2. AIR QUALITY

Introduction

The findings of the environmental impact assessment for air quality for the Mackenzie Gas Project (see EIS Volume 5, Section 2) were based on the following components (see Section 1, Introduction, of this document):

- anchor fields
- gathering pipelines and associated facilities
- NGL and gas pipeline corridor
- infrastructure
- NGTL NWML Dickins Lake Section

The two NGTL pipeline sections, Dickins Lake Section and Vardie River Section, are located in northwestern Alberta. The Dickins Lake assessment was included in the EIS. This EIS supplemental information includes:

- new information for the Vardie River Section
- an impact assessment for northwestern Alberta based on the new information
- a combined project effects assessment that includes the Mackenzie Gas Project and NGTL's Dickins Lake and Vardie River sections

See under EIS Summary for a summary of the EIS findings for air quality.

EIS Summary

Potential effects from the Mackenzie Gas Project on air quality were related primarily to emissions during operations from compressor stations and heater facilities (see EIS Volume 5, Section 2). Dust from vehicle traffic could also contribute to air quality effects. Other air effects associated with construction and decommissioning emissions were expected to be smaller than effects during peak operations.

The effects assessment for air quality focused on the following key indicators (KIs):

- sulphur dioxide (SO_2)
- nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- particulate matter less than 2.5 micrometres (μm) in diameter ($PM_{2.5}$)
- benzene
- benzene, toluene, ethylbenzene and xylene (BTEX)
- potential acid input (PAI)

Predicted ground-level concentrations of all compounds were below applicable federal, provincial and territorial guideline levels for all locations assessed in the production area and pipeline corridor.

Effects were predicted in the EIS to be adverse, local and long term. The magnitude of effects was moderate or low. No significant effects on air quality were predicted in the EIS.

Study Areas

The air quality assessment for the Dickins Lake and Vardie River sections used dispersion models to predict changes in ambient concentrations and atmospheric deposition. A single airshed was defined for the assessment. This Alberta airshed defines the area over which model predictions were made, and within which emissions from different facilities could interact.

The Alberta airshed, which was used as the regional study area (RSA), was identified from information about the location and type of facilities, regional meteorology and topography. This RSA was defined as a 150 by 200 km area that includes the NGTL interconnect facility and the NGTL Thunder Creek compressor station (see Figure 2-1).

A local study area (LSA) was identified near the NGTL Thunder Creek compressor station. The LSA is the area in which any effects are likely to occur, and was defined as a 20 by 20 km area centred on the NGTL Thunder Creek compressor station.

Baseline

Data was collected on climate and meteorology, existing air quality and existing air emissions.

Climate Conditions

For current climate conditions in the northwestern Alberta study area, defined by average conditions over the last five years of available data, i.e., 1996 through 2000, see EIS Volume 3, Section 2. Differences between current and past conditions are also shown.

Air Quality

Because air quality in the RSA will be influenced by a number of existing industrial facilities, existing concentrations and deposition rates of airborne compounds should be measurable and higher than in northern regions of Canada.

