12 AIR QUALITY

Chapter 12 describes the existing air environment of the Gas Field Component of the Queensland Curtis LNG (QCLNG) Project, the potential impacts of Gas Field construction and operations on the air environment and measures to mitigate those impacts. A preliminary air quality impact assessment of Gas Field infrastructure has been prepared and is provided in *Appendix 3.5.*

As part of front-end engineering design (FEED), QGC is considering options for the type, configuration and location of infrastructure required for coal seam gas (CSG) extraction, transport and processing. The air impact assessment described in this chapter is based on the Environmental Impact Statement (EIS) Reference Case described in *Volume 2, Chapter 2.*

However, should the final infrastructure type, configuration and location selected for FEED significantly alter further air impact assessment will be conducted as part of a Supplementary EIS.

12.1 AIR QUALITY OBJECTIVE AND VALUES

The Project environmental objective for air quality is to preserve ambient air quality to the extent that ecological health, public amenity or safety is maintained.

In accordance with the *Environment Protection Act 1994* (Qld) *(EP Act)*, the Environmental Protection (Air) Policy 2008 (Qld) (EPP (Air)) is the main legislative instrument regulating air emissions in Queensland. The National Environment Protection Council (NEPC) defines national ambient air quality standards and goals in consultation and with agreement from all state governments. The EPP(Air) 2008 has adopted the National Environmental Protection Measures (Ambient Air Quality) goals as air quality objectives.

For air quality assessments, it is common practice to consider, and where appropriate adopt, an air quality objective for a specific substance from another jurisdiction if information is not available in the EPP (Air). The predicted ground-level concentrations of air pollutants have been compared with the relevant national and international goals and standards including:

- Queensland Environmental Protection (Air) Policy 2008
- National Environment Protection Measure (Ambient Air Quality) 1998
- NSW Department of Environment and Climate Change (NSW DECC), Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005)
- Environment Protection Authority Victoria (Vic SEPP) State Environment Protection Policy (Air Quality Management)
- World Health Organisation (WHO) Guidelines for Air Quality (Chapter 3) 2000

- National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (NOHSC:1003(1995))
- Texas Commission on Environmental Quality (TCEQ) Effects Screening Levels 2008.

The principal air pollutants considered in this assessment are associated with the combustion of CSG in the gas engines used to drive the compressors. These pollutants are:

- oxides of nitrogen (NO_X), as nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- ozone
- hydrocarbons (Volatile Organic Compounds (VOC) and Polycyclic Aromatic Hydrocarbons (PAH)).

Table 3.12.1 presents a summary of the relevant ambient air quality objectives under the EPP(Air) 2008 for criteria pollutants adopted for this assessment.

Table 3.12.1 Ambient Air Quality Objectives

Indicator	Environmental value	Averaging period	Air quality objective [1] (µg/m³)	Number of days of exceedence allowed
Nitrogen dioxide	Health and wellbeing	1-hour	250	1
		1-year	62	0
	Health and biodiversity of ecosystems	1-year	33	0
Carbon monoxide	Health and wellbeing	8-hour	11,000	1
Ozone	Health and wellbeing	1-hour	210	1
		4-hour	160	1

[1] Air quality objective at 0°C

In addition to the air pollutants detailed above, the combustion of CSG in gas-fired engines and flares will produce small quantities of hydrocarbons. The air quality objectives for hydrocarbons have been obtained from the sources listed above. A full list of hydrocarbons and their respective air quality objectives is presented in *Table 15, Appendix 3.5*.

QGC will not exceed air quality objectives as set by company guidelines where these are more stringent than EPP (Air) guidelines. In general, QGC standards are more stringent than the air quality objectives in EPP (Air). The following air quality objectives are set in company guidelines[1]:

- CO, 8hour – 10,000 µg/m³

1 BG Group, BG Standard, Environment Air Quality Standard BGA-HSSE-ENV-ST-150, August 2007

- NO_2, 1 hour - 200 µg/m³
- NO_2, 1 year – 40 µg/m³ (health), 30 µg/m³ (ecosystems).

Particulate emissions have not been modelled for the following reasons:

- Due to the composition of the CSG used as the fuel source in the reciprocating engines of compressors, it is not expected that these engines will emit particulates
- Any dust generated during construction will be temporary and it is expected that only minor volumes of particulates will be released following mitigation measures
- Any dust generated during operations will be minor, and mitigation measures will be in place to reduce dust generations.

12.2 ATMOSPHERIC DISPERSION MODELLING METHODOLOGY

Modelling of air pollutants from background sources has been carried out using the CSIRO's The Air Pollution Model (TAPM) to predict contributions to air quality levels.

This dispersion model has also been used to derive meteorological information at three nominal site locations spread across the proposed Gas Field footprint. The TAPM-generated meteorological information has then been incorporated into the AUSPLUME dispersion model (former Queensland Environmental Protection Agency approved air dispersion modelling software) to predict the impacts of NO_X, CO and hydrocarbons from the compressor stations and flares. For further details about modelling assumptions and parameters refer to *Appendix 3.5, Section 6.*

12.2.1 Infrastructure Modelling

The configuration and location of the well sites and compressor stations has not been finalised. Notwithstanding this, the dispersion modelling for the impact assessment has been carried out using a nominal compressor station layout. This involves, for each Field Compression Station (FCS) and Central Processing Plant (CPP), laying compressors out in two rows and equally spaced every 50 m.

For the purposes of modelling, each of the nine CPPs was located across the Gas Field area to cover all gas extraction possibilities. Each CPP was located in the centre of the three FCSs, with each FCS 5 km from the CPP and 120° apart (that is, equal-spaced at a distance of 5 km from the CPP).

The FCS will be situated adjacent to gas wells to minimise the CSG transmission distances. Gas wells will be approximately 750 m apart on all tenements.

12.2.2 *Modelling Scenarios*

The impact assessment has been carried out for the arrangement of compressor stations for three nominal regions, in order to account for variable wind fields across the Gas Field. The three regions selected for the assessment were centred on the following coordinates.

- North West Region 1: -26.9183 S and 150.3567 E
- Central Region 2: -26.2858 S and 149.7227 E
- South East Region 3: -27.1653 S and 150.7862 E

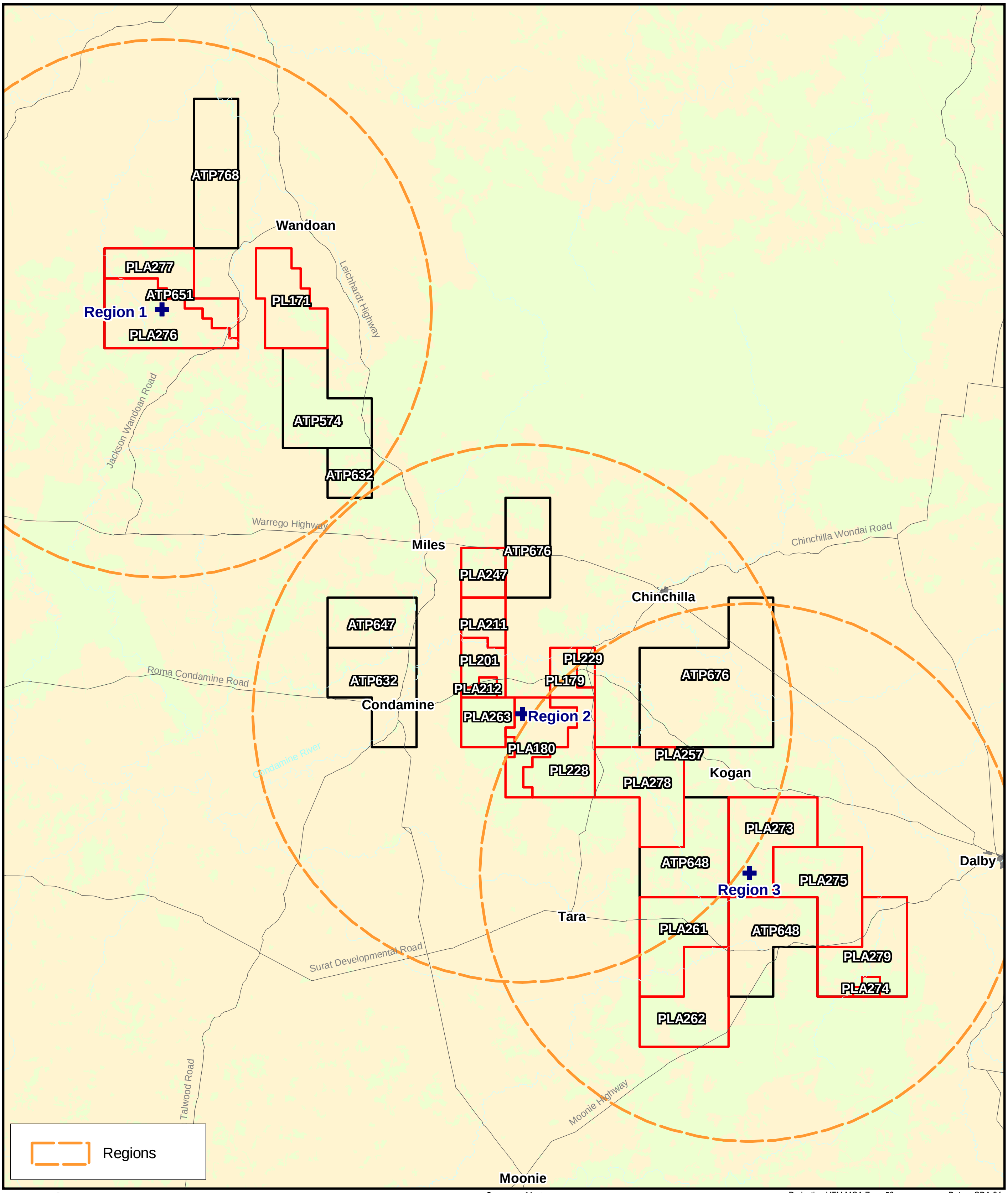
Figure 3.12.1 shows these regions.

