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Delta Electricity

Proposed Gas Power Facility at Bamarang

Application to Modify the Project Approval - Section 75W Environmental Assessment

September 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Glossary & Acronyms

AGO	Australian Greenhouse Office
Approved Project (including "Stage 1" and "Stage 2" details)	The details as provided in Table 1
DoP	NSW Department of Planning
EA	Environmental Assessment
EP&A Act	*NSW Environmental Planning and Assessment Act 1979*
Gas turbine	The gas turbine unit consists of a compressor, combustion chamber, turbine and generator. Air is compressed to a high pressure before being admitted into the combustion chamber. Fuel (natural gas in this case) is injected into the combustion chamber where combustion occurs at very high temperature. The resulting mixture of hot gas is admitted into the gas turbine where the hot gases expand. The expansion of the hot gases converts heat energy into power by causing the turbine to turn.
Heggies Air Quality Report	Refers to the report *Proposed Gas Turbine Power Station Bamarang, NSW Air Quality Impact Assessment Stage 2 Operations*, 27 March 2008 (Heggies Australia Pty Ltd)
Heggies Noise Report	Refers to the report *Bamarang Proposed Gas Turbine Power Station Noise Assessment of Air Cooling Options*, 7 August 2008 (Heggies Australia Pty Ltd)
Marulan Noise Report	Refers to the noise and vibration assessment report that sits as Appendix E of the *Marulan Gas Turbine Facility Environmental Assessment* (August 2008). The Marulan Noise Report was undertaken by Wilkinson Murray (Report No. 05255 VG, August 2008)
NSW	New South Wales
Open cycle	In an open cycle configuration for a gas turbine, hot exhaust gas is vented directly to atmosphere through the exhaust stack, without heat recovery.
p.a.	*Per annum*
Project Approval	As per the definition in Part 3A of the EP&A Act
Proposed modification (to the Approved Project)	The Proponent now seeks approval to increase the operational capacity of the power facility from approximately 400 MW to approximately 450 MW.
Stage 1 EA	Refers to the report *Proposed Gas Power Facility at Bamarang near Nowra – Environmental Assessment*, May 2006 (GHD Pty Ltd)
Stage 2 EA	Refers to the report *Proposed Gas Power Facility at Bamarang Stage Two – Environmental Assessment*, April 2008 (GHD Pty Ltd)
The Proponent	Delta Electricity

Units of measurement

dB(A)	Decibel (A-weighted)
kV	Kilovolt
m	Metre
ML/d	Megalitres per day
MW	Megawatt

1. Introduction

1.1 Background

On 27 February 2007, Delta Electricity (the Proponent) received concept plan approval for the two-staged development of a new gas-fired power station at Bamarang approximately seven kilometres west of Nowra, in New South Wales. At the same time, Project Approval to develop the first stage of that power station was granted under Part 3A of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act). This first stage of the project ("Stage 1") comprises of the construction and operation of an approximately 300 MW open-cycle gas turbine facility, including ancillary gas pipeline and 132 kV transmission line infrastructure.

On 29 October 2008, the Proponent received Project Approval for Stage 2 of the Project. This stage will involve the conversion of the Stage 1 plant to a combined-cycle facility with an approximate capacity of 400 MW and the construction and operation of water supply infrastructure to supply both the Stage 1 and Stage 2 facilities.

The proposed 132 kV transmission line for connection of the Bamarang Gas Turbine Facility to the Shoalhaven Substation, under certain demand conditions, may place constraints on the output from the CCGT facility. Delta Electricity has been considering an alternative higher voltage electricity grid connection that would allow for output from the facility to a 330 kV network[1].

Additionally, on further consideration of available technologies and the likely use of the site for power generation, the Proponent now seeks approval to increase the operational capacity of the power facility to approximately 450 MW.

1.2 Previous Environmental Assessments

As part of the planning and approvals processes for Stage 1 and Stage 2 of the Project previous Environmental Assessments (EAs) have been undertaken:

- *Proposed Gas Power Facility at Bamarang near Nowra – Environmental Assessment*, May 2006 (hereon referred to as the "Stage 1 EA").
- *Proposed Gas Power Facility at Bamarang Stage Two – Environmental Assessment*, April 2008 (hereon referred to as the "Stage 2 EA").

Both of those EAs were undertaken by GHD Pty Ltd.

An EA on the proposed modification for a 330 kV network connection has also been undertaken, as outlined in:

- *Bamarang Gas Fired Power Station: Modification for a 330 kV Network Connection – Environmental Assessment*, July 2009.

That assessment was undertaken by Sinclair Knight Merz (SKM).

[1] *Bamarang Gas Fired Power Station: Modification for a 330 kV Network Connection – Environmental Assessment*, July 2009

1.3 Purpose of this Environmental Assessment

The Proponent seeks to modify the Project Approval that has been granted for Stage 2 of the development under Section 75W of the EP&A Act to allow for a facility with a capacity of approximately 450 MW rather than approximately 400 MW. No other changes to the approved facility are proposed.

This Environmental Assessment report has been prepared to support an application by the Proponent to modify the Project Approval.

1.4 Approach

The objective of this assessment was to determine whether the environmental impacts associated with the proposed modifications:

- may be different to or beyond those that were described in the original Environmental Assessment for Stage 2 of the Project, or
- may be in breach of the specific environmental conditions of the existing Project Approval

The approach adopted to undertake this Environmental Assessment was:

1. Describe the Approved Project, including the conditions of approval (Section 2)
2. Outline the statutory framework under which this modification to the Project Approval is being sought (Section 3)
3. Describe the proposed modifications to the Project (Section 4)
4. Identify and document any modified or new mitigation measures or environmental safeguards that may be required to accommodate the proposed modification (Section 5). This was done by conducting:
   (a) an assessment of the environmental impacts of the proposed modification & comparing them to the impacts described in the Stage 2 EA, and
   (b) a revision of the statement of commitments listed in the Stage 2 EA.

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2. The Project

A justification, description and discussion of the Project have been provided in the Stage 1 EA and Stage 2 EA. A short summary highlighting only the points that are relevant to this report is provided in the following sections.

2.1 Overview

2.1.1 Need for a power generating facility at Bamarang

A shortfall in electricity supply is predicted to occur in NSW within the next few years. Analysis of electricity supply and demand shows that the level of demand in NSW is increasing by approximately 3% per year, with summer peak load demand growing by approximately 500 MW per year. Based on current rates of supply, it is predicted that NSW will need to rely on imports from interstate to meet minimum requirements from 2005/06, and that by 2008/09 NSW will not be able to source additional supply from other states.

The Owen Inquiry into Electricity Supply in NSW found that, with a risk-averse approach, NSW needs to be in a position where new base load power generation can be operational by 2013/2014 if necessary, in order to avoid potential energy shortfalls.

