Jemena Northern Gas Pipeline Pty Ltd

Northern Gas Pipeline

Draft Environmental Impact Statement

APPENDIX V – AIR QUALITY ASSESSMENT

Public

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Environmental Monitoring and Assessment

Air Quality Assessment - Northern Gas Pipeline - FINAL

Jemena Limited

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Executive Summary

The Northern Gas Pipeline (NGP) project involves the construction of 622 km of pipeline, beginning at Warrego, Northern Territory and extending east towards Mt Isa, Queensland. To address the potential air quality impacts of the NGP project, Air Noise Environment has been commissioned by Jemena to undertake an air quality assessment. The assessment has been completed using computational modelling and results have been compared to relevant criteria outlined in the National Environmental Pollution Measure for Air (NEPM Air) and Queensland Environment Protection (Air) Policy 2008 (EPP Air). In addition, a greenhouse gas assessment has been undertaken to determine annual greenhouse gas emissions quantified as tonnes CO_2-e per year.

As part of the pipeline operations, End of Line (EOL) and Start of Line (SOL) facilities will be constructed at either end of the pipeline. These facilities will comprise gas engine alternators (GEAs) and compressor turbines, which have a potential to emit combustion gases during the operational phase of the project. During construction, key air emission sources include diesel powered equipment and earthwork activities (such as trenching, drill/blasting and backfilling). The main air quality indicators associated with these construction and operational sources are carbon monoxide, nitrogen dioxide and particulate matter (TSP, PM_{10} and $PM_{2.5}$).

The pipeline route traverses through isolated rural areas (with the exception of the Mt Isa end), thus limiting the number of potentially affected sensitive receptors. The nearest sensitive residential receptors to the pipeline route include a family outstation near Tennant Creek, a pastoral homestead and residential dwellings in the Mt Isa area. These receptors are 1 km to 3.5 km from the proposed pipeline. All other receptors are more than 10 km from the pipeline route. The nearest residential receptor to the Start of Line (SOL) facility is 28 km to the west. The nearest residential receptor to the End of Line (EOL) facility is 1.2 km to the north-east in Mt Isa.

To assess air quality impacts from construction and SOL/EOL facility operations, air dispersion modelling was undertaken using Ausplume (for construction) and CALPUFF (for SOL/EOL operations). A prognostic meteorological dataset developed using TAPM was utilised for predicting local meteorological conditions within the project area. Emission rates for the relevant pollutants have been based on emission factors defined by the National Pollution Inventory and from supplier data.

For the construction air quality assessment, modelling of excavation, drilling/blasting and diesel exhausts was completed as these were considered to represent construction activities with the highest pollutant emissions. The results of the construction modelling demonstrate full compliance with the relevant air quality goals. The predicted results at the nearest sensitive receptors are relatively low and this is due to the large separation distance to the nearest receptors (1 to 4 km).

For the modelling of the SOL and EOL facilities, the prognostic TAPM meteorological data was input to CALMET to develop a 3D meteorological grid for the project areas. The derived CALMET meteorology and estimated emission rates were then used as an input for CALPUFF to predict ground level concentrations of pollutants in the surrounding area. The results of the modelling indicates full compliance with the relevant air quality goals. It is noted that conservative inputs were considered in the modelling including simultaneous operation of standard operational and standby

equipment.

The greenhouse gas assessment has been completed based on the requirements of the National Greenhouse Energy and Reporting Act 2007 and associated technical guidelines. Emissions for the project are primarily categorised as Scope 1 emissions and are associated with land clearing, and diesel and gas combustion. The EOL facility will utilise mains power hence, there is a potential for Scope 2 emissions also. GHG emissions are estimated to be above the National Greenhouse and Energy Reporting thresholds for CO_2*-e emitted and energy consumed. During both construction and operations, there are opportunities for reducing GHG emissions including use of fuel efficient equipment and ensuring regular maintenance of equipment. Opportunities for reductions should be investigated throughout the life of the project to assist in minimising emissions.*

Overall, the assessment has identified that construction and operation of the NGP is expected to contribute to pollutant concentrations in the surrounding area however, pollutant concentrations are predicted to be compliant with relevant air quality criteria. The potential for air quality impacts can be further minimised by adopting various air quality management measures as outlined in the NGP Air Quality Management Plan (Document 399-PA-EV-010).

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1 Introduction

1.1 Scope of Study

Jemena Ltd commissioned Air Noise Environment Pty Ltd to undertake an air quality assessment for the Northern Gas Pipeline (NGP) Project, extending from Warrego (Northern Territory) to Mt Isa (Queensland).

The study has been undertaken to assess the potential air quality impacts on nearby sensitive receptors during the construction and operational phase of the pipeline. To assess the potential for impacts, computational modelling has been undertaken and results have been compared to criteria relevant to Queensland and Northern Territory, as presented in the following documents:

- *Queensland Environmental Protection (Air) Policy 2008 (EPP Air)*;
- *National Environment Protection Measure for Ambient Air Quality (NEPM Air)*.

A greenhouse gas assessment has also been undertaken in accordance with the *National Greenhouse Energy and Reporting Act 2007* and using emission factors found in the Department of Climate Change and Energy Efficiency National Greenhouse Accounts Factors – August 2015.

1.2 Terms of Reference

The Northern Territory Environmental Protection Authority issued Terms of Reference for the NGP Project in December 2015. In relation to air quality, the ToR specifies the following:

> *"The EIS should assess the impacts of the Project on air quality, including ambient air quality (e.g. PM_{10} fraction), dust and odour/gases, where relevant. Risks to air quality may arise from emissions of chemicals, particulates or biological materials from:*
>
> - *venting*
> - *gas processing*
> - *gas compression*
> - *power generation*
> - *movements of mobile plant and vehicles*
> - *wind erosion mobilising dust from exposed surfaces, such as from laydown areas, access tracks and sites of vegetation clearing.*
>
> *The assessment should be informed by meteorological information applicable to air quality in the project area. The sources and projected quantities of greenhouse gases emitted by the Project should be described, including from land clearing and the construction and operational requirements of the Project. The EIS should outline measures for managing and monitoring the impacts of air quality, including dust suppressions strategies and monitoring of dust impacts.*

A discussion of existing variability in air quality target parameters, such as the impact of seasonal smoke haze, should be included in a relevant section of the EIS. Details of the proposed air monitoring, including technique, location, frequency and details of laboratory undertaking analysis, target parameters, and proposed reactive management that are tied to monitoring thresholds should be provided."

This air quality assessment report addresses the requirements of the ToR. An assessment of both construction and operational air quality risks has been completed. Where relevant, recommendations have been provided for achieving project air quality goals. An Air Quality Management Plan (Document 399-PA-EV-010) is provided separately to this modelling assessment report. The AQMP provides a summary of air emission management measures and monitoring requirements for the project.

1.3 This Report

This report summarises the methodology, results and conclusions of the air quality assessment. A glossary of terms is presented in Appendix A to assist the reader.

2 Proposed Pipeline

2.1 Pipeline Route

The NGP is a proposed 622 km long pipeline, beginning at Warrego (Northern Territory) and extending east towards Mt Isa (Queensland). The majority of the pipeline is located in the Northern Territory and the final 165 km will be located in Queensland. The proposed pipeline will connect gas supplies from offshore and land-based sources in the Northern Territory to the eastern gas markets.

Several pipeline facilities are proposed at specific points along the pipeline route. These facilities include the following:

- Start of Line (SOL) facility at Warrego;
- End of Line (EOL) facility at Mt Isa; and
- Main Line Valve (MLV) sites for maintenance and operational requirements (total of 3).

A total of five Cathodic Protection (CP) sites are also proposed however, the are no air emissions associated with these facilities.

During the construction phase, potential air quality impacts are associated with dust emissions from construction activity and exhaust emissions (primarily diesel exhaust) from operation of equipment. The main potential air quality impacts during the operational phase of the pipeline are associated the burning of fuel for powering the SOL and EOL equipment.

Figure 2.1 presents the pipeline route and key features of the pipeline. Figure 2.2 presents a close-up of the pipeline route and EOL facility in Mt Isa.

Figure 2.1 - NGP Route and Facilities

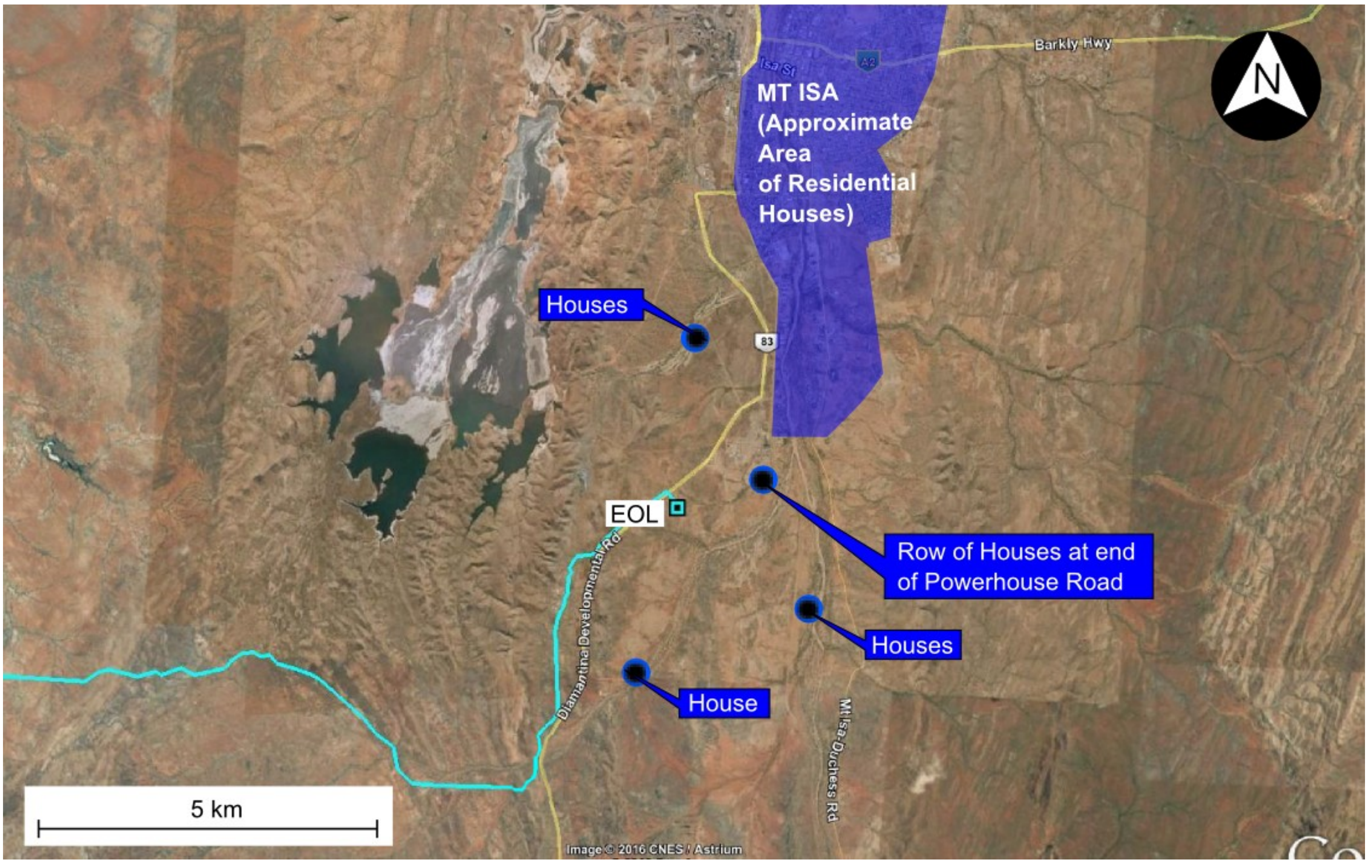

Figure 2.2 - Mt Isa Pipeline Route and EOL Facility

2.2 Nearest Sensitive Receptors

The pipeline route traverses primarily through isolated rural areas, thus limiting the number of potentially affected sensitive receptors. Potential air quality impacts from projects of this type are generally limited to within a 5 km radius.

The nearest sensitive residential receptors to construction and operations are located at the end of the proposed pipeline in the Mt Isa area. These sensitive receptors include homesteads on large rural lots immediately outside Mt Isa and residential areas within Mt Isa. The nearest homestead is approximately 2.5 km from the EOL facility, and 1 km from the pipeline route. The nearest houses in the Mt Isa city area are approximately 1.2 km north-east of the EOL facility.

Along the rest of the pipeline route, the number of potentially affected sensitive receptors are limited and include a small number of family outstations and a pastoral homestead (18 km east of MLV3). The nearest family outstation (No. 975) is 3.4 km south of the pipeline route. The pastoral homestead is 3.5 km north of the route. It is noted that the SOL facility is at a significant distance from sensitive receptors (at least 28 km) hence, no air quality impacts on the population are expected from operation of SOL facility equipment.

Figures 2.1 and 2.2, and Table 2.1 identify sensitive receptors within 20 km of the pipeline route. Figure 2.1 also identifies the nearest sensitive receptors (family outstations 239, 248, 255 and 974)

to the SOL facility. These receptors are noted to be between 28 to 46 km from this facility.

Table 2.1 - Summary of Sensitive Residential Receptors within 20 km of Pipeline Route

Receptor	Distance from Pipeline Route	Distance from Nearest Pipeline Facility	Population / No. of Dwellings
Tennant Creek	16.5 km South	41.5 km south-east of SOL Facility 121 km west of MLV1	3,061
Family Outstation 952	6.8 km South	41.8 km south-east of SOL Facility 121 km west of MLV1	3 houses
Family Outstation 975	3.4 km South	60 km east of SOL facility 101 km north-west of MLV1	2 houses
Family Outstation 721	14.8 km north	73 km east of SOL facility 95 km north-west of MLV1	8 houses
Family Outstation 732	12.4 km south	44 km south-east of MLV1	4 houses
Pastoral Homestead	3.5 km north	18 km east of MLV3	3 houses and a school
Homestead South of Mt Isa	1 km east	2.5 km south of EOL facility	Single house
Mt Isa	1.2 km north-east	1.2 km north-east of EOL facility	Row of houses near power station

Table 2.2 presents a summary of minimum separation distances to sensitive receptors for the SOL and EOL facilities, and MLV sites.

Table 2.2 - Separation Distances of Pipeline Facilities

Pipeline Facility	Distance to Nearest Residential Receptor
Start of Line Facility	28 km east of Family Outstation 248
End of Line Facility	1.8 km south-west of nearest house in Mt Isa
MLV1	33 km south of Family Outstation 907
MLV2	88 km east of Family Outstation 732
MLV3	18 km west of a pastoral homestead

2.3 Pipeline Operational Facilities

2.3.1 SOL Facility

The Start of Line (SOL) facility consists of gas compression infrastructure to pressurise gas for transportation to the Mt Isa End of Line (EOL) facility. The facility will also comprise various filtration and separation equipment to remove liquids and impurities which may have formed in the gas pipeline through condensation. For emergency purposes, a flare and pipeline vent system is proposed to be constructed. Other supporting infrastructure includes an office, workshop, accommodation room and car park. The main equipment with a potential for air emissions are as follows:

- 2 x Export Compressor turbines;
- 2 x Residue Compressor turbines;
- 3 x Gas Engine Alternators (GEAs);
- Process heater;
- High Pressure/Low Pressure (HP/LP) Flare; and
- Gas vent.

