## 7.1 Introduction

This chapter assesses the likely impact of the Marulan Gas Turbine Facility on air quality under the following three components:

- greenhouse gasses;
- local air quality; and
- aviation safety.

In order to ensure that the potential impacts from the Delta Electricity Facility are adequately assessed, the air quality assessment investigated the standalone Delta Electricity Facility as well as the combined impact of the emissions from both the Delta Electricity and EnergyAustralia Facilities.

A comprehensive greenhouse gas assessment has been conducted and is presented in **Appendix D**. This chapter presents a summary of the assessment.

In August 2005, the New South Wales Environment Protection Authority (NSW EPA), currently incorporated in the NSW Department of Conservation and Climate Change (DECC), updated the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*. (referred to herein as the *Approved Methods*). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the *Approved Methods*. This chapter provides a summary of this assessment and the full assessment is presented in **Appendix D**.

An aviation safety assessment has been conducted for the project to determine compliance with the Civil Aviation Safety Authority's (CASA) Advisory Circular "Guidelines for Conducting Plume Rise Assessments" (June, 2004). This assessment is summarised in this section and presented in full in **Appendix D**.

## 7.2 Greenhouse Gas Assessment

### 7.2.1 Policy Context

Global and national greenhouse gas policy is complex and while the Kyoto protocol came into force internationally in 2005 and in Australia in March 2008, the practical implications are still being finalised. This section briefly summarises the policy issues.

#### *International Policy*

The Kyoto Protocol to the United Nations Framework Convention on Climate Change was signed in 1997 and entered into force in 2005. Its aim is to limit greenhouse gas emissions of countries that ratified the protocol by setting individual mandatory greenhouse gas emission targets in relation to those countries' 1990 greenhouse gas emissions. It sets out three "flexibility mechanisms" to allow greenhouse gas targets to be met:

- The Clean Development Mechanism;
- Joint Implementation; and
- International Emissions Trading.

The definitions of the three mechanisms above are complex but effectively they allow greenhouse gas reductions to be made at the point where the marginal cost of that reduction is lowest. Essentially, an industrialised country sponsoring a greenhouse gas reduction project in a developing country can claim that reduction towards its Kyoto Protocol target and those greenhouse gas reductions can be traded.

### *Australian Policy*

In December 2007, the Australian Government ratified the Kyoto Protocol which effectively states that greenhouse gas emissions not to be more than 8 % above 1990 levels. This came into force in Australia in March 2008.

#### Australia's Climate Change Policy

*Australia's Climate Change Policy* was released in July 2007 (Department of the Prime Minister and Cabinet, 2007a) and sets out the Commonwealth Government's focus on reducing emissions, encouraging the development of low emissions and emission reduction technology, climate change adaptation, and setting Australia's policies and response to climate change within a global context.

Existing monitoring and reporting programs at a national level include the following:

- National Greenhouse Gas Inventory (NGGI);
- Greenhouse Challenge Plus, including the Generator Efficiency Standards;
- National Pollutant Inventory;
- ABARE Fuel and Energy Survey;
- Energy Efficiency Opportunity Assessment subset of the NFEE;
- Mandatory Renewable Energy Trust (MRET); and
- Greenhouse Friendly.

#### National Emissions Trading Scheme

The recently released report of the Prime Ministerial Task Group on Emissions Trading (Department of the Prime Minister and Cabinet, 2007b) has foreshadowed a national emissions trading scheme to help Australia address the global issues of climate change. The initial information is that this will be a "cap-and-trade" scheme, and will be developed by 2010.

Key features of the proposed scheme are:

- setting of a long-term emissions abatement goal;
- setting of an initial low target to establish a low starting price for carbon;
- implementing progressively more stringent targets, to help drive deeper emission reductions and longer-term technology development;
- establishing maximum practical coverage of all emission sources and sinks and of all greenhouse gases;

- permit liability placed on direct emissions from large facilities and on upstream fuel suppliers for other energy emissions;
- practical considerations include initial exclusion of agriculture and land use emissions;
- allocates permits for trade-exposed emission-intensive industries to reduce short-term impacts while encouraging abatement and energy efficiency;
- recognition of a wide range of credible domestic and international carbon offset regimes; and
- capacity, over time, to link to other national and regional schemes in order to provide the building blocks of a truly global emissions trading scheme.

**National Greenhouse and Energy Reporting Act 2007**

The *National Greenhouse and Energy Reporting Act 2007* establishes a single, national system for reporting greenhouse gas emissions, abatement actions, and energy consumption and production by corporations from 1 July 2008. Data reported through the system will underpin the Australian Emissions Trading Scheme (AETS). The ability to monitor, report and verify businesses' emissions data will be essential for maintaining the environmental and financial integrity of the trading system.

AETS requires “controlling corporations” to register and report if its “corporate group” or “facilities” under its “operational control” emit greenhouse gases, produce energy or consume energy above specific thresholds. AETS commences in July 2008 and will facilitate collection of data for an emissions trading scheme.

The Facilities will be subject to mandatory reporting under the *National Greenhouse and Energy Reporting Act 2007* as per the requirements outlined in the Greenhouse Gas Emissions and Energy Reporting Policy Paper issued for comment in February 2008.

**Greenhouse Challenge Plus**

The Greenhouse Challenge Plus program, run by the Australian Greenhouse Office, encompasses reducing emissions from electricity infrastructure, buildings, fleet, manufacturing operations and end-use waste. Delta Electricity has been a member of the Greenhouse Challenge Plus program since 1997.

**Energy Efficiency Opportunities (EEO)**

The Energy Efficiency Opportunities legislation came into effect in 2006, and requires large energy users (over 0.5PJ of energy consumption per year) to participate in the program. The objective of this program is to drive ongoing improvements in energy consumption amongst large users, and businesses are required to identify, evaluate and report publicly on cost effective energy savings opportunities.

Energy Efficiency Opportunities is designed to lead to:

- improved identification and uptake of cost-effective energy efficiency opportunities;
- improved productivity and reduced greenhouse gas emissions; and
- greater scrutiny of energy use by large energy consumers.

Generators and distribution companies are currently exempt for three years from EEO with respect to energy generation and losses associated with transmission and distribution. Accordingly it is not mandatory for Delta Electricity or EnergyAustralia to participate in the program.

### *State-based Policy*

#### NSW Greenhouse Plan (2005)

The NSW Government Greenhouse Plan was released in November 2005. The plan provides a strategic approach to combating climate change in NSW. The NSW Greenhouse Plan outlines new and ongoing actions to limit greenhouse emissions in NSW, and achieve key emission reduction targets announced by the NSW Government. Key principles and goals of the Greenhouse Plan are to:

- raise awareness of climate issues within the broader community;
- recognise that climate change is a global, long term and complex issue with no easy solution;
- promote understanding of the likely impacts on NSW, and identify strategies for adaptation to the environmental, social and economic impacts of climate change;
- limit the growth of greenhouse gas emissions and reduce these emissions in NSW. The Plan outlines targets, strategies and actions to achieve significant emission reductions;
- promote climate change partnerships through co-operative approaches by Government, individuals, industry, business and community groups;
- reduce business uncertainties by establishing carbon constraints in order to promote new investment and innovation; and
- identify key strategic areas for cooperative work with other Australian jurisdictions including the development and establishment of a Kyoto compliant national emissions trading scheme.

#### The NSW Greenhouse Gas Reduction Scheme

The NSW Greenhouse Gas Reduction Scheme (GGAS) (formally known as the NSW Greenhouse Gas Abatement Scheme) commenced on 1 January 2003 with the aim of reducing greenhouse gas emissions from the production and use of electricity. It uses a “baseline and credit” approach to abatement, where project-based activities generate offsets that can be used to abate greenhouse gas emissions.