Consistent with this finding, the Proponent has progressed with plans and has gained Planning Approval to construct a gas fired power facility at Bamarang.

2.1.2 Why a gas fired power station?

Gas fired combined cycle plants produce less carbon dioxide per unit energy output than other fossil fuel technologies because of the relatively high thermal efficiency of the technology and the high hydrogen-carbon ratio of methane (the primary constituent of natural gas).

A combined cycle gas turbine power facility consists of one or more gas turbine generators equipped with heat recovery steam generators to capture heat from the gas turbine exhaust.

Steam produced in the heat recovery steam generators powers a steam turbine generator to produce additional electric power. Use of the otherwise wasted heat in the turbine exhaust gas results in high thermal efficiency. Because of their high thermal efficiency, relatively low initial cost, high reliability, relatively low gas prices and low air emissions, combined cycle gas turbines are increasingly playing an important role in base load power generation. Other advantages include significant operational flexibility, the availability of relatively inexpensive power augmentation for peak period operation and relatively low carbon dioxide production.

2.2 The Proponent

Delta Electricity is an electricity generation company owned by the NSW Government (a State owned corporation). Delta produces around 12% of the electricity consumed in the national electricity market, which covers consumers in NSW, South Australia, Queensland, Victoria, the ACT and Tasmania.

2.3 Existing Approvals and Conditions

The Proponent has attained the following Project Approvals under Part 3A of the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act):

- On 27 February 2007 - Project Approval for Stage 1 of the Project (from hereon referred to as the "Stage 1 Approval"). This stage comprises of the construction and operation of a 300 MW open-cycle gas turbine facility, including ancillary gas pipeline and transmission line infrastructure.
- On 29 October 2008 - Project Approval for Stage 2 of the Project (from hereon referred to as the "Stage 2 Approval"). This stage involves the conversion of the Stage 1 plant to a combined-cycle facility with a capacity of approximately 450 MW and the construction and operation of water supply infrastructure to supply both the Stage 1 and Stage 2 facilities.

On each occasion the Minister for Planning was the Approval Authority and the approvals were granted subject to a series of Limit of Approval conditions ("Stage 1 Conditions" and "Stage 2 Conditions" respectively).

2.4 Description of the Approved Project

A summary of the Approved Project is provided below (Table 1). Further relevant details to enable the assessment of environmental impacts associated with the proposed modification are provided in later sections of this report.

Table 1 Summary of the Approved Project details

Infrastructure	Stage 1	Stage 2
Gas Power Facility	Two gas turbines with an electrical output in the range of 130 – 150 MW each Step-up transformers to convert the generator output to 132 kV for transmission 132 kV switchyard containing electrical equipment for connection to transmission lines Gas piping to deliver fuel gas to the turbines	Two heat recovery steam generators connected to the gas turbine generators Steam turbine with an electrical output of approximately 100 MW Steam generator step-up transformer
Ancillary on-site infrastructure	Electrical and control building used to monitor the power station Administration building Access roads, car parking area and site drainage	Cooling tower (air) Water storage and treatment plant
Gas supply	A 150 mm gas pipeline approximately 900 m in length, would be provided to allow natural gas to be supplied to the proposed facility from the eastern gas pipeline	-
Electricity transmission connections	A 132 kV electricity transmission line, approximately 7.2 km in length, would be provided to connect the proposed facility to the electricity distribution network	-
Electricity generated	Approximately 300 MW	Approximately 400 MW
Employment (estimate maximum)	Construction – 100 – 150 employees Operation 8 employees	Construction 200 – 300 employees Operation *ca.* 18 employees
Water Supply	Domestic – Nowra potable supply (0.2 ML *p.a.*) Process water – Nowra potable supply (2 ML *p.a.*)	Domestic water – Nowra potable supply (0.4 ML *p.a.*) Process water – Nowra potable supply (~ 0.5 ML/d)

3. Statutory Framework

As the proposed increased capacity of the gas power facility is not covered by the current Project Approval, an application must be made to the NSW Department of Planning (DoP). Under Section 75W of the EP&A Act, a proponent may request the Minister to modify the Minister's approval for a project.

The proposed modification would involve changing the terms of the Minister's approvals; (DoP reference 06_0029) for Concept Approval for stages 1 and 2, by seeking a variation to Condition 1.1 and (DoP reference 08_0021) for stage 2 of the project, by seeking a variation to Condition 1.6, which states:

"The proposal shall comprise two heat recovery steam generators and one steam turbine with a total nominal output capacity of approximately 400 MW."

Modification requests under Section 75W are lodged with the Director-General of the Department of Planning. The Director-General will then notify the proponent of environmental assessment requirements, if any, with respect to the proposed modification that the proponent must comply with before the matter will be considered by the Minister.

No specific procedures for Section 75W modifications have been established by the Department of Planning. Their advice has been that the general procedures for modifications of Part 4 approvals under Section 96 will be applied. Therefore, initial consultation with the department was required to inform them of the proposed modification. Delta Electricity have consulted with the department who have agreed that the proposed change can be considered as a modification under Section 75W.

4. Proposed Modifications

4.1 Concept

The Proponent now seeks approval to increase the operational capacity of the power facility from approximately 400 MW to approximately 450 MW. This is based on a consideration of the gas turbines that are commercially available.

4.2 Details

To accommodate the increased operational capacity of the plant described above, the details of the proposed gas turbine units and plant layout will need to be modified. The extents of the modifications (from the descriptions in the Stage 2 EA) are detailed below. No other modification details are proposed.

