6.8 Air Quality

6.8.1 Introduction

This air quality impact assessment has considered the potential air quality impacts associated with the construction and operational phases of the CSG field development program.

6.8.2 Methodology

A description of the CSG fields used as the basis for the assessment is provided in Section 3.6, which provides overview of the construction and operation of CSG fields.

The air quality assessment included:

- Description of the existing air quality in the proposed CSG fields;
- An overview of applicable air quality criteria based on relevant Queensland and national legislations and guidelines;
- Description of air emissions during the construction and operational phases of the CSG field development program;
- Air quality modelling to predict the potential impacts at sensitive receptors during the operational phases of the CSG field development program; and
- A summary of possible mitigation measures which could be incorporated into the CSG field development program to minimise the potential for impacts.

The assessment forms part of the initial (Phase 1) environmental assessments. Using the protocols developed under this EIS for Phase 2 (post EIS) processes, consideration will be given to site specific air quality investigation as part of the site specific development of the CSG fields described in Section 6.1.

Key findings of the air quality assessment for the proposed CSG fields are described below, with a full copy of the assessment report provided in Appendix S.

6.8.2.1 Air Dispersion Modelling

Ausplume was used to model the NO_x emissions from the CSG field compressors. Ausplume is a steady-state Gaussian plume air dispersion model, used to predict ambient air concentrations of emissions using historic hourly meteorological data to calculate plume rise and dispersion. Radial receptors were used to model the impacts at various distances in any direction from the source. No terrain file was included in the model because the actual locations of the field compressor stations are yet to be accurately determined.

Meteorological data for a representative site location in either the Fairview or Roma areas was generated using The Air Pollution Model (TAPM), a three-dimensional prognostic meteorological model developed by the CSIRO. Meteorological characteristics derived from TAPM (refer Section 6.2) were used as an input for Ausplume dispersion modelling.

Ausplume was configured with eight engine sources per compressor site and the operating characteristics provided by the vendor. The total emissions of NO_x were 3.7 g/s. It was assumed that the compressor stations are sufficiently spaced such that there is no potential for cumulative effects from having multiple compressor stations in the area.

Oxides of nitrogen (NO_x) are released from combustion sources as mostly NO with some NO_2 present (approximately 10 % at the release point). Studies in regional cities such as Gladstone have shown that there is typically a ratio of approximately 35 % NO_2 to NO_x for the highest ambient NO_2 concentrations. This ratio has been assumed for receptors at all distances from the compressor stations, although it is likely that the proportion of NO_2 to NO_x would remain well below 35 % at distances of up to 1 km from the compressor station, depending on weather conditions and existing concentrations of ozone and nitrogen dioxide. This assumption was applied to the NO_x concentration and will result in over-estimation of the NO_2 impacts close to the source.

Ausplume modelling was conducted for the compressor configuration, using the meteorology in both the Fairview and Roma areas. This was done to test the sensitivity of the results to changes in location, and the associated prevailing winds in each region.

6.8.2.2 Limitations and Accuracy of the Models

The model limitations may include:

- The limitations of TAPM to model local meteorology;
- The limitations of Ausplume to model dispersion;
- The limitations of not using local topography in the TAPM and Ausplume modelling, as the modelling is representative of impacts until specific sites are identified for the compressor stations; and
- The limitations of using preliminary design data for the compressor stations.

These limitations may lead to under or over prediction of impacts at ground level, which is largely unknown without actual monitoring data and source-specific emissions data for comparison. Hence, air dispersion modelling will be conducted later using local topography when actual locations of field compressor stations become known. A quantifiable monitoring and measuring program will be implemented through the Environmental Management Plan (EMP). Compliance with emission standards and ambient air quality standards will be ensured, as part of the EMP.

6.8.3 Regulatory Framework

In addition to legislation, there are a number of guidelines and standards that apply to air quality in relation to the CSG field.

6.8.3.1 Environmental Protection Act 1994

The Environmental Protection Act 1994 (EP Act) aims to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (being ecologically sustainable development).

6.8.3.2 Environmental Protection (Air) Policy 2008

The Environmental Protection (Air) Policy 2008 (EPP (Air)) aims to achieve the object of the EP Act in relation to the air environment by identifying environmental values to be enhanced or protected, stating indicators and air quality objectives for enhancing or protecting the environmental values and providing a framework for making consistent, equitable and informed decisions about the air environment.

