Bamarang Gas Fired Power Station

MODIFICATION FOR A 330 KV NETWORK CONNECTION

ENVIRONMENTAL ASSESSMENT

- July 2009

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Contents

Executive Summary

Delta Electricity is currently developing gas fired power generation options for its generating portfolio and, as part of this process, has identified a site at Bamarang, near Nowra on the south coast of NSW, for a gas turbine generation plant. On 27 February 2007, Delta Electricity was granted Concept Approval for Stage 1 and Stage 2 and Project Approval for Stage 1 of a gas turbine power generation facility at Bamarang, west of Nowra, under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Stage 1 plant would have a power generation capacity of approximately 300 MW and would be used as a peaking plant. The Stage 1 Project Approval also included the new 132 kV transmission line connecting the Bamarang facility to the 132kV Shoalhaven Substation and associated Integral Energy 132 kV sub-transmission system at West Nowra.

On 29 October 2008, Delta Electricity received Project Approval for Stage 2 of the Bamarang Gas turbine facility under Part 3A of the EP&A Act. Stage 2 comprises conversion of the Stage 1 OCGT facility into a 400 MW combined cycle gas turbine (CCGT) facility via the addition of, a steam turbine, a condenser and a generator. Stage 2 Project Approval also enables the facility to be constructed as a base load facility directly, depending on electrical demand and other power generation developments in NSW.

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 is therefore seeking an alternative higher voltage electricity grid connection that would allow for output from the facility to a 330 kV network. The existing TransGrid Kangaroo Valley-Canberra 330 kV Transmission Line (Line 6), located approximately five kilometres to the west of the proposed Bamarang Gas Turbine Project site, was identified as the best 330 kV grid connection option.

Delta seeks to retain the already approved option of constructing and operating a 132 kV transmission line between the approved facilities site and the existing Integral Energy electricity grid to the east. The decision on which transmission line connection will be constructed will be made during the selection of the plant and preparation of final design.

Planning Process

Delta Electricity is applying to modify the existing gas turbine generating facility approval under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposed modification is for the construction and operation of a 330 kV transmission line between the gas turbine generating facility and the existing TransGrid Kangaroo Valley-Canberra 330 kV Transmission Line (Line 6) to the west of the site.

Project Description

The proposed modification to the approved project involves construction and operation of a new 330 kV transmission line to connect the Bamarang Gas Turbine Facility to TransGrid Line 6. As part of the proposed modification, a new sub-station within the Bamarang Gas Turbine Facility site would also be required to convert the voltage output from the gas turbines to 330 kV. The details of the proposed transmission line are summarised in **Table 1**.

Table 1: Details of the proposed transmission line

Voltage and circuit type	Grid connection location	Connection type	Tower height	Easement width	Line length	Associated infrastructure
330 kV double circuit / single tower (DCST)	TransGrid Line 6	Turn-in / Turn-out	42-47 m	60 m	5.2 km	Sub-station located at gas turbine site

Need for the Project

The approval for Stage 1 of the works includes the construction and operation of a 132 kV transmission line to enable the facility to connect into the grid and export its output into the National Electricity Market (NEM). Two main factors have been identified which constrain the maximum feed-in capacity of the power station into the NEM via the 132kV network. While the 132 kV line would facilitate the transmission of the output of electricity from the Stage 1 plant, it is likely that under low demand conditions on the South Coast, output from the facility may be constrained, effectively limiting the facility's ability to operate reliably at the full capacity of the Stage 2 works. A 330kV connection would minimise export constraints. This ensures the full capacity of the Stage 2 works would be able to be dispatched into the NEM.

Environmental Assessment

The section assesses the key environmental issues associated with the construction and operation of the proposed modification, and identifies the measures that would be required to mitigate and manage the potential impacts of the proposed modification. The key issues assessed are discussed below.

Flora and Fauna

The proposed transmission line easement will require the partial removal/modification of up to approximately 30 ha of remnant vegetation based on the establishment of a 60 m wide easement, although there is some scope to limit the amount of clearing in areas where vegetation will be below the required buffer distance between the vegetation and the proposed transmission line.