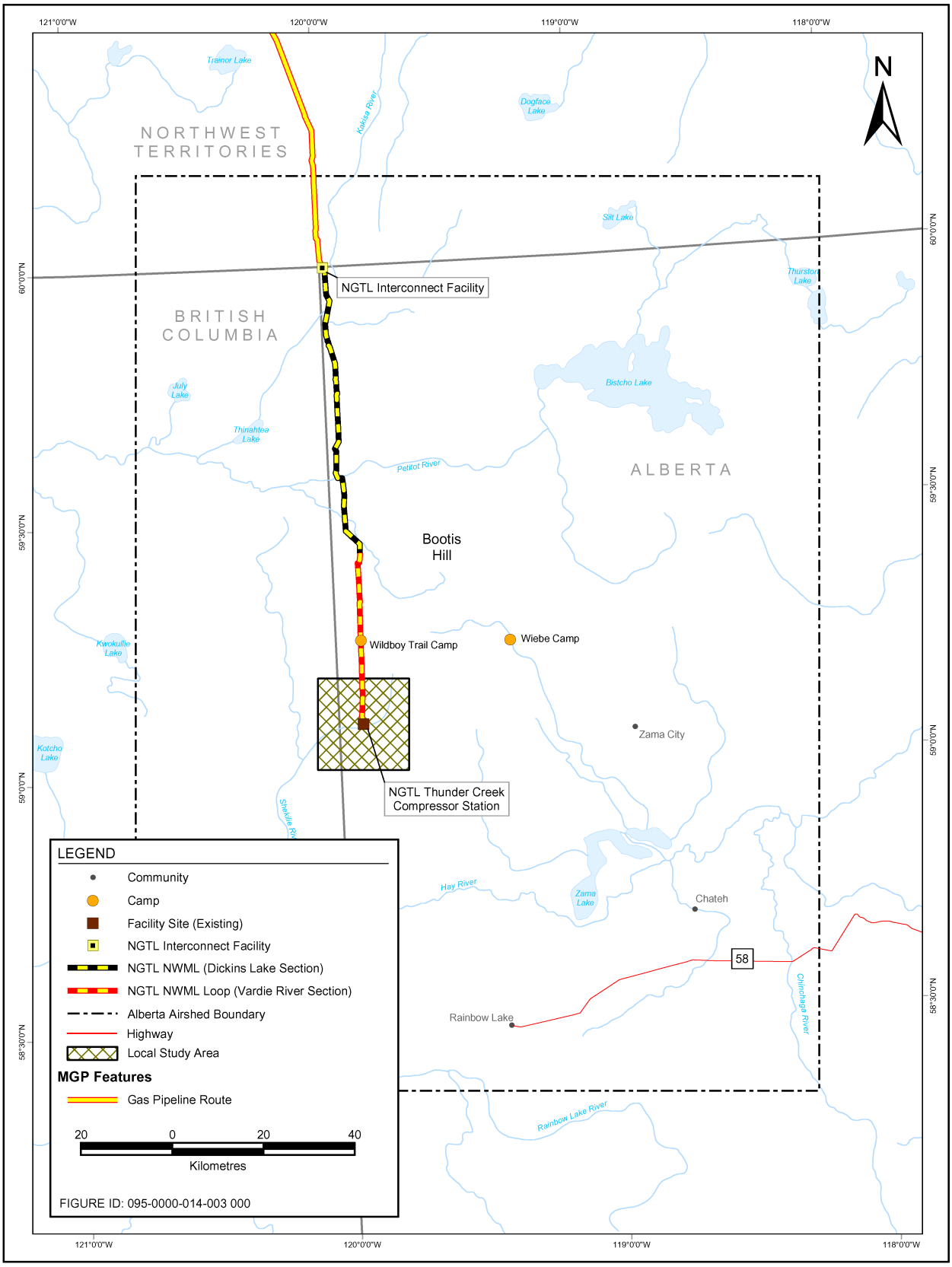

Figure 2-1: Alberta Airshed and Associated Local Study Area

The monitoring station closest to the NGTL Thunder Creek compressor station is Silver Valley, which is 350 km south of the compressor station and located in an area with a number of oil and gas emission sources. It uses passive monitoring to measure levels of SO_2, NO_2 and ozone (O_3). Data regarding background deposition rates was derived from the precipitation monitoring station at High Prairie, about 450 km southeast of the compressor station. Results from these monitoring stations are indicative of air quality at the NGTL Thunder Creek compressor station.

For a summary of background concentrations of the KI compounds expected at the NGTL Thunder Creek compressor station, see Table 2-1. The compressor station is near current sources of industrial air emissions. Background levels of combustion products, e.g., SO_2 and NO_2, are expected to be measurable because of existing industrial activity in the area. Furthermore, detectable levels of O_3 are expected, as O_3 levels in northern Alberta are naturally high. Background potential acid input (PAI), from long-range transport of acid-forming compounds emitted by large industrial facilities elsewhere in western Canada, is measurable in the region, but below Clean Air Strategic Alliance (CASA) recommended levels.