The tradable unit in the GGAS is a New South Wales Greenhouse Abatement Credit (NGAC), equivalent to one tonne of abated $CO_2$-e. A more generic name for these credits in GGAS is Abatement Certificate. Retailers are liable for a certain number of NGACs calculated on the basis of their share of the NSW electricity market. Therefore, retailers provide the demand for NGACs, and other parties supply NGACs into the market.

#### NSW Energy Savings Plan and Fund

High energy users in NSW are required to prepare Energy Savings Action Plans. The Government introduced new legislation in May 2005 to encourage a better understanding of energy use by business, government agencies and local councils and establish detailed plans of action for savings.

**The NSW Energy Efficiency Strategy**

This initiative was announced in early December 2007 by the NSW Premier, however functional details are as yet to be developed and announced.

### 7.2.2 Methodology

The greenhouse gas emission inventory for the Facilities is based on the methodology detailed in the *Greenhouse Gas Protocol* (WBC for SD&WRI, 2004) (referred to herein as the *Protocol*), and the relevant emission factors in the *National Greenhouse Accounting (NGA) Factors* (DECC, 2008). The Protocol was first established in 1998 to develop internationally-accepted accounting and reporting standards for greenhouse gas emissions from companies.

The Greenhouse Gas Protocol is based on the concept of emission “scopes”:

- Scope 1: Direct greenhouse gas emissions. Direct greenhouse gas emissions occur from sources that are owned or controlled by a company. For example:
  - emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.;
  - emissions from chemical production in owned or controlled process equipment.
- Scope 2: Electricity indirect greenhouse gas emissions. This accounts for greenhouse gas emissions from the generation of purchased electricity consumed by the Facility. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the various generators which provide power to the transmission network when the proponent’s electricity consumption (purchase) occurs.
- Scope 3: Other indirect greenhouse gas emissions. This is an optional reporting class that accounts for all other indirect greenhouse gas emissions resulting from a company’s activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation and extraction of purchased fuels; and use of sold products and services.

This greenhouse gas assessment has been conducted using the Australian Greenhouse Office’s quantitative methodology. Based on estimated plant operation, total emissions ($CO_2$-e) have been calculated and compared to state and national greenhouse gas inventories for both the energy sector, and the sum of all sectors.

### 7.2.3 Greenhouse Gas Inventory

Greenhouse gas emissions from gas fired turbines comprise primarily carbon dioxide ($CO_2$) with small amounts of methane ($CH_4$) and nitrous oxide ($N_2O$).

The greenhouse gas assessment encompasses the operational stage of the Facilities. The construction and decommissioning phases have not been included. Due to the small size of the project and relatively short construction duration, greenhouse gas emissions during construction and decommissioning are considered insignificant (as compared to plant operation) in the calculation of emissions over the lifetime of the project.

The greenhouse gas inventory for the Facilities has included Scope 1 and Scope 3 emissions in order to account for the direct (Scope 1) and indirect (Scope 3) emissions from the project. The operational boundary is defined as the boundary of the power station site. Scope 3 emissions are limited to upstream emissions from the production of gas fuel used for electricity generation.

Given that the Facilities are generators of electricity, where the power generated has been quantified as net power sent out (i.e. generator output minus electricity required to power auxiliary plant and equipment), electricity consumption associated with Scope 2 has been addressed in the forecast of electricity sent out.

The Facilities will operate on natural gas and estimated fuel consumption and power generated per year (electricity sent out) are presented in **Table 7-1**. These figures have been based on the maximum proposed operating duty of 500 hours per annum (per turbine) during Delta Electricity Facility Stage 1 and 90 % of the year during Delta Electricity Facility Stage 2. The EnergyAustralia Facility has been based on the maximum proposed operating duty of 10 % of the year per turbine.

**Table 7-1 Estimated Gas Consumption and Electricity Sent Out**

| Parameter | Project Stage | Value | Units |
|---|---|---|---|
| Gas combusted | Delta Electricity Stage 1 | 2 | PJ/yr |
| | Delta Electricity Stage 2 | 32 | |
| | EnergyAustralia | 3* | |
| Electricity sent out | Delta Electricity Stage 1 | 150 | GWh/yr |
| | Delta Electricity Stage 2 | 3500 | |
| | EnergyAustralia | 219 | |

Note: Electricity sent out for Delta Electricity sourced from Burns and Roe Worley (2006) and electricity sent out for EnergyAustralia sourced from EnergyAustralia.
* Rounded value presented. Assessment calculations have used the estimation of 2.96 as provided by EnergyAustralia.

The following parameters were not included in the assessment as they contribute negligibly to the Facilities' greenhouse gas inventory:

- fuel combusted by off-site vehicle use;
- loss of biomass due to construction;
- liquid refrigerant losses; and
- Sulphur Hexafluoride ($SF_6$) emissions from switchgear.

### *Delta Electricity Facility*

Quantitative greenhouse gas emissions from the Delta Electricity Facility and comparison with greenhouse gas generated from the electricity sector in NSW and Australia are provided in **Table 7-2**.

**Table 7-2 Comparison of Delta Electricity Facility to State and National Greenhouse Gas Inventories**

| Parameter | Units (Mt $CO_2$-e per year) Delta Electricity Facility | | % Contribution represented by the Facility | |
|---|---|---|---|---|
| | Stage 1 | Stage 2 | Stage 1 | Stage 2 |
| Total Direct Greenhouse Gas Emissions | 0.102 | 1.641 | | |
| Total Indirect Greenhouse Gas Emissions | 0.028 | 0.454 | | |
| **Total combined Greenhouse Gas Emissions for each Stage** | **0.131** | **2.096** | | |
| NSW Electricity generation sector | 57.8 | | 0.23 % | 3.63 % |
| Total NSW GHG emissions | 158.2 | | 0.08 % | 1.32 % |
| Australia Electricity generation sector | 194.3 | | 0.07 % | 0.81 % |
| Total Australian GHG emissions | 559.1 | | 0.02 % | 0.37 % |

Based on the Stage 1 scenario, the Delta Electricity Facility is estimated to release 0.131 million tonnes of $CO_2$-e (includes direct and indirect emissions) per year as a peak load station, representing 0.23 % of the emissions from electricity generation in NSW, or 0.07 % of all sources of greenhouse gas in Australia in 2005.

Based on the Stage 2 scenario, the Delta Electricity Facility is estimated to release 2.096 million tonnes of $CO_2$-e (includes direct and emissions) per year as a combined cycle station, representing 3.63 % of the emissions from electricity generation in NSW, or 0.37 % of all sources of greenhouse gas in Australia in 2005.

Detailed plant selection for the proposed Delta Electricity Facility is yet to be made. The technology employed will be typical of current best practice for peaking applications, in terms of fuel type (natural gas), technology type and detailed equipment selection.

This assessment has incorporated relatively coarse estimations of annual fuel consumption and net electricity sent out. As these are annualised figures, they also incorporate fuel consumption associated with start up, shut down, testing and operation at lower loads (the plant's turbines will operate between around 60-100 % load). This means that the annualised intensities presented in **Table 7-2**, are indicative of the scale of annual greenhouse emissions from the EnergyAustralia Facility. However, the coarser resolution of the annualised intensities means that they are not suitable for marginal comparisons of generator greenhouse intensity when considering the type of generating technology employed.

**Table 7-3** provides greenhouse gas emissions for the Facility based on an assumed project lifetime of 30 years, **Table 7-3** shows greenhouse gas emissions for the proposed plant on a project lifetime on the basis that only Delta Electricity Facility Stage 2 operates, as the operating period for Delta Electricity Facility Stage 1 is currently uncertain. Long term market trends define the operating duty, and ultimately the commercial life of the plant; hence there exist large uncertainties in potential emissions over the Project lifetime.

