8. AIR QUALITY

This chapter describes the supplementary air quality assessment undertaken to address changes made to the project description as a result of detailed front end engineering design (FEED) that was completed after the Arrow LNG Plant EIS (Coffey Environments, 2012) was finalised and exhibited. The chapter presents the findings of the supplementary air quality assessment completed by Katestone Environmental Pty Ltd (Katestone), which is attached as Appendix 14.

8.1 Studies and Assessments Completed for the EIS

This section provides an overview of the air quality impact assessment completed for the Arrow LNG Plant EIS and the main conclusions from that assessment. Katestone was engaged to conduct the air quality impact assessment, which is included as Appendix 14 of the EIS. Chapter 21 of the EIS presents the findings of the air quality impact assessment.

The air quality impact assessment included baseline assessments of potential sensitive receptors and existing sources and types of air pollutants using applicable legislation and criteria, and commitments to reducing project emissions. Katestone compiled an emissions inventory for all applicable emission sources resulting from project activities (routine and non-routine operations) and assessed the potential impacts on the Gladstone region with regard to the air dispersion models that were generated using the Gladstone Airshed Modelling System (Version 3) (GAMS). Site meteorological conditions and factors influencing air quality impacts were also identified and assessed, including discussion of adverse conditions over the life of the project. A cumulative impact assessment was prepared for existing and approved industrial developments, including other LNG facilities on Curtis Island and Fishermans Landing, to capture the impacts of key air pollutants in the region.

The assessment showed that the major emissions to air will be produced during the operation of the LNG plant rather than during construction, the emissions from which are relatively low and short-term. The main emissions from the LNG plant will be nitrogen dioxide (NO_2) from the combustion of gas in the turbine generators and sulfur dioxide (SO_2) from the LNG carriers and from the tugs used to assist these vessels.

Modelling was undertaken of the dispersion of the main air pollutants (NO_2, SO_2 and carbon monoxide (CO), as well as particulate matter) during routine operations. Other oxides of nitrogen and sulfur (NO_x and SO_x) are comparatively minor pollutants and were not modelled. The modelling predicted that levels will not exceed relevant air quality criteria at any sensitive receptor locations for the LNG plant. Expected ozone levels and odours were also not expected to exceed relevant air quality criteria at any of the sensitive receptor locations.

The design of the LNG plant has incorporated several measures to minimise emissions, including the use of low-emission technology for equipment (e.g., gas turbines), waste heat recovery, the use of low-sulfur fuel, and minimisation of flaring.

Measures to limit and manage air quality emissions were developed with expert advice from Katestone. Table 8.1 lists the commitments related to air quality that were presented in the EIS.

Table 8.1 Air quality EIS commitments

No.	Commitment
C21.01	Design the LNG plant to comply with the air quality assessment criteria, which are based upon all relevant air quality standards and objectives. Compliance with these criteria will ensure protection of environmental values within the air quality impact assessment study area and all sensitive receptor areas.
C21.02	Where feasible, apply low-emission technology to equipment with high combustion rates (e.g., gas turbines).
C21.03	Fit compressors and boil-off gas recovery systems with dry gas seals and where practical, hydrocarbon pumps will be fitted with double seals.
C21.04	Minimise fugitive emissions from sources such as pumps, seals, valves, connectors and pipe work via the application of the latest proven stage of development processes, facilities and methods of operation. These include using closed drainage, where practical, minimising the number of flanges, installing dry gas seals on compressors and vapour recovery systems and, where applicable, double seals for hydrocarbon pumps.
C21.05	Incorporate waste heat recovery units on the compressor drive gas turbine exhausts to provide process heat to use elsewhere in the LNG plant, thereby reducing operational requirements for gas-fired heaters.
C21.06	Fit all stacks with emissions monitoring ports suitable for continuous monitoring even if continuous monitoring is not currently required to facilitate future monitoring should the need arise.
C21.07	Reduce exposure time of bare soils on the ground surface as far as practicable, and undertake revegetation of bare surfaces as soon as practical following construction.
C11.20	Control speed limits on site via posted speed limit signs and confine vehicles generally to marked trafficable areas.
C11.21	Keep trafficked surfaces damp during construction with sprayed water when conditions are dry to suppress dust generation. Use water of a similar quality to that which is available in the locality and do not spray as concentrated flow.
C21.08	Maintain construction vehicles and equipment regularly to reduce exhaust emissions.
C21.09	Where practical, use low-sulfur diesel fuel in diesel-powered equipment (i.e., not more than 0.01% sulfur by mass).
C21.10	Do not use chlorofluorocarbons (CFC), halogens or related materials listed as banned under the Montreal Protocol in new installations.
C21.11	Where practical, limit the volume of hydrocarbons flared or vented to the atmosphere from the LNG plant. Ensure that the flare is luminous and bright (i.e., show smokeless combustion at operating design gas flow rate) and the relative density of emitted smoke does not exceed No. 1 Ringelmann Number.
C21.12	Do not vent boil-off gas to the atmosphere; instead route it to the feed gas inlet for reprocessing or sent to the end flash gas compressor for use in the high-pressure fuel gas system.
C21.13	Use low-sulfur fuel in diesel-powered generators will (not more than 0.01% sulfur by mass).
C21.14	Maintain equipment in accordance with manufacturer specifications in order to minimise fugitive emissions.