The air quality guidelines in the EPP (Air), which came into force on 1 January 2009, have been used throughout this assessment. The air quality guidelines relevant to the project in EPP (Air) are those for nitrogen dioxide, and they are included in Table 6.8.1. The guidelines are specified for health and wellbeing of humans, and for health and biodiversity of ecosystems (ecosystem health), as noted in the relevant sections of this report.

This section is supported by more a detailed air quality assessment that is presented in Appendix S. The study in the appendix used the superseded EPP (Air) guidelines from 1997, as it was prepared before the new EPP (Air) guidelines came into force. This change in guidelines has not affected the air quality modelling that was undertaken for the project, however it has relevance for the comparison of the predicted impacts to the relevant guideline levels and these are reported below.

6.8.3.3 National Air Quality Guidelines

National air quality guidelines are specified by the National Environment Protection Council (NEPC). The National Environmental Protection Measure (NEPM) for Ambient Air Quality was released in 1998 (with an amendment in 2003) (NEPC, 2003) and sets standards for ambient air quality in Australia.

The NEPM and EPP (Air) 2008 standards relevant to the project are included in Table 6.8.1. The NEPM standards are intended to be applied at monitoring locations that represent air quality for a region or sub-region of more than 25,000 people, and are not used as recommendations for locations near industrial facilities. For this reason, only the EPP (Air) 2008 guidelines have been used in evaluating air quality impacts from the CSG fields. The EPP (Air) guidelines have been applied at indicative distances from the compressor stations.

Table 6.8.1 Relevant Queensland and Australian Guidelines and Standards for Ambient Air Quality

Pollutant	Averaging time	Guideline, Goal or Standard Value	Jurisdiction	Allowable Exceedances
Nitrogen dioxide	1 hour	250 µg/m³ 246 µg/m³	EPP (Air) 2008[1] NEPM-Ambient Air	1 day each year
	Annual	62 µg/m³ 33 µg/m³	EPP (Air) 2008[1], NEPM-Ambient Air EPP (Air) 2008[2]	

[1] Human health and wellbeing
[2] Health and biodiversity of ecosystem

6.8.3.4 Emission Standards

General emission standards are not specified in either Queensland or national legislation. The NSW Department of Environment and Climate Change (DECC)'s legislation *Protection of the Environment Operations (Clean Air) Regulation, 2002* has specified limits on emissions from various activities, including general activities and plants. The NSW DECC emission standards vary depending on the age of the plant. The standards for new plants built since 1 September 2005 have been adopted for this project. The relevant NSW DECC emission concentration standards are presented below in Table 6.8.2.

Table 6.8.2 NSW Department of Environment and Climate Change's Emission Concentration Standards Related to this Project

Pollutant	Maximum Emission Concentration	Applicable activity	Reference conditions
Nitrogen Oxides	450 mg/m³	Stationary reciprocating internal combustion engines	Dry, 273 K, 101.3 kPa, 3% O_2

6.8.4 Existing Environmental Values

6.8.4.1 Climate

See Section 6.2 for the climate summary of temperature, rainfall, evaporation, relative humidity, wind speed and wind direction, atmospheric stability, mixing height and temperature inversions.

6.8.4.2 Existing Ambient Air Quality

There are no Queensland EPA-operated air quality monitoring sites in the vicinity of the CSG fields. The closest station is at Toowoomba, approximately 350 km ESE and 330 km SE of the Roma and Arcadia

Valley CSG fields respectively. The Toowoomba monitoring station is surrounded by light industry and residential areas and measures nitrogen dioxide (NO_2) and PM_{10}. The air quality data for NO_2 at Toowoomba station are summarised in Table 6.8.3.

Table 6.8.3 Ambient Nitrogen Dioxide Concentration Statistics at the EPA Monitoring Station at Toowoomba, 2003-2008

Pollutant	Averaging time	Pollutant concentration ($\mu g/m^3$)	Guideline ($\mu g/m^3$)
Nitrogen Dioxide	1 hour, 95th percentile	41	250 EPP 2008 (Air)
	Annual average	12	62 EPP (Air) 2008 Human Health 33 EPP (Air) 2008 Ecosystem Health

The measured levels of nitrogen dioxide at Toowoomba did not exceed guidelines for ambient air quality for both 1 hour and annual averaging times.