**Table 7-3 Estimated Greenhouse Gas Emissions on a Project Lifetime Basis – Delta Electricity**

| Greenhouse Gas Emissions Parameter | Units (Mt $CO_2$-e over 30 years) |
|---|---|
| Direct Emissions | 49.2 |
| Indirect Emissions | 13.6 |
| Total Emissions (each Facility) | 62.9 |

### *Cumulative Assessment*

The cumulative greenhouse emissions from both the Delta Electricity Facility and EnergyAustralia Facilities have also been assessed. **Table 7-4** summarises the direct and indirect greenhouse gas emissions from the project and presents a comparison with greenhouse gas generated from the electricity sector in NSW and Australia.

**Table 7-4 Cumulative Greenhouse Gas Inventory for Delta Electricity and EnergyAustralia Facilities**

| Parameter | **Units** (Mt $CO_2$-e per year) | | | % Contribution represented by the combined Facilities |
|---|---|---|---|---|
| | Delta Electricity Facility | | EnergyAustralia Facility | |
| | Stage 1 | Stage 2 | | |
| Total Direct Greenhouse Gas Emissions | 0.102 | 1.641 | 0.152 | - |
| Total Indirect Greenhouse Gas Emissions | 0.028 | 0.454 | 0.042 | - |
| Total combined Greenhouse Gas Emissions for each Facility | 0.131 | 2.096 | 0.194 | - |
| **Total combined Greenhouse Gas Emissions (assuming Delta Stage 2 and EnergyAustralia)** | **2.29** | | | **-** |
| NSW Electricity generation sector | 57.8 | | | 3.96 % |
| Total NSW GHG emissions | 158.2 | | | 1.45 % |
| Australia Electricity generation sector | 194.3 | | | 1.18 % |
| Total Australian GHG emissions | 559.1 | | | 0.41 % |

**Table 7-5** provides greenhouse gas emissions for the proposed plant based on an assumed project lifetime of 30 years, and operation for 10 % of each year for the EnergyAustralia Facility. **Table 7-5** shows greenhouse gas emissions for the proposed plant on a project lifetime on the basis that only Delta Electricity Facility Stage 2 operates, as the operating period for Delta Electricity Facility Stage 1 is currently uncertain. Long term market trends define the operating duty, and ultimately the commercial life of the plant; hence there exist large uncertainties in potential emissions over the project lifetime.

**Table 7-5 Estimated Greenhouse Gas Emissions on a Project Lifetime Basis – Combined**

| Greenhouse Gas Emissions Parameter | Units (Mt $CO_2$-e over 30 years) | |
|---|---|---|
| | Delta Electricity (assumed Stage 2) | EnergyAustralia |
| Direct | 49.2 | 4.6 |
| Indirect | 13.6 | 1.3 |
| Total (each Facility) | 62.9 | 5.8 |
| Total combined Emissions | 68.7 | |

## 7.2.4 Participation in Greenhouse Gas Programs

Delta Electricity has long recognised the growing concern by communities and governments of the issues of global warming and emissions of greenhouse gases from the combustion of fossil fuels. Delta Electricity monitors GHG emissions and thermal efficiency at each power station site and implements programs to improve operational performance and reduce emissions.

These programs include:

- development of renewable energy generation sources including two 30 MW biomass fired co-generation facilities on the north coast of NSW, biomass co-firing in existing power stations and mini hydro generators;
- development of gas fired power stations to provide a lower greenhouse alternative for future electricity demand;
- participation in the Greenhouse Challenge Program since 1997;
- participation in the Generator Efficiency Standards (GES). Delta Electricity was the first generator to agree to legally binding targets under the Australian Government's Generator Efficiency Standards (GES);
- participation in the NSW Greenhouse Gas Abatement Scheme and creation of 200,000 to 300,000 NGACs/year; and
- implementation of Environmental Management System ISO 14001:2004 standard.

Delta Electricity is not proposing to implement any greenhouse gas offsets specifically for this Project.

Further information on EnergyAustralia's participation in Greenhouse Gas programs is presented in the EnergyAustralia *Project Application,* however it is noted that similarly EnergyAustralia is not proposing to implement any greenhouse gas offsets specifically for this Project.

## 7.3 Air Quality Impacts

### 7.3.1 Methodology

The Environmental Assessment Requirements require the air quality assessment to be prepared in accordance with the *Approved Methods*. The *Approved Methods* identify a number of stages in an air quality impact assessment:

1) Input data collection.

2) Dispersion modelling.

3) Processing dispersion model output data.

4) Interpretation of dispersion modelling results.

5) Preparation of an impact assessment report.

The first step in the impact assessment is the collection of information required to complete the dispersion modelling. This includes development of an air emissions inventory, compilation of meteorological data, background air quality data and terrain data. This stage is addressed in detail in **Appendix D**. A summary of the meteorology and background data is presented in **Section 7.3.2**.

For Step 2 of the assessment it is noted that three dispersion models are generally endorsed by DECC for development approvals, namely AUSPLUME, TAPM and CALPUFF. The TAPM and CALPUFF models both incorporate site-specific factors such as terrain influences, regional-scale winds and inversions to predict ground-level concentrations.

Given the significance of this assessment, it was considered that the use of two models provided greater reliability in the prediction of the potential impacts. The CALPUFF model better handles calm atmospheric conditions and was used to generate the majority of results, with TAPM providing validation of the CALPUFF model concentrations. The results presented in **Section 7.3.4** therefore present the results from the CALPUFF modelling. The TAPM and CALPUFF model results are in close agreement hence the use of CALPUFF in this assessment was considered valid. A discussion of the validation of these results using TAPM modelling is presented in **Appendix D**.

Due to the different operational scenarios for each of the Delta Electricity (both stages) and EnergyAustralia Facilities and the varying emission characteristics, several scenarios were required to be modelled. The modelling scenarios are discussed further in **Section 7.3.4**. Additional “combined Facility” scenarios were modelled and the results are provided in **Appendix D**, however only the worst case results have been presented and discussed in this chapter.

Step 4 of the impact assessment is the interpretation of dispersion modelling results. The outputs of the dispersion modelling are added to existing maximum background concentrations of pollutants to determine the predicted ground level concentrations. These ground level concentrations are compared with the DECC’s impact assessment criteria. DECC states in the *Approved Methods* that *“compliance indicates the proposal is unlikely to result in adverse air quality impacts”*.

The proposed Facilities would be situated in a rural area and emissions from surrounding industrial sources are negligible. Consequently, the impact of the Facilities on local air quality is expected to be minor. Similarly, given the distance of the Facilities from the greater metropolitan regions of Sydney and Wollongong, a detailed regional air quality assessment was not considered warranted.

### *Air Quality Criteria*

There are three main types of air quality criteria relevant to industrial developments such as the Delta Electricity and EnergyAustralia Facilities:

- *Emission Standards* – which are maximum allowable pollutant emission concentrations (stack concentrations) specified for particular types of equipment;
- *Air Impact Assessment Criteria* – which are designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources; and
- *Ambient Air Quality Standards* – which set standards against which ambient air quality monitoring results may be assessed.

In general, Emission Standards and Air Impact Assessment Criteria are used to evaluate the expected impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant Ambient Air Quality Standards.

The *Approved Methods* also state that cumulative impacts from adjacent facilities must be taken into consideration. Thus this report discusses separately the impacts from the Delta Electricity Facility and the combined Delta Electricity and EnergyAustralia Facilities. A comparison of turbine emissions from the EnergyAustralia Facility with Emission Standards is presented in the EnergyAustralia *Project Application*.

#### Emission Standards

*The Protection of the Environment Operations (Clean Air) Regulation 2002* sets emission limits for air impurities from stationary plant and equipment. The current standards, taken from Schedule 3 (Electricity Generation) of the Regulation, relevant to the Delta Electricity Facility are presented in **Table 7-6** for solid particulates and oxides of nitrogen. The plant is classified as a Group 6 source, as it will commence operation after 1 September 2005.