8.2 Study Purpose

The supplementary air quality assessment addresses changes to the project description that have arisen as a result of the front end engineering design (FEED) that was completed after finalisation and exhibition of the EIS. The key changes are identified below.

Project description changes relevant to the supplementary air quality assessment are described below.

8.2.1 Changes to Power Options

The current options being taken forward for power generation are:

- The all mechanical option (also referred to as 'power island mode'). This option is the base case that was assessed in the EIS and was modelled as part of the EIS air quality impact assessment.
- The mechanical/electrical option (also referred to as 'partial auxiliary power import mode'). This option reflects an alternative case. It was described in the EIS but was not assessed in the EIS air quality impact assessment.

The all electrical option that was included in the EIS has been discontinued.

The all mechanical option represents the most emissions-intensive power option in terms of air quality. As such, the mechanical/electrical option has not been further assessed for the purposes of this supplementary air quality assessment. The all mechanical option has been assessed with consideration given to the changes to the project description presented in Section 8.2.2. Note that emissions intensity in terms of overall greenhouse gas emissions is different from that of local and regional air quality. Greenhouse gas emissions are discussed in Chapter 10.

8.2.2 Relocation of Gas Turbine Generators and Flare

The plant infrastructure layout has changed. Relevant changes include the relocation of the gas turbine compressors and gas turbine generators from the east side of the LNG trains to the west side and relocation of the flare further south of the LNG trains. The updated site plan for the LNG plant (all mechanical option) is provided in Figure 4.2 (see Chapter 4).

The relocation of infrastructure represents a material change, as the relocation of emissions sources has the potential to affect the results of the air quality modelling. As a result, revised modelling has been undertaken as part of the supplementary air quality assessment completed by Katestone, which is attached as Appendix 14.

8.3 Legislative Update

No changes to relevant policy or legislation have occurred since the EIS was finalised and exhibited.

8.4 Study Method

The supplementary air quality assessment was conducted using the same method used for the EIS assessment. This method is discussed in detail in Section 3 of Appendix 14 of the EIS. The supplementary air quality assessment focused on the emissions of NO_2 from full-load, routine operation of the LNG plant (including LNG carriers and tugs). Emission rates and stack parameters for the emission sources were consistent with the EIS air quality impact assessment and were not changed.

The most critical air quality pollutant associated with routine LNG plant operations identified in the EIS air quality impact assessment was NO_2. Other aspects of the assessment are largely unchanged and for this reason were not considered in the supplementary assessment. This

includes all pollutants other than NO_2, the 50% load option for the gas turbines, and non-routine operations.

As with the EIS assessment, NO_2 levels attributable to the Arrow LNG Plant were modelled both in isolation and with background pollutant levels using the GAMS. For the purpose of this assessment, there have been no changes to this background air quality model. GAMS includes emissions from other industries that may impact on air quality in the Gladstone region. This includes existing industries and those projects either under construction or proposed, such as the other three LNG plants on Curtis Island. Oxides of nitrogen modelled from these industries were used in the background model for this supplementary air quality assessment.