4.2.1 Gas turbine units

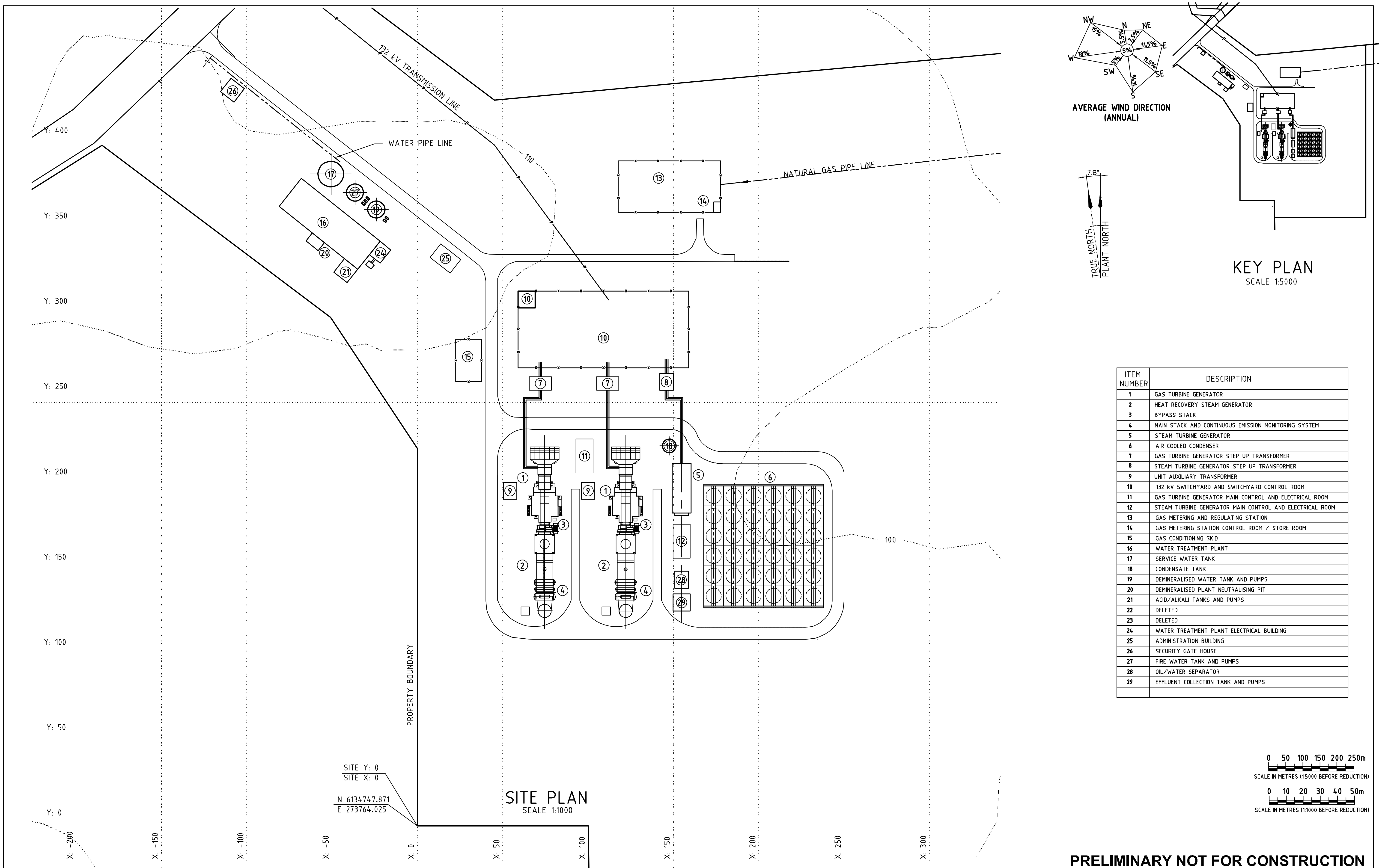
The approved configuration of the plant consists of two “generic” 150 MW gas turbine units plus a steam turbine generator in a combined cycle configuration (CCGT) for a 400 MW electricity generation capacity. To enable the required modified base load plant capacity, an assessment has been carried out with consideration of two larger gas turbines and a steam turbine generator. Alstom 13E2 units have been used as representative of gas turbines to achieve the total overall CCGT 450 MW output. These units are slightly larger in size (in particular, they are approximately 20 m longer) than the “generic” gas turbine units described in the Stage 2 EA.

4.2.2 Plant layout

A nominal modified plant layout is shown in Figure 1.

Specifically, the location of the 132 kV switchyard and switchyard control room would need to move north to accommodate the longer gas turbines, as depicted. However under the arrangements shown in Figure 1, the general ‘footprint’ of the plant layout (in terms of land that would require clearing to enable construction and plant operation, ecological impacts, and taking into account bushfire Asset Protection Zones) would not alter in comparison to the layout described in the Stage 2 EA.

The location and dimension of all plants are subject to detailed design.



ITEM NUMBER	DESCRIPTION
1	GAS TURBINE GENERATOR
2	HEAT RECOVERY STEAM GENERATOR
3	BYPASS STACK
4	MAIN STACK AND CONTINUOUS EMISSION MONITORING SYSTEM
5	STEAM TURBINE GENERATOR
6	AIR COOLED CONDENSER
7	GAS TURBINE GENERATOR STEP UP TRANSFORMER
8	STEAM TURBINE GENERATOR STEP UP TRANSFORMER
9	UNIT AUXILIARY TRANSFORMER
10	132 kV SWITCHYARD AND SWITCHYARD CONTROL ROOM
11	GAS TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
12	STEAM TURBINE GENERATOR MAIN CONTROL AND ELECTRICAL ROOM
13	GAS METERING AND REGULATING STATION
14	GAS METERING STATION CONTROL ROOM / STORE ROOM
15	GAS CONDITIONING SKID
16	WATER TREATMENT PLANT
17	SERVICE WATER TANK
18	CONDENSATE TANK
19	DEMINERALISED WATER TANK AND PUMPS
20	DEMINERALISED PLANT NEUTRALISING PIT
21	ACID/ALKALI TANKS AND PUMPS
22	DELETED
23	DELETED
24	WATER TREATMENT PLANT ELECTRICAL BUILDING
25	ADMINISTRATION BUILDING
26	SECURITY GATE HOUSE
27	FIRE WATER TANK AND PUMPS
28	OIL/WATER SEPARATOR
29	EFFLUENT COLLECTION TANK AND PUMPS

PRELIMINARY NOT FOR CONSTRUCTION

No	Revision	Note: * Indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date

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This Drawing must not be used for Construction unless signed as Approved

Client: DELTA ELECTRICITY
Project: 450 MW COMBINED CYCLE POWER PLANT - BAMARANG
Title: APPROVED Vs PROPOSED MODIFICATION

Original Size A1 Drawing No: **Figure 1** Rev: A

Plot Date: 12 October 2009 - 9:38 AM Plotted by: Cameron Cassar, Brisbane Cad File No: N:\AU\Sydney\Projects\21\16013\CADD\Drawings\Figure 1(09,10,09).dwg

5. Environmental Assessment

5.1 Scope

The focus areas for this assessment are the same as those that were assessed for the original Stage 2 EA, namely:

- Water demand
- Noise and vibration
- Air quality
- Landuse and zoning
- Ecology
- Indigenous heritage
- Bushfire
- Visual impact
- Greenhouse gases

This assessment was undertaken in two steps:

- Firstly, by determining whether the proposed modification *may* incur environmental impacts that may differ to those described in the Stage 2 EA for each of the above criteria (*i.e.* by doing a **screening assessment** as per Section 5.2), and
- Secondly, if the screening assessment indicates that different impacts *may* be incurred for any of the above criteria, then:
  - **further assessing** these impacts against the original Stage 2 EA results, adopted criteria & Conditions of Approval, and
  - **documenting** any mitigation requirements that may be required.

