Air Quality Assessment of the Surat Basin Acreage Development

Prepared for:

QGC Pty Ltd

June 2018

Final

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Document Control

Deliverable #:	D17105-3
Title:	Air Quality Assessment of the Surat Basin Acreage Development
Version:	1.0 (Final)
Client:	QGC Pty Ltd
Document reference:	D17105-3 Air Quality Assessment Surat Basin Acreage Development v1.0
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Approved by:	Natalie Shaw 25/06/2018

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Glossary

Term	Definition
km	kilometre
m	metre
m/s	metres per second
m^2	square metres
Abbreviations	**Definition**
Air EPP	*Environmental Protection (Air) Policy 2008*
BoM	Bureau of Meteorology
DES	Department of Environment and Science (Qld)
EA	Environmental Authority
FCS	Field compressor station

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) has been commissioned by QGC Pty Ltd (QGC) to undertake an air quality assessment for the next phases of the Surat Basin Acreage Development, located near Wandoan in central Queensland.

Existing operations already approved as part of the initial phase of the Surat Basin Acreage Development include extraction and transport of natural gas from up to 400 production wells to a field compressor station (FCS). Forthcoming phases of the Surat Basin Acreage Development involve the construction and operation of up to 800 additional production wells and associated pipeline infrastructure. The additional production wells will be located within the existing Surat Basin Acreage Development petroleum tenures and will extend the life of the development.

Due to the extent of the Surat Basin Acreage Development and its potential to impact on the surrounding environment, a qualitative air quality assessment of the next phases of development is required to support an amendment to the existing EA.

The scope of work for the air quality assessment includes the following:

- Description of the existing air environment.
- Identification of air emissions sources associated with the next phases of the Surat Basin Acreage Development.
- Determination of potential air quality impacts as a result of the next phases of the Surat Basin Acreage Development.
- Preparation of an air quality assessment report to support the EA amendment application.

2. PROJECT OVERVIEW

2.1 Operations

The existing Surat Basin Acreage Development covers authorised petroleum tenures in the northern part of the Surat Basin (as shown in Figure 1) and operates under an existing Environmental Authority (EA) EPPG00700113. QGC is seeking to amend its existing Surat Basin Acreage Development EA to include an additional 800 production wells within the existing petroleum tenures.