**Table 7-6 Emission Standards for Electricity Generation**

| Pollutant | Applicability | Limit |
|---|---|---|
| Solid Particulates (Total) | - | 50 mg/$m^3$ |
| $NO_2$ or NO or both as $NO_2$ equivalent | Any turbine operating on gas, being a turbine used in connection with an electricity generating system with a capacity of 30 MW or more | 70 mg/$m^3$ as $NO_2$ |

#### Air Impact Assessment Criteria

The *Approved Methods* specifies a range of impact assessment criteria for toxic and odorous air pollutants. The impact assessment criteria for these pollutants associated with the proposed Facility are shown in **Table 7-7.**

**Table 7-7 DECC Impact Assessment Criteria for Modelled Pollutants**

| Pollutant | Concentration (ppm) | Concentration ($\mu g/m^3$) | Averaging Period |
|---|---|---|---|
| **Criteria Pollutants** | | | |
| $NO_2$ | 0.12 | 246 | 1 hour |
| | 0.03 | 62 | Annual |
| $PM_{10}$ | - | 50 | 24 hour |
| | - | 30 | Annual |
| $SO_2$ | 0.25 | 712 | 10 minutes |
| | 0.20 | 570 | 1 hour |
| | 0.08 | 228 | 24 hours |
| | 0.02 | 60 | Annual |
| CO | 87 | 100,000 | 15 minutes |
| | 25 | 30,000 | 1 hour |
| | 9 | 10,000 | 8 hours |
| **Hazardous Air Pollutants** | | | |
| Acetaldehyde | 0.023 | 42 | 1 hour |
| Acrolein | 0.00018 | 0.42 | 1 hour |
| Benzene | 0.009 | 290 | 1 hour |
| Ethylbenzene | 1.8 | 8000 | 1 hour |
| Formaldehyde | 0.018 | 20 | 1 hour |
| Total PAH | - | 0.4 | 1 hour |
| Toluene | 0.09 | 360 | 1 hour |
| Xylenes | 0.04 | 190 | 1 hour |

**Ambient Air Quality Criteria**

The ambient air quality criteria adopted by NSW are provided by the *National Environment Protection Measure (NEPM) for Ambient Air Quality* (referred to herein as 'NEPM for Ambient Air Quality'), published by the National Environment Protection Council (NEPC) (1998). The NEPM for Ambient Air Quality sets out national standards and goals for six common ambient air pollutants (NEPC, 1998) namely nitrogen dioxide ($NO_2$), carbon monoxide (CO), photochemical oxidants (as ozone), sulfur dioxide ($SO_2$), lead and particulates as $PM_{10}$. When reviewing the standards and goals set out in the NEPM for Ambient Air Quality, it should be noted that they are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria. Consequently, proposed facility emissions have not been assessed directly against NEPM guidelines, however it should be noted that the NEPM guidelines for $NO_2$, $PM_{10}$, $SO_2$ and CO are identical to the DECC criteria, as shown in **Table 7-7**.

The NSW Government has also published an *Air Quality Management Plan* (NSW EPA, 2006) for the Greater Metropolitan Region (GMR) of NSW. In August 2006, the DECC updated and re-issued '*Action for Air'* - the NSW Government's 25-year Air Quality Management Plan, which was originally published in 1998. The proposed development site is situated slightly outside the GMR, thus the management plan does not strictly apply to this development. However, the National Standards and Goals provided in 'Action for Air' acknowledge the NEPM criteria, which are considered to be identical to the values adopted for this assessment.

In 2004 the NEPC released the *Air Toxics NEPM* (NEPC, 2004) that presented a number of monitoring investigation levels for some key Volatile Organic Compounds (VOCs). The air investigation levels were derived on the basis of the long term protection of human health within regional areas. The purpose of the Air Toxics NEPM is the collection of ambient air concentration of VOC "…*at locations where elevated levels are expected to occur and there is a likelihood that significant population exposure could occur*." (NEPC, 2004 p 2). Similarly to the Ambient Air Quality NEPM, the Air Toxics NEPM is designed for use in assessing regional air quality and not intended for use as site boundary or atmospheric dispersion modelling criteria. Thus, the predicted concentrations of Hazardous Air Pollutants (HAPs) are compared against the DECC criteria.

## 7.3.2 Existing Environment

### *Climate and Meteorology*

A summary of the climatological data collected at the Goulburn (Airport) station by the Bureau of Meteorology is provided in **Appendix D**. The Goulburn Meteorological Station is located 37 km south west of the site, and is considered to be representative of the region, including the proposed development site. These data indicate the region experiences hot summers and cold winters. The records show the average maximum daily temperature for summer is approximately 27 °C, with temperatures as high as 40 °C being recorded. The area has moderate rainfall with an average annual rainfall of 513.8 mm.

As site specific meteorology was not available, the meteorological data used in the dispersion modelling was generated using the CSIRO's *The Air Pollution Model* (TAPM) (Hurley, 2005), using data from automatic weather stations (AWS) located at the following locations:

- Goulburn Airport AWS (located approximately 37 km south west of the Site);
- Lynwood AWS (located approximately 12 km south south west of the Site); and
- Berrima AWS (located approximately 28 km east north east of the Site).

### *Background Air Quality and Concentrations Used for Modelling*

Background air quality is generally a function of regional industrial and residential air emission sources. The *Approved Methods* requires that the peak concentration of a criteria pollutant measured by an appropriate ambient air quality monitoring station is used to represent the background concentration of that pollutant for a region. This results in a conservative assessment as concentrations of an individual pollutant may vary over different time scales. While the maximum concentration of a pollutant may be elevated due to unusual events (for example $PM_{10}$ is elevated during dust storms and bushfires), the concentrations for the remainder of the year may remain low, hence the use of the maximum background value provides a conservative measure of impact.

The background data for $NO_2$ and $SO_2$ was taken from the DECC air monitoring site at Bargo (2006). Background $PM_{10}$ and CO are not measured at Bargo and were taken from the closest available DECC monitoring stations at Oakdale and Macarthur.

The $PM_{10}$ data for Bargo showed one exceedance of criteria during 2006, on 1$^{st}$ November. This 24 hour averaged result of 57.3 µg/m$^3$ was due to a local bushfire at Lake Burragorang (DECC, 2007). In accordance with the *Approved Methods* this value was excluded from the assessment. The next highest 24 hour averaged concentration was found to be 40.0 μg/m$^3$, which occurred on the 22$^{nd}$ of November 2006. This elevated value is likely to be a result of bushfires occurring in the Blue Mountains (DECC, 2007), but has been used in this assessment on the basis of conservativeness.

It should also be noted that the Macarthur monitoring station is located adjacent to the Hume Highway and between the heavily trafficked Narellan and Menangle Roads, consequently the background CO concentrations used in this assessment are considered conservative as the proposed development site is situated away from heavily trafficked roads and industrial areas.

A summary of the background air quality concentrations used in this assessment, as measured by DECC, is provided in **Table 7-8** and a map showing the location of the ambient air quality stations is provided in **Appendix D**.

**Table 7-8 Summary of Background data used in Air Quality Modelling - 2006**

| Species | Averaging Time | DECC Monitoring Station Data | Maximum Background Concentration (μg/m$^3$) | Air Quality Criteria (μg/m$^3$) |
|---|---|---|---|---|
| $NO_2$ | 1 hour | Bargo | 116.9 | 246 |
| | Annual average | Bargo | 13.7 | 62 |
| $PM_{10}$ | 24 hour | Oakdale | 40.0 | 50 |
| | Annual | Oakdale | 14.0 | 30 |
| $SO_2$ | 10 minute | Bargo | 36.8 | 712 |
| | 1 hour | Bargo | 25.7 | 570 |
| | 24 hour | Bargo | 5.7 | 228 |
| | Annual average | Bargo | 1.2 | 60 |
| CO | 15 minute | Macarthur | 3299 | 100,000 |
| | 1 hour | Macarthur | 2500 | 30,000 |
| | 8 hour | Macarthur | 2250 | 10,000 |

## 7.3.3 Potential Discharges to Air during Construction

Bulk earthworks for the two Facilities should they occur at the same time, are anticipated to take approximately 6 months to complete. The Delta Electricity Facility would be constructed in two stages with the Stage 1 assumed to take 12 months and Stage 2 assumed to take 18 months. The EnergyAustralia Facility would be constructed entirely in on stage and is assumed to take 12 months to complete. These construction periods may or may not overlap.