Table 2-1: Baseline Air Conditions at the NGTL Thunder Creek Compressor Station

Parameter	Baseline Conditions
Sulphur dioxide (SO_2)[1] (µg/m³)	1.2
Nitrogen dioxide (NO_2)[1] (µg/m³)	2.8
Ozone (O_3)[1] (µg/m³)	57.2
Potential acid input[2] (PAI) (keq/ha/a)	0.051
Sulphate deposition[2] (kg/ha/a)	3.076
Nitrate deposition[2] (kg/ha/a)	1.754

NOTES:
1 Background concentrations per month were determined from passive monitoring at Silver Valley, Alberta
2 Background acid deposition rates were determined from precipitation monitoring at High Prairie, Alberta

Greenhouse Gas Emissions

Adding a line heater at the NGTL Thunder Creek compressor station will contribute greenhouse gas (GHG) emissions. Table 2-2 lists current and future GHG emissions for Alberta and Canada.

Table 2-2: National and Alberta Greenhouse Gas Emissions

Reporting Year	GHG Emissions	
	Canada (kt/a of ECO_2)	**Alberta** (kt/a of ECO_2)
1995	673,000	195,000
2000	730,000	205,000
2010	764,000	233,000

NOTES:
ECO_2 = equivalent carbon dioxide
ECO_2 emissions were calculated using greenhouse gas potentials of 1 for carbon dioxide (CO_2), 21 for methane (CH_4) and 310 for nitrous oxide (N_2O) (Environment Canada 2002)
Data from Environment Canada (1999)

Effects on Air Quality

Effect Pathways

The effect pathway diagram for air quality (see Figure 2-2) shows the key pathways and their intermediate pathways, and indicates how adding a line heater at the NGTL Thunder Creek compressor station could affect air quality KIs. For a full discussion of the pathways, see EIS Volume 5, Section 2.

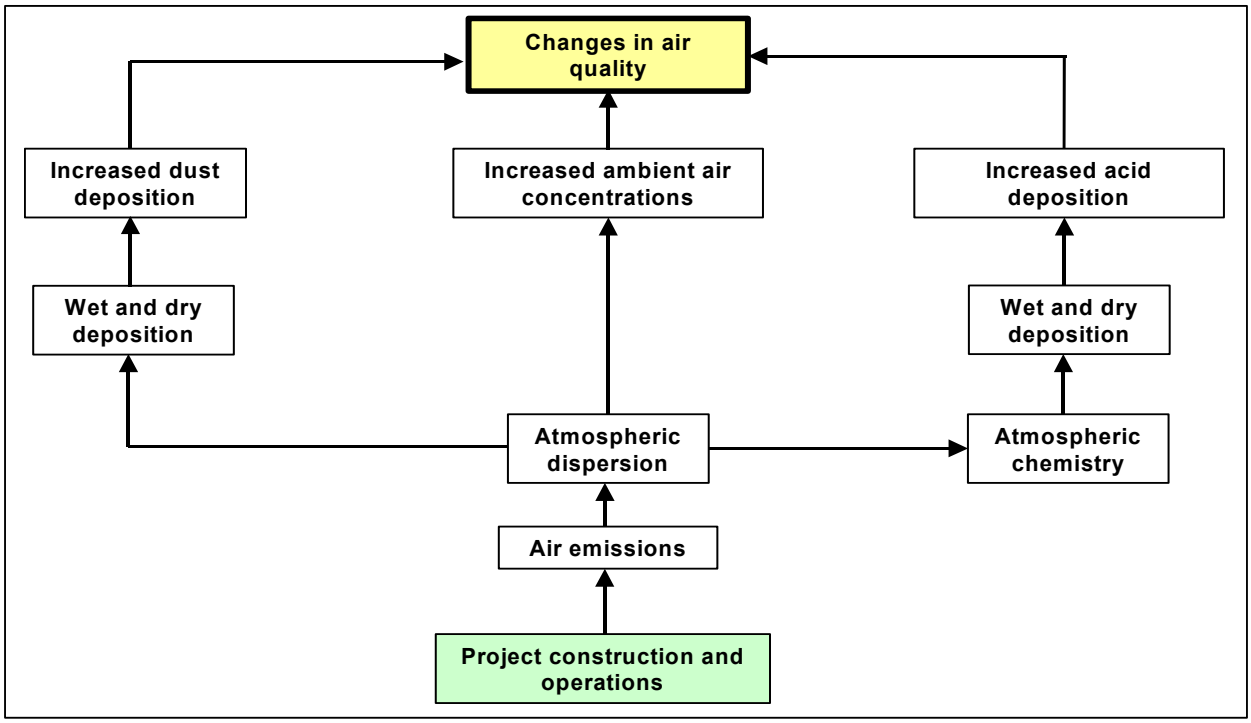

Figure 2-2: Effect Pathways – Air Quality

Two of the pathways, increased ambient air concentrations and increased acid deposition, are considered applicable in northwestern Alberta. Because dust emissions apply to vehicular traffic, this pathway was considered not applicable.