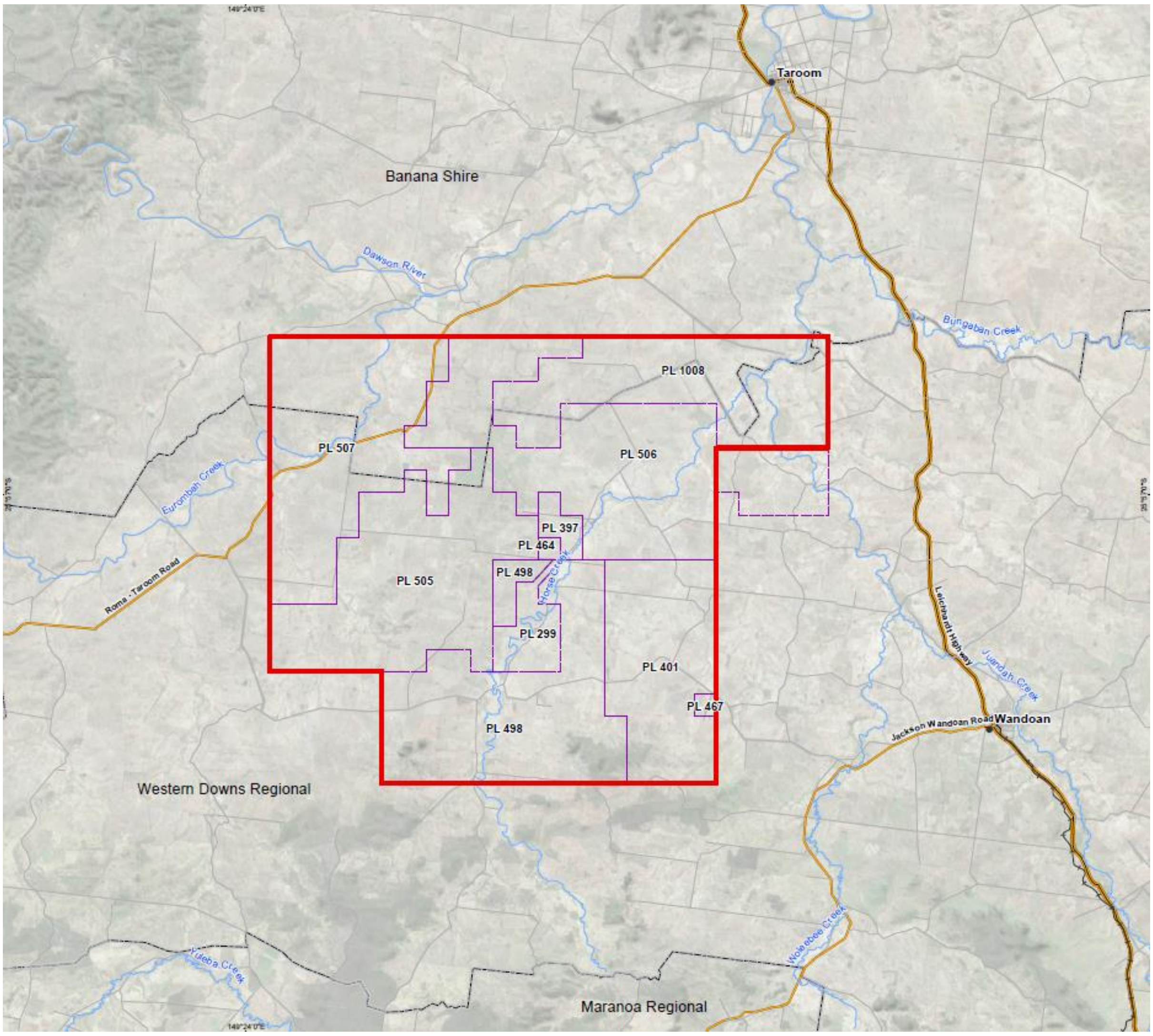

Figure 1 Surat Basin Acreage Development petroleum tenures

QGC's existing Surat Basin Acreage Development operations involve the construction and operation of production wells and pipeline infrastructure that extract and transmit natural gas from wells to a centralised field compressor stations (FCS).

Natural gas is compressed at the FCS with a small amount of moisture removed before transport via trunk pipeline to an off-tenure processing plant located at Woleebee Creek (associated with a different EA). From there, natural gas is supplied into QGC's portfolio, which includes sales gas for the domestic market, power generation and supply to the Liquified Natural Gas (LNG) Processing Facility on Curtis Island in Gladstone.

Air emissions associated with the Surat Basin Acreage Development are related to the following:

- Transient emissions during construction of wells and pipeline. Air pollutants include dust and the products of fuel combustion.
- Combustion of natural gas in gas engines (pumps) and flares located at the production wells. Air pollutants include oxides of nitrogen and carbon monoxide.
- Combustion of natural gas in the flare at the FCS. Air pollutants include oxides of nitrogen and carbon monoxide. All other FCS
- Fugitive natural gas (mainly methane) releases during any venting and from equipment leaks.

The Surat Basin Acreage Development FCS is "electrified" (connected to the grid) so there is no natural gas combustion at the FCS other than during flaring. Consequently, air emissions from the Surat Basin Acreage Development are relatively small compared to other natural gas operators (such as those located to the south of Miles and Dalby) that use gas-fired engines and turbines to provide power during gas compression activities.

2.2 Existing EA

QGC's Surat Basin Acreage Development operations are conducted under Environmental Authority (EA) EPPG00700113, which became effective on 23 August 2016. The EA conditions that relate to air quality are focused on flaring. These conditions are reproduced below:

Schedule H Air

Venting and flaring

(H1) *Unless venting is authorised under the Petroleum and Gas (Production and Safety) Act 2004 or the Petroleum Act 1923, waste gas must be flared in a manner that complies with all of condition (H1)(a) and condition (H1)(c) or with condition (H1)(d):*

a) *An automatic ignition system is used*

b) *A flame is visible at all times while the waste gas is being flared; and*

c) *There are no visible smoke emissions other than for a total period of no more than 5 minutes in any 2 hours; or*

d) *It uses an enclosed flare*

Fuel burning and combustion facilities

(H2) *A **fuel burning or combustion facility** is not permitted*

3. AIR QUALITY IMPACT ASSESSMENT METHODOLOGY

The objective of this report is to assess the potential impacts of the Project as part of an EA amendment application. The air quality impact assessment includes the following components:

1. Description of the Existing Environment.
    - A detailed description of the air environment will be provided using observations from air quality and meteorological monitoring stations operated by QGC, the Bureau of Meteorology (BoM) and the Queensland Government.
2. Source Identification.
    - A description of the existing activities in the Surat Basin Acreage Development has been provided with a focus on processes, plant and equipment that have the potential to emit air pollutants to the atmosphere.
    - A qualitative assessment of the changes in air emission resulting from the proposed next phases of the Surat Basin Acreage Development has been provided.
3. Determination of Air Quality Impacts.
    - The potential for air quality impacts from the Surat Basin Acreage Development will be inferred from the potential emission sources and using previous air quality assessment work prepared for the Surat North gas field. Previous assessment work includes a dispersion modelling assessment of gas-fired infrastructure proposed for the Surat North gas field (Katestone, 2014).

4. EXISTING ENVIRONMENT

The existing air environment in the region of QGC's Surat Basin Acreage Development is discussed in the following sections in terms of the local terrain and land-use, meteorological conditions and the existing ambient air quality.