Pipeline gas will be used to power the compressor turbines and GEAs. Carbon monoxide and nitrogen oxides are the main pollutants expected from combustion of gas in the SOL facility equipment. Use of the gas vent and flare will occur during commissioning, periodic testing, variations in incoming gas quality and in emergency situations. Minor flaring (0.8 kg/hr per flare) and gas venting (from a Nitrogen Reduction Unit) is also proposed.

As noted previously, the nearest sensitive receptors to the SOL facility are 28 km to the west. At such a large separation distance, these receptors are not expected to be affected by air emissions from the SOL facility operations. Figure 2.3 presents the proposed layout of the SOL facility.

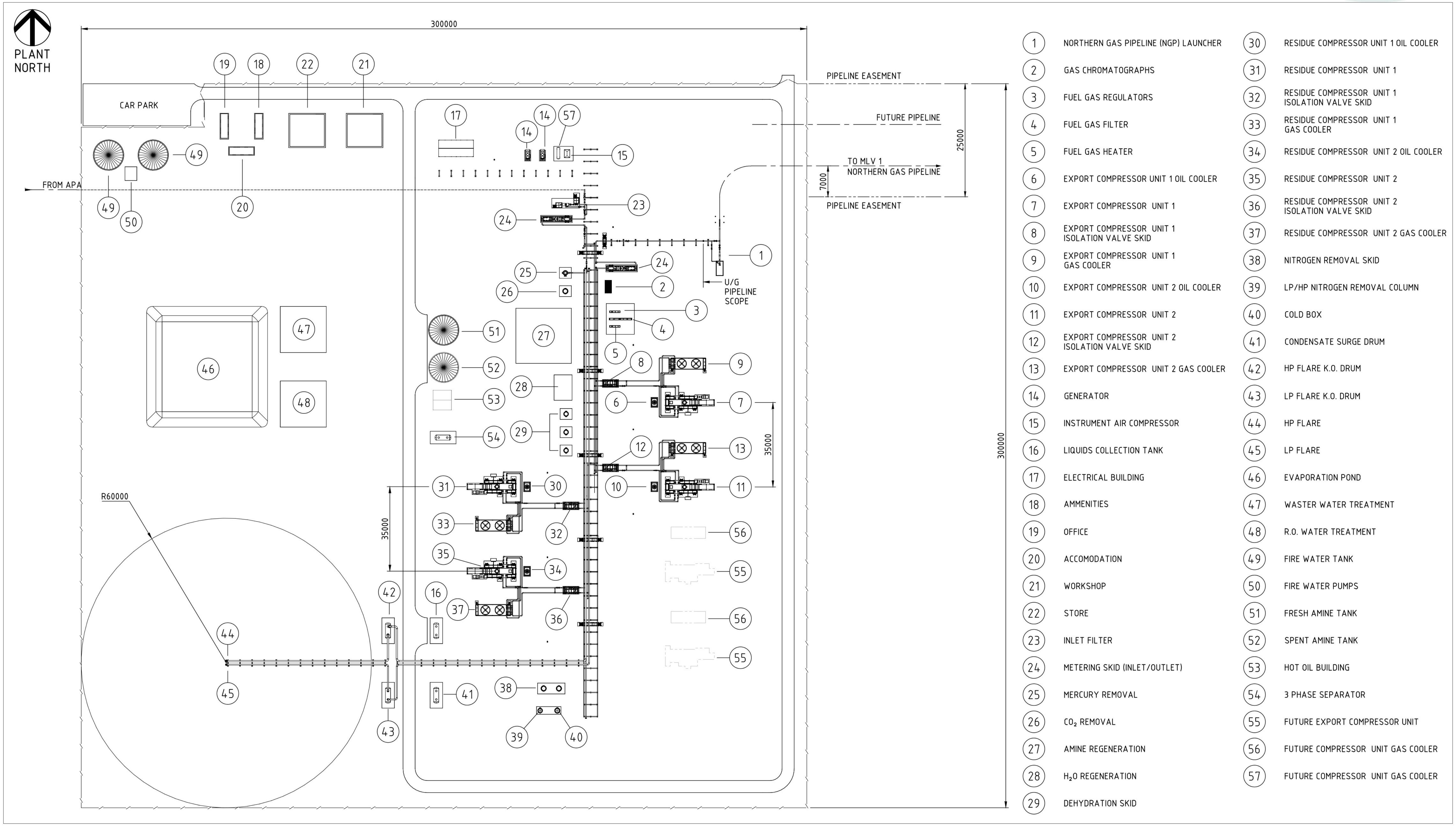

Figure 2.3 - Proposed SOL Facility Layout

2.3.2 EOL Facility

The End of Line (EOL) Facility provides additional gas compression infrastructure. The main equipment expected to contribute to air emissions from the facility are summarised as follows:

- 2 x compressor turbines;
- 1 x Gas Engine Alternator (GEA);
- boiler heat exchanger; and
- gas vent.

The EOL facility is expected to operate continuously. As with the SOL facility, pipeline gas will be used at the EOL facility and key air pollutants are expected to be CO and NO_x. Use of the gas vent will occur during commissioning, periodic testing and in emergency situations. Figure 2.4 presents the proposed layout of the SOL facility.

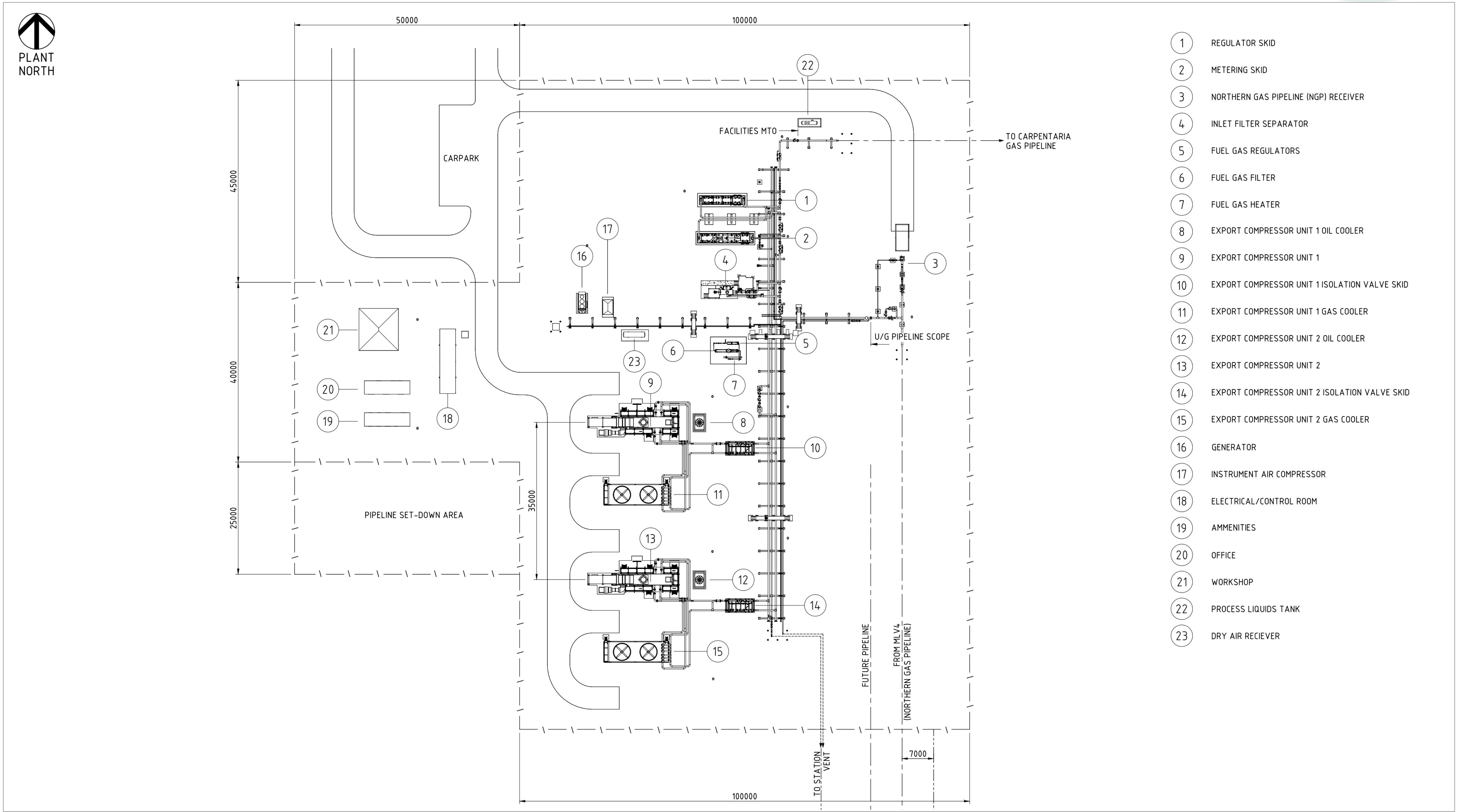

Figure 2.4 - Proposed EOL Facility Layout

2.3.3 Main Line Valves

In addition to the gas vents at the SOL and EOL facilities, three main line valves (MLVs) are proposed along the pipeline route. The MLV sites provide a means of controlling gas flow along the pipeline and, during an emergency, the valves are closed to isolate a section of the pipeline. Once isolated, the gas from the relevant section is vented prior to incident investigation and/or maintenance taking place.

2.4 Pipeline Constructions

Pipeline construction will be undertaken by individual crews (e.g. trenching, pipe laying) with each crew working sequentially along the pipeline route during construction. A 30 m wide Right of Way (ROW) will be utilised for the majority of the pipeline. In general terms, the pipeline construction process involves the following stages:

- clearing the Right of Way (ROW);
- preparing the pipeline (e.g. stringing, bending);
- excavating a trench for the pipeline;
- lowering the pipeline;
- backfilling and restoration.

Construction works specific to certain sections of the pipeline will also be required. This includes construction of the EOL and SOL facilities at each end of the pipeline, blasting only at hard rock locations and boring for trenchless crossings.

Potential air quality impacts primarily relate to particulate emissions which are greatest during earthwork construction stage. Earthworks and truck movements over unpaved surfaces result in the disturbance of surface material, which may be dispersed towards sensitive receptors during downwind conditions. Overall, there are only a limited number of construction stages involving intensive earthwork activities. These stages include clearing of RoW, trenching, backfilling and drill/blasting when required. The key air quality indicators for the above mentioned activities are Total Suspended Particulates and PM_{10} (particulate matter less than 10 microns).

Other air pollutant emissions from construction activities include combustion products from the operation of diesel engines. These pollutants include carbon monoxide, nitrogen dioxide and PM_{10}.

Five main construction camps are proposed along the pipeline route. Potential air emissions from these camps include diesel emissions from power generation equipment.

2.5 Summary of Potential Air Emissions

Table 2.3 presents a summary of the key potential air emissions during the construction and operational phase of the NGP project. The potential for air quality impacts associated with these air emission sources have been assessed in detail through computational modelling.

Table 2.3 - Summary of Potential Air Emissions

Air Emission Source	Key Air Quality Indicators / Pollutants
Construction Phase	
Excavation	Particulate matter (as defined by TSP and PM_{10})
Drilling and Blasting	Particulate matter (as defined by TSP and PM_{10})
Operation of Heavy Machinery	Diesel exhaust (CO, NO_2, PM_{10} and $PM_{2.5}$)
Operational Phase	
SOL Compressor Turbines	CO and NO_2
SOL Gas Engine Alternator	CO and NO_2
SOL HP/LP Flares	CO and NO_2
SOL process heater	CO and NO_2
EOL Compressor Turbines	CO and NO_2
EOL Gas Engine Alternator	CO and NO_2
Boiler heat exchanger	CO and NO_2

The SOL facility is at least 28 km from the nearest sensitive receptors. At distances of this order, air quality emissions from the operations would not be identifiable either through modelling or monitoring. Nevertheless, modelling of the SOL facility (flare, process heater, compressor turbines and GEAs) has been completed.

3 Existing Ambient Environment

3.1 Existing Air Emission Sources

The pipeline route predominantly traverses through remote areas where there are a limited number of anthropogenic air emission sources. For the majority of the route extending from Warrego to immediately west of the Mt Isa region, road traffic and unpaved surface emissions from nearby roads represents the nearest existing air emission sources with similar air emissions to the project (carbon monoxide, nitrogen dioxide and particulate matter). These roads include the sealed Stuart Highway, Barkly Highway and other local unpaved roads.

While these local highways are considered to be the nearest air emission sources potentially affected sensitive receptors of the project, they are still relatively remote from the nearest affected sensitive receptors to the pipeline route (i.e. Outstation 975 is 7.2 km south of the Barkly Highway, a pastoral homestead is 55 km from the Barkly Highway). The pastoral homestead (18 km east of MLV3) is also located adjacent to an unpaved road which connects the Barkly Highway to the southern Sandover Highway. Based on site observations, this unpaved road is not highly trafficked.

At the eastern end of the pipeline, the Mt Isa air shed is influenced by operations of the Mt Isa Mine, which comprises a number of mining operations. Air emissions from the mine include particulates from excavation activities and combustion emissions from operation of heavy machinery and processing equipment.

Besides the Mt Isa Mine, other key air emission sources closest to the project sensitive receptors are the Diamantina and Leichardt Power Stations located on Powerhouse Road (east of Diamantina Development Road). These power stations have a potential to emit combustion products from gas turbine equipment.

The air emission sources described above contribute to the typical background air quality in the project area. However, other sources, such as bush fires, can occur from time to time which may increase background pollutant concentrations above what is considered normal. Bushfires have a potential to result in elevated particulate concentrations across large distances extending well beyond the location of the fire, and could result in smoke haze. For the pipeline route, bush fires in the region are likely to be the only potential air emissions which could result in significant variability to background air quality and reduced visibility in the area.

Figure 3.1 identifies the location of Mt Isa Mine and nearby power stations in proximity to the nearest sensitive receptors.

