wells, Blackwater River and Trail River compressor

stations, the Trout River heater station and the NGTL interconnect facility. These emissions are not significant (see Table 2-106). The combined GHG emissions were assigned a moderate magnitude because they exceed 1% of Northwest Territories totals but are less than 1% of national emissions.

Table 2-106: Significance of Greenhouse Gas Emission Effects for the Pipeline Corridor

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.6 Infrastructure

As discussed in Section 2.4.1, Effect Pathways, the project infrastructure is expected to have a limited and localized effect on air quality. Potential effects of activities, such as vehicle movement, are likely minor compared with the operating facilities and are not considered in this assessment.

2.4.10.7 NGTL Interconnect Facility

The GHG emissions from the NGTL interconnect facility are not significant (see Table 2-107). The emissions were assigned a moderate magnitude because they exceed 1% of Northwest Territories totals but are less than 1% of national emissions.

Table 2-107: Significance of Greenhouse Gas Emission Effects for the NGTL Interconnect Facility

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.8 Combined Project Components

The GHG emissions from the combined project are not significant (see Table 2-108). The direction is adverse with a moderate magnitude rating assigned because combined GHG emissions of 1,830 kt/a of ECO_2 exceed 1% of Northwest Territories totals but are less than 1% of national emissions.

Table 2-108: Significance of Greenhouse Gas Emission Effects for the Combined Project Components

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
GHG emissions	Operations	Adverse	Moderate	National	Long term	No

2.4.10.9 Prediction Confidence

Available information and understanding of the project components are used to predict the project's contribution to greenhouse gas emissions. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty.

The prediction confidence in the effects related to greenhouse gas emissions is high because the likely emissions will be less than predicted. The potential contribution of the project to greenhouse gas emissions was calculated based on peak operations, with all equipment operating at full capacity. Actual operations will likely be at a lower level and result in lower emissions.

2.5 Monitoring

Volume 7, Section 6, Environmental Compliance and Effects Monitoring Plan, provides an overview of the intent and purpose of the environmental monitoring program to be implemented for the project.

Two types of programs will be developed:

- compliance monitoring
- effect monitoring

2.5.1 Compliance Monitoring

The Environmental Compliance and Effects Monitoring Plan (see Volume 7, Section 6) provides details of the compliance monitoring program.

2.5.2 Effect Monitoring

Passive monitoring for NO_2 will be conducted at the following facilities:

- Niglintgak
- Taglu
- Parsons Lake
- Little Chicago compressor station
- Norman Wells compressor station
- Blackwater River compressor station
- Trail River compressor station
- Trout River heater station
- NGTL interconnect facility

Hours when short-term, i.e., 1-hour, NO_2 levels were predicted to exceed the objectives are few and do not warrant further monitoring.

Further effect monitoring programs for air quality will be designed to assess the KIs that were used in assessing project effects. Effect monitoring programs will be established in consultation with communities and regulators.

References

Alberta Environment (AENV). 2000. Alberta Ambient Air Quality Guidelines *Environmental Protection and Enhancement Act.* Edmonton, Alberta.

Alberta Environmental Protection (AEP). 1996. *Code Of Practice For Compressor And Pumping Stations And Sweet Gas Processing Plants.* Alberta Queen's Printer, Edmonton, Alberta

Clean Air Strategic Alliance (CASA). 1999. *Application of Critical, Target, and Monitoring Loads for the Evaluation and Management of Acid Deposition.* Prepared by the Target Loading Subgroup, Edmonton, Alberta.

Environment Canada. 1981. The Clean Air Act. Compilation of Regulations and Guidelines. *Air Pollution Regulations Codes and Protocols Report: EPS-1_AP-81-1*. Air Pollution Control Division. Ottawa, Ontario.

Environment Canada. 1999. *Canada's Emission Outlook: An Updated. National Climate Change Process Analysis and Modelling Group.* Ottawa, Ontario.

Environment Canada. 2002. *Canada's Greenhouse Gas Inventory*, *1990–2000*. Ottawa, Ontario.

Environment Canada. 2003. *Canada's Greenhouse Gas Inventory*, *1990–2001*. Ottawa, Ontario.

Golder and Conor Pacific. 1998. *Technical Reference for the Meteorology, Emissions and Ambient Air Quality in the Athabasca Oil Sands Region.* Prepared for Suncor Energy Inc., Oil Sands by Golder Associates Ltd. and Conor Pacific Environmental Technologies Inc. Calgary, Alberta.

Government of Northwest Territories (GNWT). 2002. *Air Quality Code of Practice - Upstream Oil and Gas Industry (Consultation Draft)*. Environmental Protection Service, Department of Resources Wildlife and Economic Development.

NRC (Natural Resources Canada). 1999. *Canada's Emissions Outlook: An Update*. Prepared by the Analysis and Modelling Group of the National Climate Change Process. Ottawa, Ontario.

Ontario Ministry of the Environment. 2001. *Summary of Point of Impingement Standards, Point of Impingement Guidelines, and Ambient Air Quality Criteria (AAQCs)*. Prepared by Standards Development Branch of Ontario Ministry of the Environment. Toronto, Ontario.

Resources, Wildlife and Economic Development (RWED). 2001. *Northwest Territories Greenhouse Gas Strategy.* Yellowknife, Northwest Territories.

Resources, Wildlife and Economic Development (RWED). 2002. *Guideline for Ambient Air Quality Standards in the Northwest Territories.* Government of the Northwest Territories, Environmental Protection Service. Yellowknife, Northwest Territories.

Texas Natural Resources Conservation Commission (TNRCC). 2000. *Listing of Effects Screening Levels (ESLs) for use in Texas*. Austin, Texas.

U.S. EPA 1995. *Compilation of Air Pollutant Emission Factors*. *Volume 1: Stationary Point and Area Sources*. Document AP-42. Office of Air Quality Planning and Standards, Research. Triangle Park, NC 27711.