4.1 Local Terrain and Land-use

The Surat Basin constitutes part of the Great Artesian Basin of Australia and covers an area of approximately 122,655 km^2. The Surat Basin Acreage Development is located approximately 25km northwest of the small town of Wandoan, in the Western Downs on the western slopes of the Great Dividing Range (Figure 1). Wandoan is approximately 300 km inland from the Queensland coast.

The terrain in the region is predominantly flat to mildly undulating hills. Land use in the region is rural and predominantly made-up of native shrub-land, interspersed with agriculture land (grazing and feedlots) and industry (mining and natural gas extraction).

The closest sensitive receptors to Surat Basin Acreage Development infrastructure are isolated rural residential properties located sparsely across the Surat Basin Acreage Development gas tenures. The small town of Wandoan is located 25km southeast of the Project and the larger towns of Miles and Roma are located 80 km southeast and 100 km southwest, respectively.

The flat, low-lying hills in the project area result in a relatively uniform wind field across the region as there are no significant terrain influences, such as tall peaks, lakes or coastline to generate highly localised affects.

4.2 Meteorology

Southern central Queensland is largely dominated by tropical/sub-tropical weather patterns that lead to relatively drier winters and wetter summers. Whilst there are no site specific metrological observations available, historical meteorological observations from the Bureau of Meteorology weather monitoring station located at Roma Airport have been used to describe meteorology in the Surat Basin Acreage Development area. The meteorology at Roma Airport is likely be generally representative of the weather patterns in the Surat Basin Acreage Development area.

4.2.1 Wind speed and direction

Wind speed and wind direction are important parameters for the transport and dispersion of air pollutants released from a source. The winds across the region are largely driven by synoptic scale influences such as pressure gradients, convergence and convection, and subsidence of cool air from aloft, rather than orographic affects and ocean-land interactions such as land-sea breezes.

The distributions of wind speed and direction observed at Roma Airport between 2006 and 2016 have been used to characterise the wind fields in the Surat Basin Acreage Development Area. The annual average distribution of winds at Roma Airport are presented as a wind rose diagram in Figure 2. The seasonal and diurnal distributions of wind are presented as wind roses in Figure 3 and Figure 4, respectively.

The analysis of the annual distribution of winds at Roma Airport show that approximately 50% of the winds occur from the northeast quadrant (between north and east). Winds also occur from most other directions for around 5% of the time except for northwest winds which are infrequent. The winds are moderate (between 2 and 6 m/s) in all directions with few light winds.

The seasonal distribution of winds at Roma Airport (Figure 3) indicates that the winds from the northeast quadrant, and in particular from the north and north-northeast direction, dominate all year round. The seasonal distribution also shows that winds from the south to southwest are more significant during winter whilst winds from southeast are more significant during autumn.

The diurnal distribution of winds (Figure 4) also illustrates the dominance of the winds from the northeast quadrant, and in particular between midnight to midday and a lesser extent between 6pm to midnight. The diurnal profile also indicates that the winds during the afternoon, the warmest time of the day, are evenly distributed from all directions.