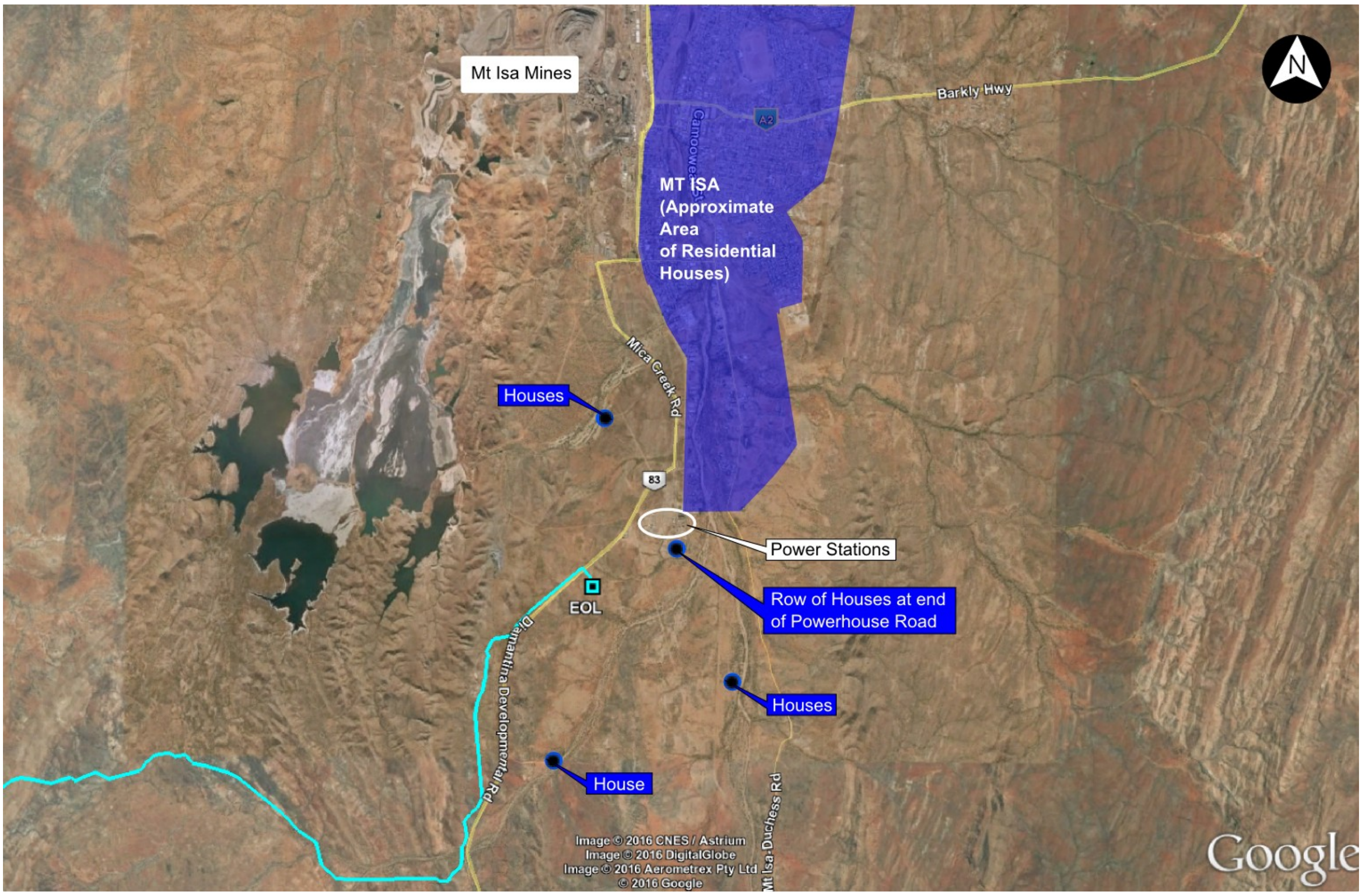

Figure 3.1 - Mt Isa Existing Air Emission Sources

3.2 Background Air Quality Data

The Queensland Department of Environment and Heritage Protection (EHP) operates two air monitoring stations in the Mt Isa area (The Gap and Menzies station). The Menzies station monitors for sulfur dioxide only, while the the Gap station monitors for sulfur dioxide, PM_{10} and metals. Figure 3.1 identifies the location of the Gap monitoring station. No other permanent monitoring stations are located in the project area within Queensland or the Northern Territory.

The key air quality indicators identified for the project are carbon monoxide, nitrogen dioxide and particulate matter (TSP, PM_{10} and $PM_{2.5}$). For the purpose of assessing cumulative PM_{10} impacts, background PM_{10} data for the Mt Isa Gap station has been referred to. Table 3.1 presents the measured background concentrations at the Gap station for the year 2015.

Table 3.1 - Measured 2015 PM_{10} Background Concentrations – Mt Isa

Monitoring Station	Measured PM_{10} Concentration	Averaging Time
The Gap	24.2	24-hour, 75th Percentile

TSP, $PM_{2.5}$, CO and NO_2 are monitored at a number of stations within Queensland and Northern

Territory outside the project study area. A number of these stations are located in or near industrial areas. In the absence of site specific data, monitoring data from these stations provide an indicator of background concentrations that may be experienced in the Mt Isa area. Monitoring stations are generally located in populated areas only and as such, data representative of isolated rural areas, such as areas located along the majority of the pipeline route, is not available.

Table 3.2 presents monitoring data for TSP, $PM_{2.5}$, CO and NO_2 obtained from NT and QLD monitoring stations in areas affected by industry.

Table 3.2 - Measured 2015 Background Concentrations

Pollutant	Measured Concentration $\mu g/m^3$	Averaging Time	Monitoring Station	Area Description
TSP	36.3	Annual	Jondaryan	Near to highway and coal train loading area
	29.1		Townsville Coast Guard	Industrial Port
$PM_{2.5}$	5.5 4.4	24-hour, 75th %ile Annual	South Gladstone	Residential near heavy industry
	5.2 4.5		Clinton, Gladstone	Residential near heavy industry
	11.8 8.1[a]		Palmerston, Darwin	Boundary of General Industry
	13.3 9.1[a]		Winnellie, Darwin	Near suburban area and refinery
CO	124.9	8-hour, 75th %ile	Boyne Island, Gladstone	Residential near heavy industry
	249.8		Pinkenba, Brisbane	Industrial
	342.8		Palmerston, Darwin	Boundary of General Industry
	381.9		Winnellie, Darwin	Near suburban area and refinery
NO_2	14.4 10.4	1-hour, 75th %ile Annual	South Gladstone	Residential near heavy industry
	10.3 8.6		Memorial Park, Gladstone	Residential near heavy industry
	8.2 7.1		Clinton, Gladstone	Residential near heavy industry
	11.1 7.7		Palmerston, Darwin	Boundary of General Industry
	7.4 5.6		Winnellie, Darwin	Near suburban area and refinery

[a] Measured $PM_{2.5}$ annual concentrations in Darwin were above the annual goal defined in the National Environmental Protection Measure for Air (see Section 4). Annual concentrations are typically below the annual goal even in industrial areas and these measured concentrations are likely to be unique to the Darwin area.

The above data shows the range of background concentrations that may be experienced in areas close to various types of industry. Based on a review of the background data, the highest background concentrations identified have been considered in the assessment:

- TSP – 36.3 $\mu g/m^3$ (annual);
- PM_{10} – 24.2 $\mu g/m^3$ (24-hour);
- $PM_{2.5}$ – 13.3 $\mu g/m^3$ (24-hour) and 4.5 $\mu g/m^3$ (annual);
- CO – 381.9 $\mu g/m^3$ (8-hour);
- NO_2 – 14.4 $\mu g/m^3$ (1-hour) and 10.4 (annual);

As a conservative approach, the background concentrations have been adopted for both the Mt Isa area and areas along the pipeline route (rural areas).

As discussed previously, bush fires could result in significant variability to background particulate (TSP, PM_{10} and $PM_{2.5}$) concentrations, that would be above the typical background concentrations represented by 75^{th} percentile values. During such an event, particulate concentrations are usually defined by the bush fire and the contribution from other local sources (such as industry) are usually minor. In view of this, it is considered appropriate to assess potential cumulative impacts based on typical background levels (as represented by the 75^{th} percentile value).

3.3 Local Meteorological Conditions

The project area extending from Warrego to Mt Isa may be classified as having a semi-arid climate. Mean annual rainfall ranges from 400 to 474 mm based on historical data from the Bureau of Meteorology stations at Tennant Creek, Camooweal and Mt Isa monitoring. Average temperatures range from 17-20°C (minimum) to 32-33°C (maximum).

Figure 3.2 presents measured wind roses for three Bureau of Meteorological weather stations located close to the pipeline route. The Tennant Creek wind rose shows that the project area is dominated by an easterly component at the western end of the pipeline. Towards the eastern end (as represented by Camooweal and Mt Isa monitoring data), wind conditions are dominant by the southerly and south-easterly components. Overall, westerly winds are a minor feature along the length of the pipeline route. Calm conditions are noted to be relatively low at Tennant Creek (1.3%) but the proportion of calms increases towards Mt Isa (9.2%).

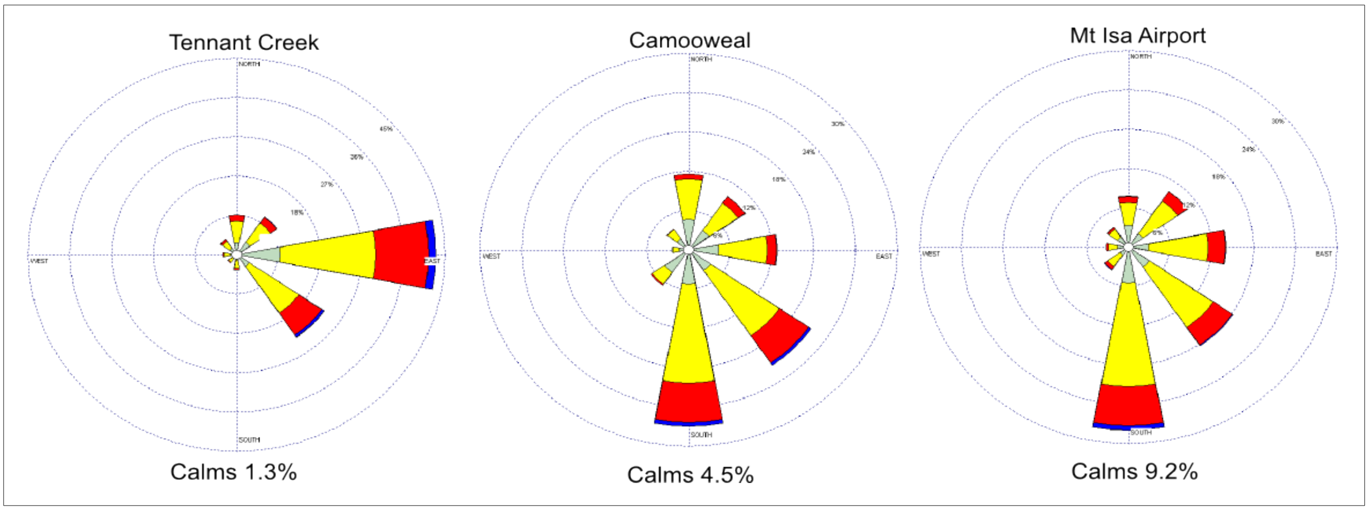

Figure 3.2 - 2011-2015 BOM Wind Roses

4 Assessment Criteria

The Northern Territory government provides guidance on the assessment of air quality through the use of Environmental Protection Objectives established in accordance with the *Northern Territory Waste Management and Pollution Control Act (14 October 2015)*. The Act does not provide specific air quality criteria however, reference is made to the *National Environmental Protection Policy (NEPM) for Ambient Air (1998)* as a possible source of criteria.

The NEPM Air (1998) provides ambient air quality standards for the protection of human health and well-being. In Queensland, ambient air quality criteria is defined in the *Queensland Environmental Protection (Air) Policy 2008*. A comparison of the *NEPM Air* and *QLD EPP Air* indicates that air quality goals for pollutants relevant to the project are similar in both legislation.

The key air quality indicators relevant to the project are related to combustion of diesel and gas (carbon monoxide, nitrogen dioxide and particulate matter. Table 4.1 summarises the air quality criteria. All criteria are associated with the protection of human health and well-being, unless stated otherwise.

Table 4.1 - Air Quality Criteria

Compound	Air Quality Criteria (µg/m^3)	Averaging Period	Source
Carbon Monoxide	11,000	8-hours	*NEPM & QLD EPP Air*
Nitrogen Dioxide	250	1-hour	*NEPM & QLD EPP Air*
	62 33 (health and biodiversity of ecosystems)	Annual	*NEPM & QLD EPP Air* *QLD EPP Air*
TSP	90	Annual	*QLD EPP Air*
PM_{10}	50	24-hour	*NEPM & QLD EPP Air*
$PM_{2.5}$	25	24-hour	*NEPM[a] & QLD EPP Air*
	8	Annual	*NEPM[a] & QLD EPP Air*

[a] Advisory Reporting Standard under the current NEPM Air. A review has recently been undertaken by the National Environment Protection Council and the proposal is to adopt the advisory $PM_{2.5}$ goals as national standards.

5 Construction Air Quality Assessment

5.1 Overview

Air dispersion modelling has been completed to assess the potential impacts of construction activity on nearby sensitive receptors. As identified in Section 2.4 and 2.5, the key air emission sources associated with construction includes excavation activity, drill and blasting, and diesel exhaust fumes from heavy machinery. Collectively, these sources have a potential to emit particulate matter (TSP, PM_{10}, deposited dust), carbon monoxide and nitrogen dioxide. The following sections discuss the methodology, inputs and results of the construction modelling.

5.2 Modelling Methodology

The Ausplume model (version 6.0) has been used in the modelling of construction air emissions. Ausplume is a Gaussian plume dispersion model for the assessment of air quality impacts. The model accounts for meteorological data, building wake effects and terrain effects in the prediction of ground level concentrations of pollutants from stack, area or volume sources. Ausplume assumes steady state meteorology for the field of influence of the source being considered.

Steady state meteorology assumes that for any given time period of model calculation (usually 1 hour), the wind and other meteorological conditions are uniform over the entire area being modelled, and that a plume is assumed to travel instantaneously to the edge of the modelled area in a straight line. A number of additional parameters are considered in the modelling. The following sections present the methodologies and findings of the air dispersion modelling.

5.3 Modelling Scenarios

The main air emissions (in the form of particulates) will occur during excavation, drilling and blasting. It is noted that these activities will occur along the length of the pipeline route. To assess potential impacts from these activities, pollutant concentrations have been predicted at various setback distances from a 5 km section of construction.

Diesel exhaust emissions will also be released from the operation of heavy machinery. Diesel exhaust includes carbon monoxide, nitrogen oxides and particulate matter. The amount of diesel exhaust fumes reaching a sensitive receptor will depend on the number of equipment operating simultaneously and the size of the equipment (which influences fuel burning). To provide an indication of pollutant concentrations, a worst-case scenario has been modelled with 10 items of heavy machinery operating simultaneously at a single location. .

In summary, the following scenarios have been modelled:

- Scenario 1 – Excavation (TSP, PM_{10});
- Scenario 2 – Drill and blast (TSP, PM_{10});
- Scenario 3 – Diesel Exhaust (CO, NO_x, TSP, PM_{10}, $PM_{2.5}$).

5.4 Terrain and Receptors

Flat terrain has been considered in the modelling and predictions have been made at various setback distances, including the setback distances of the nearest sensitive receptors.

5.5 Meteorological Data

For the purpose of the assessment, a site specific meteorological dataset suitable for use in Ausplume has been derived using the prognostic model TAPM (The Air Pollution Model). Prognostic models, such as TAPM, permit the development of localised meteorological datasets, based on synoptic weather conditions. The model predicts the regional flows important to dispersion, such as sea breezes and terrain induced flows, against a background of larger-scale meteorology provided by synoptic analyses.