For each region, meteorology was extracted from TAPM for application in the AUSPLUME dispersion model. For each region, the following, referred to as a ''production unit'', was modelled:

- one CPP, comprising 10 Caterpillar 3608 gas engines with two-stage Ariel reciprocating compressors
- three FCSs, comprising eight G3512 gas engines per FCS with single-stage Ariel screw compressors.

Each region will contain three production units (i.e. three CPPs and nine FCSs) in the configuration described above. There is potential for the clustering of production units in regions of high gas yield. Consequently, the plumes associated with multiple CSG production units located within close proximity to one another have the potential to accumulate under certain meteorological conditions and lead to higher ground-level concentrations than predicted by modelling results.

Notwithstanding this, the large area associated with the Gas Field tenures is likely to result in the production units being situated at least 20 km to 40 km apart, and result in only a small increase in the background concentration of air pollutants at emission points downwind.



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Title **Regions Selected For Air Impact Assessment**

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As discussed in *Section 12.3.1*, the terrain and land use is relatively uniform across the Gas Field area for dispersion meteorology; with no significant features to divert or influence wind flows. Consequently, an assessment of the emissions sources at the specific regions above can be considered representative of a larger area across each of the three regions, as general wind patterns are unlikely to change significantly.

12.3 EXISTING ENVIRONMENTAL VALUES

The Surat Basin constitutes part of the Great Artesian Basin of Australia and covers an area of approximately 122,655 km^2. The proposed Gas Field area covers approximately 468,700 ha (4,687km^2).

The rural nature of the Surat Basin provides an indication that air quality of the region will be good. The topography and geomorphology of the Gas Field are described in *Volume 3, Chapter 3.* Geology and soils of the Gas Field are described in *Volume 3, Chapter 4.*

12.3.1 Climate

The climate of the Gas Field is described in *Volume 3, Chapter 2.* Further climate data, relevant to air modelling is presented below.

For the purposes of modelling air impacts, an overview of the climate in the Surat Basin in south central Queensland was obtained, based on long-term monitoring information. Meteorological monitoring data from the Bureau of Meteorology (BoM) station at Miles Post Office has been used to characterise long-term wind speed and direction, temperature and solar radiation, surface pressure, rainfall and relative humidity in the region. While the precise location of Gas Field infrastructure has not yet been determined, the town of Miles is centrally located within the Gas Field tenements.

12.3.1.1 Wind Speed and Direction

The flat, low-lying hills in the area result in a relatively uniform wind field across the region due to the lack of significant terrain influences, such as tall peaks, lakes and coastline generating highly localised effects. The flat areas of shrubby, low vegetation also present a low-surface roughness resulting in a higher proportion of moderate (3 to 5 m/s) winds (refer to *Table 3.12.2*). The winds in the Surat Basin are influenced by the region's relatively flat terrain, dry conditions and the absence of land and sea breezes.

Annual wind rises for the one-hour average measurements of wind speed and direction from the Miles site have been presented for the April 2003 to April 2008 period in *Figure 3.12.2*. The seasonal distributions are presented in *Figure 3.12.3*.

Figure 3.12.2 Annual Distribution of Wind Speed and Direction at Miles

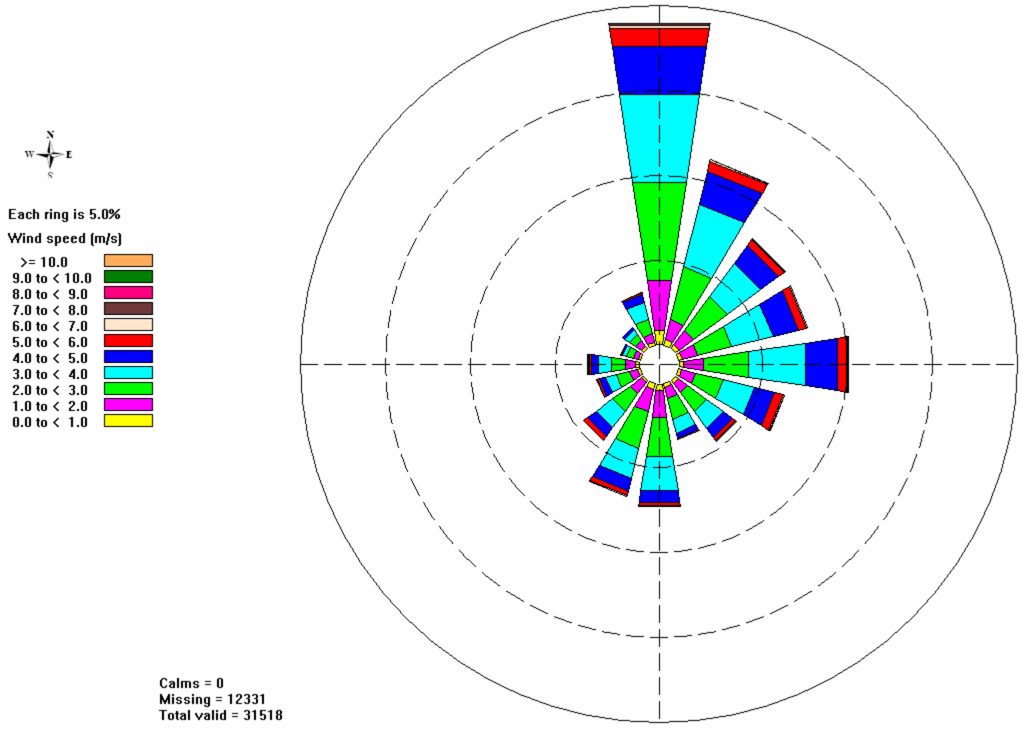

Figure 3.12.3 Seasonal Distribution of Wind Speed and Direction at Miles

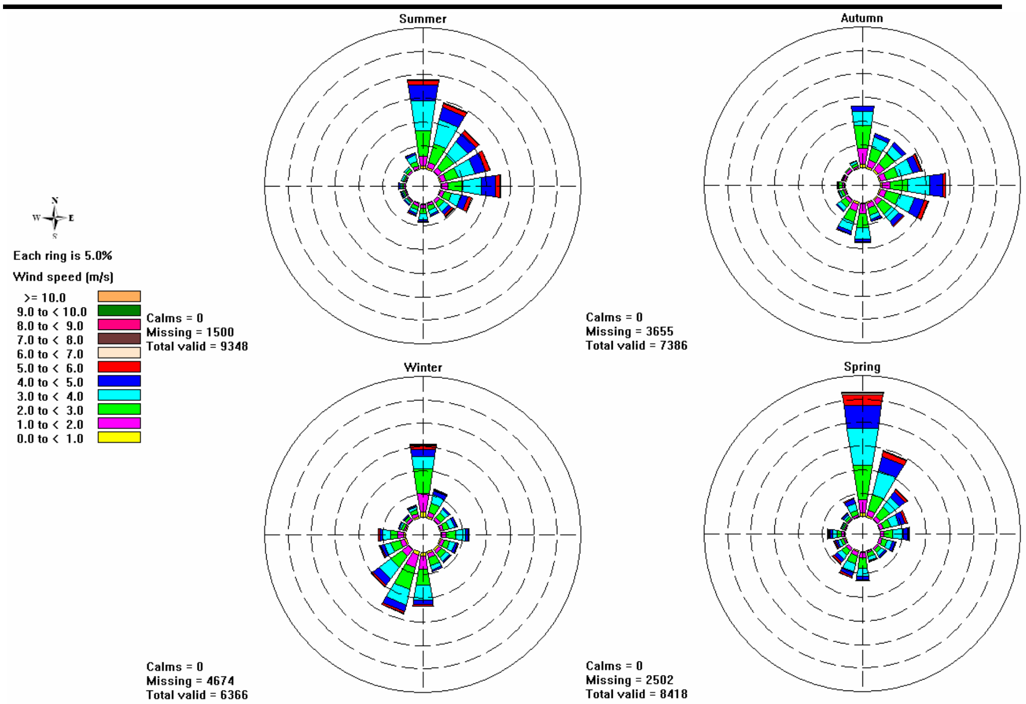

Table 3.12.2 presents a summary of the distribution of wind speed and direction at Miles for the period April 2003 to April 2008, indicating the predominant wind direction sectors and frequency.

The predominant annual wind flows at Miles are from the north to north-east with 38 per cent of winds blowing from this direction. A further 24 per cent of winds are from the east-northeast to east-southeast, while 18 per cent of winds are from the south to south-west sector. Moderate wind speeds of between 2 and 5 m/s dominate the region with 74 per cent of the winds being in this range. Light winds account for 20 per cent of the time, while strong winds greater than 5 m/s occur for 6 per cent of the time.

Table 3.12.2 Distribution of Wind Speed and Direction at Miles

Wind direction	**Distribution of Wind speed (% of total winds in m/s)**			
	Light winds 0 – 1.99	**Moderate winds 2.0 – 4.99**	**Strong winds > 5.0**	**Total winds 0 – >10.0**
All sectors	20%	74%	6%	100%
North-eastern sector (N, NNE, NE)	7%	29%	3%	38%
Eastern sector (ENE, E, ESE)	4%	19%	2%	24%
South-south-western sector (S, SSW, SW)	5%	13%	1%	18%

Note: Only 71.9% of valid data was retrieved from the Miles BOM meteorological station during the period 1998-2008.

The diurnal distribution of winds indicates that the evening, night-time and morning wind flows are dominated by winds from the northern and eastern sectors, with winds during the afternoon period more evenly distributed from all directions. Seasonally, winds from the north-eastern quadrant tend to dominate spring, summer and autumn months, while the winter is dominated by winds from the opposite direction, the south-western quadrant.

An analysis of the correlation between TAPM predicted and BoM observed wind fields at Miles indicates the model has performed reasonably well in simulating the general distribution of wind direction and speeds[2]. The TAPM model was therefore considered as a valid prognostic meteorological model.