Impacts to rare flora species recorded in the study area will be limited to any individuals in the vicinity of the proposed pole locations and access trails provided the shrub layer can be retained within the proposed easement. Similarly for threatened species which potentially occur in the study area as many of these are shrub, herb or orchid species which can be retained within the easement, with direct impacts limited to the proposed pole locations and access trails. However, it is likely that clearing of the canopy and larger shrubs will result in changes to the species composition and vegetation structure of the understorey, which may or may not advantage some of these species.

The proposal will potentially result in impacts on Endangered Ecological Communities (EEC) to up to 0.7 ha of Lowland Rainforest and 0.3 ha of River-flat Eucalypt Forest. There is potential for the transmission lines to span across these EECs as the topography surrounding these areas is likely to provide adequate height between the existing canopies and the spanning transmission lines.

The proposal will remove approximately 30 ha of habitat which is potentially occupied by populations of several threatened fauna in particular the Grey-headed Flying-fox, Yellow-bellied Glider, Glossy Black Cockatoo, Eastern Pygmy Possum, Forest Owls, Ground-dwelling mammals and threatened microchiroperan bats. The loss of habitat will also remove hollow-bearing trees used by hollow-dependent fauna and important foraging resources for birds as well as fragment currently continuous areas of intact habitat.

Of particular consideration is the potential level of impact on local populations of the Grey-headed Flying-fox. The potential for impact on this species exists due to the presence of transmission lines and not the associated small loss of foraging habitat which is widespread and expansive in the region. The location of the transmission line itself will not occur in close proximity to an identified roost camp such that frequent collisions and interruption to movements in the vicinity of a roost site will not occur. However, there is a risk associated with bats colliding and being electrocuted on the newly established overhead transmission lines while accessing foraging habitat. This risk can potentially be mitigated if the transmission line is constructed so that the wires are not arranged in one plane or are greater than 1.6 metres apart, that is, greater than the wingspan of a flying-fox. The concept design has allowed for a gap greater than this between wires.

Management and mitigation will occur by minimising vegetation clearance, avoiding EECs by using topographic elements surrounding the EECs in the study area, avoiding individual habitat features of conservation significance within the study area and managing general habitat features of importance by use of appropriate management practices in the study area.

Indigenous Heritage

An assessment of Indigenous heritage issues arising from the proposal was undertaken and included a search of all relevant registers of information, consultation with the Nowra Local Aboriginal Land Council (LALC) and other registered stakeholders as per the ICCR guidelines, field survey to identify and record cultural heritage sites along the proposed easement for the transmission line, assessment of the significance of recorded sites, the potential significance of the

heritage resource along the corridor and the formulation of general and specific management options.

The significance of the archaeological sites located was addressed with the community representatives during survey. Conversations held with the representatives of the Nowra LALC determined that all site types are culturally significant to the Aboriginal community because they provide physical evidence of Aboriginal occupation of the local area. In this respect, all Aboriginal sites located on this survey are considered to be of high significance to the Aboriginal community and potentially the community at large.

The scientific assessment of sites revolves around the known local context of the site type (i.e. are there many, some or no such features known locally). The overall location of sites discovered during the current survey conforms to the general archaeological settlement pattern that has already been established throughout the broader region.

The small open camp site and isolated finds recorded along disturbed access tracks, provided few artefacts, which impacts upon their on their scientific significance because it is a limiting factor in the amount of information they may be able to provide. Overall the scientific significance of isolated finds is low unless they are, in some way, rare. The isolated finds are not rare examples of artefact types or materials and are assessed as having low scientific significance.

The study area covers a variety of landforms including gullies with associated ephemeral drainage features, spurs and ridgelines as well as some small areas of escarpment, creeks and floodplain. Based on the broader regional archaeological context and local recordings, it is considered that the study area has the potential to have a number of different site types depending on the local environmental conditions. As a result, the following recommendations will be implemented:

- Of the three recorded Indigenous sites along the proposed alignment, all will be avoided by the project impacts, although they may require the implementation of appropriate site management measures to ensure no inadvertent impacts occur;
- All management of Indigenous sites in relation to the proposal will eventually be embodied into an AHMP or CEMP. Development of these management documents would occur in consultation with the Indigenous community;
- Should any previously unidentified Indigenous ‘objects’ or other Aboriginal sites (such as burials) be uncovered during the course of construction, work in that area would cease and the DECC Regional Archaeologist (Queanbeyan Office), and the Nowra Local Aboriginal Land Council would be contacted to discuss how to proceed.