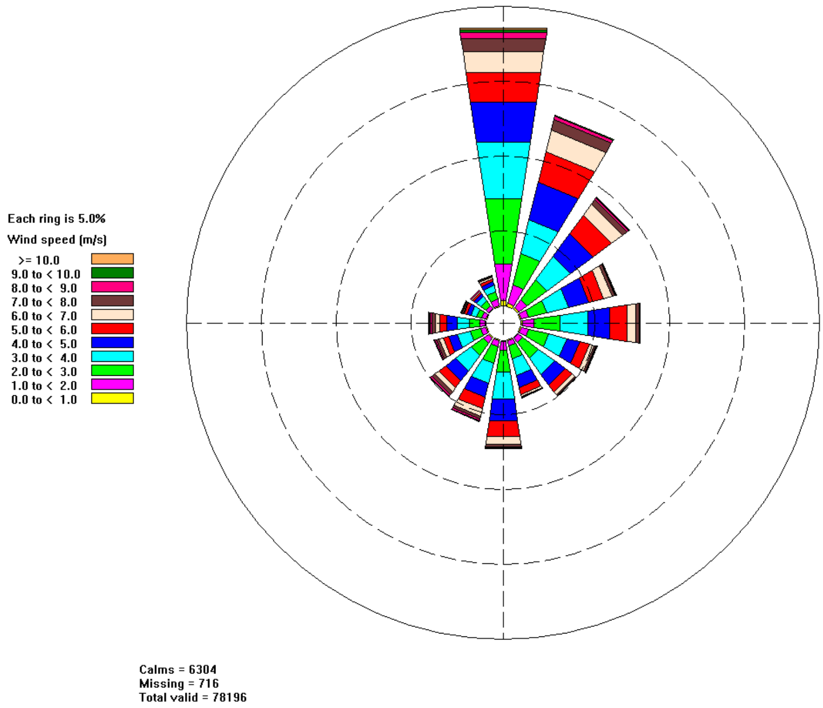

Figure 2 **Annual distribution of winds at Roma Airport (2008-2016)**

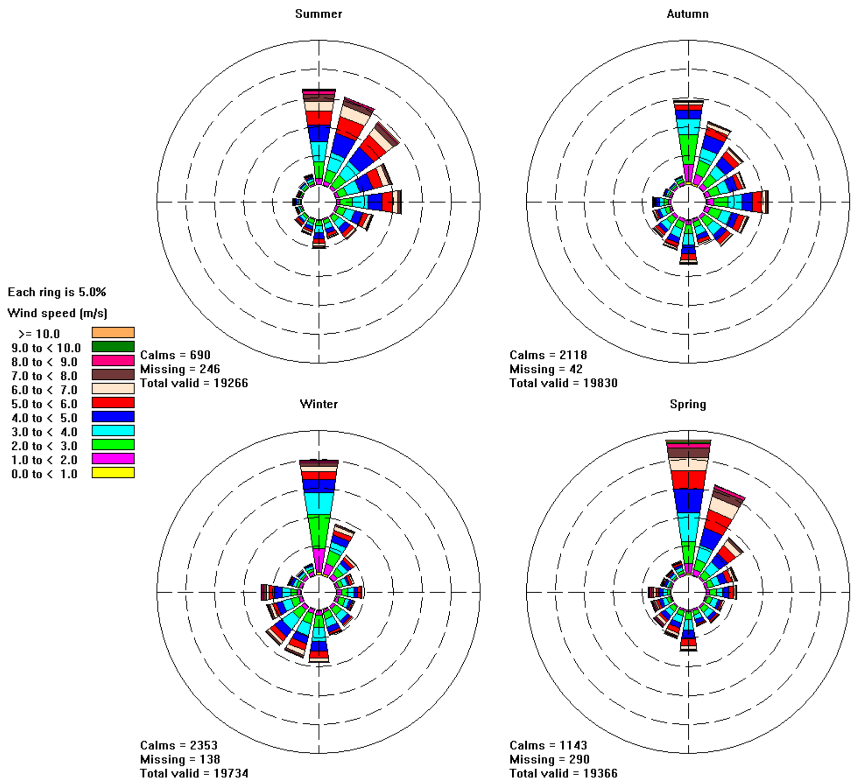

Figure 3 **Seasonal distribution of winds at Roma Airport (2008-2016)**

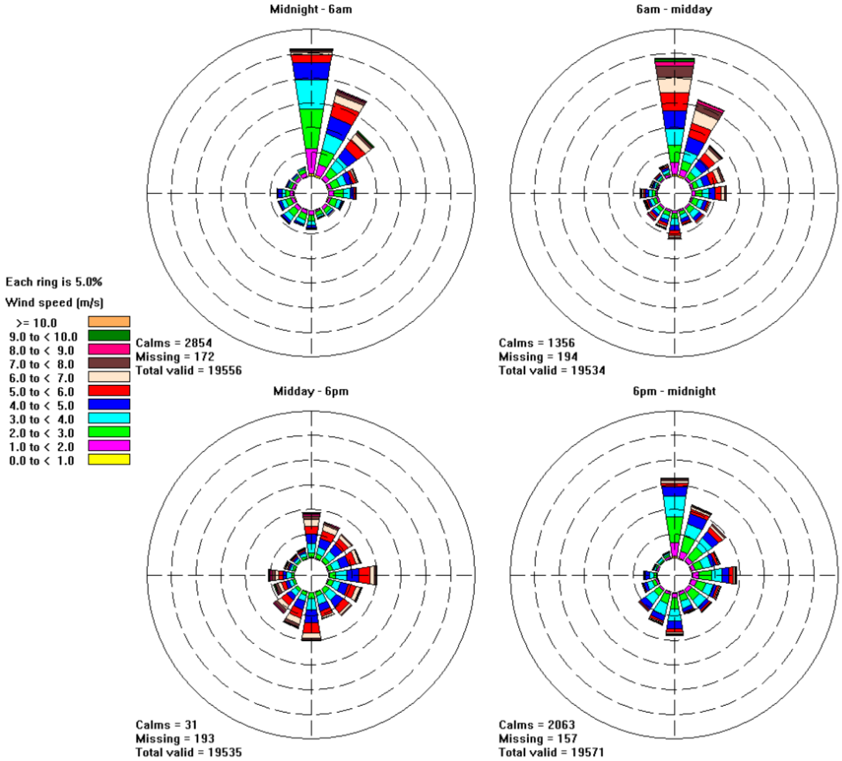

Figure 4 **Diurnal distribution of winds at Roma Airport (2008-2016)**

4.2.2 Temperature

The average daily minimum and maximum temperatures at Roma Airport between 1992 and 2018 (BoM, 2018) is presented in Figure 5. The figure shows a seasonal temperature profile typical of the sub-tropical Queensland climate, with cooler winter months of June, July and August and warmer summer months of December, January and February.