12.3.1.2 Atmospheric Stability

Atmospheric stability is typically classified under the Pasquill-Gifford scheme and ranges from Class A, which represents very unstable atmospheric conditions that may typically occur on a sunny day, to Class F which represents very stable atmospheric conditions that typically occur

2 For further analysis of the relationship between the TAPM model and the BOM data refer to Appendix 3.5, Section 6.1.1.

during light wind conditions at night. Stability refers to the vertical movement of the atmosphere and is therefore an important factor in the dispersion and transport of pollutants within the boundary layer [3].

The percentage frequency distribution of stability classes at the three assessment sites is presented in *Table 3.12.3.*

Table 3.12.3 Atmospheric Stability by Region

Pasquill-Gifford Stability Class	Frequency (%)		
	Region 1	Region 2	Region 3
A	2.8	2.1	2.4
B	13.4	13.2	11.9
C	18.7	20.1	18.9
D	35.6	41.2	42.8
E	10.7	12.2	12.5
F	18.7	11.2	11.5

For a high percentage of time the area is described as a Class D or with neutral stability. This is due to the high frequency of wind speeds greater than 2 m/s. The relatively high proportion of Class B and C stability is due to the combination of daytime surface heating and moderate wind speeds.

The small percentage of extremely unstable Class A conditions is the result of the low proportion of light winds. At night, the Class D stability is indicative of a stable boundary layer with moderate winds. The stable Class F conditions occur during light wind conditions at night.

12.3.1.3 Mixing Height

Mixing height refers to the height aboveground within which the plume can mix with ambient air. Mixing height information for the model input has been extracted from TAPM for Region 2. The data shows the mixing height tends to develop around 9am, peaks around mid afternoon (2–3pm) before decreasing again around sunset (6pm). The mixing height's diurnal profile, using the 95th percentile, extends to approximately 1,400 m around early afternoon, and collapses below 50 m during the night.

During stable atmospheric conditions at night, the mixing height (inversion) is often quite low. During these atmospheric conditions, the plume from compressor emissions is unlikely to touch the ground as there is a lack of significantly elevated terrain in the region, and the combination of the plume's vertical velocity and high temperature is likely to provide it with adequate mechanical and thermal buoyancy to penetrate any low stable layer or temperature inversion.

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3 For further discussion of atmospheric stability and mixing height refer to Section *6.1.1.2, Appendix 3.5.*

At night when the mixing height is low the plume can become trapped under the mixing layer and have limited air available to mix with, resulting in higher ground-level concentrations.

During the day, solar radiation heats the air at the ground level and causes the mixing height to rise. The air above the mixing height during the day is generally colder. The growth of the mixing height is dependent on how well the air can mix with the cooler upper levels of air and therefore depends on meteorological factors such as the intensity of solar radiation and wind speed.

During strong wind speed conditions the air will be well mixed, resulting in a high mixing height. During periods when the mixing height is high, the plume emissions will disperse and will be diluted by the large volume of air.

While the compressor engine stacks are relatively short, the emission's elevated temperature and vertical velocity are likely to generate sufficient thermal and mechanical buoyancy for the plume to penetrate any low night-time inversion conditions, resulting in good plume dispersion conditions.

12.3.2 Ambient Air Quality in the Region

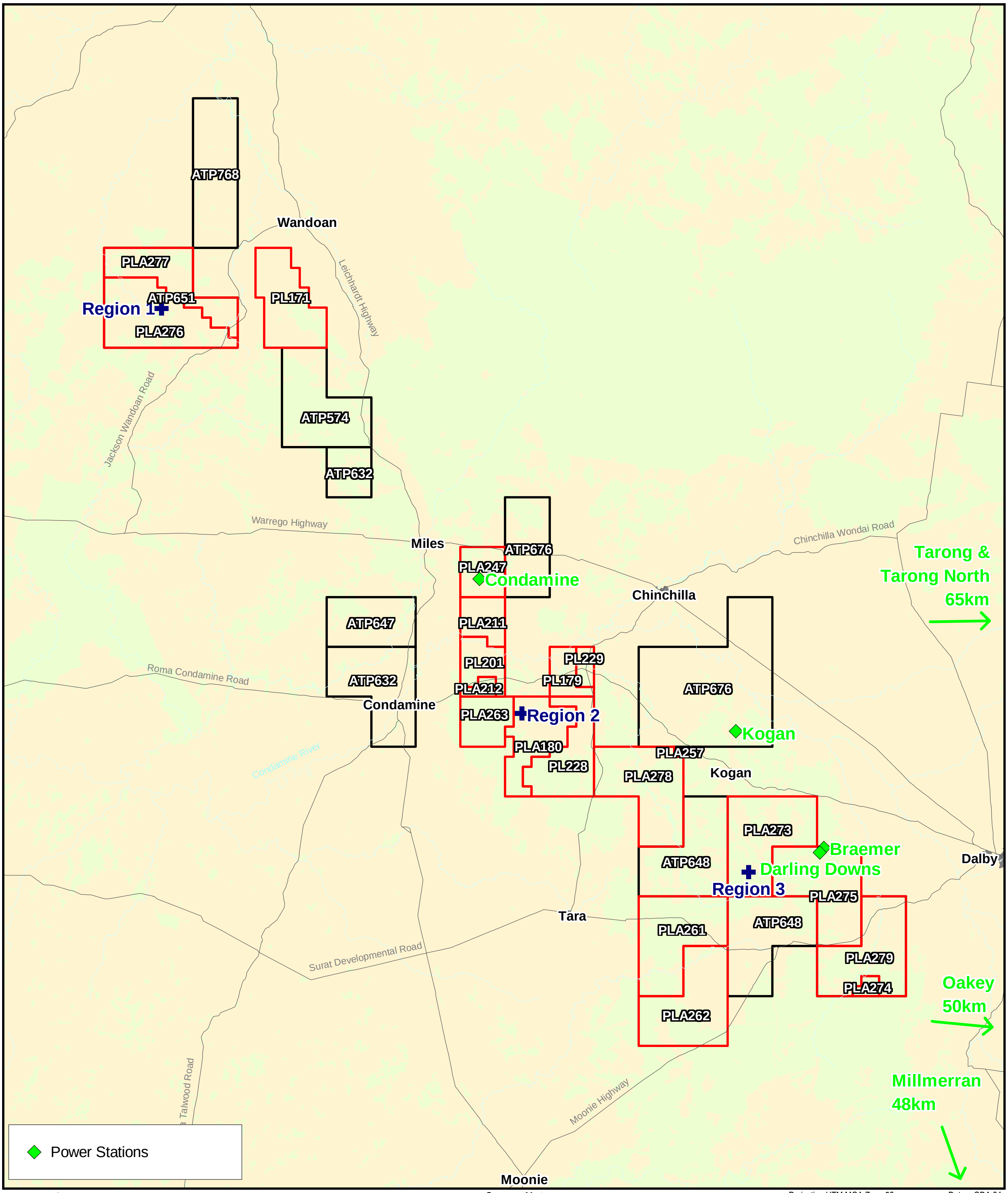
There is currently no monitoring of ambient air quality performed in the Gas Field area or Surat Basin. Notwithstanding this, the existing air quality in the region is likely to be fairly good due to the nature of land use and the operation of low-impact industries within the Western Downs Regional Council area.

12.3.2.1 Existing Industries and Sources of Oxides of Nitrogen

Industries identified through a review of the National Pollutant Inventory include:

- log sawmilling and timber dressing
- mineral, metal and chemical wholesaling
- oil and gas extraction
- pasture and cropping.

Further afield and within the southern central Queensland region the most significant sources of air pollution, likely to impact on regional air quality, are associated with coal- and gas-fired power stations located at Kogan Creek, Braemar, Tarong, Millmerran and Oakey. Other currently proposed power stations in the region include Condamine and Darling Downs. These developments will also provide a cumulative impact on the airshed in the future. Existing and proposed power stations are shown in *Figure 3.12.4*.



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Title **Existing and Proposed Power Stations**

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Due to the significant distances between, and geographical locations of, these power sources, the impacts on background air-quality levels are likely to be relatively minor. Individual plumes will impact differently depending on the wind patterns and regional flows on sensitive receptors situated in and around the Gas Field area.

CSG extraction and exploration is currently being conducted by several CSG producers in the Surat Basin and southern Queensland region. Emissions from extraction activities conducted by these CSG producers have not been included in this air quality impact assessment.

The cumulative impacts from other CSG extraction activities are expected to be minimal because the distance between gas extraction and processing infrastructure and the emissions sources results in highly localised minor impacts.

12.3.2.2 Determination of Background Levels for Oxides of Nitrogen

The aforementioned power stations have been included to quantify an appropriate ambient background concentration of NO_2 for assessing cumulative impacts in air quality.