Effect Attributes

Effects on air quality are described using the following effect attributes:

- direction
- magnitude
- geographic extent
- duration

For a detailed description of effect attributes, see EIS Volume 5, Section 2. For definitions of the effect attributes for air quality, see Table 2-3.

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 less than one year
Medium term	Effects on the key indicator occur from one to four years
Long term	Effects on the key indicator last more than four 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. Direction, magnitude, duration and geographic extent are consistent with those used in EIS Volume 5, Section 2.

Consistent with the EIS, when assigning magnitudes for GHGs (one of the KIs considered in the assessments), 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 GHGs are assigned a high magnitude when they exceed 1% of the forecasted 2010 national emissions. GHGs include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

Other KIs considered are SO_2, NO_2, and PAI . Other KIs, such as CO, $PM_{2.5}$ and volatile organic compounds, were not considered because of the small amounts of these compounds expected from the line heater at the NGTL Thunder Creek compressor station.

For a summary of the air quality criteria referred to in the air assessment, see Table 2-4.

Table 2-4: Alberta Ambient Air Quality Objective Values

Parameter	Alberta Ambient Air Quality Objectives[1] (µg/m³)	Federal Air Quality Objectives[2]		
		Desirable (µg/m³)	Acceptable (µg/m³)	Tolerable (µg/m³)
Sulphur dioxide				
1-hour	450	450	900	N/A[3]
24-hour	150	150	300	800
Annual	30	30	60	N/A
Nitrogen dioxide				
1-hour	400	N/A	400	1,000
24-hour	200	N/A	200	300
Annual	60	60	100	N/A

NOTES:
N/A = not applicable
1 Alberta ambient air quality objectives (AENV 2004)
2 Federal ambient air quality objectives from *The Clean Air Act* (Environment Canada 1981)

For the criteria for magnitude ratings, see Table 2-5. The magnitude determination criteria were based on available air quality standards. Alberta ambient air quality objectives were used, wherever possible.

Table 2-5: Magnitude Determination for Air Quality Effects

Key Indicator	Maximum Prediction			
	Effect	Low	Moderate	High
1-hour SO_2[1] ($\mu g/m^3$)	No change	<22.5[a]	<450	>450
24-hour SO_2[1] ($\mu g/m^3$)	No change	<7.5[a]	<150	>150
Annual SO_2[1] ($\mu g/m^3$)	No change	<2[a]	<30	>30
1-hour NO_2[2] ($\mu g/m^3$)	No change	<20[a]	<400	>400
24 hour NO_2[2] ($\mu g/m^3$)	No change	<10[a]	<200	>200
Annual NO_2[2] ($\mu g/m^3$)	No change	<5[a]	<60	>60
Potential acid input (keq/ha/a)	No change	<0.17[b]	<0.25[c]	>0.25[c]
Greenhouse gas emissions (kt/a)	No change	<2,330[d]	<7,640[e]	>7,640[e]

NOTES:
NO_2 = nitrogen dioxide
SO_2 = sulphur dioxide
a This value is about 5% of the available criteria used to determine a high magnitude
b Based on the CASA monitoring load value for sensitive ecosystems (CASA 1999)
c Based on the CASA critical load for sensitive ecosystems (CASA 1999)
d Based on 1% of the 2010 GHG emission forecast (2,330 kt ECO_2/a) for Alberta (Environment Canada 1999)
e Based on 1% of the 2010 GHG emission forecast (764,000 kt ECO_2/a) for Canada (Environment Canada 1999)
1 Based on Alberta ambient air quality objectives (AENV 2004)
2 Based on the acceptable federal ambient air quality objectives from the *Clean Air Act* (Environment Canada 1981). Although oxides of nitrogen (NO_x) predictions have been provided in the assessment, there are no regulatory guideline values for NO_x.