5.2 Screening assessment

Broadly, the environmental investigation areas listed above can be divided into two categories:

1. 'Footprint' issues – which are those issues whereby the severity of the impact can be considered as directly related to the land area that would be disturbed during the construction and operation of the plant. The issues in this category are: landuse & zoning, ecology, bushfire (in terms of hazard management), and visual impact.
2. 'Input-Output' issues – which are those issues whereby the impact is measurable in terms of the resource requirements (inputs) for the operation to run, or, in terms of emissions produced during operation (outputs). The issues in this category are: water demand, air quality impacts, noise & vibration, and greenhouse gases.

As indicated in Section 4, and shown in Figure 1 the 'footprint' of the plant will be unchanged as compared to that described and assessed in the existing Stage 1 and Stage 2 Project Approvals. Hence the assessments and statements described in the Stage 2 EA and in the Project Approval in regard to these issues are still applicable. These 'footprint' issues do not require further assessment.

The increased power generation capacity may result in a need for additional resources or in the generation of greater levels of emissions. Hence, the 'input-output' issues may be impacted by the increased operating and power generation capacity. These have been reassessed, as outlined in the following Sections 5.3 - 5.6.

5.3 Water Demand

5.3.1 Water demand assessment

The Stage 2 EA outlined that the process water demands for operating the plant were in the order of ~ 0.5 ML/d. The process water demand at the site is driven by other processes and is not directly related to the size of the gas turbines.

5.3.2 Outcome

The water uses, demands and supply infrastructure requirements described in the Stage 2 EA are not to be altered or impacted by the proposed modification.

5.4 Noise and Vibration

5.4.1 Noise and vibration assessment

A noise and vibration assessment was undertaken as part of the Stage 2 EA. This assessment was detailed in the report *Bamarang Proposed Gas Turbine Power Station Noise Assessment of Air Cooling Options* (7 August 2008) undertaken by Heggies Australia Pty Ltd. (from hereon referred to as the Heggies Noise Report). The Stage 2 EA and Conditions of Approval include a list of noise mitigation requirements so as to meet adopted noise and vibration targets[2].

For the purpose of this report, a subsequent noise data review was undertaken by GHD to determine if the noise source levels generated by a plant that generates approximately 450 MW may be greater than those modelled in the Heggies Noise Report.

5.4.2 Data review

Noise data for the original Bamarang assessment (outlined in the Heggies Noise Report) was supplied by Delta Electricity.

For this assessment, GHD were supplied the Appendix E noise and vibration assessment report for the *Marulan Gas Turbine Facility Environmental Assessment* (August 2008). The Marulan noise and

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[2] As part of a previous noise impact assessment undertaken by GHD (and this is described in the Stage 1 EA), an ambient noise study was conducted to determine design criteria in accordance with the Department of Environment and Climate Change's Industrial Noise Policy (INP). Given the power station may operate 24 hours per day it was determined that the more stringent night-time criteria apply of a continuous equivalent noise level of 35 dB (A) for all the receivers. This noise criterion was also used in the updated noise assessment.

vibration assessment report, undertaken by Wilkinson Murray (Report No. 05255 VG), from hereon referred to as the Marulan Noise Report, provides noise levels for the following scenarios:

- Stage 1 – Two open cycle gas turbine (OCGT) with a total capacity in the range of 250 to 350 MW; and
- Stage 2 – Conversion to combined cycle gas turbine (CCGT) with a total capacity range of 400 to 450 MW.

As such, the Stage 2 scenario was similar to the proposed modification at Bamarang, and the noise data outlined therein was compared to the outputs from the Heggies Noise Report (see below).

5.4.3 Comparison of modelled equipment Sound Power Levels (SWL)

A comparison between the equipment sound power levels (SWL) described in the Heggies and Marulan Noise Reports are shown in Table 1. The attenuation used in the Heggies Noise Report has been incorporated into the table for comparison. There are some variances in equipment noise levels, with the most prominent difference being the stack exit.

Table 1 Comparison of equipment SWL including attenuation, dB(A)

Equipment	Heggies Noise Report	Marulan Noise Report	Difference
Combustion Turbine Generator	111	113	+2
Stack exit	100 (15 dB(A) attenuation)	110 (includes attenuation)	+10
Generator Transformer	105	102	-3
Air cooled condenser	102 (10 dB(A) attenuation)	105 (5 dB(A) attenuation)	+3
Heat recovery steam generator	102 (10 dB(A) attenuation)	100 (5 dB(A) attenuation)	-2
Steam turbine	107	110	+3
Pumps / motors	105 (5 dB(A) attenuation)	N/A	-
Water treatment plants	N/A	83	-

The Heggies Noise Report specifies that the dominant noise source at the receivers is from the stack exits. The Bamarang stack was modelled with a SWL of 115 dB(A). In order to achieve the environmental noise criteria of 35 dB(A) additional silencers were recommended to attenuate the stack noise by 15 dB(A) to a SWL of 100 dB(A). The stack was modelled at a height of 27 m in the Heggies Noise Report. The stack emits low frequency noise which is difficult to attenuate, therefore a 15 dB(A) reduction with the installation of a silencer may have been optimistic.

The Marulan Noise Report silenced stack is 10 dB(A) greater and 13 m higher than the silenced stack used in the Heggies Noise Report. Since the stack was predicted to be the dominant noise source on site there is likely to be an increase in the noise levels at the receivers, which would require attenuation, as described below.

5.4.4 Noise mitigation requirement

In summary, the data review indicated that there is likely to be an increase in the equipment sound power levels associated with the turbine units required to generate approximately 450 MW as compared to what was modelled as part of the Stage 2 EA, especially in regard to the noise emanating from the stacks. This will require additional noise attenuation measures in order to meet the adopted operating noise criteria. The details of the necessary attenuation is described above, however in short, the sound power level emanating from the stack will need to be limited to 100 dB (A) with the aid of attenuation/silencers.

An original equipment manufacturer has provided advice that this attenuation would be achievable.

5.5 Air Quality

5.5.1 Air quality and plume rise assessment

An air quality assessment was undertaken as part of the Stage 2 EA. This assessment was detailed in the report *Proposed Gas Turbine Power Station Bamarang, NSW Air Quality Impact Assessment Stage 2 Operations* (27 March 2008) undertaken by Heggies Australia Pty Ltd (from hereon referred to as the Heggies Air Quality Report). Apart from the general air quality considerations for the protection of environment and health, the Stage 2 EA also addressed issues associated with the plume rise from the stacks of the power plant and its potential to interfere with an aircraft flight path. The Stage 2 EA and Conditions of Approval include a list of air quality protection requirements and measures to reduce the impact of the plume rise on the aircraft flight path.

For the purpose of this report, a subsequent air quality data review was undertaken by Heggies to determine if the air quality and plume rise issues generated by the proposed modifications may be greater than those modelled in the Heggies Air Quality Report. The details of this review are provided at Appendix A.