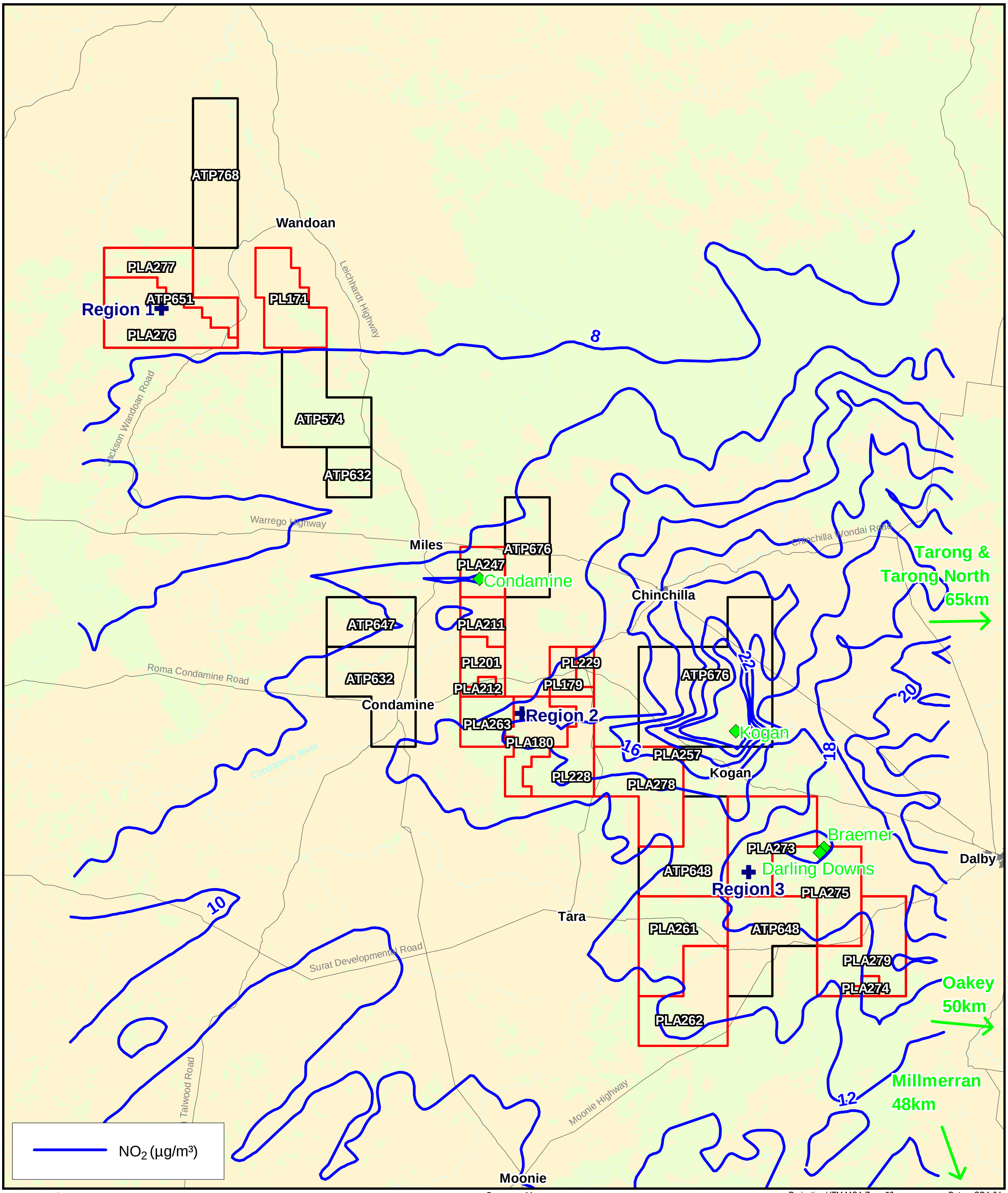
Regional transport and dispersion of NO_X emissions from the power stations was modelled using TAPM, with the maximum one-hour average and annual average ground-level concentrations of NO_X determined across a gridded domain that covered the Gas Field area.

The maximum one-hour average and annual average ground-level concentrations of NO_X were then determined within a 50 km radius of the assessment site and used as the background NO_X level for each of the three regions assessed. This provided a highly conservative ambient background concentration for the cumulative assessment.

The predicted maximum one-hour (99.9th percentile) and annual average ground-level concentrations of NO_2 for the background in each region are presented in *Table 3.12.4.* Contour plots illustrating the distribution of NO_2 across the Gas Field for the one-hour (99.9th percentile) and annual average are presented in *Figure 3.12.5* and *Figure 3.12.6* respectively.

Table 3.12.4 Background Concentrations of Nitrogen Dioxide for each Region

Region	Averaging Period	Predicted maximum (99.9th percentile) background concentration (µg/m³)
1	1-hour	9.9
	Annual	0.4
2	1-hour	41.3
	Annual	3.4
3	1-hour	41.3
	Annual	3.4



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QUEENSLAND CURTIS LNG A BG Group business	Project	Queensland Curtis LNG Project	Title	Predicted Maximum 1-hour Average Background Concentrations of NO_2 (µg/m³)
	Client	QGC - A BG Group business		
ERM Environmental Resources Management Australia Pty Ltd	Drawn Mipela	Volume 3 Figure 3.12.5	Disclaimer: Maps and Figures contained in this Report may be based on Third Party Data, may not be to scale and are intended as Guides only. ERM does not warrant the accuracy of any such Maps and Figures.	
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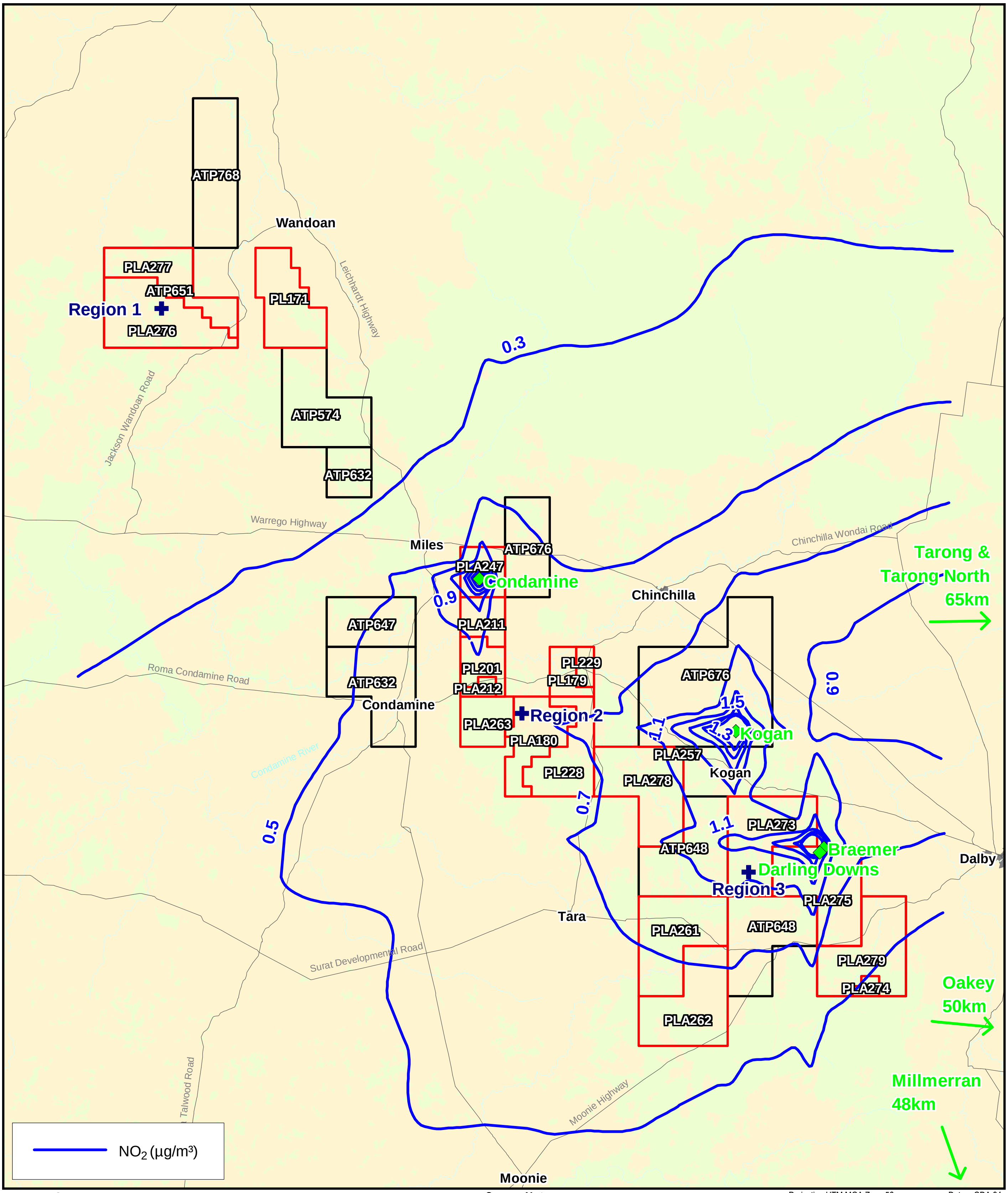

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Title **Predicted Annual Average Background Concentrations of NO_2 (µg/m³)**

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12.3.2.3 *Determination of Background Levels for other Air Emissions*

Other air pollutants emitted by the Gas Field include CO and various hydrocarbons. Emissions data and ambient air monitoring data for these substances are not available, and consequently their cumulative impact has not been assessed. Therefore the impact assessment of these air pollutants has been conducted based on the Gas Field's incremental impact to the region.

With the exception of areas that are close to major roadways, background levels of CO are expected to be low in comparison with the EPP(Air) air quality objective.

Background levels of hydrocarbons are expected to be extremely low in comparison with the relevant air quality objectives due to the largely rural nature of the Gas Field area.

12.3.2.4 *Measured Background Levels for Ozone*

Background levels for ozone have been determined from the Department of Environment and Resource Management's (DERM) monitoring station at Toowoomba (refer to *Table 3.12.5*), which is the nearest monitoring station to the Gas Field area. Results from July 2003 to August 2007 have been analysed and are likely to be a slightly conservative estimate of the ozone levels in the Surat Basin due to the number of industrial activities and motor vehicles in the Toowoomba area compared to that in the more rural Gas Field area.

Table 3.12.5 Ozone Concentrations at Toowoomba

Air pollutant	Averaging period	Concentration ($\mu g/m^3$)		Objectives ($\mu g/m^3$)
		Maximum	95th percentile	
Ozone	1-hour	192	84	210
	4-hour	148	82	160

12.3.3 Sensitive Receptors

It is important to consider the proximity of Gas Field infrastructure which includes CSG extraction wells, compressor stations, field offices and camp sites that employ gas engines for power generation to sensitive receptors and land uses in the region.

However, as the specific locations and configuration of the Gas Field infrastructure have not been determined, the identification of the sensitive receptors likely to be impacted by air emissions cannot be determined for this assessment. Notwithstanding this, the dominant annual, seasonal and diurnal wind patterns in the region have been analysed to identify the likely directions for plume transport from the proposed Gas Field area.

12.4 EMISSIONS SOURCES

12.4.1 Infrastructure

Air emissions from the following sources have been considered in the air impact assessment:

- gas-powered reciprocating engines used to power reciprocating and screw compressors
- gas-powered wellhead pumps
- gas-powered generators
- flares
- dust generation.