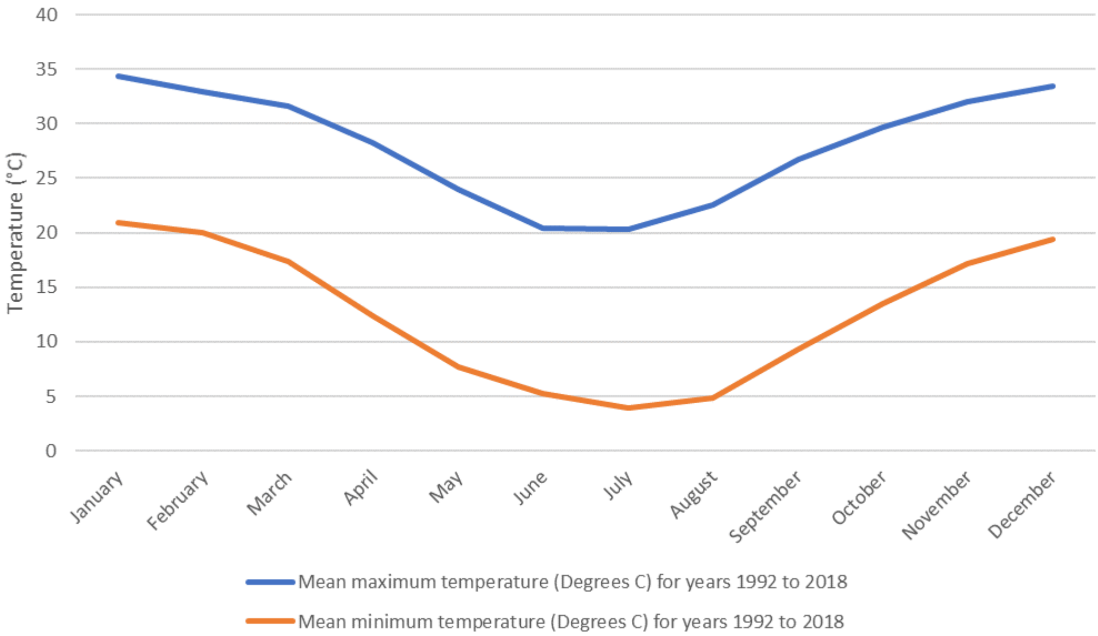

Figure 5 **Average daily maximum and minimum temperature at Roma Airport (1992-2018)**

4.2.3 Rainfall

Annual average rainfall at Roma Airport between 1985 and 2018 is 580 mm. The monthly pattern of average rainfall (Figure 6) illustrates the sub-tropical climate of the region where most precipitation occurs during the monsoonal months of November to February.

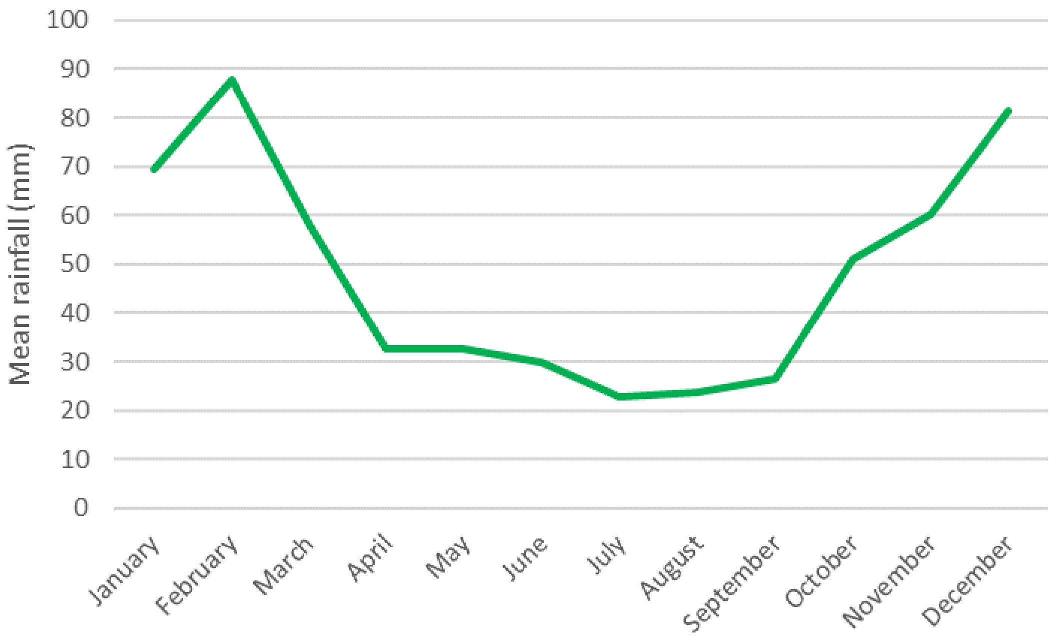

Figure 6 Mean monthly rainfall at Roma Airport (1985-2018)

4.3 Existing Ambient Air Quality in the Region

The existing ambient air quality in the Surat Basin Acreage Development area is likely to be fairly good due to the remoteness of the area and lack of air pollution sources. Notwithstanding this, industry and agricultural operations in the region such as the natural gas extraction and processing (both QGC and other proponents) and sheep and beef cattle farming would be the main contributors to air quality.