The review has found that the assumptions made in regard to the plant layout and the air condensed cooler details as documented in the original Heggies Air Quality Report had resulted in highly conservative estimates of pollutant emissions being and plume characteristics being modelled exiting the power plant. Those assumptions were revised and amended as part of this current work to better reflect the present understanding about how the plant will be laid out and operated. Despite slight increases in the exit velocity and pollutant emission rates expected to occur in association with an increase to a 450 MW plant, such levels had already been adequately considered as part of the Stage 2 approvals process due to the extent of the conservatism in the original modelling.

The review of the air quality impact assessment (Appendix A) concluded that such an increase in exit velocity and pollutant emission rates would not significantly enhance the potential of the Project to adversely impact upon the surrounding environment with regards to ambient air quality and vertical plume rise.

5.5.2 Result

The Conditions of Approval associated with air quality and plume rise do not require any amendments in relation to this proposed modification.

5.6 Greenhouse Gas Assessment

5.6.1 Emissions estimates

Annual natural gas consumption could also increase as a result of the increase in generation capacity from approximately 400 MW to 450 MW. Consequently, greenhouse gas emissions for the operation of the approximately 450 MW facility were assessed.

A greenhouse gas assessment was undertaken as part of the Stage 2 EA. As part of the updated air quality impact assessment undertaken by Heggies (as contained in Appendix A of this report greenhouse gas impacts of the operations of an approximately 450 MW plant were examined.

This assessment has shown that the greenhouse gas impacts of the proposed modification to the gas power facility will increase as compared to the figures from the Stage 2 EA (Table 2).

Table 2 Predicted emissions of greenhouse gases - natural gas-fired turbine engines (dry cooling)

Compound:	CO_2	CH_4	NO_2	Total
Estimated emissions (tonnes/year)	For 400 MW plant[a] 1.25 M	192	2.4	1.25 M
	For 450 MW plant[b] 1.59 M	3 040	913	1.56 M
CO_2-equivalent (tonnes/year)	For 400 MW plant: 1.25 M	4 030	744	1.25 M
	For 450 MW plant: 1.59 M	63 900	283 000	1.91 M
% of CO_2 emissions of Australian electricity generation, 1990	For 400 MW plant: 0.96 %	0.00313 %	0.00058 %	0.97 %
	For 450 MW plant: 1.2 %	0.05 %	0.22 %	1.47 %
% of CO_2 emissions of Australian electricity generation, 2002	For 400 MW plant: 0.68 %	0.00222 %	0.00041 %	0.68 %
	For 450 MW plant: 0.78 %	0.03 %	0.14 %	0.96 %

[a] As listed in the Heggies Air Quality Report that sits as Appendix C of the Stage 2 EA; [b] As listed in the revised air quality assessment (at Appendix A of this report)

5.6.2 Greenhouse gas abatement strategies

As the second largest electricity generator in Australia, Delta recognises its responsibility to continue to meet increasing energy demands, the need to deliver this energy in the most sustainable form practicable, and to meet the increasing concerns of the global community regarding global warming.

Delta currently manages greenhouse gas abatement at a whole-of-organisational level, through participation in the Australian Government's Greenhouse Challenge (Plus) Program and the Generator Efficiency Standards Program. These programs are established by the Australian Greenhouse Office (AGO) of the Commonwealth Department of Environment, Water, Heritage and Arts (DEWHA).

The AGO provides a range of programs and initiatives designed to assist Australian business and industry to meet Australia's Kyoto target.

The approach to greenhouse gas abatement adopted by Delta includes:

- Minimising impacts of existing coal-fired plants;
- Investigating transitional, combined technologies; and

- Developing new renewable energy technologies for the future.

While natural gas is a non-renewable fuel source, the proposal provides increased energy efficiency over traditional coal fired power stations.

Through its commitment to the Generator Efficiency Standards and the Greenhouse Challenge Program, Delta has implemented a range of greenhouse gas emissions abatement measures including:

- Technology upgrades and replacement for older stations;
- Installation of control systems;
- Introducing co-firing of renewable fuels (biomass) as a fuel feed at coal fire power stations; and
- Installation of a number of mini-hydro power stations and sugar mill cogeneration projects to increase the production of electricity from renewable sources.

In the 2002/2003 period, Delta achieved abatement of 304 000 tonnes of CO_2 equivalent from projects implemented under the Generator Efficiency Standards and Greenhouse Challenge programs. Development of cogeneration plants with sugar mills in NSW are expected to achieve some 400 000 tonnes of greenhouse gas abatement each year.

Implementation of the proposed gas power facility will follow the introduction of the new National Greenhouse and Energy Reporting Act of 2007. This Act introduces a mandatory single national framework for reporting and disseminating information on greenhouse gas emissions. The Act will underpin the introduction of a national emission trading scheme which Delta Electricity will participate in. The completion of the mandatory reporting and participation in any future Emissions Trading Scheme will incorporate Delta Electricity's current activities described above and include this project.

6. Environmental Management & Proposal Evaluation

6.1 Proposed amendments to the Minister's Conditions of Approval

The proposed modification would require changing the terms of the Minister's approval (Project Approval 08_0021), by seeking a variation to Limit of Approval condition 1.6, to read:

The proposal shall comprise two heat recovery steam generators and one steam turbine with a total nominal output capacity of approximately 450 MW.

No other amendments would be required.

6.2 Statements of Commitment

In Chapter 8 of the Stage 2 EA, a statement of commitments was listed. Having reviewed the details and potential environmental impacts of the proposed modification, it has been concluded that the same commitments are applicable. In particular, below is a reiteration of the commitments that were made in regard to the areas of noise, air quality and greenhouse gases:

6.3 Evaluation of the proposal (conclusion)

The Proponent has requested the Project Approval to be modified to allow for approximately 450 MW, rather than 400 MW, capacity gas fired power plant to be located at Bamarang, NSW. The proposed modification is considered to be justified, as it would enable the Proponent to make use of current, commercially available gas turbine technology.

The environmental impacts of the proposal are considered to be minor and justified because:

- The 'footprint' of the plant layout, *i.e.* the extent of the land that would be cleared or disturbed for construction and operation of the power facility, would be unaltered as compared to the currently approved layout;
- The proposed modification would not increase the facility's water demand;
- The proposed modification would likely see increases in the exit velocity and the amount of emissions generated from the power plant stacks as compared to the Approved Project, however the increases would not jeopardise the ability of the facility to meet the air quality and plume rise targets set out in the Stage 2 EA and the Minister's Conditions of Approval;
- The proposed modification may result in greater noise emanating from the facility's stack. These will require attenuation through the use of silencers. Advice has been received that the stack sound power level targets set out in the Stage 2 EA could be met.
- Greenhouse gas emissions will be larger as a result of the modification, though not significantly. The Proponent would continue to meet its greenhouse gas commitments under the Commonwealth Government's Generator Efficiency Standards and Greenhouse Challenge (Plus) Program. Under these agreements, the Proponent is committed to achieving greenhouse gas emissions abatement through diversification of its generation portfolio, reflecting community and government expectations of a sustainable future for electricity generation.