The maximum predicted ground-level concentrations of nitrogen dioxide were determined at the same seven sensitive receptor regions used for the EIS air quality impact assessment. These results were tabulated. Ground-level concentrations were also predicted for the surrounding environment, using contour plots to indicate the spatial distribution of nitrogen dioxide levels.

Levels were compared against the air quality assessment criteria for NO_2 developed for the EIS. The criteria for NO_2 are derived from the Environmental Protection (Air) Policy 2008 and are set out in Table 8.2.

Table 8.2 Air quality assessment criteria

Indicator	Environmental Value	Averaging Period	Project Criteria	Source
Nitrogen dioxide (NO_2)	Human health and wellbeing	1 hour (99.9th percentile)*	250 µg/m³	Environmental Protection (Air) Policy (2008)
		1 year	62 µg/m³	
	Health and biodiversity of ecosystems	1 year	33 µg/m³	

* Target can be exceeded one day every year.

8.5 Study Findings

The ground-level concentrations of nitrogen dioxide for the reconfigured layout of the Arrow Energy LNG plant on Curtis Island under the all mechanical power option (and associated project LNG shipping) at the seven sensitive receptor regions are shown in Table 8.3. The table compares these results to those in the air quality impact assessment undertaken for the EIS.

The supplementary air quality assessment study area is shown in Figure 8.1 and encompasses all sensitive receptor regions.

Ground-level concentrations of nitrogen dioxide at all sensitive receptor regions for the Arrow LNG Plant in isolation comply with the project air quality criteria for nitrogen dioxide for all averaging periods. When background nitrogen dioxide levels are included (using GAMS), the levels with the Arrow LNG Plant are predicted to be below the criteria for annual average nitrogen dioxide ground-level concentrations for all sensitive receptor regions. Predicted ground-level concentrations do exceed the air quality criteria for the 99.9th percentile one-hour average at the Gladstone sensitive receptor region; however, the current ground-level concentrations at this location already exceed the air quality criteria.

Table 8.3 Predicted ground-level concentrations of nitrogen dioxide

Sensitive Receptor Region	GAMS Background (µg/m^3)		Arrow LNG Plant in Isolation as Assessed in the EIS (µg/m^3)		Arrow LNG Plant in Isolation as Assessed in the SREIS (µg/m^3)		Arrow LNG Plant plus GAMS Background as Assessed in the EIS (µg/m^3)		Arrow LNG Plant plus GAMS Background as Assessed in the SREIS (µg/m^3)	
	1-hour average[1]	Annual average	1-hour average[1]	Annual average	1-hour average[1]	Annual average	1-hour average[1]	Annual average	1-hour average[1]	Annual average
Gladstone	**257.1**	8.6	45.6	0.4	45.9	0.4	**257.7**	8.8	**257.7**	8.8
Tannum Sands	32.7	0.5	9.7	0.1	9.9	0.1	34.8	0.6	34.8	0.6
Targinie	76.8	7.4	54.0	1.0	53.1	1.0	76.8	8.1	76.8	8.1
Yarwun	102.6	7.4	49.5	0.6	49.5	0.6	106.2	7.6	106.2	7.6
Fishermans Landing	82.8	5.9	30.3	0.5	29.3	0.5	82.8	6.3	82.8	6.3
Southend	34.2	0.4	30.0	0.2	29.5	0.2	39.3	0.5	39.3	0.5
Island receptors[2]	45.2	0.9	60.5	1.0	60.9	1.0	65.0	1.9	65.0	1.9
Construction camps[3]	52.4	1.3	147.5	6.7	148.7	6.8	148.3	7.9	148.7	8.0
Maximum percentage of applicable air quality criteria (%)[4]	**102.8**	13.9 /26.2	59.0	10.8 /20.3	59.5	11.0 /20.6	**103.1**	14.2 /26.6	**103.1**	14.1 /26.5
Air quality criteria	250	62[5] /33[6]	250	62[5]/33[6]	250	62[5] /33[6]	250	62[5] /33[6]	250	62[5] /33[6]

[1] 99.9th percentile, 1-hour average.