Conservative methods were used to determine the magnitude of PAI effects. An area PAI was calculated by averaging the PAI predictions over the LSA. The area PAI predictions were then compared with the Clean Air Strategic Alliance (CASA 1999) monitoring and critical load values for ecosystems with a high sensitivity, even though some of the areas affected could have low sensitivity.

Analysis and Significance

For the direction, magnitude, geographic extent, duration and significance of air quality changes resulting from the addition of a line heater at the NGTL Thunder Creek compressor station, see Table 2-6.

There are no significant air quality effects. Effects on all seven KIs associated with increased ambient concentrations will be low magnitude.

Two analytical techniques were used to evaluate air quality:

- emission calculations
- dispersion modelling using the CALPUFF model

Table 2-6: Effects on Air Quality for Operations

Key Indicator	Phase When Impact Occurs	Effect Attribute				Significant
		Direction	Magnitude	Geographic Extent	Duration	
1-hour sulphur dioxide	Operations	Adverse	Low	Local	Long term	No
24-hour sulphur dioxide	Operations	Adverse	Low	Local	Long term	No
Annual sulphur dioxide	Operations	Adverse	Low	Local	Long term	No
1-hour nitrogen dioxide	Operations	Adverse	Low	Local	Long term	No
24-hour nitrogen dioxide	Operations	Adverse	Low	Local	Long term	No
Annual nitrogen dioxide	Operations	Adverse	Low	Local	Long term	No
Area potential acid input	Operations	Adverse	Low	Local	Long term	No
NOTE: Only operations was assessed because effects during construction and decommissioning will be less						

The CALPUFF dispersion model was used:

- to model how air emissions from facility operations might be increased
- to determine sulphate and nitrate deposition, and from that, area PAI

For full details on the approach, see EIS Volume 5, Section 2.

Infrastructure

Infrastructure during construction is expected to have a limited and localized effect on air quality. Potential effects of activities, such as vehicle movement and operation of camps, are likely minor compared with potential effects of operating facilities, and were therefore not assessed. Air effects from these sources would be localized and of lower magnitude than effects during peak operations.

Increased Ambient Air Concentrations

For a summary of emissions from the line heater at the NGTL Thunder Creek compressor station, see Table 2-7.

Sulphur Dioxide

For a summary of predicted ground-level SO_2 concentrations in the LSA resulting from the heater, see Table 2-8. All predicted 1-hour, 24-hour and annual SO_2 concentrations are below Alberta ambient air quality objectives. Modelling results are not shown in a figure because of the low levels of predicted SO_2.

Nitrogen Dioxide

For maximum NO_X and NO_2 predictions in the LSA, see Table 2-9. All predictions are below federal objectives. Modelling results are not shown in a figure because of the low levels of predicted NO_2.

Table 2-7: Emissions from the Line Heater at the NGTL Thunder Creek Compressor Station

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 Thunder Creek compressor station local study area	Power generation	N/A	N/A	N/A	N/A	N/A	N/A
	Heater	0.00	0.03	0.04	0.00	0.00	0.00
	Total	0.00	0.03	0.04	0.00	0.00	0.00

NOTES:
BTEX = benzene, toluene, ethylbenzene and xylene
CO = carbon monoxide
N/A = not applicable
NO_X = oxides of nitrogen
$PM_{2.5}$ = particulate matter less than 2.5 µm
SO_2 = sulphur dioxide

Table 2-8: Sulphur Dioxide Predictions

Area	Parameter	Averaging Period Predictions[1]		
		1-hour	24-hour	Annual
NGTL Thunder Creek compressor station local study area	Maximum sulphur dioxide concentration (µg/m³)	2.4	0.8	0.1
	Distance to maximum[2] (km)	<0.1	0.1	<0.1
	Direction to maximum[2]	S	N	S
	Expected occurrences exceeding standard[3]	0	0	0
	Area exceeding standard[4] (ha)	0	0	0
Sulphur dioxide standards[5] (µg/m³)		450	150	30

NOTES:
S = south
N = north
1 The predictions in the table include the effects of combined emissions from project sources in the airshed
2 Distance and direction are relative to the NGTL Thunder Creek compressor station
3 The *expected occurrences exceeding standard* is the number of hours, days or years with predicted concentrations exceeding the applicable standards. Because it is the average of five years of modelling data, 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 applicable standards
5 Alberta ambient air quality objectives (AENV 2004)