As Toowoomba air quality monitoring station is surrounded by light industry and residential areas, the air quality would be somewhat different from the CSG field study area: the background nitrogen dioxide levels may be lower in the CSG field study area as there are less major emission sources (such as motor vehicles and other high temperature combustion activities).

These measured data from the Toowoomba station were used to represent background NO_2 levels for the assessment of impacts from the CSG fields as a conservative estimate for the background NO_2 level for the CSG fields.

6.8.5 Potential Impacts and Mitigation Measures

6.8.5.1 Description of Activities

Development of the CSG fields may include a range of activities from geophysical investigations and well drilling through to production and processing. The wells will be developed progressively through the project life; hence for any production year there will be wells at different development stages, together with in-field gas pipelines to connect wells, and gas processing facilities during production. See Section 3.6 for a full description of the CSG fields used as the basis for the assessment.

6.8.5.2 Emission Rates

Emissions During Construction

Impacts

Emissions to air during the construction phase of the CSG field development program will be primarily dust related, with some minor sources of combustion pollutants such as NO_x due to diesel and petrol vehicles operating on site.

Emissions will be generated from a number of sources including:

- Clearing of vegetation and topsoil;
- Excavation and transport of earth material;
- Vehicles travelling on unpaved roads; and
- Vehicles and machinery exhausts.

The impacts of construction activities will be managed though the Environmental Management Plan. This will include strategies to prevent or minimise dust emissions during construction activities, an outline of methods to monitor the effects of construction activities, and documentation of procedures that will be implemented to mitigate any adverse off-site impacts.

Mitigation Measures

Mitigation measures to reduce potential emissions during construction activities are listed below, and represent best practice management tools for construction site dust control:

- The land cleared for construction purposes will be kept to the minimum necessary. This shall include minimising size of well leases and equipment laydown/storage areas;
- The number and sizes of stockpiles will be kept to a minimum;
- The cleared areas and stockpiles will be progressively rehabilitated through revegetation and/or mulching; and
- Dust suppression will be undertaken during construction and clearing activities, particularly during high wind conditions. Haul roads and other unsealed areas may be watered to suppress dust.

Mitigation measures to reduce vehicle and machinery exhaust emissions include, as suggested by Victoria EPA (1996):

- Ensure that all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturers' specifications; and
- Smoke from internal combustion engines should not be visible for more than ten seconds.

Emissions During Normal Operation

Impacts

Potential emissions to the air environment include permanent and intermittent point source emissions, fugitive emissions, area source emissions and mobile source emissions. The main types of emissions anticipated during operational activities include:

- Emissions from combustion equipment, including compressor turbines and power generation turbines;
- Emissions from diesel combustion associated with diesel generator sets and vehicles;
- Emissions from cold vents, and fugitive emissions from wells; and
- Particulate emissions from traffic movements on unpaved roads.

The emissions from cold vents and fugitive emissions from wells will be predominantly methane, with minor releases of carbon dioxide and nitrogen, and with trace releases of ethane (See Section 3.8.3.2 for chemical composition of the coal seam gas). Those gases are not considered as air pollutants and not listed in the key pollutants table in the Terms of Reference (ToR), and hence they have not been assessed for air quality impacts.

Of the four emission sources listed above, the only significant continuous emission sources during normal operational activities are the combustion emissions from generators associated with field compressor engines at the gas processing facilities, referred to as field compressor stations. It is not possible at the current stage of project development to identify their specific locations. Therefore, the impact assessment was based on modelling known emissions from a typical field compressor station in a generic location in the field area.

Up to 12 field compressor stations are proposed as part of the CSG field development program. Each compressor station will include an average of eight compressor units with a compression capacity of 7 TJ of CSG.

NO_x is the main pollutant of concern from the compressor station, as gas engines emit very low quantities of particulate matter and carbon monoxide. The emission of sulphur oxides is also very low as there is negligible amount of sulphur in the coal seam gas used as a fuel. The NO_x emission rate is estimated to be 0.461 g/s per compressor engine unit based on vendor-supplied data.