Visual Impacts

The study area is recognised for its scenic value. A number of land parcels within or adjacent to the study area have been classified as "Scenic Preservation Area" under the Shoalhaven LEP in recognition of their scenic qualities.

Visual impacts were assessed by comparing visual modification and visual sensitivity and generally relate to the ability of the landscape to absorb visual modification. The degree to which the environment can absorb any visual impacts is influenced by topography (whether it can be screened) and vegetation (whether it can be concealed). In general, there are more opportunities to minimise the visual impact of a development from distant views and in varied and undulating landscapes than areas of flat terrain. The visual assessment showed that high visual impact would result on two existing or potential views in VMU 3 (refer to Figure 4-6 and Plates 1 and 4), whereas other visual impacts, given distance or land use, would be low to moderate.

In areas where the topography does not conceal the development from surrounding areas, vegetation can be used to screen the development from sensitive viewpoints. In general, smaller trees with low canopies can be used effectively on gentle slopes or flat areas to screen developments, and taller trees with high canopies are more effective on steeper slopes.

The visual impacts of the new transmission alignment have been mitigated, as far as practicable, through its location and design.

Bushfire

Due to oil-bearing eucalyptus trees, dry grass, low humidity and hot, gusty winds, the countryside of south-eastern Australia is a very flammable environment. In such an environment, bush fires can result from both the construction and operation of transmission lines. The transmission line easement and surrounding landscape comprises a mix of native pasture grasses and woodland. This area would be prone to bushfires during the summer months.

Bushfire risks and corresponding risk control measures for construction activities may take place during the construction of the proposal and present a bushfire hazard, and the bushfire hazard would be minimised as far as practical during the construction of the proposal through the implementation of appropriate management measures. With the implementation of these measures, construction of the proposal would not present a significant bushfire risk.

During operation any overhead electricity reticulation system is a potential source of ignition. Bushfires can be caused by faults in the system and by vegetation coming into contact with conductors. The bushfire hazard associated with the operation of the proposal would be minimised as far as practical through the implementation of appropriate management measures. With the implementation of these measures, operation of the proposal would not present a significant bushfire risk.

Electromagnetic Fields (EMF)

The general rationale for selecting the transmission line route has been dictated by a number of factors including visual impacts, impacts on the natural environment, proximity to houses and community concerns about electric and magnetic fields. To this end the route chosen ensures the closest existing or potential dwelling remains at a distance where magnetic fields in the residence would be dominated by the effects of low voltage electricity use by the consumer and the proposed transmission line would not add to magnetic field exposure by residents.

It has not been scientifically established that power frequency electric and magnetic fields in general have any adverse health effects. Although the possibility of there being some adverse effect cannot be ruled out, there is a recent trend for the range of possible health effects to be narrowed.

Several review panels and public inquiries have recommended prudent avoidance as an appropriate response to the present state of scientific uncertainty. In designing and locating the new transmission line, Delta Electricity has implemented measures consistent with the concept of prudent avoidance.

The transmission line would not result in any significant increase in electric or magnetic field exposure in any existing or identified future residence. Based on the findings of the scientific and medical reviews, it may be concluded that the new transmission line can proceed without any significant impact due to power frequency fields.

Aviation safety

The proposed power station site is approximately 4 km from the Naval Air Station Nowra – HMAS Albatross. The power station and the area proposed for the 330 kV transmission line are located within the area affected by the Defence (Area Control) Regulations (DACR) for NAS Nowra. The DACR controls the height of the objects (structures and vegetation) and the purpose for which they may be used within approximately 15 km radius of the airfield. The DACR height restrictions are based on the Obstruction Clearance Surface (OCS) for NAS Nowra. The OCS for NAS Nowra represents 3 dimensional reference surfaces in air space around the airfield and their purpose is to limit the height of objects that may endanger aircraft operations.