Table 2-9: Nitrogen Dioxide and Oxides of Nitrogen Predictions

Area	Parameter	Averaging Period Predictions[1]		
		1-hour	24-hour	Annual
NGTL Thunder Creek compressor station local study area	Maximum nitrogen dioxide concentration (µg/m³)	16.7	9.6	1.1
	Maximum oxides of nitrogen concentration (µg/m³)	60.0	22.7	2.5
	Distance to maximum[2] (km)	5.7	0.1	<0.1
	Direction to maximum[2]	NE	N	S
	Expected occurrences exceeding objective[3]	0	0	0
	Area exceeding objective[4] (ha)	0	0	0
Nitrogen dioxide objectives[5] (µg/m³)		400	200	60

NOTES:
NE = northeast
N = north
S = south
1 Predictions in the table include the effects of combined emissions from project sources in the airshed
2 Distance and direction are relative to the NGTL Thunder Creek compressor station
3 The *expected occurrences exceeding objective* is the number of hours, days or years with predicted concentrations exceeding the applicable objectives. Because it is the average of five years of modelling data, 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 applicable objectives
5 Alberta ambient air quality objectives (AENV 2004)

Increased Acid Deposition

Emissions of SO_2 and NO_2 have the potential to cause acid deposition in the environment. The indicator used to evaluate the deposition of acid-forming compounds, PAI, includes 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^+.

The assessment also shows expected sulphate and nitrate deposition rates. Although these are not key air quality indicators, the information is used to assess potential effects on water quality and vegetation.

For a summary of PAI predictions that might result from adding a line heater at the NGTL Thunder Creek compressor station, see Table 2-10. The PAI levels integrated over the LSA are conservative estimates. The CASA critical load values are based on a 1° latitude by 1° longitude grid. At northern latitudes, this represents an area of 500,000 ha. The LSA is less than 10% of this area, at 40,000 ha. The area PAI prediction is well below the CASA monitoring load for the most sensitive ecosystems.

The KI 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.

Table 2-10: Potential Acid Input Predictions

Area	Parameter	Results[1]
NGTL Thunder Creek compressor station local study area	Maximum potential acid input (keq/ha/a)	0.02
	Area potential acid input (keq/ha/a)[2]	0.001
	Maximum sulphate deposition (kg/ha/a)	0.09
	Maximum nitrate deposition (kg/ha/a)	1.18
	Area with potential acid input >0.17 keq/ha/a[3] (ha)	0
	Area with potential acid input >0.25 keq/ha/a[4] (ha)	0

NOTES:
1 Predictions in the table include the effects of combined emissions from project sources in the airshed
2 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
3 0.17 keq/ha/a represents the monitoring load value for sensitive ecosystems
4 0.25 keq/ha/a represents the critical load value for sensitive ecosystems

Prediction Confidence

Because of the precautionary approach used to predict air quality effects, there is a high degree of confidence in the assessment of significance of effects. The level of confidence is consistent with that in EIS Volume 5, Section 2.

Effects on Greenhouse Gas Emissions

Effect Pathways

The effect pathway diagram for greenhouse gas emissions (see Figure 2-3) shows how the line heater at the NGTL Thunder Creek compressor station and construction activities along the pipeline could 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.

During construction of facilities and the pipeline, construction camp operations and vehicle and aircraft use will contribute to air emissions. Mitigation measures will be used to control GHGs. Because emissions from construction are expected to be minor compared with the GHG emissions from adding the line heater at the NGTL Thunder Creek compressor station, they were not assessed. The pathway is applicable to northwestern Alberta.