Potential impacts from the proposal are considered to be minor and would not significantly change environmental impacts from the overall project. These impacts would be managed by implementing the Minister's Conditions of Approval and Statement of Commitments that are already in place.

Table 3 Statement of commitments: air quality, noise and greenhouse gases

Issue	Commitment	Timing
Air quality	*Operating conditions* Natural gas is the only fuel to be used for firing the power station turbines. All activities at the premises would be undertaken in a manner that does not cause or permit the emission of offensive odour beyond the boundary of the premises. All plant and equipment installed at the premises or used in conjunction with the construction or operation of the facility activity would be maintained in a proper and efficient condition and would be operated in a proper and efficient manner.	Operation
	Discharge limits The project air quality goals specified by the project approval for stage two are achieved. The proposal would be designed and operated to ensure that the concentration of each pollutant listed in Table 7.4 of Stage 2 EA would not be exceeded for each discharge point.	Design, operation
	Dust emissions All activities undertaken would be carried out in a manner that minimises the generation of dust, or emission of dust from the site, including windblown and traffic generated dust. Measures proposed to minimise dust would be specified in the construction and operation environmental management plans.	Construction, operation
Greenhouse gases	*Delta's greenhouse commitments* Delta would continue to meet its commitments under the Commonwealth Government's Generator Efficiency Standards and Greenhouse Challenge (Plus) Program. Under these agreements, Delta is committed to achieving greenhouse gas emissions abatement through diversification of its generation portfolio, reflecting community and government expectations of a sustainable future for electricity generation. Delta's approach to greenhouse gas abatement includes: ◗ Minimising impacts of existing coalfired plants ◗ Investigating transitional, combined technologies ◗ Developing new renewable energy technologies for the future	Construction, operation
Noise and vibration	*Noise emission limits* The project noise criteria specified in Table 9.2 and 9.3 of the Stage 1 EA are achieved. The proposal would be designed, constructed and operated to ensure that noise criteria are not exceeded. The contractor responsible for the design and management of the facility would be required to meet noise criteria.	Design, construction, operation
	Construction time restrictions ◗ Monday to Friday: 7am to 6pm; ◗ Saturday: 7am to 1pm if inaudible at a residential premises, otherwise 8am to 1pm; and ◗ No work on Sundays or Public Holidays.	Construction
	Noise attenuation on machinery	Construction

Issue	Commitment	Timing
	All practical measures would be used to silence construction equipment, particularly in instances where extended hours of operation are required.	
	Noise management strategy to be prepared ◗ A noise management strategy would be prepared as part of the construction environmental management plan, detailing the methodology proposed by the construction contractor and the relative phasing of different construction activities in different areas. This would also outline a program of operational noise monitoring. ◗ To achieve the construction noise criteria at the closest residence (as depicted in the Heggies Noise Report and the Stage 2 EA) the overall sound power level from construction as a guide should not exceed approximately 112 dB(A).	Construction

Appendix A

Air Quality Assessment Details

8 October 2009

10-4044 Addendum to AQIA 20091008.doc

GHD Pty Ltd
GPO Box 1877
Canberra ACT 2601

Attention: Ryan Signor

Dear Ryan

Addendum to Air Quality Impact Assessment Proposed Gas Turbine Power Station Bamarang, NSW

1 Introduction

Heggies Pty Ltd (Heggies) have been historically contracted by GHD Pty Ltd (GHD) on behalf of Delta Electricity (DE) to conduct an air quality impact assessment for the proposed gas turbine power station at Bamarang, NSW (hereafter, the Project).

The Project was designed to be implemented in two stages:

- Stage 1: Open Cycle Gas Turbine facility for peaking periods. Generation capacity of 300 MW; and
- Stage 2: Conversion of facility to Combined Cycle Gas Turbine for base load power supply. Generation capacity of 400 MW.

Stage 1 of the Project gained approval in March 2007. Concept approval was also granted for Stage 2.

It is understood that DE propose to increase the capacity of the Stage 2 phase of the Project from 400 MW to 450 MW.

The purpose of this document is to review potential changes in operational conditions that may result in the increase in generation capacity and the implications for the air quality impact assessment and associated studies, including plume rise assessment.

2 Amendments to Project Operation

GHD have provided Heggies with emissions data for a range of operating conditions for the 450 MW Stage 2 facility. A summary of the full-load exit parameters for the 450 MW facility are given in **Table 1**. Additionally, the parameters adopted for the 400 MW power station (as per Table 13 of Heggies Report 10-4044R3R1, dated 27 March 2008) are presented in brackets in **Table 1** for comparative purposes.

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It is noted that as per the previous Project configuration, information from the technical design team indicates that operational emissions of SO_2 and PM_{10} are anticipated to be negligible. Within Heggies Report 10-4044R3R1, in order to predict "worst-case" conditions, an emission rate for SO_2 was derived based on sulphur content limits for natural gas of 50 mg/Nm^3. An emission rate for particulate was also derived based on vendor maximum of 10 kg/hour for a gas fired turbine (URS, 2001).

These values have also been adopted within this document. It is considered that these parameters will be appropriately conservative despite the increase of 400MW to 450MW.

Table 1 Full Load Stack Exit Parameters – Stage 2 Operations

Stack Parameter	**East and West HRSG Exhaust Stacks**			
Description	Exhaust stack servicing the Eastern Gas Turbine, operating in Combined Cycle mode. Combustion gases passed through the Heat Recovery Steam Generator prior to exhaust			
Location (Easting, Northing)	273812 6134875		273851 6134869	
Height (m)	40		40	
Diameter (m)	6.7		6.7	
Area (m^2)	35.3		35.3	
	Ambient Temperature (K)			
	273 (0°C)	**288 (15°C)**	**298 (25°C)**	**313 (40°C)**
Exit Temperature (K)	403 (398)	404 (422)	406 (416)	409 (406)
Flow Rate (Nm^3/s)	414 (392)	416 (372)	418 (360)	402 (339)
Flow Rate (Am^3/s)	612 (572)	616 (575)	623 (548)	604 (503)
Exit Velocity (m/s)	17.4 (16.0)	17.5 (16.2)	17.7 (15.5)	17.1 (14.2)
Atmospheric Pollutant				
Particulate Matter (g/s)	2.8 (2.8)	2.8 (2.8)	2.8 (2.8)	2.8 (2.8)
Sulphur Dioxide (g/s)	0.5 (0.5)	0.5 (0.5)	0.5 (0.5)	0.5 (0.5)
Oxides of Nitrogen (g/s)	20.0 (18.3)	19.9 (17.2)	19.8 (16.7)	19.2 (15.6)
Carbon Monoxide (g/s)	4.9 (4.4)	4.8 (4.2)	4.8 (4.2)	4.7 (3.9)
Unburnt Hydrocarbons (g/s)	2.0 (1.7)	1.9 (1.7)	1.9 (1.7)	1.9 (1.4)

NOTE: Values in brackets indicate parameters adopted in Heggies Report 10-4044R3R1 for 400 MW power station.