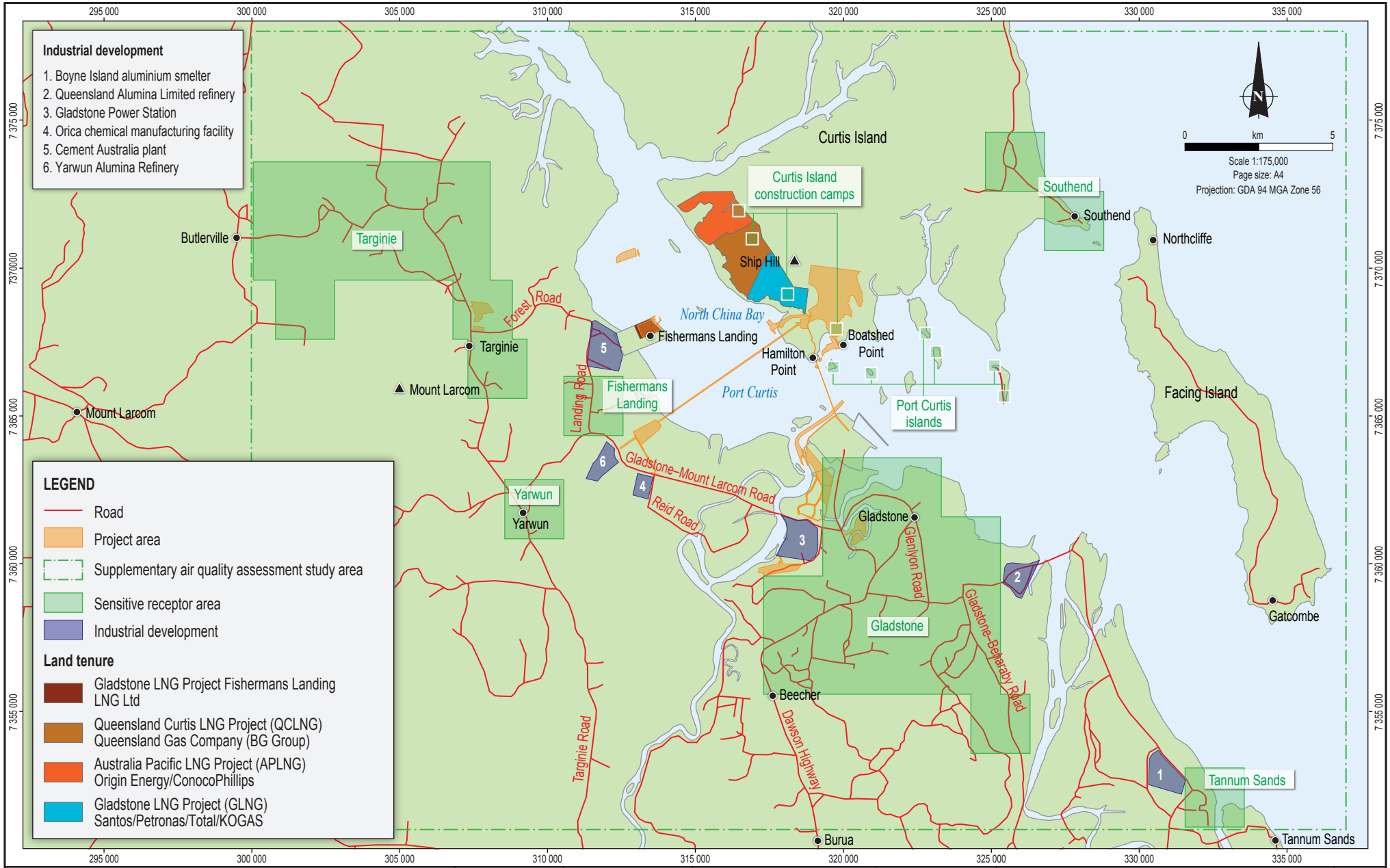
[2] The reported value represents the maximum ground-level concentration predicted at all of the sensitive receptors situated on islands in Port Curtis.

[3] The reported value represents the maximum ground-level concentration predicted at all of the construction camps situated on Curtis Island.

[4] Maximum percentage of applicable air quality criteria takes the maximum concentration at any sensitive receptor location (above) and represents it as a % of the applicable criteria (below)

[5] Objective for health and wellbeing.

[6] Objective for health and biodiversity of ecosystems.