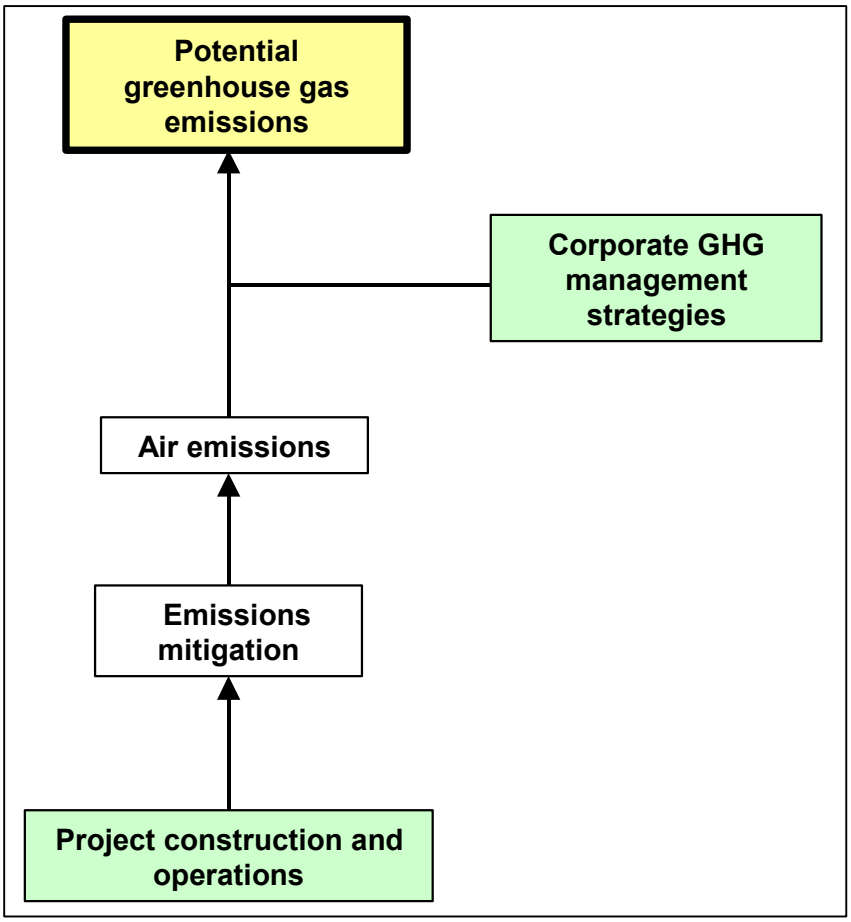

Figure 2-3: Effect Pathways – Greenhouse Gas Emissions

Effect Attributes

For definitions of the effect attributes used to describe GHGs, see Table 2-3, shown previously.

Analysis and Significance

For a summary of predicted GHG emission effects from operations after adding a line heater at the NGTL Thunder Creek compressor station, see Table 2-11. Direction is adverse and magnitude low because emissions are below 1% of Alberta GHG emissions. The effect is not significant.

Table 2-11: Effects on Greenhouse Gas Emissions

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

The KIs considered for the assessment of GHGs include CO_2, CH_4 and N_2O. The KI amounts were used to calculate ECO_2 values. For GHG emissions from the line heater at the NGTL Thunder Creek compressor station, see Table 2-12.

Table 2-12: Line Heater Greenhouse Gas Emissions at the NGTL Thunder Creek Compressor Station

Area	Activity	Emissions			
		CO_2 (kt/a)	CH_4 (kt/a)	N_2O (kt/a)	ECO_2[1] (kt/a)
NGTL Thunder Creek compressor station local study area	Power generation	N/A	N/A	N/A	N/A
	Heater	7.04	0.00	0.00	7.085
	Total	7.04	0.00	0.00	7.085

NOTES:
CO_2 = carbon dioxide
CH_4 = methane
ECO_2 = equivalent carbon dioxide
N_2O = nitrous oxide
N/A = not applicable
1 ECO_2 emissions were calculated using greenhouse gas potentials of 1 for CO_2, 21 for CH_4 and 310 for N_2O (Environment Canada 2002)

Prediction Confidence

Because of the precautionary approach used to predict GHG emissions, there is a high degree of confidence in the assessment of significance of effects. The level of confidence is consistent with that in EIS Volume 5, Section 2.

Combined Project Effects

Effects from adding a line heater at the NGTL Thunder Creek compressor station are predicted to be adverse, local and long term for all KIs. The magnitude of effects will be low. No significant effects on air quality or on GHG emissions are predicted.

The EIS concluded that the Mackenzie Gas Project in combination with NGTL's Dickins Lake Section would produce no significant effects on:

- air quality
- potential GHG emission

This assessment for northwestern Alberta concludes that the Mackenzie Gas Project combined with NGTL's Dickins Lake and Vardie River sections will also produce no significant effects.