Three sets of meteorological data have been derived to represent the three nearest sensitive receptors to construction activity (Outstation 975, pastoral homestead 18 km east of MLV3 and Mt Isa).

5.6 Air Emission Data

5.6.1 Scenario 1 and 2 (Excavation, Drilling and Blasting)

In order to predict emission rates for potential air emission sources, a review of available published literature most relevant to the proposed construction has been completed. The following documents have been utilised to estimate emissions:

1. AP 42 (5th Edition), Compilation of Air Pollutant Emission Factors, Vol. 1 Stationary Point and Area Sources, Chapter 13.2.2, Unpaved Roads (November 2006).
2. National Pollution Inventory, Emission Estimation Technique Manual for Mining, Version 3.1 (January 2012).

Table 5.1 presents emission factors sourced from the above literature.

Table 5.1 - Emission Factors

No.	Activity/Source	Units	TSP	PM_{10}
Typical Excavation				
F1	Topsoil stripping	Kg/hr/dozer	5.09	0.66
F2	Excavation at trench	kg/Mg	0.025	0.012
F3	Wind erosion over exposed areas	$kg/m^2/hr$	0.00004	0.00002
F4	On-site truck routes	g/VKT	3577	1056
Drill and Blasting				

No.	Activity/Source	Units	TSP	PM_{10}
F4	Drilling[a]	Kg/hole	0.059	0.031
F5	Blasting	Kg/blast	6.96	3.62

[a] Drilling is based on one-tenth of the kg/hole emission factor estimated in the US EPA 42 and referenced in the NPI Mining Manual for coal mines. Typical, hole depths for coal mines range between 10 m to 40 m. The trench depth for the pipeline project will be approximately 1 metre only, therefore, drilling emissions are expected to be significantly less than those for coal mine operations.

Emission Factor F1 has been derived using Equation 16 and 17 from the NPI Mining Manual. Equations 16 and 17 calculates emissions from material handling as follows:

- Emission Factor (kg/T) = k x $S^{1.2}$ / $M^{1.3}$
  - k = 0.26 and 0.34 for TSP and PM_{10}
  - S = silt content (%)
  - M = material moisture content (%).

Typical silt and moisture contents of 10% and 5% respectively have been adopted for the purpose of the assessment.

The F3 wind erosion emission factor for exposed trenching areas has been based on the values presented in Section 1.1.17 of the NPI Mining Manual. This NPI document presents wind erosion emission factors associated with coal mines and are likely to be conservative when applied to a general excavation area.

Emission Factor F4 for haul routes has been derived using Equation 1a from the US EPA AP 42 Compilation of Air Pollutant Emission Factors (Chapter 13.2.2, Unpaved Roads). Equation 1a is as follows:

- Emission Factor (g/VKT) = 281.9 x k x $(s/12)^a$ x $(W/3)^b$
  - k = 4.9 and 1.5 for particle sizes less than 30 microns and 10 microns
  - a = 0.7 and 0.9 for particle sizes less than 30 microns and 10 microns
  - b = 0.45
  - s = silt content (%)
  - W = vehicle weight (tons)

A silt content of 10.0 % has been adopted which is considered typical of an unpaved road. A typical truck weight of 30 tonnes has been adopted.

Emission Factor 5 is based on Equation 19 of the NPI Mining Manual:

- Emission Factor (kg/blast) = 0.00022 x $A^{1.5}$

- A = area blasted (m^2)

A blast area of 1,000 m^2 has been adopted in the model.

In order to derive emission rates using the above emission factors, the following information has been considered:

- up to 4 dozers operating during top soil removing;
- hourly trench material excavation rate of 630 tonnes per hour, based on the following:
  - volume of material trenched per day of 4200 m^3;
  - soil density of 1,500 kg/m^3;
  - typical construction day (7 am to 5 pm).
- exposed excavation area of 150,000 m^2;
- haul route vehicle kilometres travelled (VKT) of 5 km/h – assumes at least one truck travels the length of the pipeline construction section every hour;
- In a one day period, a total of 1000 holes has been estimated for drilling activities.

The modelling accounts for a typical 10-hour construction day and 5 km per day construction rate. Extended hours and a higher construction rate are unlikely to increase potential air quality impacts at a sensitive receptor (compared to the typical construction hours/rates). This is because, in such a scenario, construction activities would be progressing at a faster rate and spend less time in close proximity to a sensitive receptor.

Table 5.2 presents the estimated emission rates adopted in the air dispersion modelling.

Table 5.2 - Estimated Emission Rates (g/s)

Activity/Source	Factor Value	Factor Unit	TSP	PM_{10}
Scenario 1 - Excavation				
Topsoil stripping	6,750	tonnes/hr	5.65	0.74
Excavation at trench	630	tonnes/hr	4.37	2.1
Wind erosion over exposed areas	150,000	m^2	1.67	0.833
Haul truck on unpaved surface	5	VKT/hr	4.97	1.466
Scenario 2 – Drill and Blast				
Drilling	1,000	Holes/day	1.64	0.861
Blasting	1	Blast/day	0.193	0.100

5.6.2 Scenario 3 – Diesel Exhaust

The amount of diesel exhaust emitted will depend on the number of equipment items operating simultaneously, the size of each item of equipment and the emission technology.

To provide an indication of pollutant concentrations, a total of 10 items of heavy machinery have been modelled at a single location, each with a kW rating of 250 kW (average size for heavy machinery used in the pipeline construction). It is noted that 10 items represents the maximum number of diesel powered heavy machinery required for the construction stages. In terms of emission technology, it is likely that the majority of equipment would have US EPA Tier 2 standards or better, which was introduced in the early to mid 2000s.

Table 5.3 - Scenario 3 - Estimated Emission Rates (g/s)

Pollutant	Emission Factor (g/kWh) for 250 kW heavy equipment	Emission Rate (g/s) for 10 items of heavy machinery
CO	3.5	2.43
NO_x	6.6	4.58
Total PM	0.2	0.14

Emission standards for specific particulate size fractions (ie. PM_{10} and $PM_{2.5}$) are not available. Therefore, it is assumed that PM_{10} and $PM_{2.5}$ emissions from diesel engines is equivalent to total PM. This is a conservative assumption.

5.7 Source Parameters

For Scenario 1 and 2, sources have been modelled as area sources covering the whole potential daily work area. This allows consideration of the fact that construction would occur along the length of the work area during a typical construction day. For Scenario 3, a single point source (representative of multiple equipment operating) has been modelled.

5.8 Modelling Results

Tables 5.4 to 5.6 presents predicted ground level concentrations for the three modelled scenarios. Each table provides predictions at various setback distances including the nearest receptors to the construction pipeline. The nearest receptors include Outstation 975, a pastoral homestead and a homestead south of Mt Isa. It is noted that drilling and blasting will occur at certain sections of the pipeline only and based on a review of the locations, a house south of Mt Isa and Outstation 975 are the nearest receptors (1 km and 4 km respectively).

Table 5.4 - Scenario 1 (Excavation) - Predicted Ground Level Concentrations

Distance from Construction (m)	Predicted Ground Level Concentrations	
	TSP μg/m^3 (Annual)	PM_{10} μg/m^3 (24-hour)
Source Only		
1,000 m (Mt Isa)	6.1	10.1
3,400 m (Outstation 975)	1.6	6.0
3,500 m (Pastoral Homestead)	1.5	6.0
Background	36.3	24.2
Cumulative		
1,000 m (Mt Isa)	42.4	34.3
3,400 m (Outstation 975)	37.9	30.2
3,500 m (Pastoral Homestead)	37.8	30.2
Criteria	***90***	***50***

Table 5.5 - Scenario 2 (Drilling/Blasting) - Predicted Ground Level Concentrations

Distance from Construction (m)	Predicted Ground Level Concentrations	
	TSP μg/m^3 (Annual)	PM_{10} μg/m^3 (24-hour)
Source Only		
1,000 m (Mt Isa)	4.9	10.7
4,000 m (Outstation 975)	1.3	6.4
Background	36.3	24.2
Cumulative		
1,000 m (Mt Isa)	41.0	34.9
4,000 m (Outstation 975)	37.2	30.5
Criteria	***90***	***50***

Table 5.6 - Scenario 3 (Diesel Exhaust) - Predicted Ground Level Concentrations

Distance from Construction (m)	Predicted Ground Level Concentrations μg/m^3					
	CO (8-hour)	NO_2 (1-hour)	NO_2 (Annual)	PM_{10} (24-hour)	$PM_{2.5}$ (24-hour)	$PM_{2.5}$ (Annual)
Source Only						
1,000 m (Mt Isa)	62.4	189.0	0.8	1.4	1.4	0.1
3,400 m (Outstation 975)	14.3	43.4	0.1	0.4	0.4	0.0

Distance from Construction (m)	Predicted Ground Level Concentrations µg/m³					
	CO (8-hour)	**NO_2 (1-hour)**	**NO_2 (Annual)**	**PM_{10} (24-hour)**	**$PM_{2.5}$ (24-hour)**	**$PM_{2.5}$ (Annual)**
3,500 m (Pastoral Homestead)	13.9	42.1	0.1	0.4	0.4	0.0
Background	381.9	14.4	10.4	24.2	13.3	4.5
Cumulative						
1,000 m (Mt Isa)	444.3	203.4	11.2	25.6	14.7	4.6
3,400 m (Outstation 975)	396.2	57.8	10.5	24.6	13.7	4.5
3,500 m (Pastoral Homestead)	395.8	56.5	10.5	24.6	13.7	4.5
Criteria	***11,000***	***246***	***62***	***50***	***25***	***8***

The results of the construction modelling demonstrate compliance with the ambient air quality goals for the modelled scenarios. It is noted that diesel exhaust from equipment (Scenario 3) will occur simultaneously with earthworks (Scenario 1). Where both scenarios are considered together, compliance is still predicted and the results confirm that the contribution of diesel exhaust to total PM_{10} concentrations is minimal compared to earthwork activity.

The scenarios modelled represent worst-case activities that would contribute to dust in the surrounding area. All other construction stages which involve significantly less disturbance of dust and material (e.g. pipe laying, hydrotesting) are also expected to comply with the relevant ambient air quality criteria.

6 Operational Air Quality Assessment

6.1 Overview

Air dispersion modelling has been completed to assess the potential impacts of pipeline operations on nearby sensitive receptors. As identified in Section 2.3, the key operational air emission sources include the following:

- SOL faciliity – compressor turbines, process heater, GEAs and flares; and
- EOL facility - compressor turbines, a heater and a GEA.

These sources have a potential to emit carbon monoxide and nitrogen oxides. As the proposed equipment will be gas powered (as opposed to diesel powered), the potential for particulate emissions are expected to be negligible. The modelling has also assumed flaring occurs under efficient combustion processes, therefore, particulate emissions are assumed to be negligible. The following sections discuss the methodology, inputs and results of the modelling.

6.2 Modelling Methodology

6.2.1 Overview

Atmospheric dispersion modelling involves the mathematical simulation of the dispersion of air contaminants in the environment. The modelling utilises a range of information to estimate the dispersion of pollutants released from a source including:

- meteorological data for surface and upper air winds, temperature and pressure profiles, as well as humidity, rainfall, cloud cover and ceiling height information;
- emissions parameters including source location and height, source dimensions and physical parameters (e.g. exit velocity and temperature) along with pollutant mass emission rates;
- terrain elevations and land use both at the source and throughout the surrounding region; and
- the location, height and width of any obstructions (such as buildings or other structures) that could significantly impact on the dispersion of the plume.

For the purpose of the operational assessment, meteorological modelling has been undertaken using TAPM (The Air Pollution Model) and CALMET to predict localised meteorological conditions. The meteorological data derived from these models have been used as an input for the CALPUFF dispersion modelling.

6.2.2 TAPM Predictions

A site specific meteorological dataset has been determined using the prognostic model TAPM (The Air Pollution Model). Prognostic models, such as TAPM, permit the development of localised meteorological datasets, based on synoptic weather conditions. The model predicts the regional flows important to dispersion, such as sea breezes and terrain induced flows, against a background of larger-scale meteorology provided by synoptic analyses. The output of this model, when used with

a diagnostic meteorological model, such as CALMET, provides a meteorological dataset suitable for introduction into the diagnostic wind field results. This methodology is the recommended approach for the modelling of contaminant concentrations using CALMET[1].

Predictions of meteorological parameters for the year 2012 for the region in the surroundings of the development site were undertaken using TAPM (Version 4). The model was configured with a series of nested grids chosen to provide an appropriate communication and transfer of information from the broad synoptic to the local scale.

The model was configured to use a domain consisting of 25 x 25 x 25 grid points with nesting spacings of 30 km, 10 km and 3 km.

6.2.3 CALMET Predictions

6.2.3.1 Overview

A three dimensional prognostic dataset derived from the TAPM model was input to CALMET to predict meteorological conditions near the operational facilities. TAPM 2012 data has been used to allow for comparison against historical meteorological data from the nearest BOM station at Mt Isa Airport and Tennant Creek. The following sections provide an overview of the data utilised in the CALMET modelling, along with details of some of the key parameters selected to establish calculation limits within CALMET.

6.2.3.2 Vertical Stations

For the purposes of the modelling, CALMET was initialised with a total of 12 vertical layers with layer boundaries at 20 m, 50 m, 75 m, 100 m, 150 m, 200 m, 500 m, 1,000 m, 1,500 m, 2,000 m, 3,000 m and 4,000 m respectively. The vertical levels used in the modelling were selected to provide the model with the ability to predict a generic range of atmospheric conditions near to the site.

6.2.3.3 Terrain And Land Use Data

Terrain height data was based on data from the Shuttle Radar Imaging Mission (SRTM), and obtained from the United States Geological Survey (USGS) web site. This produced terrain height data on a 3 arc-second longitude/latitude grid (approximately 0.09 km) for a grid domain of 20 km x 20 km encompassing the site region.

Land use was also obtained from the USGS and incorporated into the CALMET model.

6.2.4 CALPUFF Dispersion Modelling

The CALPUFF modelling system treats emissions as a series of puffs. These puffs are then dispersed throughout the modelling area and allowed to grow and bend with spatial variations in meteorology. In doing so, the model is able to retain a memory of the plume's movement throughout a single hour and from one hour to the next while continuing to better approximate the effects of complex air flows.

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1 TRC Environmental Corporation (March 2011) 'Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the ‘Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia’ prepared on behalf of the NSW Office of Environment and Heritage.

CALPUFF utilises the meteorological processing and prediction model CALMET to provide three dimensional wind field predictions for the area of interest. The final wind field developed by the model (for consideration by CALPUFF) includes an approximation of the effects of local topography, the effects of varying surface temperatures (as is observed in land and sea bodies) and surface roughness (resulting from varied land uses and vegetation cover in an area). The CALPUFF model is able to resolve complex terrain influences on local wind fields including consideration of katabatic flows and terrain blocking.