The air pollutants considered in this assessment are associated with the combustion of CSG fuel in the gas engines employed throughout the Gas Field. The primary focus of emission sources for the dispersion modelling assessment are the gas-fired reciprocating engines. This is due to the large number of units and their engine capacity in comparison to the other engines and small pumps used across the Gas Field for power generation.

Emissions from power generation sources for water management infrastructure, such as water pumps and water treatment plants, have not been modeled. However, these emissions are expected to be less than 10 per cent of the total emissions from compressor engines.

Table 3.12.6 presents a summary of the emissions sources across the Gas Field, including engine/unit type, capacity and number.

Table 3.12.6 Emissions Sources

Process	Application	Engine model or type	Engine capacity (kW)	Number of engines/units across the Gas Field
Wellhead pumps[1]	CSG/water flow pump	Oil Lift G2000 pump	36	10-156
FCS	CSG compression	Caterpillar G3512 gas engines	2,097	216
CPP	CSG compression	Caterpillar G3608 gas engines	4,696	90
TEG dehydration units	CSG dehydration	Vortec 8,100 gas engine	240	9
Camp sites	Power generation	Gas engine model to be advised[2]	360	5
Field office	Power generation	Gas engine model to be advised[2]	288	2
Flares at CPP	Maintenance or emergencies	Refer to *Table 3.12.12*	n/a	9

1) Wellhead pumps are required for approximately six months per well and the number value represents the annual range of pumps required over the lifetime of the Gas Field.

2) The exact model of engine is not known, however, an engine of required capacity has been used as a reasonable estimate.

12.4.2 Coal Seam Gas

Table 3.12.7 presents the composition of CSG as extracted from the resource and as received at the LNG Facility. Emissions from the oxidation of sulfur compounds during the combustion of fuel gas or other reduced sulfur compounds have not been assessed as sulfur is not present in the CSG resource, and therefore sulfur dioxide is not present in combustion emissions.

Table 3.12.7 Composition of CSG Pre and Post Processing

Compound	Gas composition at extraction well pre-processing (mole %)	Gas composition post-compressor station for delivery to the LNG Facility (mole %)
Methane	97.51	97.80
Nitrogen	2.23	2.00
Ethane	0.01	0.02
Carbon Dioxide	0.22	0.16

12.4.3 Emissions from Construction

Emissions generated during construction activities are likely to consist of engine exhausts from vehicles and diesel generators, and dust generated by earthworks and vehicle movements on unsealed roads. The composition of engine exhaust emissions are expected to be primarily NO_X and CO with small quantities of hydrocarbons.

Due to the relatively low emission rates of mobile vehicles in comparison to the compressor engines; and the short duration and transient nature of these emissions during Gas Field construction over such a large region, these emissions have been excluded from this assessment.

Control strategies to minimise dust generation from vehicle movements and earthworks will be discussed as part of the Gas Field's Environmental Management Plan (refer to *Volume 9*). Dust control is addressed in *Volume 3 Chapter 4.*

12.4.4 Emissions from Operations

12.4.4.1 Screw Compressors

The air quality assessment has investigated the impacts associated with screw compressors operating at 100 per cent engine capacity. The performance characteristics of the Caterpillar G3512 gas engines with single-stage Ariel screw compressors, to be located at the FCS, is presented in *Table 3.12.8*.

Table 3.12.8 Performance and Source Characteristics for Screw Compressors

Parameter	Units	Value
Engine power	bkW	705
LHV input	kW	2,097
Nominal engine efficiency	%	33.6
Nominal fuel consumption	$MJ/bkWhr^{-1}$	10.71
Stack height	m	7.2
Stack diameter	m	0.2603
Exhaust gas temperature	°C	460
Exhaust gas velocity	m/s	48.7
Exhaust mass flow rate (0°C, 1 Atm, wet)	$kg/bkW\ hr^{-1}$	6.11
Exhaust gas flow rate (0°C, 1 Atm, wet)	$Nm3/bkW\ hr^{-1}$	4.86
Exhaust gas flow rate (actual stack conditions)	m^3s^{-1}	2.6
Normalised exhaust gas flow rate (0°C, 1 Atm wet)	Nm^3s^{-1}	0.96

Note 1: Exhaust gas oxygen content (dry) is 8.2%
Note 2: All data under normal operating conditions at 100% capacity

Table 3.12.9 presents the concentrations and emission rates for NO_X, CO, total hydrocarbons, acrolein and formaldehyde for the screw compressors based on the Caterpillar G3512 specification and other sources, including testing of stack emissions from existing QGC Caterpillar G3512 compressor units.

Table 3.12.9 Emissions Data for Screw Compressors

Parameter	Concentration[1] ($g/bkWhr^{-1}$)	Emission rate (gs^{-1})
Oxides of nitrogen (as NO_2)	2.68	0.558
Carbon monoxide	2.41	0.489
Total Hydrocarbons[2]	4.16	0.814
Formaldehyde	0.34	0.066
Acrolein[3]	-	$9x10^{-5}$

Note 1: Information obtained from Caterpillar gas engine technical data sheet.
Note 2: Total hydrocarbons as non-methane hydrocarbons and presented as methane equivalents.
Note 3: Measured by Leeder Consulting, 7 May 2009, in G3512 screw compressor fuelled with CSG

Based on the United States Environmental Protection Agency (USEPA) AP-42 emission factors document for natural gas-fired reciprocating engines (*Natural Gas-fired Reciprocating Engines (Chapter 3.1))*, 52 separate hydrocarbons were identified, in addition to formaldehyde and acrolein, as contributing to total hydrocarbon emissions. Emission rates of these hydrocarbons are presented in *Table 5* of *Appendix 3.5.*

Assumptions Made in Modelling Hydrocarbons

In order to assess the impact of specific hydrocarbon emissions on environmental values, the USEPA AP-42 document, *Natural Gas-fired Reciprocating Engines (Chapter 3.1),* has been referenced to determine the potential composition of hydrocarbon emissions associated with the gas-fired reciprocating engine exhaust.

Preliminary dispersion modelling was conducted using the AP-42 emission factors for hydrocarbons. The preliminary dispersion modelling found some potential for elevated levels of acrolein. However, acrolein is unlikely to occur in the exhausts of the Caterpillar engines when fired on CSG because, unlike the natural gas which is used in the US and is the basis of the AP-42 emission factors, the CSG does not contain propene, the necessary precursor for the formation of acrolein. This was demonstrated in sampling of emissions from G3512 reciprocating engines fuelled on CSG (Leeder Consulting, 2009). Consequently, acrolein emission rates have been characterised in this study using the results of Leeder Consulting sampling, which was carried out on existing QGC CSG-fired compressors, rather than AP-42.

In order to assess the potential impact of specific hydrocarbon emissions on environmental values other than acrolein and formaldehyde, the USEPA AP-42 emission factors have been referenced to determine the potential composition of hydrocarbon emissions associated with the gas-fired reciprocating engine exhaust.

12.4.4.2 Reciprocating Compressors

The air quality assessment has investigated the impacts associated with reciprocating compressors operating at 100 per cent engine capacity. The performance characteristics of the Caterpillar 3608 gas engines with two-stage Ariel reciprocating compressors, located at the CPP, are presented in *Table* 3.12.10, while pollutant concentrations and emission rates are presented in *Table 3.12.11*.

Based on the USEPA AP-42 emission factors document for natural gas-fired reciprocating engines, 52 separate hydrocarbons were identified, in addition to formaldehyde and acrolein, as contributing to total hydrocarbon emissions. Emission rates for these hydrocarbons are presented in Table *8*, *Appendix 3.5.*

Refer to *Section 12.4.4.1* for the assumptions used in modelling hydrocarbons.

Table 3.12.10 Performance and Source Characteristics for Reciprocating Compressors

Parameter	Units	Value
Engine power	bkW	1,767
LHV input	kW	4,696
Nominal engine efficiency	%	37.6
Nominal fuel consumption	MJ/bkW-hr	9.56
Stack height	m	8
Stack diameter	m	0.5968
Exhaust stack temperature	$^{\circ}$C	470
Exhaust gas velocity	m/s	26.9
Exhaust mass flow rate (0°C, 1 Atm, wet)	kg/bkW-hr	7.04
Exhaust gas flow rate (0°C, 1 Atm, wet)	Nm^3/bkW-hr	5.57
Exhaust gas flow rate (actual stack conditions)	m^3s^{-1}	7.53
Normalised exhaust gas flow rate (0°C, 1 Atm, wet)	Nm^3s^{-1}	2.77

Note 1: Exhaust gas oxygen content (dry) is 11.7%
Note 2: All data under normal operating conditions at 100% capacity

Table 3.12.11 Emissions Data for the Reciprocating Compressors

Parameter	Concentration[1] (g/bkW-hr)	Emission rate (gs^{-1})
Oxides of nitrogen (as NO_2)	0.94	0.461
Carbon monoxide	3.35	1.646
Total Hydrocarbons[2]	8.06	3.957
Formaldehyde	0.54	0.26
Acrolein[3]	-	$1.3x10^{-5}$

Note 1: Information obtained from Caterpillar gas engine technical data sheet.
Note 2: Total hydrocarbons as non-methane hydrocarbons and presented as methane equivalents.
Note 3: Measured by Leeder Consulting, 7 May 2009, in G3512 screw compressor fuelled with CSG

12.4.4.3 Wellhead Pumps

Wellhead pumps will be situated at least 750 m apart but possibly at a greater distance, as wells are likely to be spread throughout the tenements to maximise the efficiency of CSG extraction. Wellhead pumps will typically, operate for nine to twelve months per well.

The impacts for the wellhead pump engines have not been assessed in the air dispersion modelling assessment due to:

- the small number of pumps required across the geographically large Gas Field
- the comparatively low NO_X emission rates due to the lower engine capacity (1.7 per cent and 0.8 per cent of the screw and reciprocating compressor engines, respectively)
- the short duration of use for each pump at each location.