Currently there is no monitoring of ambient air quality performed in the Surat Basin Acreage Development area.

QGC operate an ambient air monitoring station located within its central gas field tenements located between Miles and Tara (approximately 125 km from the Surat Basin Acreage Development). The monitoring station is located 1km north of QGC's Kenya central processing facility and 800 meters southwest of the nearest production well. It should be noted that the Kenya facility operates on fuel gas.

The QGC monitoring station measures the following air pollutants relevant to this assessment:

- Carbon monoxide
- Nitrogen dioxide
- Sulfur dioxide.

A summary of the data for 2017 is provided in Table 1 and shows that concentrations of all the relevant pollutants were well below Queensland's Air EPP air quality objectives.

Table 1 QGC 2017 Ambient Air Monitoring Data Summary

Pollutant	Averaging Period	Air EPP Objective (µg/m³)	Maximum Concentration (µg/m³)
Carbon Monoxide	8-hour	11,000	800
Nitrogen Dioxide	1-hour	250	52.9
	1-year	62	5.8
Sulfur Dioxide	1-hour	570	58.1
	24-hour	230	8.4
	1-year	57	3.2

Further to the QGC ambient air quality monitoring station, in 2014, due to the development of the natural gas industry in the Surat Basin, CSIRO, on behalf of Gas Industry Social and Environmental Research Alliance (GISERA), established an ambient air quality monitoring network within the Surat Basin. The locations of the CSIRO monitoring sites are shown in Figure 7. Three sites are within an area of intensive natural gas development and two sites are regional sites. All of the CSIRO monitoring sites are located at least 100km from the Surat Basin Acreage Development area. However, the sources of air pollutants are likely to be similar so air quality levels in the Surat Basin Acreage Development area can be inferred from the CSIRO data.