6.2.5 CALPOST

Post processing of modelled emissions is undertaken using the CALPOST package. This allows the rigorous analysis of pollutant predictions generated by the CALPUFF system. In particular CALPOST is able to provide an analysis of predicted pollutant concentrations for a range of averaging periods from 1 hour to 1 year.

6.3 Meteorology

6.3.1 Wind Predictions

Figure 6.1 presents a comparison of the measured wind rose at Tennant Creek and predicted wind rose at the SOL facility. It is noted the Tennant Creek BOM station is the nearest meteorological station to the proposed SOL facility site, though it is located at a large separation distance of 40 km to the south-east. The predicted wind rose shows a dominant south-easterly component, while the Tennant Creek measured data shows a dominant easterly component. The difference in wind directions is likely to be due to the influence of local terrain features. The Tennant Creek station is located on top of a ridge (RL 376) running north-west from Tennant Creek. The SOL facility is located on the western side of this ridge (RL 313), shielding the site from easterly winds.

Minimal northerly, westerly and southerly components are present in the predicted and measured data sets. A low proportion of calms are also predicted in both data sets (1.3% measured vs 0.3% predicted).

Figure 6.2 presents the predicted 2012 annual wind rose at the EOL facility and a measured 2011-2015 wind rose at the Mt Isa Bureau of Meteorology Station (approximately 10 km north of the EOL facility). The comparison of wind roses indicates the model is predicting within a reasonable degree of accuracy in terms of the pattern of wind conditions at Mt Isa. The area is dominated by a southerly component, followed by easterly to south-easterly winds. North-westerly to south-westerly winds are a minor feature of the area. The predicted wind rose at the Mt Isa Airport follows this pattern of winds closely, with some over-prediction in the south-westerly and northerly components.

In relation to wind speeds, the CALMET outputs predicts a significantly higher proportion of low wind speeds than the measured data. Lower proportions of calm conditions are predicted, however the combined total of calm conditions and light winds in the measured dataset (29%) is lower than the light wind and calms predicted by the CALMET model (53%). Given this, the poor dispersion conditions associated with calm and light wind periods are considered to be appropriately represented in the meteorological dataset.

On the basis of the above comparison, the wind predictions produced by CALMET are considered suitable for the modelling.

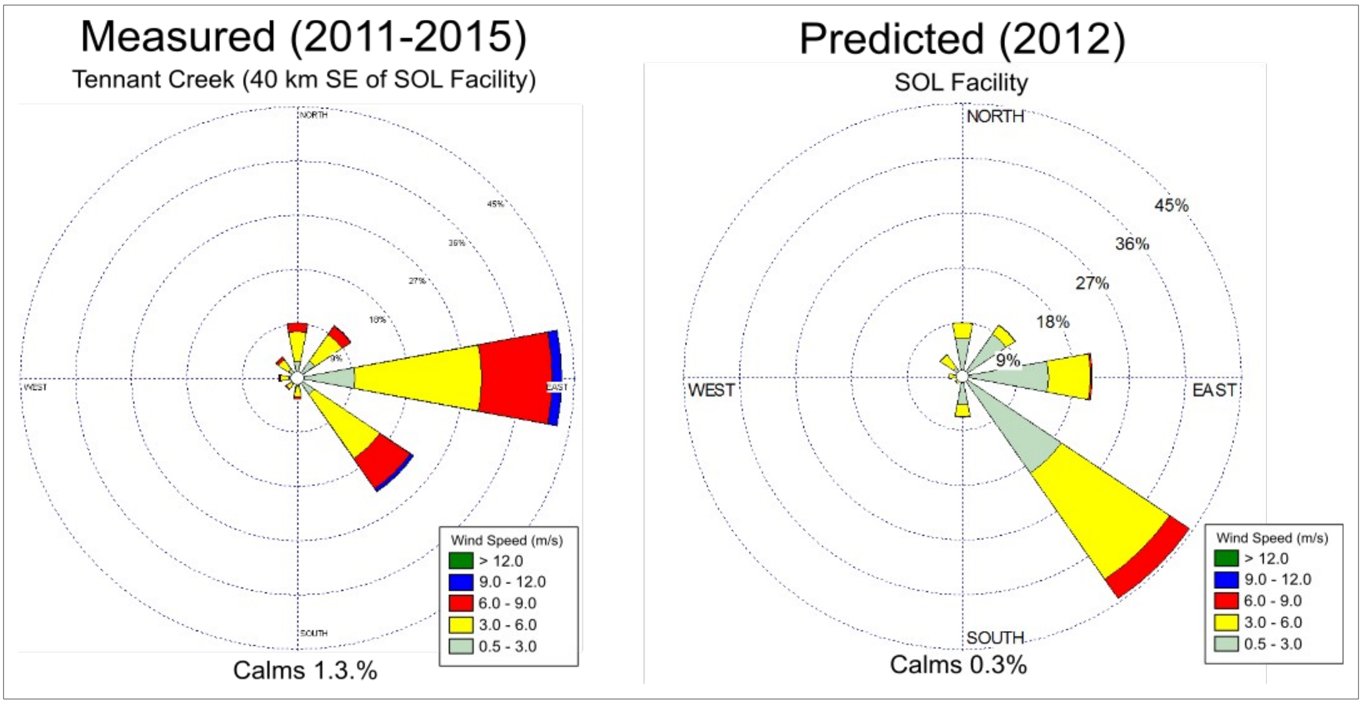

Figure 6.1: Comparison of Predicted 2012 SOL Facility Wind Rose and Measured Historical Tennant Creek Airport Wind Rose

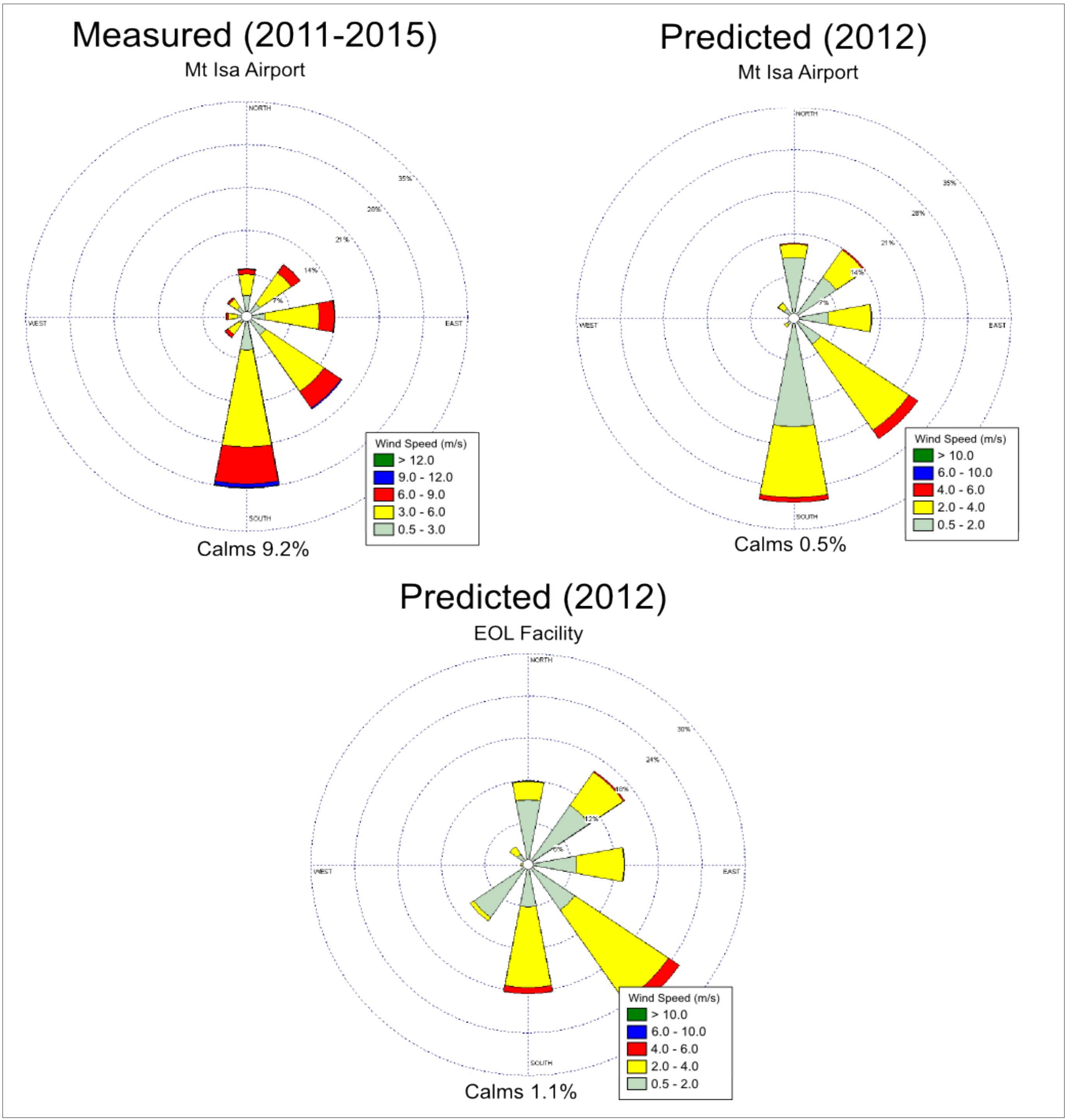

Figure 6.2: Comparison of Predicted 2012 EOL Facility Wind Rose and Measured Historical Mt Isa Airport Wind Rose

6.3.2 Predicted Atmospheric Stability

The amount of turbulence in the ambient air has a major effect upon the initial plume rise and dispersion of emissions to atmosphere. The amount of turbulence in the atmosphere is often

described using series of six Pasquill stability classes A, B, C, D, E and F (Turner, 1970). Of these, Class A denotes the most unstable or most turbulent conditions and Class F denotes the most stable or least turbulent conditions. Tables 6.2 and 6.2 provides a summary of the predicted atmospheric stability conditions (derived by CALMET) for the SOL and EOL facility regions.

Table 6.1 - SOL Facility – Summary of Predicted Stability Classes by Hour

Hour	Predicted Pasquill Stability Class					
	A	B	C	D	E	F
0	0	0	0	16	91	258
1	0	0	0	15	94	256
2	0	0	0	17	94	254
3	0	0	0	13	102	250
4	0	0	0	16	97	252
5	0	0	0	14	90	261
6	0	0	16	55	77	217
7	0	0	59	222	23	61
8	0	9	189	167	0	0
9	0	66	202	97	0	0
10	0	89	180	96	0	0
11	21	123	155	66	0	0
12	34	121	143	67	0	0
13	41	128	129	67	0	0
14	31	127	144	63	0	0
15	2	113	164	86	0	0
16	1	72	180	112	0	0
17	0	24	178	163	0	0
18	0	5	111	229	1	19
19	0	0	50	48	18	249
20	0	0	0	16	26	323
21	0	0	0	16	43	306
22	0	0	0	18	56	291
23	0	0	0	16	79	270
%	1.5%	10.0%	21.7%	19.3%	10.2%	37.3%

Table 6.2 - EOL Facility – Summary of Predicted Stability Classes by Hour

Hour	Predicted Pasquill Stability Class					
	A	B	C	D	E	F
0	0	0	0	39	83	243
1	0	0	0	39	93	233
2	0	0	0	36	95	234
3	0	0	0	31	104	230
4	0	0	0	33	102	230
5	0	0	0	27	102	236
6	0	0	51	97	64	153
7	0	27	160	178	0	0
8	0	57	189	119	0	0
9	1	92	192	80	0	0
10	3	121	185	56	0	0
11	15	134	177	39	0	0
12	28	122	169	46	0	0
13	31	137	153	44	0	0
14	21	137	154	53	0	0
15	1	108	159	97	0	0
16	0	39	205	121	0	0
17	0	10	122	233	0	0
18	0	0	42	184	32	107
19	0	0	0	19	56	290
20	0	0	0	18	48	299
21	0	0	0	20	51	294
22	0	0	0	30	57	278
23	0	0	0	35	75	255
%	1.1%	11.2%	22.4%	19.1%	11.0%	35.2%

6.4 Air Emission Data

6.4.1 Compressor Turbines, GEAs and Heaters

Pollutant emission data for the proposed GEAs and compressor turbines has been sourced from supplier specifications (Solar Turbines and GE Power). Detailed specifications for the EOL heater are not currently available however, as advised by Jemena, emission details would be similar to the GEA. For the purpose of the assessment, the heater has been modelled with the same emission rates and parameters as the GEA. Emission rates fro the SOL process heater have been provided by Jemena.

Table 6.3 presents emission factors for the compressor turbines, GEAs and heaters.

Table 6.3 - Emission Rates – Compressor Turbines, GEAs and Heaters

Compound	Compressor Turbine		GEA / EOL Heater		SOL Process Heater	
	Emission Factor	Emission Rate[a] (g/s)	Emission Factor	Emission Rate[b] (g/s)	Emission Rate kg/year	Emission Rate g/s
Carbon Monoxide (CO)	254 mg/Nm^3 (20°C, 1 atm)	8.2	8.0 g/bhp-hr	1.5	12,500	0.396
Nitrogen Oxides (NO_x)	125 mg/Nm^3 (20°C, 1 atm)	4.0	16.0 g/bhp-hr	3.0	10,000	0.317

[a] Based on specified exhaust flow rate for compressor turbine is 117,604 kg/hr. To convert this to Nm^3/hr, the density of air at 20°C has been used (1.21 kg/Mm^3). It is noted that air forms a large proportion of the exhaust gas stream (> 90%), therefore, the density of the exhaust gas stream is likely to be similar to that of air.

[b] Based on proposed power rating of 670 bhp for a proposed 1500 rpm GEA.

6.4.2 Flaring

To estimate emissions from the flaring at the SOL facility, reference has been made to emission factors for flares provided in the National Pollution Inventory document 'Emission estimation technique for Oil and Gas Extraction and Production' (Version 2.0, July 2013). The NPI provides emission factors for the key air quality indicators of carbon monoxide, nitrogen oxides, volatile organic compounds and particulate matter.

Smoking flares are usually an indicator of incomplete combustion. The NPI provides particulate matter emission factors for various categories of flares (non-smoking, lightly smoking, average smoking and heavily smoking). The modelling considers non-smoking emissions, assuming efficiently burning flares. No specific criteria for Total VOCs are available in any State or National legislation therefore, Total VOCs have not been modelled.

Table 6.4 presents the NPI emission factors for flaring.

Table 6.4 - NPI Emission Factors for Flaring

Compound	Emission Factor (kg/tonne of gas flared)
Carbon Monoxide (CO)	8.7
Nitrogen Oxides (NO_x)	1.5
Total Volatile Organic Compounds (VOCs)	< 0.05[a]
Particulate Matter (PM_{10}) – non-smoking flares	0
Particulate Matter (PM_{10}) – lightly smoking flares	0.056
Particulate Matter (PM_{10}) – average smoking flares	0.25
Particulate Matter (PM_{10}) – heavily smoking flares	0.38
[a] Based on equation provided in Section 5.2.1 Flaring of the NPI Manual. Considers default VOC destruction efficiency of 95% and less than 0.1% total VOC in gas composition	

To derive emission rates in g/s, the amount of gas flared in tonnes per hour is required. Jemena have indicated that 0.8 kg/hr of gas could undergo combustion in the HP and LP flare at the SOL facility. Table 6.5 presents the emission rates used in the modelling based on this amount of gas to be flared. As noted previously, as the flaring will adopt a high efficiency process, particulate emissions will be negligible hence have not been considered in the assessment.