A preliminary review of the OCS ranges in the eastern part of the study area indicates that transmission towers greater than 50m above ground may infringe the OCS levels. At the western end of the study area (adjacent to the existing 330 kV line), transmission towers greater than 70-80m above ground may infringe the OCS levels. Since the proposed transmission tower heights are 42-47m, it is unlikely that the proposal would infringe the OCS.

Delta Electricity has commenced consultation with the Department of Defence and will continue that consultation during final design and decision on the final locations of towers with respect to the management of aviation hazards associated with operations at HMAS Albatross.

Justification and Conclusion

The project is justified and this justification is presented in the context of Ecologically Sustainable Development (ESD). The principals of ESD have been adequately considered in the assessment of the project.

The assessment describes the proposed modification to the approved project, assesses the environmental issues associated with the construction and operation of the proposed modification, and identifies the additional measures that would be required, over and above those already specified in the current conditions of approval, to mitigate and manage the potential impacts of the proposed modification.

1. Introduction

1.1 Project Background

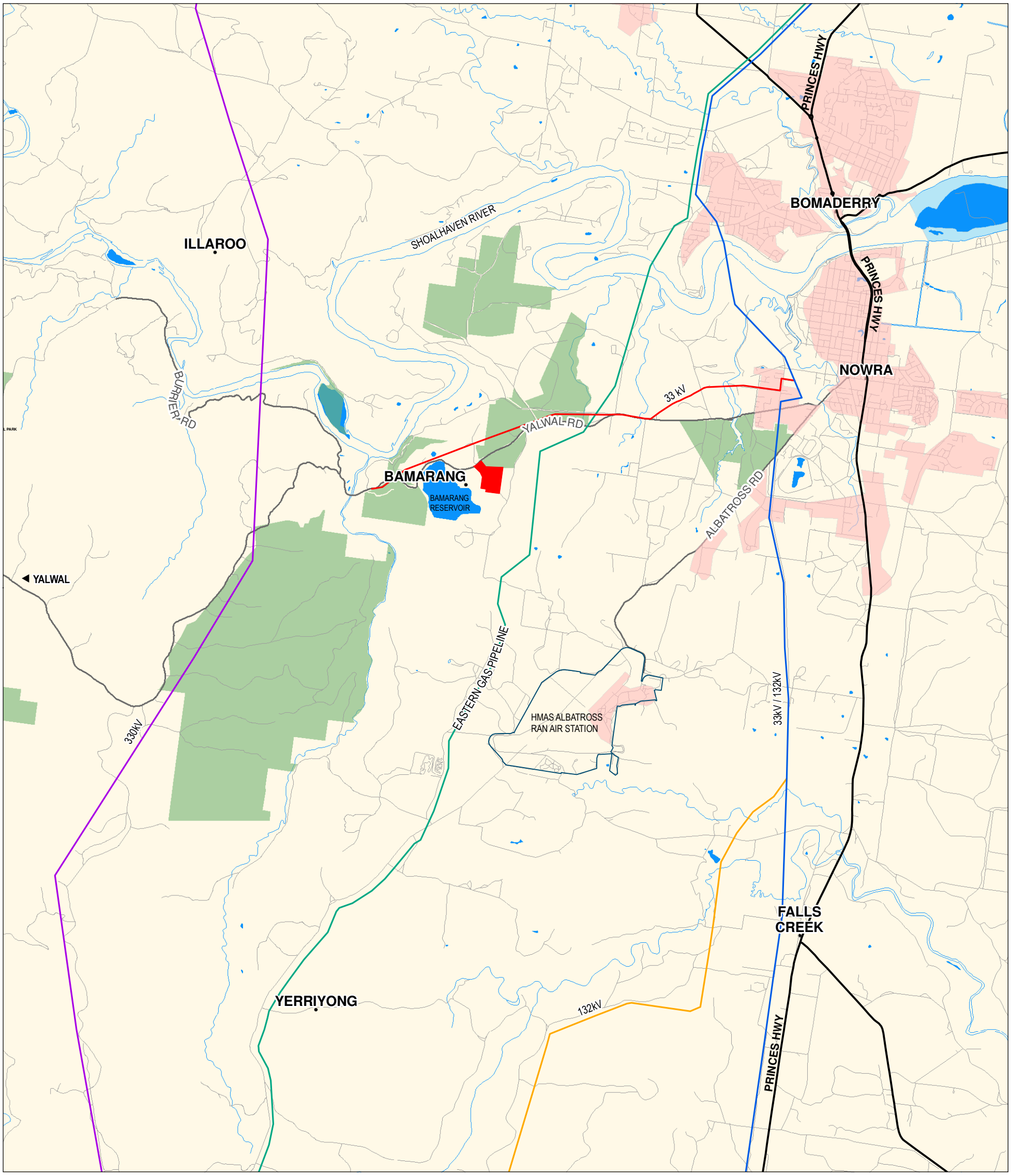
Delta Electricity is currently developing gas fired power generation options for its generating portfolio and, as part of this process, has identified a site at Bamarang, near Nowra on the south coast of NSW, for a gas turbine generation plant. The location of the project site in the region is shown in **Figure 1-1.**