### *Delta Electricity Facility*

During the construction phase, there is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicle movements, however, these emissions will be minimised through the implementation of a construction environment management plan (CEMP). Given the undeveloped nature of the site, there is considered to be no significant potential for dust emissions from construction activities to contain contaminants, or for the works to give rise to odorous emissions. The distance to the nearest residential dwellings (approximately 1.5 km) provides a sufficient buffer zone between the main work area and neighbouring land uses to prevent nuisance dust impacts. Consequently emissions during construction have not been quantified.

### *Cumulative Delta Electricity and EnergyAustralia Facilities*

It is likely that construction for the EnergyAustralia Facility would commence first however, the Delta Electricity and EnergyAustralia construction periods may overlap. As the potential for dust generation would be managed for each Facility (or together as bulk earthworks progress at the same time for both Facilities), the assumptions presented in **Section 7.3.3** remain valid and cumulative impact from the construction of the two Facilities has not been quantified.

## 7.3.4 Potential Discharges to Air during Operation

### *Emissions*

The following is a discussion on the potential emissions during operation:

**Oxides of Nitrogen**

Oxides of nitrogen ($NO_X$) are the sum of nitric oxide (NO) and nitrogen dioxide ($NO_2$). In gas turbines the primary mechanism for $NO_X$ formation is termed “thermal $NO_X$”. This occurs in the burners, where high temperatures allow the dissociation of atmospheric nitrogen ($N_2$), after which the nitrogen may combine with excess oxygen. Generally the $NO_X$ emissions from a combustion source comprise approximately 90 % NO and 10 % $NO_2$.

In the atmosphere NO and $NO_2$ are linked in a circular reaction with oxidants such as ozone, which generate $NO_2$ from NO and sunlight which breaks $NO_2$ down to NO. Due to this reaction sequence, the exact amount of NO and $NO_2$ within emissions is often unknown, and consequently the sum emission of both species (i.e., $NO_X$) is quoted. The ambient concentration of $NO_2$ near to a $NO_X$ source is dependent on the amount of oxidant and sunlight at the time.

**Particulate Matter**

Particulate matter is generally divided into two broad fractions - deposited and suspended. Deposited particulate matter is dust that, because of its aerodynamic diameter and density, rapidly falls from the air. In general terms, deposited particulates have a diameter of greater than about 20 µm. However, there is no distinct dividing line between these particles and the smaller particles of suspended matter that fall more slowly out of the air. Because of the size of the deposited particulate matter, most of this material will not enter the human body thorough inhalation. Hence the effects of deposited particulate are primarily nuisance, and may only affect health via annoyance reactions.

Major natural sources of background particulate levels include forest fires, pollen and wind-blown dust from exposed areas. Anthropogenic sources include stationary and mobile combustion sources, road dust, agriculture, mining, major fires and emissions from industrial processes. Background levels vary widely depending on location, meteorology and proximity of major point or area sources.

Particulate matter with an aerodynamic diameter of 10 µm or less ($PM_{10}$) is acknowledged as a pollutant of concern due to its ability to be inhaled into the lungs. $PM_{10}$ has been considered as part of this assessment.

Gas turbine emissions operating on natural gas generally contain very low concentrations of particulate matter due to the fuel type and combustion process (US EPA, 2000).

**Sulfur Dioxide**

Emissions of sulfur dioxide are defined by the sulfur content of the fuel. Given that sulfides are removed from natural gas as part of the “desulfurisation” process at the natural gas processing plant, sulfur dioxide emissions are likely to be low to negligible.

**Carbon Monoxide**

Carbon monoxide is produced due to the incomplete combustion of any fuel containing carbon, where there is too little oxygen within the mix or the fuel. In gas turbines this occurs primarily during the start up phase of operation.

**Hazardous Air Pollutants**

Hazardous Air Pollutants (HAPs) emissions from gas turbines are lower than for other combustion sources e.g. internal combustion engines (US EPA, 2000). This is due to the combustion environment present where high temperatures and high amounts of excess air promote more complete combustion of the fuel. The HAPs produced from gas-fired gas turbines include HAPs such as benzene and Polycyclic Aromatic Hydrocarbons (PAHs). Metallic HAPs, such as lead, are not generally considered to be present in significant concentrations in natural gas (US EPA 2000), and consequently are not assessed.

A review of US EPA (2000) and DEH (2005) suggest the primary HAPs from gas turbines are:

- Acetaldehyde;
- Acrolein
- Benzene;
- Ethylbenzene;
- Formaldehyde;
- Toluene;
- Total PAHs; and
- Xylenes.

The listed HAPs were investigated as part of this assessment.

### *Emission Parameters*

The stack emissions were the only sources assessed for the Project. An “E Class” gas turbine has been used in this assessment as this turbine is considered to have emissions representative of the range of turbines currently being considered by Delta Electricity.

Emission rates were calculated as the product of estimated stack concentrations and the exhaust flow rate. Where supplier emission data existed, these values were used, however, for other emission data, especially for start up conditions, data was primarily adopted from Parsons Brinckerhoff (2005), which assessed a similar gas turbine facility. Due to the potential frequency of starts for open cycle turbines, Start Up emissions are generally assessed. The infrequent nature of the Delta Electricity combined cycle (Stage 2) Start Up typically makes further assessment unnecessary.

The $NO_x$ (as $NO_2$) and CO emission data for the E Class (Operational Scenario) are based on gas turbine performance data provided in URS (2006). The $NO_x$ and CO emissions during start up for the E Class gas turbine were taken from Table 11.5 of Parsons Brinckerhoff (2005) which proposed a start up emission rate of 117.8 g/s and 895.6 g/s for $NO_x$ and CO respectively. A conservative approach was taken for $SO_2$ and emission data has been sourced from Parsons Brinckerhoff (2005), which showed an emission rate of 2.2 and 4.9 g/s for Start Up and Operational Scenarios respectively. It should be noted that sulfur does exist in natural gas, however, it exists in trace concentrations.

As supplier data was not available for $PM_{10}$, emission data has been sourced from Parsons Brinckerhoff (2005), which showed an emission rate of 4.4 g/s for both Start Up and Operational Scenarios respectively. Particulate matter is generally not considered a significant issue with gas turbines, given the high efficiency of the process and the gaseous fuel, which generally does not give rise to high concentrations of particulates (US EPA, 2000).

The method used to calculate HAP emissions during Operation was based on the relationship between fuel consumption and HAP provided in the US EPA (2000), commonly known as the AP-42 Emissions Factors. The ratio of HAP to fuel consumption was applied to the fuel consumption for each turbine under normal operating conditions in order to estimate the individual HAP concentrations.

Due to the different operating conditions during Start Up, fuel consumption was not deemed to be an appropriate factor to estimate HAP emissions. The method used to calculate HAP emissions during Start Up was based on the relationship between HAP produced during Start Up and normal Operation for a similar E Class turbine operating on natural gas. The HAP emission calculations for both normal Operation and Start Up are shown in **Appendix D**.

### *Scenarios Modelled*

Due to the different operational phases for each of the Delta Electricity and EnergyAustralia Facilities and the varying emission characteristics, several scenarios were required to be modelled. The modelling scenarios undertaken are provided in **Table 7-7**. Additional “combined Facility” scenarios were modelled and the results are provided in **Appendix D**, however only the worst case results have been presented and discussed here.