12.4.4.4 Gas Powered Generators

Tri-ethylene Glycol (TEG) Units

Emissions associated with the tri-ethylene glycol (TEG) dehydration process are primarily associated with the gas-fired boiler used to heat the TEG and include NO_X, CO and hydrocarbons. A single 240 kW Vortec 8100 gas-fired engine will be used to power all TEG dehydration units at a CPP. The capacity of a single 240 kW Vortec 8100 engine is approximately 5 per cent of a single Caterpillar G3608 gas engine and there will be 10 Caterpillar 3608 gas engines at each CPP.

Due to the small incremental increase in emissions from the single 240 kW Vortec 8100 gas-fired engine, when used in conjunction with 10 Caterpillar G3608 gas-fired reciprocating engines (0.5 per cent of the engine capacity of 10 Caterpillar G3608 engines), the TEG generator has not been included in the air dispersion modelling assessment.

Camp Site Generators

QGC proposes to develop approximately five camp sites across the Gas Field with these locations to be determined in detail design. Camp sites will be located at least 2 km from the compressor stations. Each camp will generate its own electrical power through a single 360 kW gas-fired generator, which is:

- 7.7 per cent of a single Caterpillar G3608 engine (0.77 per cent of the engine capacity of 10 G3608 engines)
- 17.2 per cent of a single Caterpillar G3512 engine (2.1 per cent of the engine capacity of eight G3512 engines).

Consequently, impacts from five, widely dispersed, 360 kW gas-fired generators have not been assessed due to their small incremental increase in air emissions in comparison to the compressor stations.

Field Office Power Generation

QGC proposes to develop one or two field office sites within the Gas Field with the location yet to be determined. These sites will generate their own electrical power through a single 288 kW gas-fired generator. Similar to the camp sites, the field offices will not be located in close proximity to compressor stations. Emissions from a single 288 kW gas-fired generator are:

- 6.1 per cent of a single Caterpillar G3608 engine (0.61 per cent of the engine capacity of ten G3608 engines)
- 13.7 per cent of single Caterpillar G3512 engine (1.7 per cent of the engine capacity of eight G3512 engines)

Consequently, impacts from one or two 288 kW gas-fired generator have not been assessed.

12.4.4.5 *Flaring at the CPPs*

The frequency of flaring, at each CPP, due to emergency shutdowns is estimated to be approximately 3 times per year for a duration of 30 to 60 minutes. Additionally, minor flaring events for compressor shutdowns and maintenance may occur approximately 500 times per year for a duration of less than 15 minutes.

Flares have a Ringelmann value of less than one and are therefore classified as smokeless flares with a particulate emission rate of zero.

The methodology used to estimate emissions from flaring is presented in *Appendix 3.5, Section 3.2.1.* The emissions characteristics of the proposed flare are described in *Table 3.12.12.*

Table 3.12.12 Emissions Characteristics of the Flares

Parameter	Units	Maintenance and emergency shutdowns
Nominal stack height	m	22.0
Nominal flare tip diameter	m	0.45
Temperature	$^{\circ}C$	1,000[1]
Gas exit velocity (modelled)	m/s	20.0[1]
Effective stack height (modelled)	m	23.1[2]
Effective flare tip diameter (modelled)	m	0.32[2]
Energy output	GJ/hr	4
Exhaust gas mass rate	g/s	18,517
Exhaust Gas flow rate	m^3/s	10.7

Note 1: From AP-42 Emission Factors.
Note 2: From USEPA Screen 3 Method.

The USEPA AP-42 emission factors for industrial flares and the emission rates used in the assessment for each of the pollutants, NO_X, CO, and total hydrocarbons, are presented in *Table 3.12.13*.

Table 3.12.13 Emissions Data for the Flares

Parameter	Oxides of nitrogen	Carbon monoxide	Total hydrocarbons
Emission factor (g/GJ)	29.24[1]	159.07[1]	60.19[1]
Emission Rate (g/s)	0.03[2]	0.16[2]	0.06[2]

Note 1: From AP-42 Emission Factors.
Note 2: From AP-42 Emission Factors and flare energy output data supplied by QGC.

The individual hydrocarbons comprising total hydrocarbons are presented in *Table 12 of Appendix 3.5.*

The assessment of the flare has been conducted for all hours of the year in order to determine the worst-case impact resulting from the combination of all likely meteorological conditions. In reality, a flaring event is likely to be for the duration of less than one hour at the frequency described above. Consequently, only short-term averaging periods have been assessed.

12.4.4.6 Venting at the FCS

In the event of the FCS being shut down for either maintenance or an emergency, CSG will be vented to atmosphere. Due to the composition of the feed gas, no assessment of the impact to air quality has been made as the primary constituent is CH_4, which is classified as a simple asphyxiant and only presents an impact to air quality in a confined space.

The volume of methane emitted into the ambient environment during these non-normal operating circumstances for a short duration is not enough to deplete the oxygen content in the local area. CH_4 and CO_2 both contribute to greenhouse gases, which are assessed in *Volume 7, Greenhouse Gas Management.*

Flaring is under consideration as an alternative to venting. Impacts on air quality from flaring at the FCSs are expected to be similar to those described in *Section 12.4.4.5*.

12.4.5 Air Emissions

12.4.5.1 Nitrogen Dioxide – Compressor Emissions

For this assessment a conservative ratio of 30 per cent conversion of the NO_X to NO_2 has been applied. This resulted in greater emissions of NO_2 then should actually occur.

Table 3.12.14 presents the predicted maximum one-hour and annual average ground-level concentrations within the modelling domain for each region in isolation, and including background concentrations. Modelling is based on emissions from a production unit (i.e. one CPP and 3 FCSs) in a region.

One-hour and annual average concentrations of NO_2 are presented in isolation for Region 2 in *Figure 3.12.7* and *Figure 3.12.8* respectively. Region 2 exhibits the highest one-hour average concentrations of NO_2 relative to air quality objectives.

Table 3.12.14 Predicted Maximum One-hour and Annual Average Ground-level Concentrations of NO_2

Region	Averaging Period	Incremental predicted maximum concentration (µg/m³)	Predicted maximum background concentration (µg/m³)	Cumulative concentration (µg/m³)	Air quality objective (µg/m³)	Percent of air quality objective (%)
1	1-hour	35.0	9.9	44.9	250	17.9
	Annual	3.8	0.4	4.2	62[1]	6.8
					33[2]	12.7
2	1-hour	35.7	41.3	77.0	250	30.8
	Annual	4.0	3.4	7.4	62[1]	11.9
					33[2]	22.4
3	1-hour	33.8	41.3	75.1	250	30.0
	Annual	4.3	3.4	7.7	62[1]	12.4
					33[2]	23.3

Note 1: EPP(Air) Health and wellbeing objective

Note 2: EPP(Air) Health and biodiversity of ecosystems objective

The results show the following:

- There are no exceedences predicted of the EPP (Air) air quality objective for the 1-hour and annual average ground-level concentration of NO_2 from a production unit either in isolation or including background concentrations
- The predicted maximum 1-hour average ground-level concentration of NO_2 at any location within the regions for the operation of a single CSG production unit in isolation is 77 µg/m^3 including background, which is 30.8 per cent of the EPP(Air) air quality objective of 250 µg/m^3
- The predicted annual average ground-level concentration of NO_2 at any location within the regions for the operation of a single CSG production unit in isolation is 7.7 µg/m^3 including background, which is 12.4 per cent of the EPP(Air) air quality objective of 62 µg/m^3.

While only a single production unit has been assessed, due to the assumption that production units will not be co-located within 20 km to 40 km of each other, the assessment indicates that a doubling of the emission rates, resulting from the co-location of the production units, would not generate an exceedence of the air quality objective for NO_2 at any location within the modelled domain. This is a hypothetical worst-case scenario as production units will never be located in the same position.

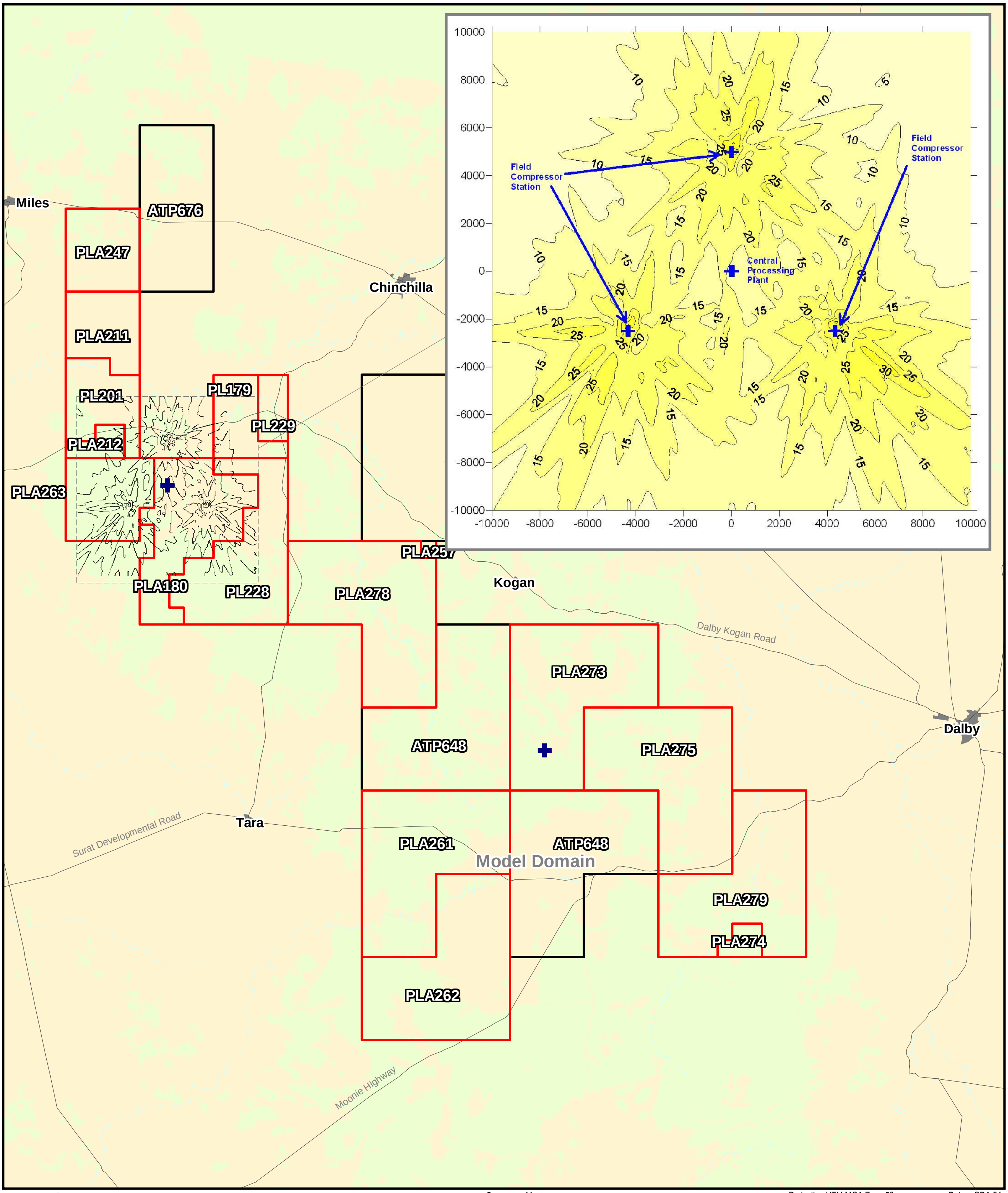
Based on Region 2, the incremental impact on 1-hour average concentrations from two production units co-located would be 71.4 µg/m^3. With the background of 41.3 µg/m^3 added, the cumulative impact would be 112.7 µg/m^3, which is 45 per cent of the air quality objective of 250 µg/m^3.