Source:
Place names and roads from DME.
Sensitive receptor areas and existing industry from Katestone.
Project area and LNG proponents from Coffey Environments.
Coastline from GBRMPA.

coffey environments

Date: 10.12.2012
MXD: 7033CA_16_GIS005_v1_5
File Name: 7033_16_F08.01_GIS_GL

Arrow Energy

Arrow LNG Plant

arrow energy go further

Supplementary air quality assessment study area

Figure No: 8.1

The Arrow LNG Plant contribution to air quality impacts at this sensitive receptor region result in a marginal increase (0.6 µg/m^3) in the NO_2 concentration. Note that, using GAMS alone, the background model indicates an existing exceedence in the Gladstone sensitive receptor location. The exceedence is attributed to existing industrial activity.

The project air quality criteria are met at the Arrow Energy construction camp (and other construction camps), where the highest concentration of NO_2 of 148.7 µg/m^3 attributed to the Arrow LNG Plant in isolation is predicted at a sensitive receptor. This is well within the project criteria of 250 µg/m^3.

The results are consistent with those reported in the air quality impact assessment completed for the EIS. No significant differences in air quality impacts are predicted for the two LNG plant configurations.

The predicted spatial distribution of NO_2 in the surrounding environment has been plotted and is shown on Figures 8.2 and 8.3. Figure 8.2 presents the contour plots of indicative annual and 99.9th percentile 1-hour average ground-level concentrations of NO_2 generated for the Arrow Energy LNG plant in isolation. Figure 8.3 presents the contour plots of the indicative annual and 99.9th percentile 1-hour average ground-level concentrations of nitrogen dioxide for the Arrow Energy LNG plant with background levels included.

Figure 8.2 shows that the air quality criteria for NO_2 for the project in isolation are not predicted to be exceeded in any of the sensitive receptor regions. Outside these regions, the criteria are also met, with the exception of an exceedence at one location for the 99.9th percentile 1-hour average NO_2 ground-level concentrations. This exceedence occurs near the location of ship loading activities at the LNG jetty. The location is not classed as a sensitive receptor, and the air quality criteria do not apply.