**Table 7-9 Scenarios Modelled**

| Scenario | Delta Electricity –Stage 1 | | Delta Electricity – Stage 2 | EnergyAustralia | |
|---|---|---|---|---|---|
| | Start Up | General Operation | General Operation | Start Up | General Operation |
| Scenario 1 - Delta Electricity | ✓ | - | - | - | - |
| Scenario 2 - Delta Electricity | - | ✓ | - | - | - |
| Scenario 3 - Delta Electricity | - | - | ✓ | - | - |
| Scenario 1 - Combined | ✓ | - | - | ✓ | - |
| Scenario 2 - Combined | - | - | ✓ | ✓ | - |

### *Delta Electricity Facility - Start Up*

The start up parameters is provided in **Table 7-8**.

**Table 7-10 Delta Electricity Start Up - Stack Parameters and Emissions**

| Stack Parameter [A] | Units | Stage 1 – open cycle Start up |
|---|---|---|
| Stack Height (above ground level) | (m) | 40 |
| Stack Diameter | (m) | 6 |
| Nominal Plant Capacity | (MW) | 320 |
| Exit Temperature | (°C) | 398 |
| Exit Velocity | (m/s) | 27 |
| **Stack Emissions (per stack) [B]** | | |
| Criteria Pollutants | | |
| $NO_X$ Emission | (g/s) | 117.8 |
| CO Emission | (g/s) | 895.6 |
| $SO_2$ Emission | (g/s) | 2.2 |
| $PM_{10}$ Emission | (g/s) | 4.4 |
| Hazardous Air Pollutants[C] | | |
| Acetaldehyde | (g/s) | 0.101 |
| Acrolein | (g/s) | 0.016 |
| Benzene | (g/s) | 0.030 |
| Ethylbenzene | (g/s) | 0.081 |
| Formaldehyde | (g/s) | 1.793 |
| Total PAH | (g/s) | 0.006 |
| Toluene | (g/s) | 0.328 |
| Xylene | (g/s) | 0.162 |

Notes:

A: Stack parameters have been taken from Burns and Roe Worley (2006). Temperature and velocity have been taken from URS (2007).

B: Stack Emissions have been taken from URS (2007).

C: HAP Emission rate calculations are provided in **Appendix D**.

### *Delta Electricity Facility – General Operation*

The start up emissions for the operational Stages of the Delta Electricity Facility are provided in **Table 7-11** and stack locations are provided in **Appendix D**.

**Table 7-11 Delta Electricity General Operation - Stack Parameters and Emissions**

| Stack Parameter [A] | Units | Stage 1 – open cycle Operational | Stage 2 – combined cycle Operational |
|---|---|---|---|
| Stack Height (above ground level) | (m) | 40 | 40 |
| Stack Diameter | (m) | 6 | 6 |
| Nominal Plant Capacity | (MW) | 320 | 450 |
| Exit Temperature | (°C) | 532 | 125 |
| Exit Velocity | (m/s) | 40 | 20 |
| **Stack Emissions (per stack) [B]** | | | |
| Criteria Pollutants | | | |
| $NO_X$ Emission | (g/s) | 19.3 | 19.3 |
| CO Emission | (g/s) | 4.6 | 4.6 |
| $SO_2$ Emission | (g/s) | 4.9 | 4.9 |
| $PM_{10}$ Emission | (g/s) | 4.4 | 4.4 |
| Hazardous Air Pollutants [C] | | | |
| Acetaldehyde | (g/s) | 0.008 | 0.008 |
| Acrolein | (g/s) | 0.001 | 0.001 |
| Benzene | (g/s) | 0.003 | 0.003 |
| Ethylbenzene | (g/s) | 0.007 | 0.007 |
| Formaldehyde | (g/s) | 0.149 | 0.149 |
| Total PAH | (g/s) | 0.0005 | 0.0005 |
| Toluene | (g/s) | 0.027 | 0.027 |
| Xylene | (g/s) | 0.013 | 0.013 |

Notes:

A: Stack parameters have been taken from Burns and Roe Worley (2006) and URS (2007). Exit temperature and velocities taken from Table 9, GHD (2006).

B: Criteria pollutant emissions have been taken from URS (2007).

C: HAP Emission rate calculations are provided in **Appendix D**.

### *EnergyAustralia Turbine Emissions – Start Up*

For the purpose of this assessment, the assumptions made for the Delta Electricity Start Up Scenario (Scenario 1 – Delta) are considered to be similar for the EnergyAustralia turbines. The start up turbine emissions for EnergyAustralia are provided in **Table 7-12** and stack locations are provided in **Appendix D**.

**Table 7-12 EnergyAustralia Start Up- Stack Parameters and Emissions**

| Stack Parameter | Units | Start Up | Operation |
|---|---|---|---|
| Stack Height (above ground level) | (m) | 30 | 30 |
| Stack Diameter | (m) | 6.5 | 6.5 |
| Nominal Plant Capacity | (MW) | 350 | 350 |
| Exit Temperature | (°C) | 398 | 532 |
| Exit Velocity | (m/s) | 23 | 34 |
| **Stack Emissions (per stack)[B]** | | | |
| Criteria Pollutants | | | |
| $NO_X$ Emission | (g/s) | 117.8 | 19.3 |
| CO Emission | (g/s) | 895.6 | 4.6 |
| $SO_2$ Emission | (g/s) | 2.2 | 4.9 |
| $PM_{10}$ Emission | (g/s) | 4.4 | 4.4 |
| Hazardous Air Pollutants [C] | | | |
| Acetaldehyde | (g/s) | 0.101 | 0.008 |
| Acrolein | (g/s) | 0.016 | 0.001 |
| Benzene | (g/s) | 0.030 | 0.003 |
| Ethylbenzene | (g/s) | 0.081 | 0.007 |
| Formaldehyde | (g/s) | 1.793 | 0.149 |
| Total PAH | (g/s) | 0.006 | 0.0005 |
| Toluene | (g/s) | 0.328 | 0.027 |
| Xylene | (g/s) | 0.162 | 0.013 |

Notes:

A: Stack parameters have been supplied by EnergyAustralia. Exit temperatures and velocities adapted from URS (2007) for Start Up and Table 9, GHD (2006) for Operation.

B: Criteria pollutant stack emissions have been taken from URS (2007).

C: HAP Emission rate calculations are provided in **Appendix D**.

## 7.3.5 Potential Ambient Air Quality Impacts – Delta Electricity Facility

### *Construction*

The assessment of the Common Shared Works, in particular bulk earthworks, is presented in the *Concept Application.* This assessment addresses emissions during the construction phase (beyond earthworks) for reprofiling of the Site (if required) and other construction works.

There is the potential for dust to be generated due to the excavation and handling of soils, site grading activities and vehicle movements, however, these emissions would be minimised through the implementation of a construction environment management plan (CEMP). The distance to the nearest residential dwellings (approximately 1.5 km) provides a sufficient buffer zone between the main work area and neighbouring land uses to prevent nuisance dust impacts.

### *Operation*

A summary of the results from the dispersion modelling for both the Delta Electricity and combined Facilities is provided in **Table 7-13.** The worst case scenario is shaded in the table.

The 'Maximum Cumulative Impact' (Column 6) presents the **sum** of the maximum background concentration (Column 4) and the maximum predicted ground level concentration of column in the table (shaded number in Column 5) (ie. *Column 4 + maximum Column 5 = Column 6*).

However, the situation is more complex for the $NO_x$ concentrations:

- For Scenarios 1-3 Delta Electricity, the peak $NO_2$ impacts from the Facility assumed that 100 % of the $NO_X$ emitted from the Facility was in the form of $NO_2$. In accordance with the *Approved Methods* further refinement of these calculations is not required as they present the conservative case which is shown to meet the Air Quality Criteria.
- For Scenarios 1 and 2 Combined the quantification of peak $NO_2$ impacts required a refinement of the assessment in accordance with the *Approved Methods*. The concentrations of $NO_2$ were estimated using an equation for estimating the conversion of $NO_X$ emitted from the Facilities to $NO_2$ (Janssen Equation). This conversion recognises that the highly conservative approach of assuming all $NO_x$ is present as $NO_2$ leads to the impact being overstated. Values in brackets assume all $NO_X$ is present as $NO_2$.
- Therefore the maximum cumulative impact for $NO_x$ 1 hour averaging period presents the concentration using an equation for estimating the conversion $NO_X$ emitted from the Facility to $NO_2$ (Janssen Equation).
- Compliance with the Air Quality Criteria is illustrated in the Table (Column 8). None of the modelled species were shown to exceed the DECC regulatory criteria.