12.4.5.2 Nitrogen dioxide – Flaring Emissions

Table 3.12.15 presents the predicted maximum 1-hour average ground-level concentrations of NO_2, associated with emissions from the gas flare during non-normal operations for each region in isolation and with background levels included.

The results show the following:

- There are no exceedences predicted of the EPP(Air) air quality objective for the 1-hour average ground-level concentration of NO_2 during non-normal operating conditions, assessed in isolation
- The predicted maximum 1-hour average ground-level concentration of NO_2 at any location within the regions during non-normal operations; in isolation, is 0.21 µg/m^3, or 42 µg/m3 including background levels, which is 17 per cent of the EPP(Air) air quality objective of 250 µg/m^3.



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Project	Queensland Curtis LNG Project		
Client	QGC - A BG Group business		
Drawn	Mipela	Volume 3	Figure 3.12.7
Approved	CDP	File No:	QC02-T-MA-00126
Date	12.06.09	Revision	A

Title **Predicted Maximum 1-Hour Average Ground Level Concentrations of NO_2 (μg/m³) in Isolation for Region 2**

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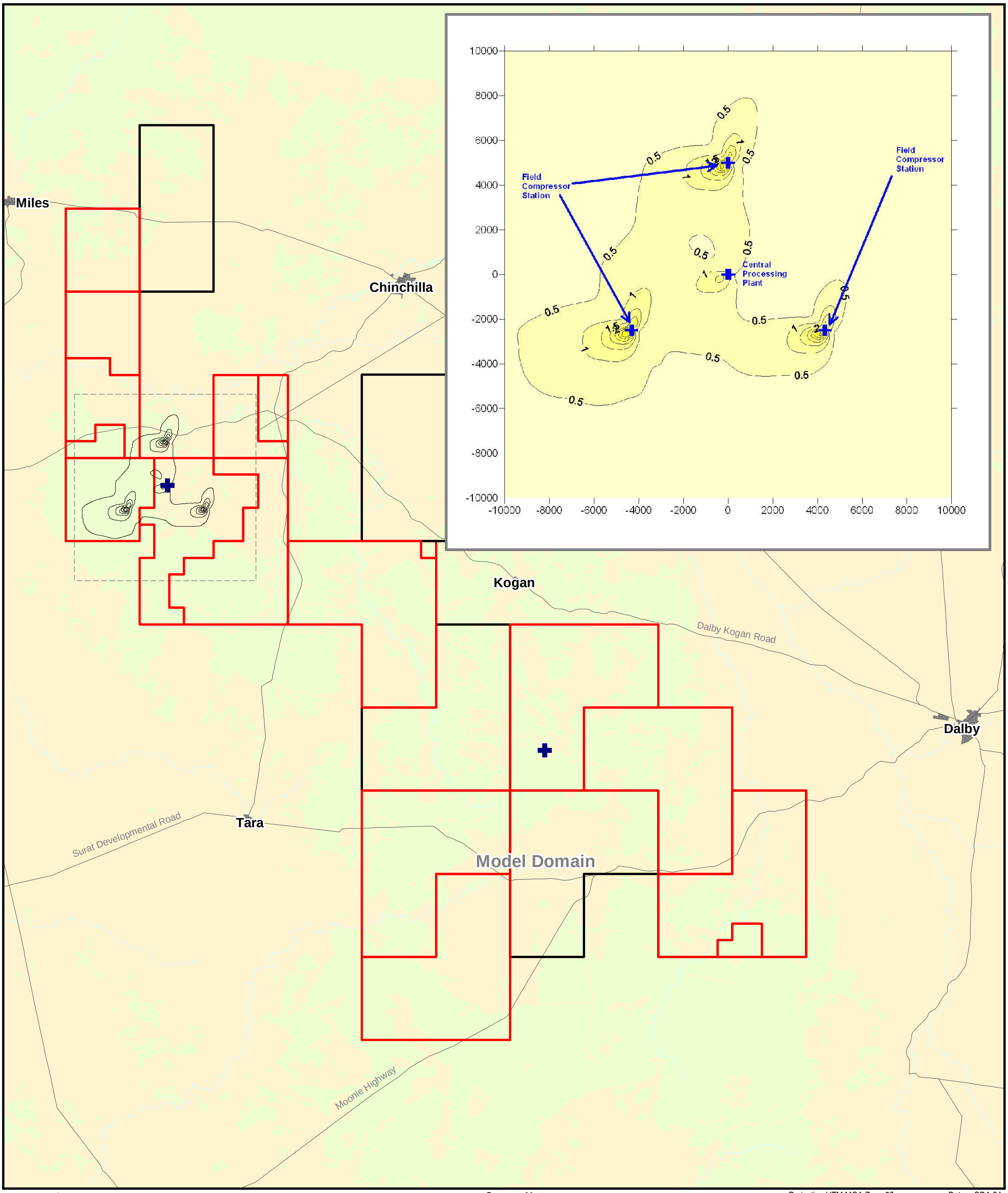

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Project	Queensland Curtis LNG Project		
Client	QGC - A BG Group business		
Drawn	Mipela	Volume 3	Figure 3.12.8
Approved	CDP	File No:	QC02-T-MA-00127
Date	12.06.09	Revision	A

Title **Predicted Annual Average Ground Level Concentrations of NO_2 (μg/m³) in Isolation for Region 2**

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Table 3.12.15 Predicted Maximum One-hour Average Ground-level Concentrations of Nitrogen Dioxide for the Flare

Region	Averaging Period	Incremental predicted maximum concentration (µg/m³)	Background concentration	Combined impact	Air quality objective (µg/m³)	Percent of air quality objective (%)
1	1-hour	0.21	9.9	10.1	250	4
2	1-hour	0.20	41.3	41.5	250	17
3	1-hour	0.18	41.3	41.5	250	17

12.4.5.3 Carbon Monoxide – Compressor Emissions

Table 3.12.16 presents the predicted maximum eight-hour average ground-level concentrations of CO for each region in isolation.

Table 3.12.16 Predicted Maximum Eight-hour Average Ground-level Concentrations of CO

Region	Predicted maximum concentration (μg/m³)	Air quality objective (μg/m³)	Percent of air quality objective (%)
1	140	11,000	1.3
2	135	11,000	1.2
3	140	11,000	1.3

The results show the following:

- there are no exceedences predicted of the EPP(Air) air quality objectives for the eight-hour average ground-level concentration of CO under normal operating conditions, and assessed in isolation
- the predicted maximum eight-hour average ground-level concentration of CO at any location within the regions for the operation of a production unit in isolation is 140 μg/m^3, which is 1.3 per cent of the EPP(Air) air quality objective of 11 000 μg/m^3.

12.4.5.4 Carbon Monoxide – Flaring Emissions

Table 3.12.17 presents the predicted maximum eight-hour average ground-level concentrations of CO associated with emissions from the gas flare for each region in isolation. It should be noted that while the eight-hour average has been assessed for comparison with the EPP (Air) air quality objective, and the modelling has been conducted for a full year of meteorological conditions, gas flaring at the CPP is likely to be less than one hour in duration and therefore the actual eight-hour average ground-level concentrations of CO will be significantly lower than the value presented in *Table 3.12.17.*

Table 3.12.17 Predicted Maximum One-hour and Annual Average Ground-level Concentrations of CO for the Flare

Region	Averaging Period	Incremental predicted maximum concentration (μg/m³)	Air quality objective (μg/m³)	Percent of air quality objective (%)
1	1-hour	1.75	11,000	0.016
2	1-hour	1.72	11,000	0.016
3	1-hour	1.74	11,000	0.016

The results show the following:

- There are no exceedences predicted of the EPP(Air) air quality objective for the eight-hour average ground-level concentration of CO from flaring, assessed in isolation
- The predicted maximum eight-hour average ground-level concentration of CO at any location within the regions during non-normal operations and in isolation is 1.75 µg/m^3, which is 0.016 per cent of the EPP(Air) air quality objective of 11,000 µg/m^3.

12.4.5.5 *Hydrocarbons – Compressor Emissions*

Table 3.12.18 presents a summary of the 10 highest predicted ground-level concentrations of hydrocarbons in terms of their percentage of the air quality objective for any location across the modelling domain and based on a single production unit in isolation. A comprehensive list of predicted maximum ground-level concentrations for all hydrocarbons likely to be emitted from the gas-fired reciprocating engines is presented in *Appendix B of Appendix 3.5.*

The results indicate that all identified hydrocarbon species associated with emissions from a production unit would comply with the ambient air quality objectives across the modelling domain.