To compare with best practice emission standards, the in-stack NO_x emission rate was calculated for compressor engines. This emission rate is 166 mg/m^3, calculated using the exhaust gas flow rate of 167 m^3/min. This emission rate is much lower than the emission standard of 450 mg/m^3 presented in Section 6.8.3.4. Note that no corrections towards the reference conditions have been made when calculating in-stack emission rates in mg/m^3 as the emission data on moisture content and oxygen content are unavailable. The low in-stack emission rates reflect the use of low NO_x emission technologies in the engines.

Mitigation Measures

Mitigation measures to reduce potential emissions during operational activities include:

- Implementation of a preventative maintenance program to ensure gas turbines are operating efficiently to minimise CO emissions and un-combusted hydrocarbons (primarily methane, with minor VOC emissions);
- Optimisation of gas turbine operations to minimize time periods of operation at low efficiency levels that may result in excess GHG emissions and higher than normal levels of NO_x emissions; and
- Implementation of a quantifiable monitoring and measuring program.

Emissions During Upset Conditions

Impacts

During upset conditions, which are typically infrequent and of short duration, the CSG will be flared. The combustion product from burning coal seam gas will be predominantly carbon dioxide with minor emissions of volatile organic compounds (VOCs). No modelling has been conducted for the upset conditions as these impacts are expected to be small.

6.8.5.3 Air Dispersion Modelling

Predicted Ground Level Concentrations

The predicted maximum NO2 concentrations for the operation of a compressor station, together with the estimated background concentration of NO2, are presented in Table 6.8.4. Ausplume estimates of the NO_2 concentrations result in values well below the one hour and annual average guideline levels at all the distances modelled. The results also demonstrate that there is little variation between impacts for Fairview and Roma regions for the compressor design modelled. Despite the model limitations identified above, the compressor stations are expected to satisfy the guidelines at the source-receptor distances modelled when the site locations and compressor station designs are finalised.

Table 6.8.4 Maximum NO_2 concentration for CSG field, including background concentration

Distance from Source	NO_2 Concentrations (µg/m^3)			
	Using Fairview meteorology		Using Roma meteorology	
	1 hour 99.9th percentile	Annual	1 hour 99.9th percentile	Annual
600 m	63	15	64	15
1 km	58	14	61	14
2 km	56	13	64	13
Background	41	12	41	12
EPP (Air) 2008 Guideline	250 (Human Health)	62 (Human Health) 33 (Ecosystem Health)	250 (Human Health)	62 (Human Health) 33 (Ecosystem Health)

Human Health Risk Assessment

Potential human health risks from activities in the CSG fields will come from NO_x, CO emissions from field compressor stations, dust emissions during the construction, exhaust fumes from field vehicles and diesel generators during construction and/or normal operation, and minor VOC emissions. Due to the low levels of emissions of CO, SO2, particulate matter and VOC, the impacts of these pollutants are well below the relevant health-based air quality guidelines and a human health risk assessment for these pollutants is not required.

Air dispersion modelling has predicted ground level NO_2 concentrations well below the EPP (Air) 2008 guidelines for human health and hence NO_x emissions from field compressor stations are not of concern for human health. These low risks indicate that a health risk assessment is not required.

Odour Assessment

Odour is often of concern for industrial facilities. The CSG and gas process facilities in the CSG fields will not release strong odorous compounds. Minor odour associated with oxides of nitrogen (primarily due to NO) is not of concern. The odour related to non-methane VOC releases is not of concern either as their emissions from the CSG fields are very low.

6.8.5.4 Mitigation Measures

This project will comply with the Santos document *EHS Management System Hazard Standard, EHS05 Air Emissions.* Santos strives to meet air quality guidelines for a new facility through EIS assessment, qualifying emissions through direct monitoring or estimation techniques, recording external and internal complaints related to offensive air emissions or odour, and establishing and maintaining an air quality monitoring program if required by the relevant environmental agency. Specific mitigation measures for each phase of the project development are discussed above.

Decommissioning

Mitigation measures to reduce potential emissions during decommissioning activities are similar to requirements for construction:

- The number and sizes of stockpiles will be kept to a minimum;
- Rehabilitation of disturbed areas will be undertaken to the maximum extent possible through revegetation and/or mulching; and

- Dust suppression will be undertaken during decommissioning and earthworks activities, particularly during high wind conditions. Haul roads and other unsealed areas may be watered to suppress dust.