Sensitive receptor locations and selected dispersion model contour plots for criteria pollutants are provided in **Appendix D**.

### Table 7-13 Summary of Predicted Ground Level Concentrations

| Column 1 **Species** | Column 2 **Averaging Period** | Column 3 **Frequency** | Column 4 **Background Concentration** | Column 5 **Scenario Modelled**[A] | | | | | Column 6 **Maximum Cumulative Impact** | Column 7 **Air Quality Criteria** | Column 8 **Compliance with Air Quality Criteria** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | μg/m$^3$ | 1 – Delta Electricity | 2 – Delta Electricity | 3 – Delta Electricity | 1 - Combined | 2 - Combined | μg/m$^3$ | μg/m$^3$ | YES/NO |
| $NO_X$ (as $NO_2$) | 1 hour | 100 % (Maximum) | 116.9 | 105.1 [B] | 28.2 [B] | 97.8 [B] | 113.0[C] | 71.2[C] | 229.9[C] | 246 | YES |
| | Annual | 100 % (Maximum) | 13.7 | 0.33 | 0.059 | 0.264 | 0.67 | 0.60 | 14.4 | 62 | YES |
| $PM_{10}$ | 24 hour | 100 % (Maximum) | 40.0 | 0.47 | 0.46 | 1.10 | 0.93 | 1.29 | 41.3 | 50 | YES |
| | Annual | 100 % (Maximum) | 14.0 | 0.02 | 0.013 | 0.060 | 0.04 | 0.08 | 14.1 | 30 | YES |
| $SO_2$ | 10 minute | 100 % (Maximum) | 36.8 | 6.46 | 10.25 | 35.54 | 12.7 | 36.0 | 72.8 | 712 | YES |
| | 1 hour | 100 % (Maximum) | 25.7 | 4.51 | 7.16 | 24.84 | 8.85 | 25.14 | 50.8 | 570 | YES |
| | 24 hour | 100 % (Maximum) | 5.7 | 0.38 | 0.510 | 1.221 | 0.740 | 1.304 | 7.0 | 228 | YES |
| | Annual | 100 % (Maximum) | 1.2 | 0.01 | 0.015 | 0.067 | 0.0256 | 0.080 | 1.3 | 60 | YES |
| CO | 15 minute | 100 % (Maximum) | 3299 | 1054 | 8.9 | 30.8 | 1795.2 | 1218 | 5094 | 100,000 | YES |
| | 1 hour | 100 % (Maximum) | 2500 | 798.7 | 6.72 | 23.32 | 1360.5 | 923.1 | 3861 | 30,000 | YES |
| | 8 hour | 100 % (Maximum) | 2250 | 181.2 | 1.44 | 3.43 | 329.5 | 166.2 | 2580 | 10,000 | YES |
| Acetaldehyde | 1 hour | 99.9 % | - | 0.026 | 0.012 | 0.043 | 0.563 | 0.034 | 0.563 | 42 | YES |
| Acrolein | 1 hour | 99.9 % | - | 0.004 | 0.002 | 0.007 | 0.090 | 0.006 | 0.090 | 0.42 | YES |
| Benzene | 1 hour | 99.9 % | - | 0.008 | 0.004 | 0.013 | 0.169 | 0.010 | 0.169 | 290 | YES |
| Ethylbenzene | 1 hour | 99.9 % | - | 0.021 | 0.010 | 0.034 | 0.450 | 0.028 | 0.450 | 8000 | YES |
| Formaldehyde | 1 hour | 99.9 % | - | 0.464 | 0.218 | 0.755 | 9.990 | 0.610 | 9.990 | 20 | YES |
| Toluene | 1 hour | 99.9 % | - | 0.085 | 0.040 | 0.138 | 1.829 | 0.112 | 1.829 | 360 | YES |
| Total (PAH) | 1 hour | 99.9 % | - | 0.001 | 0.001 | 0.002 | 0.031 | 0.002 | 0.031 | 0.4 | YES |
| Xylenes | 1 hour | 99.9 % | - | 0.042 | 0.020 | 0.068 | 0.901 | 0.055 | 0.901 | 190 | YES |

Notes:

[A] Worst case concentrations are shaded

[B] For Scenarios 1-3 Delta Electricity, the peak $NO_2$ impacts from the Facility assumed that 100% of the $NO_X$ emitted from the Facility was in the form of $NO_2$. In accordance with the *Approved Methods* further refinement of these calculations is not required as they present the conservative case which is shown to meet the Air Quality Criteria.

[C] For Scenarios 1 and 2 Combined, peak NO2 impacts showed that a more refined assessment was required in accordance with the Approved Methods. The concentrations of NO2 were estimated using an equation for estimating the conversion of NOX emitted from the Facility to NO2 (Janssen Equation).

The dispersion modelling for the Delta Electricity Facility identified the following:

**Oxides of Nitrogen**

The ground level guidelines for oxides of nitrogen are limited to $NO_2$, the principal species of concern in terms of health effects. As oxides of nitrogen undergo complex interaction after emissions from the facility, the assumption that all emitted $NO_X$ is present as $NO_2$, is considered conservative. For the modelled Scenarios, it was assumed that all $NO_X$ emitted from the facility was in the form of $NO_2$. The results presented in **Table 7-13** showed the 1 hour averages to have cumulative concentrations of $NO_2$ below regulatory guidelines.

The maximum 1 hour averaged $NO_2$ result was Scenario 1 – Delta Electricity, with a concentration of 105 µg/m$^3$. When added to the maximum background concentration of 116.9 µg/m$^3$, the cumulative concentration equates to 222 µg/m$^3$, which is below the regulatory criteria of 246 µg/m$^3$.

Stage 1 of the Delta Electricity Facility is expected to operate for approximately 500 hours of the year, and the modelling results shown in **Table 7-13** represents the worst case short-term (1 hour) predictions based on the Facility operating for every hour of the year and that all emitted $NO_X$ is present as $NO_2$. Consequently the impacts are likely to be significantly less than modelled.

The maximum annual average $NO_2$ result, assuming the facilities were running every hour of the year, was shown to occur in Scenario 1 – Delta Electricity, with a concentration of 0.33 µg/m$^3$. When added to the annual averaged $NO_2$ background concentration of 13.7 µg/m$^3$, the cumulative concentration of 14.0 µg/m$^3$, is below the criteria of 62 µg/m$^3$. Consequently, long term impacts are considered negligible.

**Photochemical Smog**

Photochemical smog is produced during extended periods of light winds (several hours to several days) accompanied by strong sunlight, as a result of reactions involving the precursor pollutants $NO_x$ and non-methane hydrocarbons (NMHCs). These reactions produce $O_3$, $NO_2$, peroxyacetyl nitrate and aldehydes. Aerosols are also formed, which result in visible orange-brown hazes.

While there is $NO_x$ available, the formation of photochemical smog is said to be in a “light-limiting” regime. When $NO_x$ is limiting the formation of smog, it is called “$NO_x$ limited”. Fresh $NO_x$ emissions, or the reaction of nitrogen oxide with partially oxidised NMHCs, may restart these photochemical reactions.

There are few major industrial sources of hydrocarbons in the area and emissions of $NO_x$ and VOCs from vehicles would be significantly lower than the levels experienced in major metropolitan air sheds such and Sydney and Melbourne. The potential for smog generation in Marulan is therefore considered to be low and photochemical smog is unlikely to occur due to operations of the Delta Electricity Facility.