Table 6.5 - Emission Rates for Flaring

Compound	Emission Rate per Flare (g/s)
Carbon Monoxide (CO)	0.00193
Nitrogen Oxides (NO_x)	0.000333

6.5 Emission Parameters

Table 6.6 presents the emission parameters adopted for the modelling.

Table 6.6 - Emission Parameters

Parameter	Compressor Turbine	GEA	Boiler Heat Exchanger	Process Heater	Flare
Total No.	4 at SOL 2 at EOL	2 at SOL 1 at EOL	1 at EOL	1 at SOL	2 at SOL

Parameter	Compressor Turbine	GEA	Boiler Heat Exchanger	Process Heater	Flare
Stack Height (m)	25	7	7	10	30
Temperature (°C)	448	576	576	576	1,000
Diameter (m)	1.676	0.3	0.3	0.6	0.3
Efflux Velocity (m/s)	35.9	26.7	26.7	6.5	Minimal

A number of equipment will be used for standby purposes only however, as a conservative approach, it is assumed that the majority of equipment (including standby equipment) are operating 24/7.

6.6 NO_x to NO_2 Conversion

Combustion engines emit a mixture of NO and NO_2 collectively referred to as NO_x. The ground level concentration of NO_2, for which ambient air quality goals are defined, is influenced by the chemical transformation of NO to NO_2 in the presence of sunlight and ozone. A number of methods are available for the prediction of NO to NO_2 conversion including a conservative 100% conversion assumption and the US EPA Ozone Limiting Method (OLM).

For the purpose of the assessment, OLM has been adopted. The method estimates conversion based on the amount of ozone in the atmosphere. Ozone monitoring stations are not available in the Mt Isa area. A review of ozone data for various stations in QLD and NT indicate background concentrations range from 41 ppb to 52 ppb (1-hour average, 99.9th percentile) and 14 ppb to 21 ppb (annual average). These background concentrations cover a range of areas including industrial, suburban and rural. The highest measured values of 52 ppb (1 hour average) and 21 ppb (annual average) have been considered as a conservative approach.

6.7 Modelling Results

The results of the air dispersion modelling are presented in Tables 6.7 and 6.8 as maximum ground level concentrations across the modelling domain and at the worst affected community receptors in the immediate surroundings, respectively. The results indicate compliance with the human health and well-being criteria for all modelled pollutants.

Table 6.7 - SOL Facility - Predicted Maximum Ground Level Concentrations

Compound	Maximum Predicted GLC Concentrations (μg/m³)			AVG Time	Criteria (μg/m³)
	Source Only	Background	Cumulative		
Modelling Domain					
CO	342.9	381.9	724.9	8-hour	11,000
NO_2	236.4	14.4	250.8	1-hour	250
NO_2	45.4	10.4	55.8	Annual	62

Table 6.8 - EOL Facility - Predicted Maximum Ground Level Concentrations

Compound	Maximum Predicted GLC Concentrations (μg/m³)			AVG Time	Criteria (μg/m³)
	Source Only	Background	Cumulative		
Modelling Domain					
CO	317.1	381.9	699.0	8-hour	11,000
NO_2	172.8	14.4	187.2	1-hour	250
NO_2	44.8	10.4	55.2	Annual	62
Worst Affected Sensitive Residential Receptors					
CO	15.2	381.9	397.1	8-hour	11,000
NO_2	71.9	14.4	86.3	1-hour	250
NO_2	0.4	10.4	10.8	Annual	62

At the SOL Facility, no sensitive receivers are located within 28 km of the site. The highest predicted CO and NO_2 (average) concentrations across an 8 km by 8 km area around the SOL facility are within the health-related criteria. Predicted concentrations of NO_2 (1-hour) are marginally above the health-related criteria (0.3% above) at a location along Warrego Road, immediately north of the facility however, no residential dwellings are located in this area. The predicted results in close proximity to the SOL facility demonstrate that compliance is expected at the nearest sensitive receivers located 28 km from the SOL facility.

For the EOL facility, further analysis of the modelling results indicates that the highest concentrations are predicted at the following sensitive receivers:

- NO_2 (annual average) concentrations, 10.8 μg/m³ - houses along Powerhouse Road (adjacent to the power station); and
- NO_2 (1-hour) and CO concentrations, 86.3 μg/m³ – house located 2.4 km to the south-east of EOL.

Figure 6.3 to 6.6 present predicted ground level concentration plots for NO_2 (1-hour) and NO_2 (annual) for the SOL and EOL facilities.

The NO_2 annual plots indicate an exceedence of the goal for ecosystem biodiversity and health in a small area surrounding the facilities. It is understood that, from available ecological survey information of the pipeline route (as provided by EcOz), there are no sensitive flora ecosystems (for which the criteria is applicable) directly around the facilities. Furthermore, the prediction methodology of annual concentrations is highly conservative by assuming that standby equipment are also operating. This provides greater certainty that the air quality impacts associated with the operation of the project are expected to be within the appropriate receptor air quality criterion.

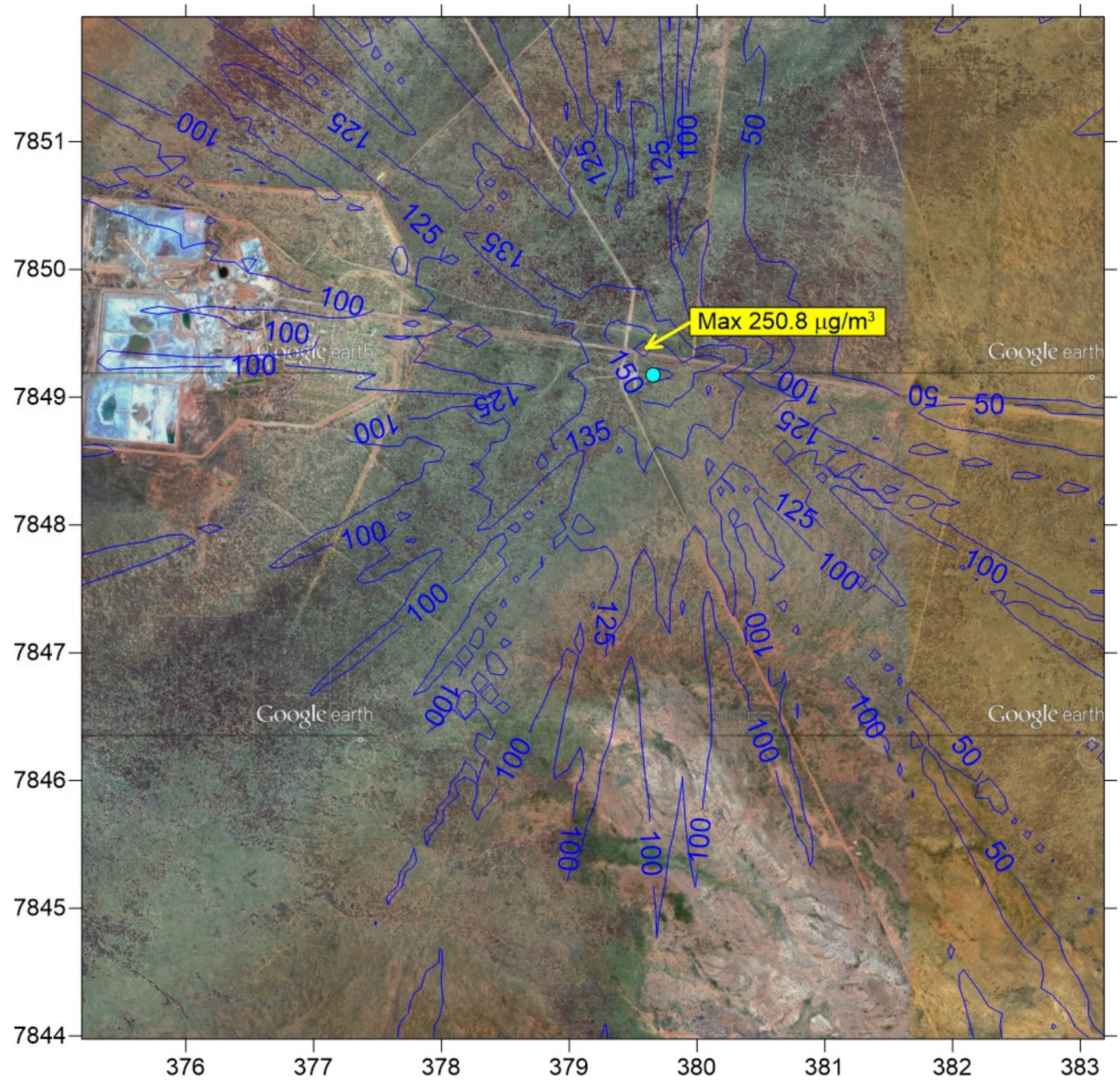

Figure 6.3: SOL Facility - Predicted 1-hour Ground Level Nitrogen Dioxide Concentrations (Cumulative)

Scenario: SOL Facility Operations	**Averaging Time:** 1-hour
Location: Phillip Creek	**Units:** μg/m^3
Pollutant: NO_2	**Criteria:** 250 μg/m^3

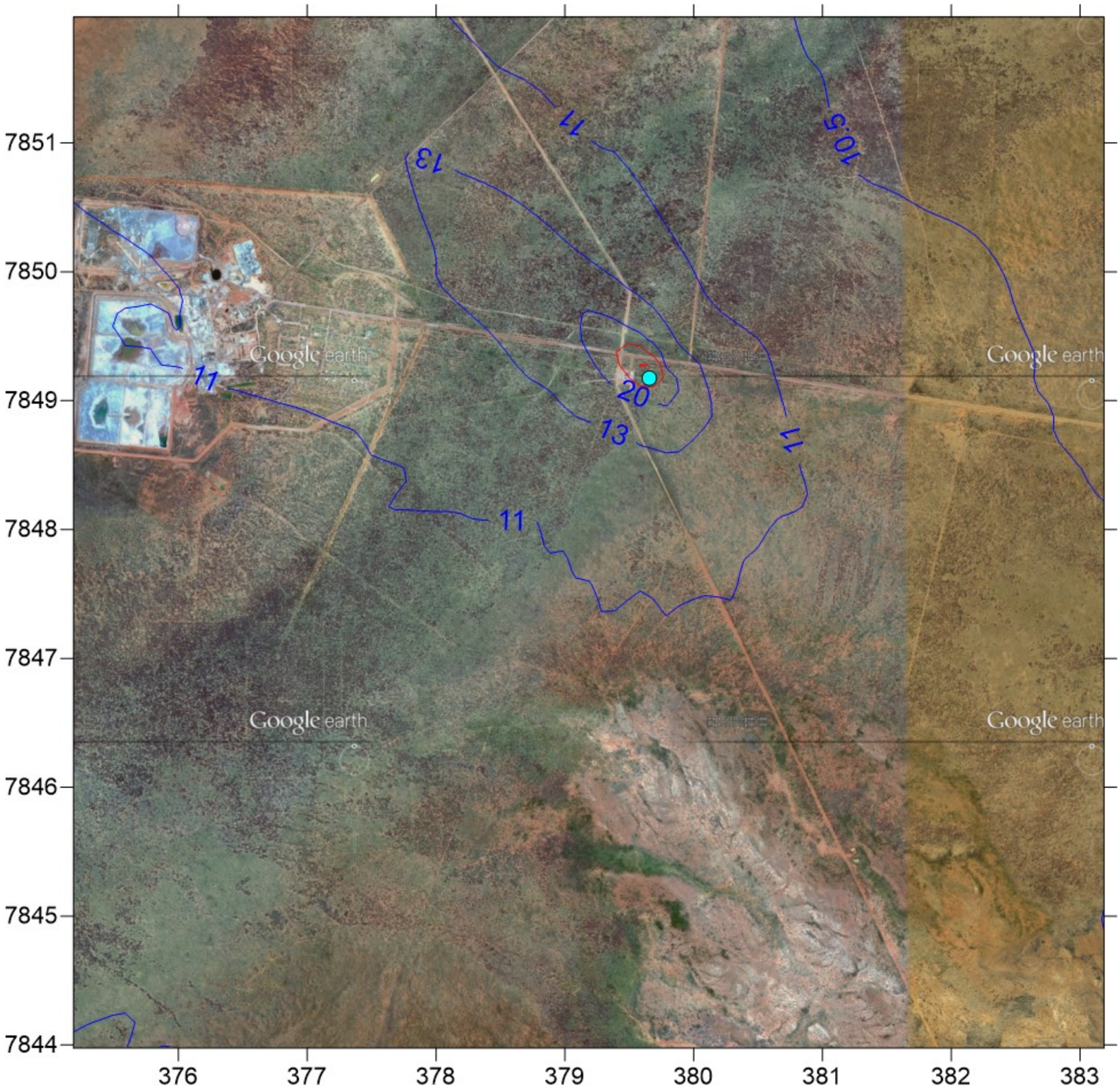

Figure 6.4: SOL Facility - Predicted Annual Ground Level Nitrogen Dioxide Concentrations (Cumulative)

Scenario: SOL Facility Operations	**Averaging Time:** Annual
Location: Phillip Creek	**Units:** µg/m³
Pollutant: NO_2	**Criteria:**
	62 µg/m³ (health and well-being)
	33 µg/m³ (health and biodiversity of ecosystems)