On 27 February 2007, Delta Electricity was granted Concept Approval for Stage 1 and Stage 2 and Project Approval for Stage 1 of a gas turbine power generation facility at Bamarang, west of Nowra, under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Stage 1 plant would have a power generation capacity of approximately 300 MW and would be used as a peaking plant. Stage 2 works would enable the facility to be constructed as an approximately 400 MW base-load plant.

The Stage 1 Project Approval comprises construction of two open cycle gas turbines (OCGTs) and associated infrastructure, such as the new 132 kV transmission line connecting the Bamarang facility to the 132kV Shoalhaven Substation and associated Integral Energy 132 kV sub-transmission system at West Nowra. On 29 October 2008, Delta Electricity received Project Approval for Stage 2 of the Bamarang Gas turbine facility under Part 3A of the EP&A Act. Stage 2 comprises conversion of the Stage 1 OCGT facility into a 400 MW combined cycle gas turbine (CCGT) facility via the addition of a steam turbine, a condenser and a generator. Stage 2 Project Approval enables the facility to be constructed as a base load facility directly, depending on electrical demand and other power generation developments in NSW.

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 (this is explained in detail in Section 3.1). Delta Electricity has therefore investigated options for an alternative higher voltage electricity grid connection that would allow for output from the facility to a 330 kV network. The existing TransGrid Kangaroo Valley-Canberra 330 kV Transmission Line (Line 6), located approximately five kilometres to the west of the proposed Bamarang Gas Turbine Project site, was identified as the best 330 kV grid connection option.

A transmission line options study was undertaken and, following review of the outcomes of that study, Delta Electricity has resolved to seek approval for a 330 kV line between the proposed Bamarang Power Station and the existing TransGrid No 6 330 kV line, 5 km to the west of the station site. The grid connection will be via a ‘Turn in – Turn out” 330 kV connection.



Legend

- National Parks
- Proposed PS Site
- Built-up Areas
- Street Network
- Main Highways
- Drainage
- Eastern Gas Pipeline
- 33kV
- 132kV
- 33 kV / 132 kV
- 330 kV

Data Sources

Topodata - Streetworks

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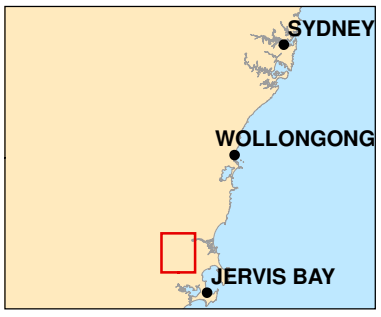

FIGURE 1.1 REGIONAL MAP

BAMARANG GENERATION 330 kV NETWORK CONNECTION

GDA 1994 | MGA Zone 56

January 23, 2009
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1.2 Approvals process

Delta Electricity is applying to modify the existing gas turbine generating facility approval under Section 75W of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The proposed modification is for the construction and operation of a 330 kV transmission line between the gas turbine generating facility and the existing TransGrid Kangaroo Valley-Canberra 330 kV Transmission Line (Line 6) to the west of the site. Delta seeks to retain the already approved option of constructing and operating a 132 kV transmission line between the approved facilities site and the existing Integral Energy electricity grid to the east. The decision as to which option will be selected will be made during plant selection and final design stage of the project.