The atmospheric dispersion modelling study has indicated that $NO_2$ emissions from the proposed Delta Electricity Facility would not result in exceedances of relevant ambient air quality criteria under normal operating conditions. It is therefore concluded that further quantitative investigations of any likely increases in the potential for smog generation as a result of the proposed Facility emissions are not warranted.

**Particulate Matter**

The maximum measured 24 hour average background concentration of $PM_{10}$ was shown to be 40.0 µg/m³, which is approaching the regulatory limit of 50 µg/m³. Given the maximum 24 hour averaged impact from Scenarios 1 through 3 is 1.1 µg/m³, $PM_{10}$ impacts from the Delta Electricity Facility are considered minor. Similarly, the annual averaged $PM_{10}$ impact was shown to be minor with a maximum predicted cumulative concentration 14.1 µg/m³, being less than the annual criteria of 30 µg/m³.

**Sulfur Dioxide**

All sulfur dioxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the discharge of sulfur dioxide from the Delta Electricity Facility.

**Carbon Monoxide**

All carbon monoxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the intermittent discharge of CO from the Delta Electricity Facility.

**Hazardous Air Pollutants**

In accordance with the *Approved Methods*, HAP were assessed for incremental impact and were below regulatory criteria. The most significant incremental impact was formaldehyde, for which the worst case 1 hour average concentration of 9.990 µg/m3 constituted 50 % of DECC criteria.

### 7.3.6 Potential Ambient Air Quality Impacts – Delta Electricity and EnergyAustralia Facilities

#### *Construction*

As the potential for dust generation would be managed for each Facility (or together as bulk earthworks progress at the same time for both Facilities), the assumptions presented in **Section 7.3.5** remain valid and cumulative impact from the construction of the two Facilities is not considered to be greater than the impact from each individual Facility.

#### *Operation*

The potential ambient air quality impacts are discussed below for the Delta Electricity and EnergyAustralia Facilities as represented in **Table 7-13** by 'Scenario 1 - Combined' and 'Scenario 2 - Combined'.

The dispersion modelling for the combined Facilities identified the following:

#### Oxides of Nitrogen

Modelling of the combined sources used the Janssen Method to estimate $NO_2$ concentrations for the 1 hour average. When added to the maximum background $NO_2$ concentration, a cumulative concentration was calculated to be 229.9 µg/m$^3$ (using the Janssen Equation to estimate $NO_2$ concentrations) which is below the DECC regulatory criteria of 246 µg/m$^3$.

The annual average $NO_2$ concentrations were estimated on the conservative basis that $NO_X$ existed as $NO_2$, and assuming the facilities were operating every hour of the year. The results provided in **Table 7-13** showed that all scenarios were below the criteria of 62 µg/m$^3$. Given the background concentration of 14.0 µg/m³, and the predicted worst case impact of concentrations at or less than 0.67 µg/m³, long term impacts are considered negligible.

### Photochemical Smog

The potential for photochemical smog generation is discussed in **Section 7.3.5** and is not considered to warrant further investigation.

### Particulate Matter

The maximum measured 24 hour average background concentration of $PM_{10}$ was shown to be 40.0 µg/m³, which is approaching the regulatory limit of 50 µg/m³. Given the maximum 24 hour averaged impact from Scenario 1 – Combined or Scenario 2 - Combined is 1.3 µg/m³, $PM_{10}$ impacts from the Facilities are considered minor. Similarly, the annual $PM_{10}$ impact was shown to be minor with a maximum predicted concentration of 14.1 µg/m³, being less than the annual criteria of 30 µg/m³.

### Sulfur Dioxide

All sulfur dioxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the discharge of sulfur dioxide from the Facilities.

### Carbon Monoxide

All carbon monoxide results were shown to be significantly below the regulatory criteria. Consequently, no adverse impacts on air quality are expected as a result of the discharge of CO from the Facilities.

### Hazardous Air Pollutants

In accordance with the *Approved Methods*, HAP were assessed for incremental impact and were below regulatory criteria. The most significant incremental impact was formaldehyde, for which the worst case 1-hour concentration of 9.99 µg/m$^3$ constituted 50 % of DECC criteria.

## 7.4 Aviation Safety

### 7.4.1 Methodology

Due to the plume rise from the Facility stack emissions, an aviation hazard analysis was performed and is presented in **Appendix D**. This scenario was chosen as this presents the most buoyant (worst case) plume rise conditions and accounts for a range of meteorological conditions over the modelled year.

The statistics have been compiled in accordance with the Civil Aviation Safety Authority's (CASA) Advisory Circular "*Guidelines for Conducting Plume Rise Assessments*" (June, 2004). Where there is potential for an exhaust plume with a vertical velocity greater than 4.3 m/s at the Obstacle Limitation Surface (OLS) of 110 m, a hazard analysis is required.

### 7.4.2 Assessment

This assessment involved the use of the TAPM model which was used to create site-specific meteorological data, including meteorology for the upper atmosphere. TAPM was also used to calculate plume rise trajectories for the stack emissions.

Due to the various development scenarios possible, the most conservative plume rise scenario was chosen, namely Delta Electricity Stage 1 (Operation) and EnergyAustralia operating for all hours of 2006 (the modelled year).

The modelling results show that the combined Facilities would produce exhaust plumes with vertical velocities that exceed 4.3 m/s above the OLS for approximately 60 % of the year, assuming both Delta Electricity and EnergyAustralia Facilities were running at full load for all hours of the year. The maximum, minimum and average heights at which the plume velocity is greater that 4.3 m/s are provided in **Table 7-14**.

**Table 7-14 Maximum, Minimum and Average Critical Plume Extents**

| | Critical Vertical Plume Extent (m) | Critical Horizontal Plume Extent (m) |
|---|---|---|
| Maximum | 852 | 262 |
| Minimum | 58 | 37 |
| Average | 133 | 92 |

### 7.4.3 Management

Whilst this assessment is considered conservative with respect to the modelled operating times and operating conditions, consideration would be given for the Facilities to be designated a potential hazard to aircraft operators in the area. The implementation of such a designation would be at the discretion of CASA.

Further consultation with CASA would be undertaken following detailed design. It is understood that CASA would require confirmation of any changes to the design that may affect the plume rise assessment. Prior to operation of the Facilities, CASA would need to be provided with the following information:

- “as constructed” coordinates in altitude and longitude of the Facilities;
- final height (in AHD) of the exhaust stacks; and
- ground level of the site (in AHD).

## 7.5 Summary of Mitigation Measures

**Table 7-15** presents a summary of the air quality mitigation measures. The phase of implementation is indicated in the table by *Cons* – Construction *Ops* – Operation, Design and Planning.

**Table 7-15 Summary of Mitigation Measures**

| Mitigation Measures | Implementation of mitigation measures | |
|---|---|---|
| | Delta Electricity Facility | Cumulative |
| Liaise with Civil Aviation Safety Authority (CASA) to address the issue of potential aviation hazard of the plant. | ✓ (Design) | ✓ (Design) |
| The Construction Environmental Management Plan would consider the most appropriate dust mitigation method suited to the activity and circumstances. This would likely include measures such as:<br>• watering, spraying or covering earthworks during excavation and handling and on exposed surfaces and stockpiles;<br>• scheduling activities for more favourable meteorological conditions;<br>• covering or limiting truck soil loads;<br>• reducing speed limits on unsealed surfaces; and<br>• cleaning soil off the undercarriage and wheels of trucks when required. | ✓ (Cons.) | ✓ (Cons.) |
| Any long-term stockpiles would be stabilised (for example using measures such as fast seeding grass or synthetic cover spray). | ✓ (Cons.) | ✓ (Cons.) |
| Delta Electricity monitors GHG emissions and thermal efficiency and when possible implements programs to improve operational performance and reduce emissions. | ✓ (Ops) | ✓ (Ops) |