Mitigation measures to reduce vehicle and machinery exhaust emissions include, as suggested by Victoria EPA (1996):

- Ensure that all vehicles and machinery are fitted with appropriate emission control equipment, maintained frequently and serviced to the manufacturers' specifications; and
- Smoke from internal combustion engines should not be visible for more than ten seconds.

Cumulative Impacts

Section 1 identifies other CSG development projects planned for the surrounding region. Some of these projects are up to 100 km from the GLNG Project CSG field areas and some may be within the GLNG Project FD area. There is limited information available as to the planned development of those projects or the quantity and timing of the development of the wells or associated infrastructure; however, a qualitative assessment can be made of the possible cumulative impacts.

Santos will develop the CSG fields in accordance with the EIS. There will be no other development by other petroleum producers in the tenements described in the CSG fields. Infrastructure impacts will not exceed those stated in the project description.

It is however, possible that other companies may develop CSG facilities within the CSG fields FD area as part of their planned CSG development projects in addition to the existing CSG domestic supply facilities. This will mean that there will be more CSG development in the FD area than the Santos project. As an area is developed, the number of wells will increase, but the spacing of wells will not intensify.

The CSG fields background pollution levels are far lower than air quality guidelines due to the low level of industrial development in the area.

To assess the cumulative impacts, background pollution levels have been obtained from Toowoomba, the closest EPA air quality monitoring site to the CSG fields, consistent with industry practice. This site is expected to be conservative compared to ambient air quality in the CSG Fields, due to its proximity to a large urban centre.

The cumulative assessment has considered the background level of NO_2 with the impacts from a typical field compressor station, resulting in combined impacts that are well below the guidelines. Due to the distance between the field compressor stations to be operated by GLNG and the rapid decrease in predicted impact within several kilometres of the stations, the cumulative impacts from all the GLNG field compressor stations have not been assessed.

As no detailed development information is available to identify where other CSG operators would site field compressor stations in relation to the GLNG field compressor stations, no evaluation of cumulative impacts can be conducted at this stage. Siting of the GLNG field compressor stations during the Phase 2 project development will consider the location of existing and proposed field compressor stations that are operated by other companies to ensure that any cumulative impacts of NO_2 are acceptable.

It is expected that the other CSG field development projects would include some or all of the proposed mitigation measures in relation to surface water impacts described in this section. By utilising these mitigation measures, it is anticipated that there will be a minimal cumulative impact on the surrounding environment.

Table 6.8.5 provides a summary of potential air quality impacts and mitigation measures for the CSG fields.

Table 6.8.5 Potential Air Quality Impacts and Mitigation Measures

Aspect	Potential Impact	Mitigation Measures	Objective
Construction			
Dust emissions.	Dust can potentially impact on human and vegetation health.	• Implement appropriate engineering design to minimise dust emissions. • Minimise areas cleared. • Use dust suppression controls. • Implement quantified monitoring and measuring program. • Educate community on GLNG emissions and their impacts.	Reduce impact of dust.
Operation			
NO_2.	NO_2 generated from compressor stations can potentially impact on human and vegetation health.	• Implement appropriate engineering design to minimise air emissions. • Implement quantified monitoring and measuring program. • Educate community on GLNG emissions and their impacts.	Reduce impact of NO_2 emissions.
Decommissioning			
Dust emissions.	Dust can potentially impact on human and vegetation health.	• Implement appropriate engineering design to minimise dust emissions. • Minimise areas cleared. • Use dust suppression controls. • Implement quantified monitoring and measuring program.	Reduce impact of dust.

6.8.6 Summary of Findings

The air quality assessment found that compliance with the applicable air quality criteria is able to be achieved at proposed compressor stations for the CSG field development. The air dispersion modelling conducted for NO_2 emissions from a compressor station under meteorological conditions for Roma and Fairview predicted ground-level concentrations well below the human health guidelines in EPP (Air) 2008, with a maximum of 25 % of the guideline for the one hour average NO_2 concentration, and 24 % for the annual average concentration at distance of 600 m away from the compressor station. The highest predictions were 45 % of the annual average ecosystem health guideline.

A Phase 2 (post EIS) impact assessment will be undertaken once the specific configuration and location of the compressor stations is known.

The predicted impacts for this site-specific assessment will be documented in the EMP for field compressor sites.