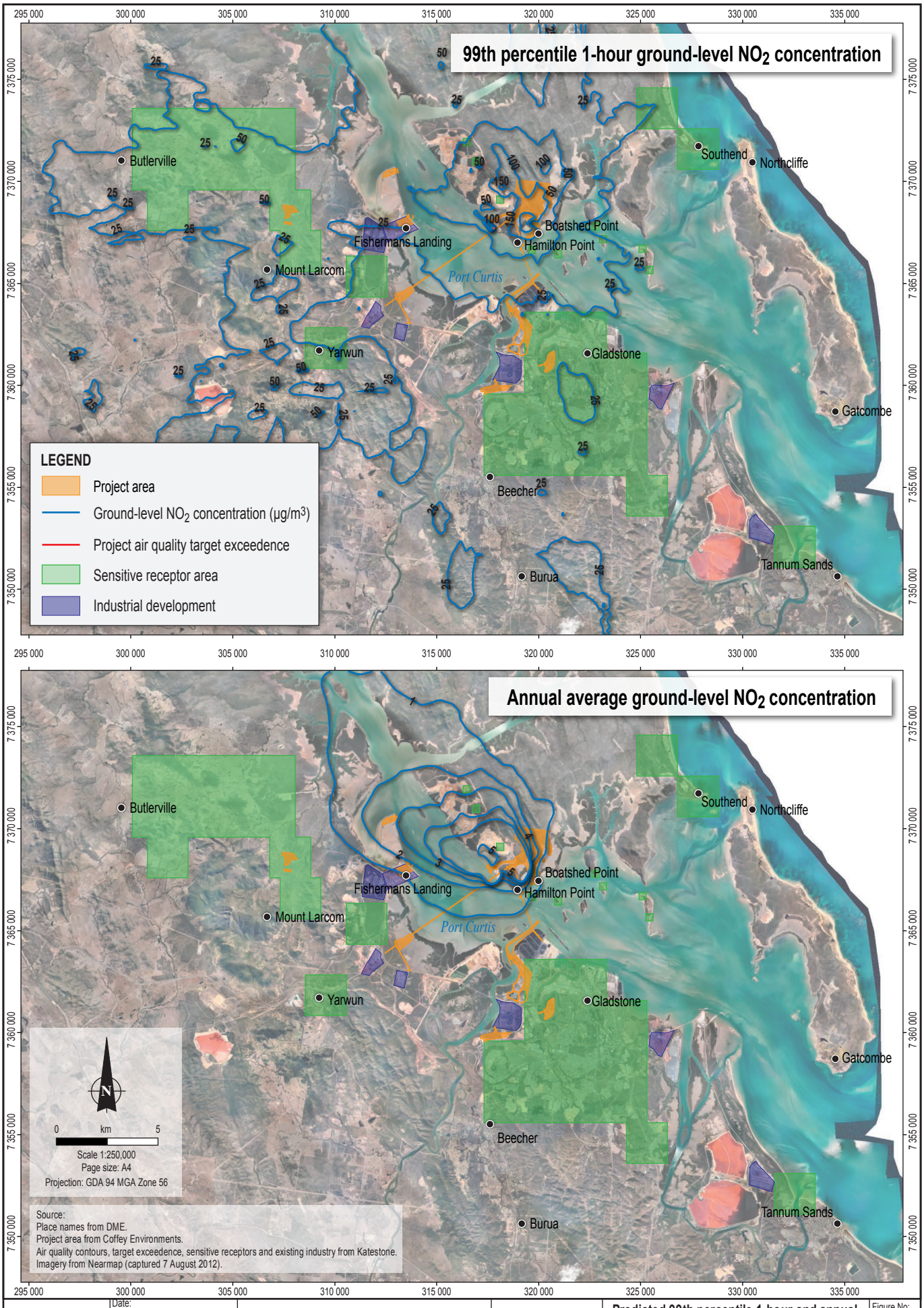
Figure 8.3 shows that, with the inclusion of background levels of NO_2, the air quality criteria are predicted to be met in all areas for annual average NO_2 ground-level concentrations. The 99.9th percentile 1-hour average NO_2 ground-level concentrations are predicted to exceed the air quality criteria of 250 µg/m^3 within a small area of the Gladstone sensitive receptor region 7 km south of the LNG plant site. This area is located immediately downwind of the coal-fired Gladstone Power Station, and the criteria are exceeded at this location even without the inclusion of the Arrow LNG Plant in the background levels.

Dispersion modelling shows that the criteria for NO_2 for the protection of the health and biodiversity of ecosystems (i.e., flora and fauna) are not exceeded at any location.