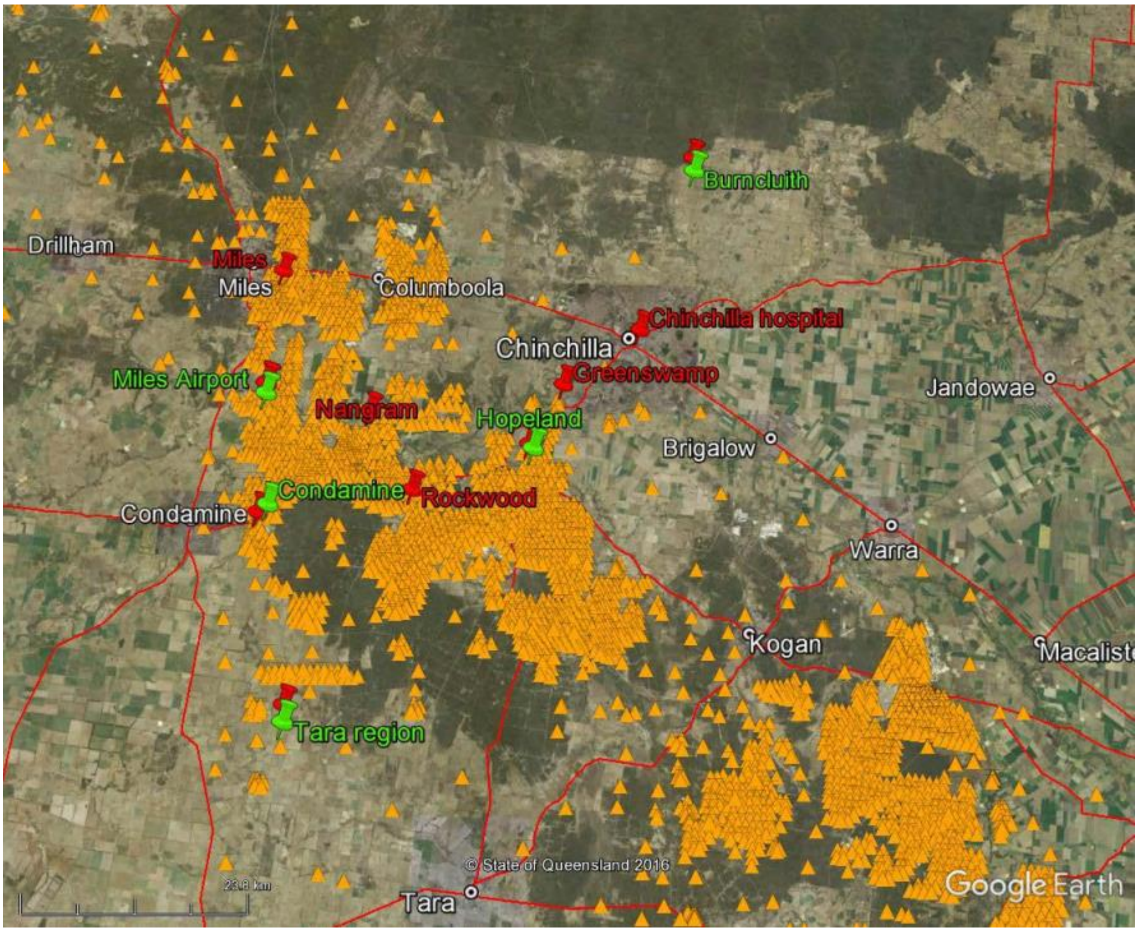

Figure 7 CSIRO monitoring sites (green pins) in Surat Basin (Source: Lawson et al, 2017)

Data from the CSIRO monitoring stations were published in an interim data summary report - September 2014 to December 2016 (Lawson et al, 2018). The report stated the following:

- *Air quality measurements from the 5 ambient air monitoring sites were compared to relevant air quality objectives including the Queensland Government Environment Protection (Air) Policy) (Air EPP), National Environmental Protection Measure (NEPM), and DEHP Nuisance Dust Guidelines for TSP.*
- *During the period January 2015 – December 2016 there were no exceedances of air quality objectives at any site for:*
    - *carbon monoxide,*
    - *nitrogen dioxide*
    - *ozone*
    - *PM_{10} (annual average)*
    - *$PM_{2.5}$ (annual average)*
- *During the period January 2015 – December 2016 there were the following exceedances of air quality objectives and guideline:*
    - *6 exceedances of the 24-hour average $PM_{2.5}$ objective*
    - *2 exceedances of the 24-hour average PM_{10} objectives at the gas field sites*
    - *8 exceedances of the 24-hour average TSP nuisance dust guideline*
- *A protocol which used a combination of wind speed and direction, source location, and pollutant correlation and ratio was developed to investigate the cause / source(s) of each exceedance.*
- *The most likely cause or source/s of the exceedance events were as identified follows:*
    - *All 6 24-hour average $PM_{2.5}$ exceedances were attributed to smoke from local or regional vegetation fires*
    - *One 24-hour average PM_{10} exceedance was attributed to smoke from a local vegetation fire,*
    - *The other 24-hour average PM_{10} exceedance source was unknown*
    - *One 24-hour average TSP event was attributed to smoke from vegetation fire*
    - *Two 24-hour average TSP events were associated with cattle farming*
    - *One 24-hour average TSP event was associated with cattle farming and an unknown source*
    - *One 24-hour average TSP event was attributed to unsealed roads/natural gas activities*
    - *One 24-hour average TSP event was attributed to a combination of smoke from vegetation fire and unsealed roads/natural gas activities.*

The ambient air quality data collected by the CSIRO monitoring stations in the Surat Basin indicate that air quality levels are generally well below the Air EPP air quality objectives for carbon monoxide, nitrogen dioxide, ozone and long-term dust (annual average $TSP/PM_{10}/PM_{2.5}$). On a small number of occasions (13 days), there were elevated levels of short term dust (24-hour average $TSP/PM_{10}/PM_{2.5}$). The sources of elevated short term dust were primarily attributed to vegetation fires and to a lesser extent cattle farming and vehicle movements on unsealed roads.

Air quality in the Surat Basin Acreage Development area can be inferred from the QGC and CSIRO data based on the similarity of sources in the airshed. The QGC and CSIRO ambient monitoring stations show air quality to be generally good as levels are below the Air EPP objectives.

5. AIR QUALITY ASSESSMENT

5.1 Emissions

5.1.1 Existing Operations

Air emissions associated with the existing Surat Basin Acreage Development operations include the following:

- Transient emissions during construction of wells and pipeline. Air pollutants include dust and the products of fuel combustion.
- Combustion of natural gas in gas engines (pumps) and flares located at the production wells. Air pollutants include oxides of nitrogen and carbon monoxide.
- Combustion of natural gas in the flare at the FCS. Air pollutants include oxides of nitrogen and carbon monoxide. All other FCS
- Fugitive natural gas (mainly methane) releases during any venting and from equipment leaks.

5.1.2 Future Phase Development

Additional air emission sources resulting from the proposed next phases of development are the additional 800 production wells and pipeline infrastructure required to extend the life of the project. No additional field compressor stations are required.

The additional 800 production wells will be developed in stages over the extended life of the project. As new wells are developed, existing wells will be decommissioned, therefore, it is unlikely that 1,200 wells would be operating simultaneously.

Air emissions associated with the next phases of the Surat Basin Acreage Development would therefore be the same as those detailed for the existing operations with the following additions:

- Additional infrastructure that could vent or leak natural gas (mainly from the wells and pipeline)
- Increase in the number of production wells (400 to 1,200) and hence additional natural gas combustion in well pumps and flares
- Increased duration of construction (however, the intensity of production well development is unlikely to change).