In order to conservatively assess the potential air quality impacts associated with the Project, all dispersion modelling conducted by Heggies has historically assumed that the provided emissions data associated with an ambient temperature of 273 K (0°C) occur continuously. Emissions at 273 K equate to worst case operational conditions. A comparison between the emissions parameters adopted in Heggies Report 10-4044R3R1 and the 450MW operations are provided in **Table 2**.

Table 2 Comparison between 400MW and 450MW Operational Emissions

Parameter	Operational Details at 273K Ambient Temperature		Percentage Change
	400MW	**450MW**	
Exit Temperature (K)	398	403	1%
Flow Rate (Nm^3/s)	392	414	6%
Flow Rate (Am^3/s)	572	612	7%
Exit Velocity (m/s)	16.0	17.4	9%
Particulate Matter (g/s)	2.8	2.8	0%[1]
Sulphur Dioxide (g/s)	0.5	0.5	0%[1]
Oxides of Nitrogen (g/s)	18.3	20.0	9%
Carbon Monoxide (g/s)	4.4	4.9	11%
Unburnt Hydrocarbons (g/s)	1.7	2.0	18%

NOTE 1: Emission for PM and SO_2 are likely to be negligible for both 400MW and 450MW power stations. Highly conservative emission rates assumed in Heggies Report 10-4044R3R1 for the 400MW facility have been carried across to 450MW.

It can be seen through the comparison presented in **Table 2** that the increase in power generation capacity between 400MW and 450MW will result in an increase in exit velocity and key pollutant emission rates.

3 Air Quality Implications

Due to the potential changes in operational emissions from the 450MW facility, it is prudent to conduct some investigation into the potential implications relating to ambient air quality. 10-4044R3R1 identified that the key pollutant of concern associated with the Project was 1-hour average concentrations of Nitrogen Dioxide (NO_2). While the predicted levels of NO_2 were well within the assessment criterion, all other pollutants were predicted to be significantly lower than the corresponding goals. Consequently, to assess the significance of the changes to emission parameters associated with the increase of generation capacity from 400MW to 450MW, only modelling of 1-hour average NO_2 for the new operational conditions has been conducted.

As per Heggies Report 10-4044R3R1, dispersion modelling has been conducted utilising the CSIRO's TAPM. All details regarding model configuration, including input meteorology, receptor locations and NO_X-NO_2 conversion, is contained within Heggies Report 10-4044R3R1. Emissions data for the two turbine stacks has been updated as per **Table 1**.

It is noted that Heggies Report 10-4044R3R1 provided extended discussion relating to the potential plume rise enhancement associated with the merging of the two exhaust plumes and the nearby air cooled condenser (ACC) system. In particular, to account for the influence of the ACC system on the plume from the turbine stacks, an hourly-varying plume rise enhancement parameter was applied throughout the dispersion modelling process. Information recently provided by GHD has indicated that the exit velocity and associated plume enhancement potential was significantly overestimated in Heggies Report 10-4044R3R1. Further discussion relating to these changes will be made in **Section 4** of this document.

For the NO_2 modelling conducted in this document, no accounting for plume enhancement, either from the merging of the two turbine stack plumes or the ACC system, has been made. This approach is considered appropriate for the screening-level modelling as the reduced plume rise potential will likely result in higher concentrations in the near-field surrounding the Project Site.

Table 3 presents the modelling results for 1-hour average NO_2 at the six key receptor locations for the 400MW and 450MW facility configurations, along with the percentage change between the two scenarios.

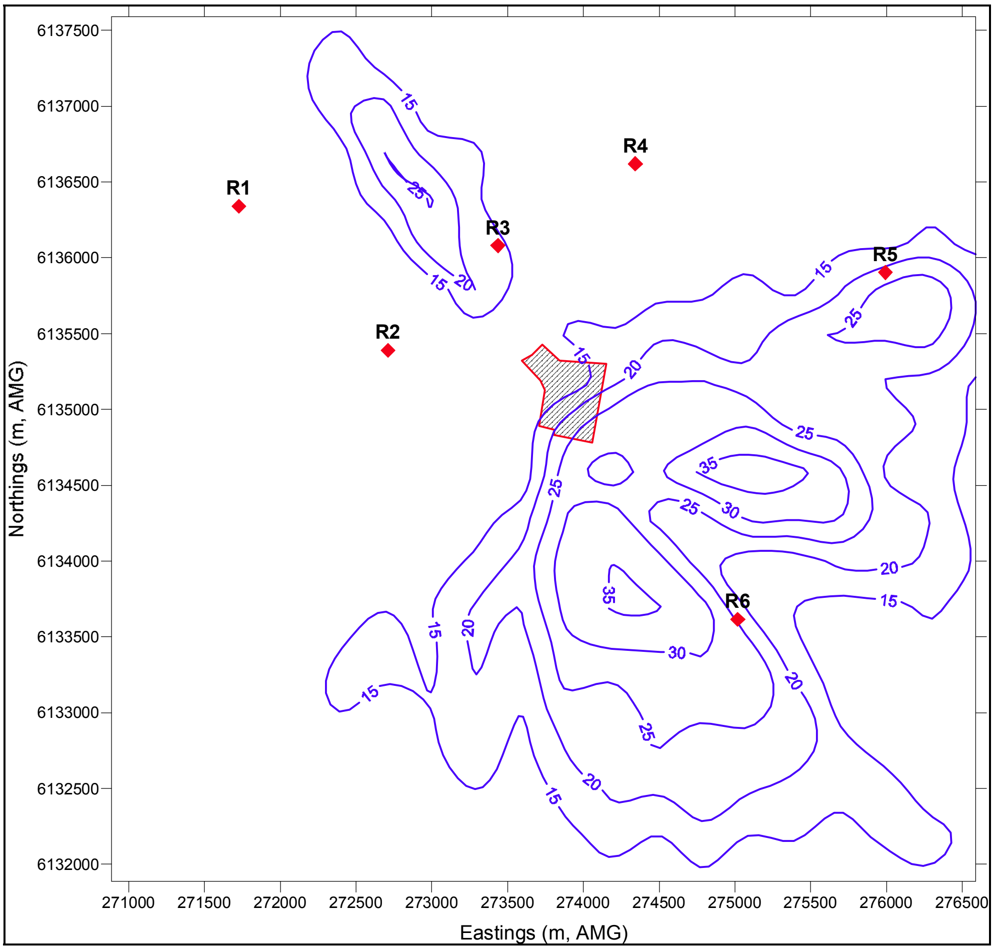
Table 3 Comparison of 1-hour Average NO_2 Concentrations – 400MW and 450MW

Receptor	NO_2 Concentrations - ppb			
	400MW	450MW	Percentage Change	Project Goal
R1	11.3	11.3	0%	120
R2	11.5	13.2	14%	120
R3	11.3	15.8	40%	120
R4	11.8	13.3	13%	120
R5	18.5[1]	21.6	17%	120
R6	18.8[1]	24.4	30%	120
Grid Maximum	27.4	38.1	39%	120

Note 1: The predicted 1-hour NO_2 Concentrations presented in 10-4044R3R1 for Receptors R5 and R6 were erroneous. The concentrations presented here are the correct values.