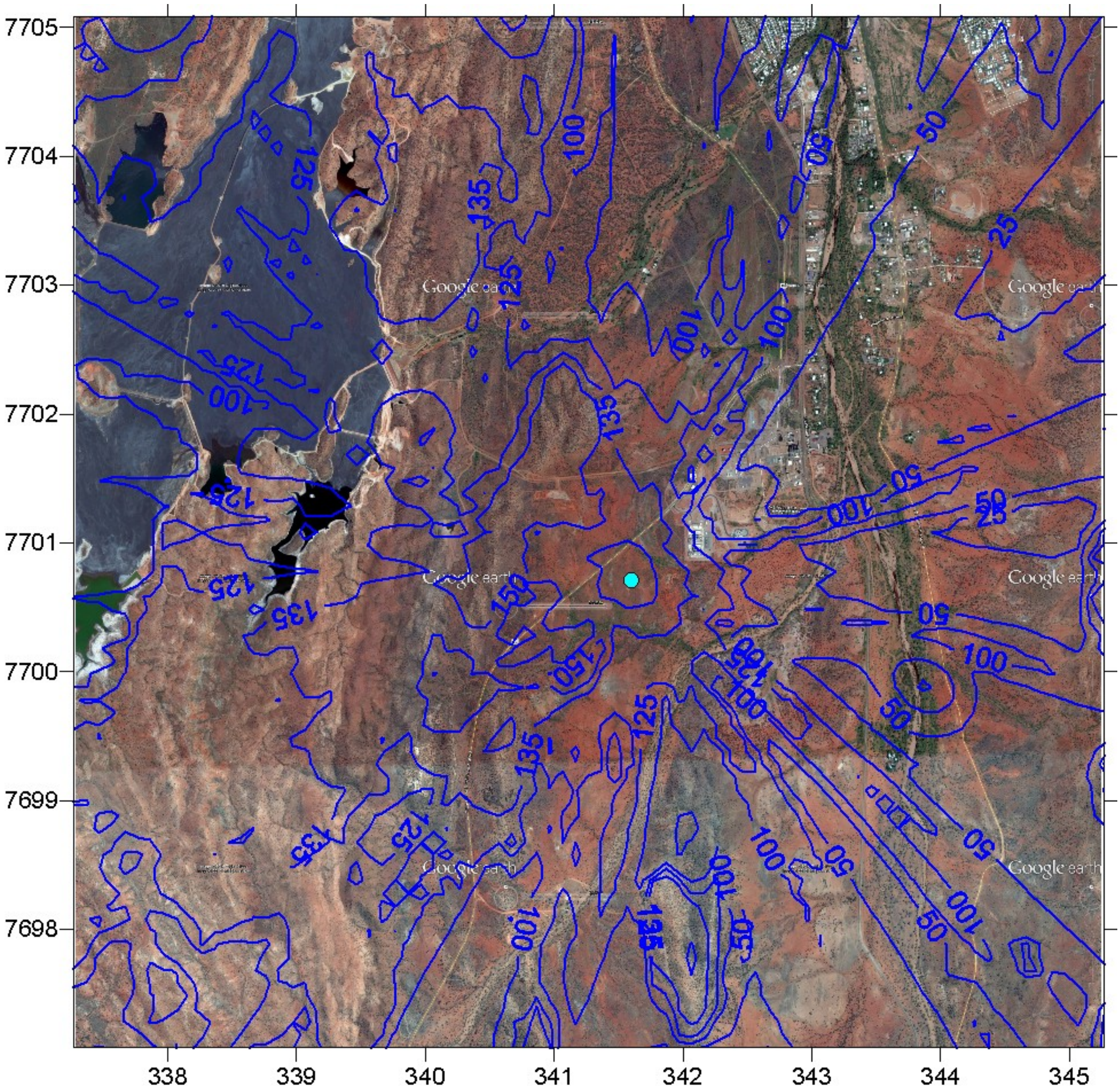

Figure 6.5: EOL Facility - Predicted 1-hour Ground Level Nitrogen Dioxide Concentrations (Cumulative)

Scenario: EOL Facility Operations	**Averaging Time:** 1-hour
Location: Mt Isa	**Units:** µg/m^3
Pollutant: NO_2	**Criteria:** 250 µg/m^3

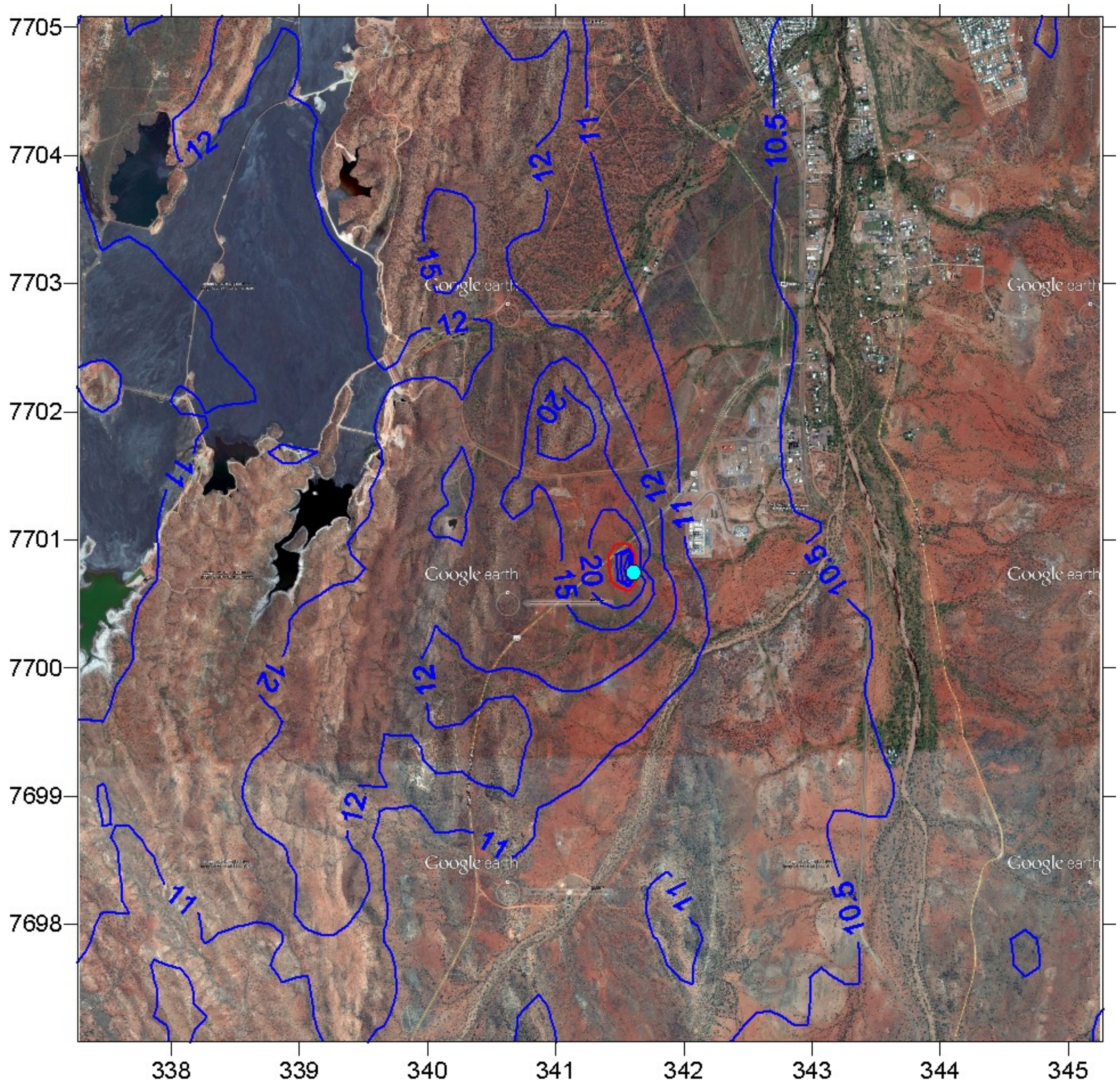

Figure 6.6: EOL Facility - Predicted Annual Ground Level Nitrogen Dioxide Concentrations (Cumulative)

Scenario: EOL Facility Operations	**Averaging Time:** Annual
Location: Mt Isa	**Units:** µg/m^3
Pollutant: NO_2	**Criteria:**
	62 µg/m^3 (health and well-being)
	33 µg/m^3 (health and biodiversity of ecosystems)

7 Greenhouse Gas Assessment

7.1 Overview

This section provides an assessment of greenhouse gas emissions for the NGP project. Estimations of annual greenhouse gas emissions during construction and operation have been estimated based on the methods outlined in the *National Greenhouse Energy Reporting Act 2007* (NGER) and associated technical guidelines.

7.2 Regulatory Framework

7.2.1 Kyoto Protocol

The Kyoto Protocol provides a framework by which developed countries (Party to the agreement) have an undertaking to reduce collective greenhouse gas emissions. The first commitment period (to which Australia's ratification come into effect in March 2008) covered the year 2008 to 2012 with aim to reduce emissions by at least 5 % below 1990 levels. A second commitment period has also been agreed to which aims at reducing emissions to 5% below 2000 levels between 2013 and 2020.

The protocol provides the following “flexible mechanisms” as a means for the Parties to the agreement to cost effectively reduce carbon pollution:

- emissions trading;
- clean development mechanism; and
- joint implementation.

These mechanisms allow for Party countries to sponsor GHG reduction programs in developing (non-Party) countries and claim the associated reductions as part of the binding reductions required under the Protocol.

In 2009 Australia issued the National Inventory Report 2009 which provided an inventory of national greenhouse gas emission estimates for the period 1990 – 2009 which was submitted under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The report identified that Australia's total GHG emissions were estimated to be 554.7 million tonnes (Mt), CO_2-equivalent ($CO_{2\text{-}e}$) in 2011.

7.2.2 Australian Climate Change Policy

The Australian Climate Change Policy provides a framework by which GHG emissions can continue to be managed. The policy is based on the under-lying concept of three pillars:

- mitigation – reduce Australia's GHG emissions;
- adaptation – adapt to the climate change we can not avoid; and
- global solution – help shape a collective international response.

Incorporated into the policy are a number of initiatives and legislative tools including the Clean

Energy Future, Australian Carbon Trust and the National Greenhouse Energy Reporting Act 2007 (NGER).

7.2.3 National Greenhouse and Energy Reporting Act 2007 (NGER)

The *NGER Act 2007* introduced a single national reporting framework for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy production of corporations. The objectives of the Act were to:

- underpin the introduction of an emission trading scheme;
- inform government policy formulation and the Australian public;
- meet Australia's international reporting obligations;
- assist Commonwealth, State and Territory government programs and activities;
- avoid duplication of similar reporting systems in the states and territories.

Under the National Greenhouse and Energy Reporting Act 2007, there are requirements for controlling corporations to register and report if they emit greenhouse gases, produce energy, or consume energy at or above specified quantities in a given financial year. The reporting thresholds have been phased in as follows:

- From 1st July 2008 corporations were required to register and report if:
    - they control facilities that emit 25 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.
    - their corporate group emits 125 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.
- For the reporting year 2009 – 2010 corporations are required to register and report if:
    - they control facilities that emit 25 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.
    - their corporate group emits 87.5 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 350 terajoules or more of energy.
- For the reporting years after 2009 – 2010 corporations are required to register and report if:
    - they control facilities that emit 25 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 500 terajoules or more of energy.
    - their corporate group emits 50 kilotonnes or more of greenhouse gas (CO_2 equivalent), or produces/consumes 200 terajoules or more of energy.

Specific guidance with respect to the scope of the reporting requirements has been developed, as well as detailed methodologies for calculating greenhouse gas emissions and/or energy use[2]. Table 7.1 defines the Greenhouse Gases that must be reported under the Act.

2 Australian Government, Department of Climate Change - National Greenhouse and Energy Reporting System Measurement, Technical Guidelines for the estimation of greenhouse gas emissions by facilities in Australia, July 2014.

Table 7.1 - Greenhouse Gases Required for Reporting

Item	Greenhouse Gas	Chemical Formula	Global Warming Potential (GWP)
1	Carbon dioxide	CO_2	1
2	Methane	CH_4	25
3	Nitrous oxide	N_2O	298
4	Sulphur hexafluoride	SF_6	22,800
5	HFC-23	CHF_3	14,800
6	HFC-32	CH_2F_2	672
7	HFC-41	CH_3F	92
8	HFC-43-10mee	$C_5H_2F_{10}$	1,640
9	HFC-125	C_2HF_5	3,500
10	HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1,100
11	HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1,430
12	HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	353
13	HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	4,470
14	HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	124
15	HFC-227ea	C_3HF_7	3,220
16	HFC-236fa	$C_3H_2F_6$	9,810
17	HFC-245ca	$C_3H_3F_5$	693
18	Perfluoromethane (tetrafluoromethane)	CF_4	7,390
19	Perfluoroethane (hexafluoroethane)	C_2F_6	12,200
20	Perfluoropropane	C_3F_8	8,830
21	Perfluorobutane	C_4F_{10}	8,860

Item	Greenhouse Gas	Chemical Formula	Global Warming Potential (GWP)
22	Perfluorocyclobutane	c-C_4F_8	10,300
23	Perfluoropentane	C_5F_{12}	9,160
24	Perfluorohexane	C_6F_{14}	9,300

The range of activities that are carried out by a Corporation are divided into groups for the purposes of determining reporting requirements under the Act. These groups are termed Scope 1, Scope 2 and Scope 3, for the purposes of reporting. Examples of the activities that fall within each are identified in Table 7.2. Only Scope 1 and 2 emission types are included in the NGER reporting requirements. Scope 3, which are outside the scope of the Corporation or facility to control or manage, are excluded from the NGER requirements.

Table 7.2 - Scope 1, 2 and 3 Activity Examples

Scope 1	Scope 2	Scope 3
The release of greenhouse gas into the atmosphere as a direct result of an activity or series of activities (including ancillary activities) that constitute the facility.	The release of greenhouse gas as a result of one or more activities that generate electricity, cooling or steam that is consumed by the facility but that *do not* form part of the facility.	Emissions that occur outside the boundary of a facility as a result of activities at a facility and are not Scope 2 activities.
E.g., power generation, emissions from haul vehicles operated by the facility, direct emission of greenhouse gases from extraction and processing of raw materials, emissions from on-site waste disposal.	E.g., greenhouse gas emissions caused by electricity use by the facility, where that electricity is not produced at the facility.	E.g., greenhouse gas emissions from off-site waste disposal, transport emissions where the transport is not provided by or managed by the facility.
Mandatory to report under NGER		Not Mandatory to report under NGER

Scope 3 emissions represent GHG emissions resulting from a company's activities, but occurring from sources not owned or controlled by the company. Scope 3 emissions can be divided into upstream and downstream components. Upstream emissions for the proposed gas pipeline may include extraction and production of purchased pipeline materials and transportation of purchased fuels. No significant downstream emissions have been identified for the proposed project.

Scope 3 emissions are not routinely reported by companies because:

- emissions are difficult to estimate accurately; and
- the company does not have effective control of the emissions sources.

A company's Scope 3 emissions will be reported elsewhere by a second company as their Scope 1 emissions. As an example, Scope 3 emissions from the production of the pipeline materials will be reported by the supplier or manufacture as one of its Scope 1 emissions. Therefore, Scope 3 emissions are/are not included in the GHG assessment.

7.3 GHG Inventory Methodology

7.3.1 Accounting and Reporting Principles

The GHG emissions inventory for the NGP project has been prepared in accordance with the accounting and reporting principles detailed within the Greenhouse Gas Protocol[3]. The protocol was developed to provide a framework for internationally accepted accounting and reporting standards for GHG emissions from companies.

The key principles provided in the Greenhouse Gas Protocol include:

- Relevance: The inventory must contain the information that both internal and external users need for their decision making;
- Completeness: All relevant emissions sources within the inventory boundary need to be accounted for so that a comprehensive and meaningful inventory is compiled;
- Consistency: The consistent application of accounting approaches, inventory boundary and calculation methodologies is essential to producing comparable GHG emissions over time;
- Transparency: Address all relevant issues in a factual and coherent manner, based on a clear audit trail. Disclose any relevant assumptions and make appropriate references to the accounting and calculation methodologies and data sources used; and
- Accuracy: Data should be sufficiently precise to enable intended users to make decisions with reasonable assurance that the reported information is credible.