5.2 Air Quality Impacts

As described above, there would likely be an increase in air emission sources due to the future phases of Surat Basin Acreage Development. However, the impact of emissions from these additional sources is likely to be low.

Fugitive natural gas releases (methane) from venting and leaks may increase with the next phases of the development due to the increase in infrastructure. Fugitive releases of natural gas from the expansion project can be managed under the existing EA conditions. Further to this, QGC operate procedures for the prevention and minimisation of natural gas leaks, including routine leak detection surveys and regular inspection and maintenance of its infrastructure. This is implemented through a Leak Management Plan and conforms to the requirements of the Department of Natural Resource and Mines which require management and mitigation of leaks to As Low As Reasonably Practical (ALARP). The Leak Management Plan will be applied to all future phases of the Surat Basin Acreage Development to ensure venting and leaks of natural gas are minimised as far as possible.

Total emissions of oxides of nitrogen and carbon monoxide from fuel combustion in well pumps and flares will increase with the future phases of development due the additional 800 production wells that are proposed over the life of the development. However, the air quality impacts from the operation of well pumps and flares are very small with wells dispersed over a large area. A previous air quality assessment for the Surat North Project (Katestone, 2014) demonstrated through dispersion modelling that ground-level concentrations of air pollutants due to well pumps and flares were insignificant.

Katestone (2014) included dispersion modelling of emissions from a single well pump and flare and found that the maximum ground-level concentration occurred within 200 metres of the source and was less than 2.5% of relevant Air EPP objectives (for nitrogen dioxide and carbon monoxide). Katestone (2014) also investigated a worst-case infrastructure scenario to understand the potential for cumulative impacts due the number of air emission sources. The worst-case infrastructure scenario investigated the ground-level concentrations of oxides of nitrogen and carbon monoxide within a 5km grid that included the following emission sources:

- 1 x FCS (assumed to be gas-fired)
- 36 production wells (spaced 750 metres apart)
- Each well had a gas-fired pump (36 in total)
- Every second well (18 in total) was assumed to be constantly flaring.

The results of the worst-case infrastructure modelling scenario indicated that ground-level concentrations of air pollutants were well below the air quality objectives across the modelling domain.

Further to this, for the gas-fired pumps at wells, the fuel consumption rate is well below the 500kg/hour trigger level for inclusion within an EA. For well flares, flaring is only undertaken during maintenance or during emergency conditions. Well maintenance occurs every 2 years and on average, lasts for 6 days.

The findings of Katestone (2014) are supported by the ambient air quality monitoring conducted by QGC and CSIRO in 2017, which is summarised in Section 4.3.

Transient emissions generated during well construction activities have the potential to increase due to the next phases of the Surat Basin Acreage Development if activities are not appropriately managed. Current management strategies to minimise air quality impacts during well construction will be implemented for the next phases and include the following:

- Management of dust:
    - Regular watering of roads and exposed areas to reduce wheel-generated dust.
    - Restricting vehicle speeds to below 40 kilometres per hour.
    - During high wind conditions, dust-generating activities such as earthworks, which could potentially affect nearby sensitive receptors should not be carried out.
    - Haul vehicles should be covered when moving outside the construction site.
    - Regular cleaning of machinery and wheel washes for vehicles will prevent track-out of dust to public roads.
- Burning or incineration of cleared vegetation or other materials should not be carried out on site at any time.
- Minimising the idling of vehicle engines.

Overall, any additional air quality sources and their emissions from the next phases of the Surat Basin Acreage Development are not likely to result in any significant change to air quality above existing levels and can be effectively managed through the application of current EA conditions and QGC management procedures.

6. CONCLUSIONS

Katestone has conducted a qualitative assessment of the potential impact to air quality as a result of the next phases of the Surat Basin Acreage Development. The next phases involve the construction and operation of up to 800 additional production wells (1,200 in total) that will extend the life of the existing petroleum tenures.

A review of ambient air quality monitoring conducted by QGC and CSIRO in an area of the Surat Basin with intensive gas production operations, showed that ambient air quality levels were generally well below the Air EPP air quality objectives. It is expected that in the Surat Basin Acreage Development area, with less intensive gas production operations, would have similar if not lower levels of air quality.

Air emission sources due to the next phases of the Surat Basin Acreage Development are related to venting and leaks of natural gas from additional infrastructure, combustion of natural gas in pumps and flares at the additional wells and transient emissions of dust and combustion products during well construction.

The scale of air emissions from the next phases of the Surat Basin Acreage Development and their influence on air quality are relatively small and localised. Air emissions can be effectively managed through the existing EA conditions and QGC's management procedures.

Overall, it is anticipated that the additional 800 wells that QGC are proposing will not likely result in any significant changes to air quality above existing levels in the Surat Basin Acreage Development.

7. REFERENCES

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