12.4.5.6 *Hydrocarbons – Flaring Emissions*

The following hydrocarbons have been identified as being likely to be emitted from the flares of the Gas Field:

- methane
- ethane/ethylene
- acetylene
- propane
- propylene.

The available published information about these hydrocarbons lists them as recognised asphyxiants.

Table 3.12.19 provides estimates of ground-level concentrations of each of the speciated hydrocarbons identified above based on the maximum prediction ground-level concentrations. These predictions are presented as a mass concentration for comparison with the TCEQ air quality standards. The predictions are also presented as a volume percentage (%v/v) in air.

Table 3.12.18 Top Ten Predicted Maximum Ground-level Concentrations of Hydrocarbons

Indicator	Source of Air quality objective or standard	Averaging period	Air quality objective or standard	Predicted maximum ground-level concentration (µg/m³)			Percentage of air quality objective (%)		
			(µg/m³)	Region 1	Region 2	Region 3	Region 1	Region 2	Region 3
Formaldehyde	EPP(Air)	24-hour	54	14.3	15.6	17.3	26.5	28.9	32.1
	EPP(Air)	30-minute	110	27.7	29.5	31.1	25.2	26.8	28.3
Chloroethane	NSW DECC	1-hour	0.05	0.0005	0.001	0.001	0.97	1.05	1.11
Phenanthrene	TCEQ	1-hour	0.5	0.003	0.003	0.003	0.52	0.56	0.59
Acrolein	NSW DECC	1-hour	0.42	0.0019	0.0020	0.0021	0.45	0.49	0.50
Benzene	NSW DECC	1-hour	29	0.11	0.12	0.13	0.38	0.41	0.43
1,3-Butadiene	EPP(Air)	1-year	2.40	0.007	0.007	0.008	0.29	0.31	0.33
Fluorene	TCEQ	1-hour	0.5	0.001	0.002	0.002	0.28	0.31	0.32
Ethylene Dibromide	TCEQ	1-hour	4.00	0.011	0.012	0.013	0.28	0.30	0.32
Biphenyl	NSW DECC	1-hour	24	0.053	0.057	0.061	0.22	0.24	0.25
Ethane	TCEQ	1-hour	12,000	26.1	28.2	30.0	0.22	0.24	0.25

Table 3.12.19 Maximum Ground-level Concentrations of Hydrocarbons from the Flares

Compound	MW	% v/v of total VOCs emitted	Texas (TCEQ) 1-hour average (µg/m³)	Predicted maximum concentrations across modelling domain								
				Region 1			Region 2			Region 3		
				ppb	% v/v in air	µg/m³	ppb	% v/v in air	µg/m³	ppb	% v/v in air	µg/m³
Methane	16.04	55	-	1.174	1.2E-07	0.8	1.090	1.1E-07	0.7	1.006	1.0E-07	0.7
Ethane	30.07	8	12000	0.171	1.7E-08	0.2	0.159	1.6E-08	0.2	0.146	1.5E-08	0.2
Ethylene	28.05	8	-	0.171	1.7E-08	0.2	0.159	1.6E-08	0.2	0.146	1.5E-08	0.2
Acetylene	26.04	5	26600	0.107	1.1E-08	0.1	0.099	9.9E-09	0.1	0.091	9.1E-09	0.1
Propane	44.09	7	18000	0.149	1.5E-08	0.3	0.139	1.4E-08	0.3	0.128	1.3E-08	0.2
Propylene	42.08	25	8750	0.534	5.3E-08	0.9	0.496	5.0E-08	0.9	0.457	4.6E-08	0.8

The findings indicate that the predicted ground-level concentration of each hydrocarbon is very low. None of these hydrocarbons is likely to be present in sufficient quantities to displace oxygen to the extent that asphyxiation could occur. At most, these hydrocarbons combined could displace 2.31×10^{-7} per cent, 2.14×10^{-7} per cent and 1.98×10^{-7} per cent of oxygen at the most affected location on the modelled domain in Regions 1, 2 and 3, respectively.

This is a negligible amount given that the recommendation for the occupational environment is to ensure that the oxygen level remains above 18 per cent (note: average content of oxygen in air is 20.9 per cent). This indicates a negligible risk of asphyxiation.

The predicted maximum concentration of each hydrocarbon is also very low compared to the TCEQ standards (maximum of 0.01 per cent).

The predicted concentration of each hydrocarbon is very low when compared with its lower explosive limit, indicating a very low risk of explosion. Whilst two of the hydrocarbons are heavier than air, all are emitted in very low concentrations and at an elevated temperature. Hence, there is a negligible risk that these compounds could concentrate in low-lying areas and cause an explosion or asphyxiation.

12.4.5.7 Photochemical Smog

In order to assess the potential of the Gas Field to cause air quality impacts in relation to ozone, an extremely conservative method has been applied. The method assumes that 100 per cent of the ground-level concentration of NO_2 at a distance of approximately 10 km downwind of the source is converted to ozone.

Table 3.12.20 presents the predicted mean, minimum and maximum one-hour average ground-level concentrations for ozone at a distance of 10 km downwind of the CPP for each region.

Table 3.12.20 Predicted Range of One-hour Average Ground-level Concentrations of Ozone

Location	Predicted ozone		Background ozone	Cumulative ozone concentration range	Air quality objective
	Mean	Range			
Region 1	37.4	17.3 – 78.5	84	101.3 – 162.5	210
Region 2	33.3	14.7 – 77.4		98.7 – 161.4	
Region 3	32.5	15.4 – 76.6		99.4 – 160.6	

The predicted range of maximum ozone concentrations is below the EPP(Air) objective of 210 µg/m^3.

12.4.6 Odour

Coal seam gas does not have a detectible odour. No mercaptans will be added to the CSG for transport along the transmission pipelines. Mercaptans are generally only used when transporting gas in a distribution pipeline.

Sewage treatment has been identified as the only potential source of odour. However, there will be no strong odours from the properly maintained sewage treatment system (maintained in accordance to the Site Based Management Plan and the Operating Manual). In addition, chlorine doses will counteract strong odours from the sewage treatment plant.

12.4.7 Cumulative Impacts

Background concentrations of NO_x have been assessed based on emissions from coal- and gas-fired power stations in the south central Queensland region. The assessment of NO_x for the Gas Field has therefore included the cumulative impacts of the regional background ground-level concentration and the incremental increase from the compressor station infrastructure. While only a single compressor station production unit has been assessed in isolation, the planned spatial distribution of production units across the large Gas Field area is aimed at maximising the efficiency of CSG extraction and processing, and consequently, will minimise the potential of plumes converging and producing cumulative impacts.

There is no ambient air monitoring for concentrations of CO in the Gas Field area, and representative emission rates for CO for the power stations was not available for inclusion in the background dispersion modelling. With the exception of areas that are extremely close to major roadways, background levels of CO are expected to be extremely low in comparison with the EPP(Air) air quality objective. Emissions of CO from the gas-fired reciprocating engines have been modelled for this air quality impact assessment and are presented in isolation.

There is no ambient air monitoring for concentrations of hazardous air pollutants such as VOCs and PAHs in the Gas Field area, and representative emission rates for these substances released from the power stations were not available for inclusion in the background dispersion modelling. Consequently, the air quality impact assessment for all hydrocarbon emissions has been conducted in isolation. Notwithstanding this, background levels of hazardous air pollutants are expected to be extremely low in comparison with the relevant air quality objectives due to the largely rural nature of the Gas Field area.

Further assessment of cumulative impacts from all emission sources will be required once infrastructure locations have been confirmed. Additionally, impacts associated with emissions from other CSG producers in the region have not been included in the assessment of background concentrations (refer to *Section 12.3.2, Ambient Air Quality in the Region*).

12.5 IMPACTS AND MITIGATION MEASURES

Air quality objectives are set at levels that enhance or protect the qualities of the air environment that are conducive to protecting human health and wellbeing, and the health and biodiversity of ecosystems.

Based on the modelling results above, there are no exceedences of air quality objectives for any of the modelled air emissions from the Gas Field. Hence, air emissions from the Gas Field are not expected to impact human health or biodiversity. As such, mitigation measures are not proposed for any air emissions.

Nevertheless, the following objectives and strategies related to air quality will be implemented and indicators will be developed to measure performance against objectives.

12.5.1 Objectives

- air emissions do not compromise human health or biodiversity
- all air emissions are below the air quality objective levels prescribed in the relevant standards
- the primary air emissions from operations, being NO_X and CO are monitored on a regular basis
- air emissions with potential to exceed objectives, are monitored on a regular basis
- the effectiveness of mitigation measures is monitored and mitigation measures are adjusted accordingly.

12.5.2 Indicators

- air-monitoring data will be collected and recorded at appropriate time intervals for selected air emissions
- collected data will be compared to air quality objectives
- complaints from the local community will be registered and investigated as appropriate.

12.5.3 Strategies

Should any air emissions prove to exceed air quality objectives, mitigation measures will be implemented to reduce emissions to the prescribed level. This may involve a reduction in output while appropriate mitigation measures are identified.

12.6 CONCLUSION

Reciprocating and screw compressors are the main sources of air emissions from the Gas Field Component of the Queensland Curtis LNG (QCLNG) Project. Emissions include oxides of nitrogen, carbon monoxide and hydrocarbons. A conservative approach has been adopted in modelling impacts on air quality, as the exact location of the compressors is not known at this stage of the design process.

Modelling indicates that there will be no exceedences of air quality objectives for oxides of nitrogen and carbon monoxide, ozone or hydrocarbons. A summary of the impacts outlined in this chapter is provided in *Table 3.12.21*.

Table 3.12.21 Summary of Impacts for Air

Impact assessment criteria	Assessment outcome
Impact assessment	Negative
Impact type	Direct
Impact duration	Short-term
Impact extent	Local
Impact likelihood	Unlikely

Overall assessment of impact significance: negligible.