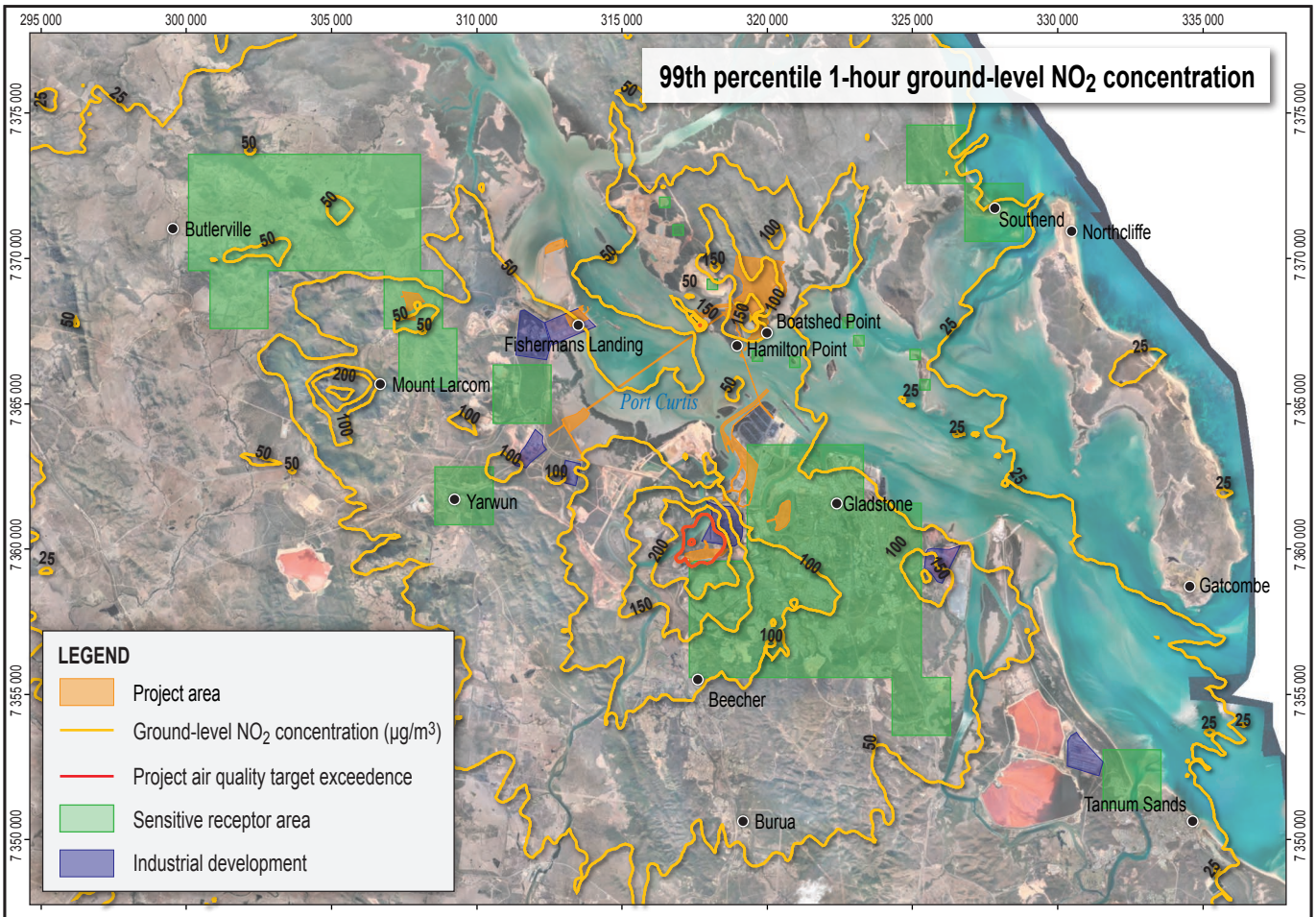
8.6 Conclusion

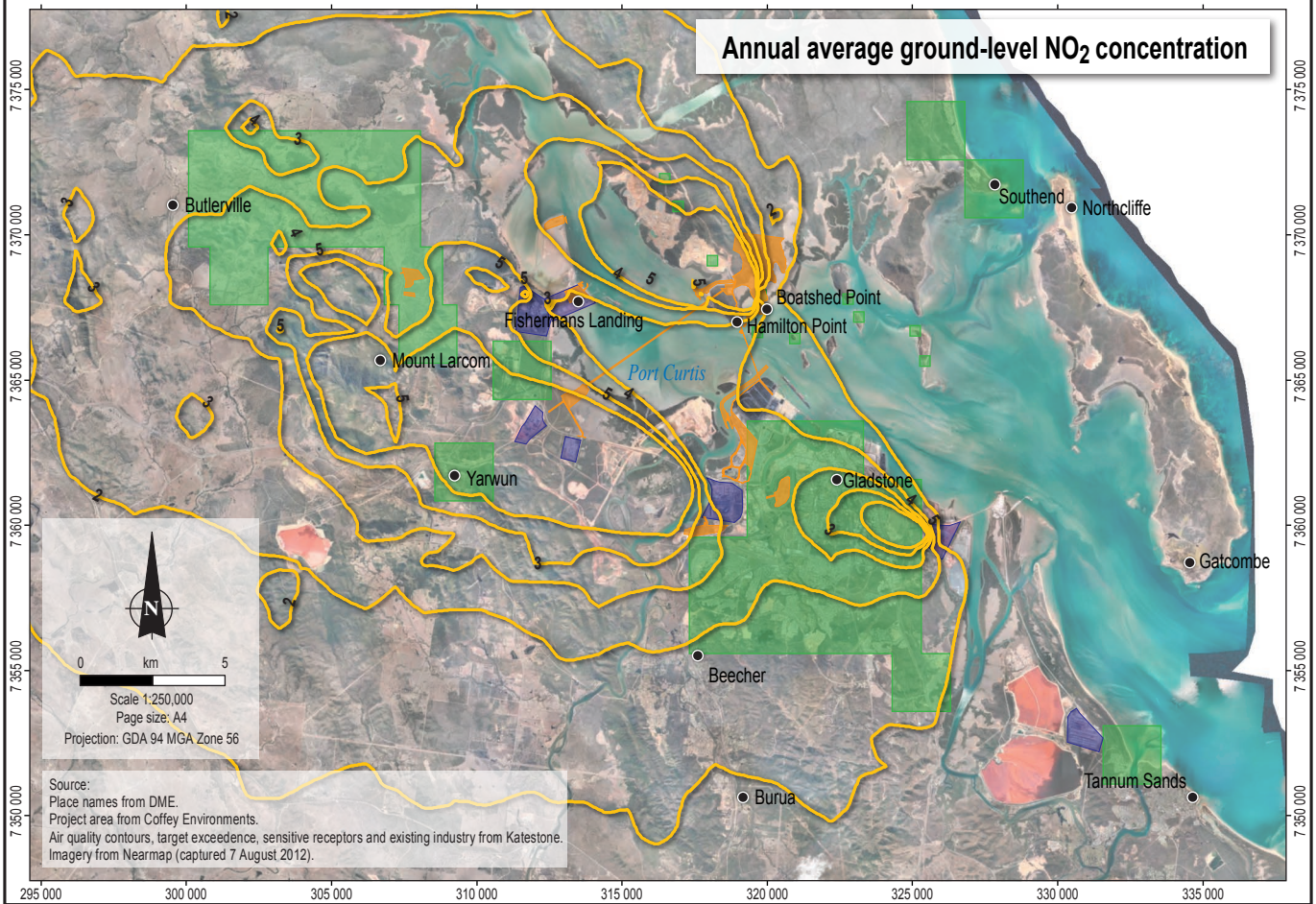
The supplementary air quality assessment predicted air quality impacts for NO_2 for the reconfigured LNG plant under the all mechanical power option (with associated LNG shipping) both in isolation and cumulatively with background levels from other existing and proposed industries in the Gladstone area.

The results of the assessment for the Arrow LNG Plant in isolation indicate compliance with the project air quality criteria for NO_2 at all sensitive receptor regions.



coffey environments	Date: 26.10.2012 MXT: 7033CC_16_GIS007_v1_4 File Name: 7033_16_F08.02_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Predicted 99th percentile 1-hour and annual average ground-level concentrations of NO_2 attributed to emissions from the Arrow LNG plant in isolation	Figure No: 8.2





Source:
Place names from DME.
Project area from Coffey Environments.
Air quality contours, target exceedence, sensitive receptors and existing industry from Katestone.
Imagery from Nearmap (captured 7 August 2012).

coffey environments	Date: 03.12.2012 MXT: 7033CC_16_GIS006_v1_5 File Name: 7033_16_F08.03_GIS_GL	Arrow Energy Arrow LNG Plant	arrow energy go further	Predicted 99th percentile 1-hour and annual average ground-level concentrations of NO_2 due to emissions from the Arrow LNG plant and industry during operations	Figure No: 8.3

When existing air quality is taken into account, the results of the assessment indicate compliance with all project air quality criteria at all sensitive receptor regions except within Gladstone. One of the air quality criteria (for the 99.9th percentile 1-hour average ground-level concentration) is exceeded at the Gladstone sensitive receptor region. This exceedence is included in GAMS. This air quality objective is exceeded without inclusion of the emissions contribution from the Arrow LNG Plant. The contribution of the Arrow Energy LNG Plant to this exceedence is negligible. This is consistent with the findings of the air quality assessment undertaken for the EIS.

The results of the supplementary air quality assessment are consistent with those of the air quality impact assessment completed for the EIS. The predicted impacts and the management measures presented in the EIS remain valid. There is no change to the worst-case scenario in terms of impacts of the project on air quality. Therefore, no changes to the air quality commitments made in the EIS are proposed.

8.7 Commitments Update

Measures to manage potential air quality impacts presented in the EIS are unchanged and are included in Attachment 7, Commitments Update.