It can be seen that while an increase is predicted at the majority of the selected receptor locations, the 1-hour average NO_2 concentrations associated with the 450MW facility are predicted to comply with the applicable assessment criterion at all locations across the modelling domain. **Figure 1** presents the contour plots of the 1-hour average NO_2 concentrations about the Project Site for the 450MW facility.

Figure 1 Predicted 1-hour Average NO_2 Concentrations - 450MW Facility



On the basis of the dispersion modelling conducted for 1-hour NO_2, considered the key indicator of air quality compliance during operation for the Project from precious assessments, the proposed increase in electricity generation from 400MW to 450MW for the Project will not significantly impact upon the surrounding air quality environment. It is reiterated that the modelling results presented in **Table 3** should be considered conservatively high, as no accounting for potential plume rise enhancement has been made.

4 Plume Rise Implications

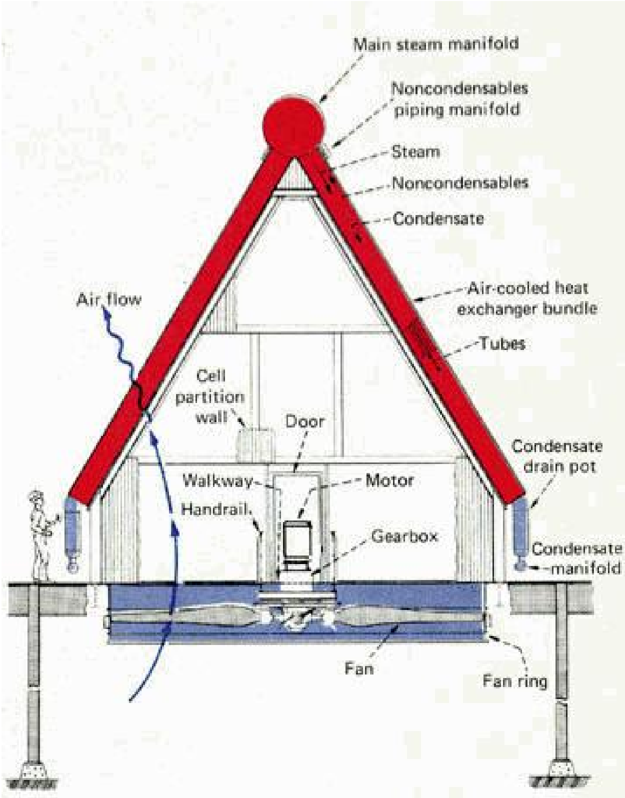
In addition to the air quality modelling assessments conducted for the Project, Heggies have undertaken modelling assessments of plume rise from the Project to determine the potential impact to aviation safety. The most recent version of this assessment appeared as Appendix C in Heggies Report 10-4044R3R1. For technical details relating to the assessment of plume rise from the Project, please review the Appendix C document.

A key component of the plume rise assessment conducted as part of 10-4044R3R1 was accounting for the additional plume rise enhancement potential that the ACC system would provide. The ACC system was understood to comprise of 36 separate release fans in a structure immediately adjacent to the turbine stacks.

In Heggies modelling assessment for both air quality and plume rise, it was assumed that the ACC system continuously ventilated warm air from each of the 36 release points, assumed to be 9.14 m in diameter, at a rate of 6.14 m/s. Such a structure was shown, through the implementation of a set of plume rise equations, to have a significant plume rise enhancement influence on the turbine stacks exhaust.

Recent information received by GHD relating to the operation of the ACC system (corresp. GHD 2009) has provided greater insight into the actual operation of the ACC system. In particular, each row of fans in the ACC system releases air into the void beneath an A-frame structure. Exhaust air is then forced through cooling bundles in the A-frame structure before release to ambient air. A schematic of the ACC system process is presented in **Figure 2**.

Figure 2 ACC System Schematic

Schematic of ACC System Fan	Actual ACC System at similar operation
	

Source: GHD 2009

Advice from GHD relating to the operation of the ACC system and the influence of the A-frame structure on release velocity has indicated that air released from the ACC system to ambient air would likely be in the vicinity of 3 m/s. Similar ACC systems known to GHD have an operational exit velocity of between 2.4-2.8 m/s.

It is therefore considered that the modelling conducted within Heggies Report 10-4044R3R1 has significantly overestimated the plume rise enhancement potential of the ACC system on the exhaust from the two turbine stacks.

The plume rise assessment (Appendix C of Heggies Report 10-4044R3R1) should therefore be viewed as conservative for the purposes of accounting for the potential influence on aviation safety from the 400MW facility.

It is noted that, as quoted in **Table 2**, the exit velocity for each gas turbine stack is expected to increase by approximately 9% during the increase of electricity capacity from 400MW to 450MW. While this increase in exit velocity is expected to influence the plume rise from the turbine exhaust stacks, it is considered that the resulting plume rise will not be worse than the conditions predicted within the conservative plume rise assessment conducted for the 400MW facility, which over-accounted for the influence of the ACC system.

Consequently, it is considered that the plume rise assessment conducted for the 400MW facility (Appendix C of Heggies Report 10-4044R3R1), an overly conservative assessment of likely conditions based on the over accounting of vertical plume enhancement from the ACC system, would also be considered conservatively appropriate for the assessment of plume rise from the 450MW facility. It is therefore considered that remodelling of plume rise from the 450MW facility would be not necessary.

5 Conclusions

Heggies have reviewed the potential changes to operating conditions to be associated with the increase in electricity generation capacity from 400MW to 450MW during Stage 2 of the proposed gas turbine power station at Bamarang, NSW.

Despite slight increases in the exit velocity and pollutant emission rates expected to occur during this increase, it is not considered that such an increase would significantly enhance the potential of the Project to adversely impact upon the surrounding environment with regards to ambient air quality and vertical plume rise.

I trust this document meets your requirements.

Kind Regards,

SCOTT FISHWICK – Project Consultant – Air Quality

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