The greenhouse gas emission inventory for the Project is based on the methodology detailed in the Greenhouse Gas Protocol, and the relevant emission factors in the National Greenhouse Accounts (NGA) Factors.

7.3.2 Inventory Organisational Boundary

The organisational boundary of the project is defined as the proposed construction site and operational facilities, and includes all GHG emissions controlled or produced by the project.

3 World Business Council for Sustainable Development and World Resource Institute (2004), 'The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard'

7.3.3 Reporting Period

For the purpose of the assessment, GHG estimates have been predicted for the following periods:

- Year 1 – Construction only;
- Year 2 – Construction completion, commissioning and commencement of operations; and
- Annual operations only (Year 3 onwards).

7.3.4 Scope 1 and 2 Emission Sources

As discussed earlier, GHG emissions are categorised into Scope 1, 2 and 3 emissions.

Scope 1 emissions for the project are related to fuel usage by construction equipment and SOL/EOL facility equipment (e.g. generators and compressor turbines). Only diesel equipment will be used during construction, which includes off-road and on-road mobile equipment and stationary equipment such as generators, pumps and compressors. At the SOL and EOL facility, natural gas will be used to operate the compressor turbines.

In relation to Scope 2 emissions, the SOL facility will be powered by on-site generators only with no mains power supply. At the EOL facility, mains electricity is proposed. An on-site generator will be provided at the EOL facility however, this will only be used for standby purposes. As a conservative approach, it is assumed that the backup generator could be used 5 hours a week.

As discussed earlier, Scope 3 emissions have not been considered in these assessments.

7.3.5 Materiality

Materiality is a concept used to minimise the time spent verifying data that does not impact on the inventory in a material way. The exact materiality threshold that is used in GHG emissions accounting and auditing is subjective and dependant on the context of the site and the features of the inventory. Depending on the context, the materiality threshold can be expressed as a percentage of a total inventory, a specific amount of GHG emissions, or a combination of both.

For the purposes of this assessment, emissions are assumed to be immaterial if they are likely to account for less than 5% of the overall emissions profile. The following GHG emission sources have not been considered in the assessment:

- scheduled/emergency gas flaring and venting – only small amounts of gas is expected to be flare or vented (i.e. 5 tonnes every few years). It is noted that continuous gas venting from the Nitrogen Reduction Unit at the SOL facility has been included in the assessment;
- on-road vehicle usage within construction site – expected to be minor compared to continuous operation of heavy machinery.

7.3.6 Activity Data Sources

Construction and operational activity data used to estimate Scope 1 and Scope 2 emissions have been based on information provided by Jemena. The following information has been provided by Jemena:

- Construction phase:
  - construction equipment inventory;
  - construction staging and durations;
  - worker camp details (power generation equipment specifications);
- Commissioning and operational phase:
  - anticipated power consumption for Start of Line and End of Line facilities;
  - type of fuel gas used.

For Scope 1 emissions, it has been necessary to estimate fuel usage of construction based the operating duration of equipment, and the type and number of equipment required for construction. Fuel consumption per hour has been based on data presented in the Caterpillar Performance Handbook (Edition 42)[4] and available literature.

7.3.7 Emission Factors

Direct measurement of GHG at the emission source can give the most accurate and precise assessment of GHG emissions. Direct measurement of emissions however is not feasible where a project is still in the design phase (as is the case for the proposed gas pipeline). For the purpose of the assessment, emission factors have been used in accordance with the GHG Protocol methodology. Emission factors are a factor expressed as the amount of GHG emissions per unit of activity, which can be used to determine inventories for a site and remove the need for site specific testing of emissions.

Emission factors can be obtained from various sources, for example, the Department of Climate Change, from site-specific information or from operational details obtained from similar emission sources. Emission factors used to calculate GHG emissions (as CO_2-e) from the combustion of diesel and electricity consumption have been sourced from the Department of Climate Change and Energy Efficiency National Greenhouse Accounts Factors – August 2015. The relevant emission factors for the project are associated with fuel-related emissions (Scope 1) and electricity usage (Scope 2).

Tables 7.3 to 7.6 presents a summary of the emission factors used in the study.

4 Caterpillar, Caterpillar Performance Handbook, Edition 42, Chapter 20 Estimating Owning & Operating Costs, January 2012.

Table 7.3 - Emission Factors – Consumption of Fuels (Scope 1)

Use	Fuel Combusted	Energy Content (GJ/m³)	Emission Factor (kg CO_2-e/GJ)		
			CO_2	CH_4	N_2O
SOL and EOL Facilities	Forms of Natural Gas[a]	39.3 x 10^{-3}	51.4	0.1	0.03
SOL/EOL Facilities and Construction Equipment (off-road/stationary)	Diesel	38.6	69.9	0.1	0.2
Construction Equipment (on-road vehicles)	Diesel[b]	38.6	69.9	0.01	0.6

[a] Represents natural gas distributed in a pipeline, compressed natural gas, unprocessed natural gas.

[b] Represents vehicles post-2004 (vehicles used for the project are assumed to be more recent models)

Table 7.4 - Emission Factors – Gas Transmission (Scope 1)

Operation	Emission Factor (tonnes CO_2-e/km pipeline length/year)		
	CO_2	CH_4	N_2O
Natural Gas Transmission	0.02	10.4	-

Table 7.5 - Emission Factors – Gas Flaring (Scope 1)

Operation	Emission Factor (tonnes CO_2-e/tonnes flared)		
	CO_2	CH_4	N_2O
Gas Flare	2.8	0.8	0.03

Table 7.6 - Emission Factors - Consumption of Purchased Electricity from the Grid (Scope 2)

State	Emission Factor (kg CO_2-e/kWh)
Queensland	0.79

For gas venting at the SOL facility, a total of 394.2 tonnes of methane is estimated to be released per year. This is equivalent to 9,855 tonnes of CO_2 per year, based on a global warming potential value of 25 for methane.

Land clearing is associated with greenhouse gas emissions through release of carbon dioxide from

decaying plant matter and the reduction in carbon sequestration provided by trees. For the estimation of emissions associated with land clearing, the Full Carbon Accounting Model (FullCAM) was utilised. FullCAM evaluates potential carbon stocks for various types of vegetation as defined by the National Vegetation Information System (NVIS). A review of the NVIS database (Version 4.2) identifies that the pipeline route comprises of the following vegetation:

- Acacia shrublands;
- Acacia open woodlands;
- Eucalypt open woodlands; and
- Tussock grasslands.

Certain types of vegetation occur at multiple points along the route. Nine geographical coordinates were selected to account for this variation in vegetation. The nine geographical points also provided consideration of the changing climatic and geophysical conditions potentially effecting the potential carbon stock along the pipeline route. As a conservative approach, it was assumed that vegetation growth was not affected by natural or land management events (e.g. bush fires, clearing) and that ROW clearing would remove all vegetation within a 25 m width (with no regrowth occurring after clearing). Table 7.7 presents the modelling inputs and outputs.

Table 7.7 - FullCAM Inputs and Outputs

No.	Vegetation	FullCAM Coordinate	Pipeline Length (km)	Carbon Stock (tC/ha)	Area (ha)	Total Carbon Stock (tC)
1	Acacia Shrublands	133.8936,-19.4562	9	4.5	23	101
2	Eucalypt Open Woodlands	133.9533,-19.4595	4	3.3	10	33
3	Acacia Shrublands	134.0266,-19.4729	13	8.1	33	263
4	Eucalypt Open Woodlands	134.7236,-19.5078	136	5.2	340	1775
5	Eucalypt Open Woodlands	136.120,-19.936	195	4.6	488	2257
6	Tussock Grasslands	137.2524,-20.3373	35	10.1	88	880
7	Acacia Open Woodlands	137.572,-20.462	38	13.6	95	1294
8	Tussock Grasslands	138.403,-20.711	132	4.4	330	1459
9	Eucalypt Open Woodlands	139.3334,-20.8126	60	4.8	150	716
					TOTAL	***8777***

The estimated total carbon to be removed is 8,777 tC (tonnes of carbon). This value has been factored by 3.67 (CO_2:C ratio) to estimate the potential CO_2 emitted.

7.4 Emissions Inventory

7.4.1 Scope 1 Emissions

Tables 7.8 to 7.10 presents the estimated Scope 1 emissions for construction, commissioning and annual operations. Construction and commissioning is expected to occur in the first one and half years of the project.

Table 7.8 - Construction - Scope 1 Emissions

Stage	Total Energy Consumed GJ	Total CO_2-e (tonnes)
Land Clearing	-	32,094
Mainline Construction	120,560	8,463
Camp Construction and Operation	31,562	2,216
Above Ground Infrastructure	53,092	3,727
Total	***205,215***	***46,510***

Table 7.9 - Commissioning - Scope 1 Emissions

Item	Total Energy Consumed GJ	Total CO_2-e (tonnes)
SOL Facility	10,635	552
EOL Facility	5,061	261
Total	***15,696***	***813***

Table 7.10 - Annual Operations - Scope 1 Emissions

Item	Total Energy Consumed GJ	Total CO_2-e (tonnes)
SOL Facility	1,107,124	66,946
EOL Facility	582,861	30,035
Gas Transmission	-	6,481
Total	1,689,985	103,462

7.4.2 Scope 2 Emissions

As discussed earlier, the EOL Facility will utilise the main electricity grid for power. Based on the expected power usage, (39,312 GJ per year) and 0.79 CO_2-e kg/kWh emission factor for the Queensland region, total emissions are estimated to be 8,627 CO_2-e tonnes/year.

7.4.3 Summary of Emissions

Table 7.11 below presents a summary of the estimated total Scope 1 and 2 emissions during Year 1, Year 2 and for subsequent operations. Year 1 includes construction only. Year 2 includes construction and commissioning in the first half of the year and operations in the second half.

Table 7.11 - Estimated GHG Emissions

Year of Project	Scope 1		Scope 2		Total Emissions (tonnes CO_2-e)
	Energy Usage (GJ)	Emissions (tonnes CO_2-e)	Energy Usage (GJ)	Emissions (tonnes CO_2-e)	
Year 1	136,810	9,604	-	-	9,604
Year 2	929,093	72,229	19,656	4,313	76,542
Annual Operation	1,689,985	103,462	39,312	8,627	112,089

Based on the estimated emissions presented above, the proposed gas pipeline is expected to trigger the NGER reporting threshold for a single facility of 25 kilotonnes CO_2-e (25,000 tonnes CO2-e) of greenhouse gases and 100,000 MJ of energy consumed.

7.5 GHG Mitigation Options

Key GHG emissions identified for the project include land clearing and operation of equipment using diesel and gas. Opportunities for reducing GHG emissions for these sources include the followings:

- Construction:
  - minimising clearing of vegetation along the pipeline ROW;
  - encouraging re-vegetation of the pipeline ROW;
  - minimising the use of fuel by selecting fuel efficient plant and equipment, operating vehicles and machinery in a fuel efficient manner e.g. turning off idling equipment, and selecting construction techniques that utilise lower amounts of fuel;
  - source supplies locally (thereby minimising transportation emissions to get product to site).
- Operation:
  - Implementation of a regular maintenance regime to minimise the potential for gas leakage along the pipeline and at facilities;

- Investigation of the use of biofuels in plant and equipment (it is noted that this may not be possible given the geographical location of the site and specific fuel requirements of the plant and equipment);
- Implementation of a regular maintenance regime for GEAs and compressor turbines to ensure they are operating at peak efficiency.

8 Conclusion

The conclusions of the air quality assessment of the NGP project are summarised as follows:

- The nearest sensitive residential receptors to the pipeline route include a family outstation (975) near Tennant Creek, a pastoral homestead (18 km east of MLV3) and residential dwellings in the Mt Isa area. These receptors are noted to be 3.4 km, 3.5 km and 1.0 km from the proposed pipeline. All other receptors are more than 10 km from the pipeline route.
- The nearest residential receptor to the Start of Line (SOL) facility is 28 km to the west therefore - no air quality impacts are expected at this distance. The nearest residential receptor to the End of Line (EOL) facility is 1.2 km to the north-east in Mt Isa.
- Key air emissions for the project include earthworks and diesel exhaust emissions during construction, and gas combustion emissions from the operation of gas engine alternators and compressor turbines at the EOL and SOL facilities. Air quality indicators from these sources combined include carbon monoxide, nitrogen dioxide and particulate matter (TSP, PM_{10} and $PM_{2.5}$).
- Relevant ambient air quality criteria for the key air quality indicators are presented in the *National Environmental Protection Measure for Air (NEPM Air)* and the *Queensland Environmental Protection (Air) Policy 2008*;
- Air dispersion modelling has been completed for worst-case construction activities, and operation of the SOL and EOL facility. The results of the modelling indicate compliance with the relevant ambient air quality goals for all key pollutants by a significant margin.
- Greenhouse gas emissions for the project are primarily categorised as Scope 1 emissions and are associated with land clearing, and diesel and gas combustion. Scope 2 emissions are associated with the operation of the EOL facility which will utilise mains power in the Mt Isa area. Reporting of GHG emissions is expected to be required, as emissions are estimated to be above the National Greenhouse and Energy Reporting thresholds for CO_2-e emitted and energy consumed.

Overall, the assessment has identified that construction and operation of the NGP is expected to contribute to pollutant concentrations in the surrounding area however, pollutant concentrations are predicted to be compliant with relevant air quality criteria. The potential for air quality impacts can be further minimised by adopting various air quality management measures as outlined in the NGP Air Quality Management Plan (Document 399-PA-EV-010).

Appendix A – Air Quality Glossary

APPENDIX A: GLOSSARY OF AIR QUALITY TERMINOLOGY

Conversion of ppm to mg/m^3	Where R is the ideal gas constant; T, the temperature in kelvin (273.16 + T°C); and P, the pressure in mm Hg, the conversion is as follows: $mg\ m^{-3}$ = (P/RT) x Molecular weight x (concentration in ppm) $= \frac{P \times \text{Molecular weight} \times (\text{concentration in ppm})}{62.4 \times (273.2 + T°C)}$ For the purposes of the air quality assessment all conversions were made at 25°C.
g/s	Grams per second
mg/m^3	Milligrams (10^{-3}) per cubic metre. Conversions from mg/m^3 to parts per volume concentrations (ie, ppm) are calculated at the relevant temperature as defined in the legislative requirements.
$\mu g/m^3$	Micrograms (10^{-6}) per cubic metre. Conversions from $\mu g/m^3$ to parts per volume concentrations (ie, ppb) are calculated at 25 °C.
ppb	Parts per billion.
ppm	Parts per million.
PM_{10}, $PM_{2.5}$, PM_1	Fine particulate matter with an equivalent aerodynamic diameter of less than 10, 2.5 or 1 micrometres respectively. Fine particulates are predominantly sourced from combustion processes. Vehicle emissions are a key source in urban environments.
50 th percentile	The value exceeded for 50 % of the time.
NO_x	Oxides of nitrogen – a suite of gaseous contaminants that are emitted from road vehicles and other sources. Some of the compounds can react in the atmosphere and, in the presence of other contaminants, convert to different compounds (eg, NO to NO_2).
VOC	Volatile Organic Compounds. These compounds can be both toxic and odorous.