As part of the application for modification of the approved project under Section 75W(2) of the EP&A Act, an Environmental Assessment (EA) report is required. This modification to the approved project EA has been prepared in accordance with Part 3A of the EP&A Act to satisfy this requirement. The Director-General's requirements for the modification to the approved project EA were issued by the NSW Department of Planning (DoP) on 29 March 2009 and are attached in **Appendix A**.

This report describes the proposed modification to the approved project, assesses the environmental issues associated with the construction and operation of the proposed modification, and identifies the additional measures that would be required, over and above those already specified in the current conditions of approval, to mitigate and manage the potential impacts of the proposed modification.

1.3 Consultation with public authorities and the community

1.3.1 Government Agencies

The Director-General's requirements identified agencies which were to be consulted during the preparation of the EA. The relevant agencies were contacted by telephone, email and letter. The results of these consultations are shown in **Table 1-1**.

1.3.2 Community Consultation

Private landowners along or near to the preferred route were consulted by telephone, letter and, where requested, meetings to discuss access, potential impacts and mitigation measures.

To inform the broader community a public notice was placed in the Shoalhaven and Nowra News on 7 May 2009. The notice described the reasons for the proposed modification and invited the public to view further information on the Delta Electricity web site or to contact a member of the study team by free-call number. Community responses are summarised in **Table 1-2** below.

Table 1-1: Agency Consultation

Agency	Response	Where addressed in the EA
Department of Defence	Required further information on location of structures to allow assessment of possible impacts on operation on NAS.	Section 4.6.3
Civil Aviation Safety Authority	Required further information on location of structures to allow assessment.	Section 4.6.3
NSW Department of Environment and Climate Change	Response attached in Appendix A.	Flora and fauna – Section 4.3 Indigenous heritage – Section 4.4
NSW Department of Water and Energy	No response.	n/a
TransGrid	TransGrid (the relevant Transmission network service provider) has been consulted concerning the proposed 330kV connection for the Bamarang power plant. This consultation process has involved: - Submission of a formal "Connection Enquiry" to TransGrid, outlining the proposed project and timeframe (issued 8 October 2008). Delta Electricity received a response to this Connection Enquiry from TransGrid on 12th November 2008 - Attended a briefing meeting between TransGrid and Delta Electricity to discuss the forthcoming "Connection Application" - Submitted formal "Connection Application" to TransGrid on 25th March 2009 - Discussed technical data with TransGrid to determine the potential feed-in capacity into TransGrid's 330kV system for the generator - Attended a number of post "Connection Application" meetings with TransGrid to discuss preliminary technical and commercial aspects of the proposed power plant - Prepared and executed an agreement between Delta Electricity and TransGrid to assess the project, including authorisation for Delta Electricity to pass their consultants technical feasibility reports to TransGrid The Connection Application is currently being assessed by TransGrid.	Design – Section 2.2
Shoalhaven City Council	Indicated a response would be made when the EA was exhibited.	n/a
NSW Department of Lands	Nowra Lands office was consulted to obtain access to Crown land while field studies were undertaken. Access was approved.	n/a

Issues raised by the community consulted included potential effects on financial outcomes, environmental (ecological), visual impacts and effects of EMF. These have all been addressed in this report.

Table 1-2: Community Consultation

Community	Response
Landowner 1 - Directly affected Easement would be required on property, which is listed for sale. View from approved house site on two lots.	Contacted by telephone and letter. Two meetings held. Interested in compensation processes. Requested in writing to resolve easement acquisition immediately.
Landowner 2 - Not directly affected Property near the alignment. View from house to alignment.	One meeting held at which alternative locations were suggested; it was indicated the easement was not wanted on the property and there was a need to minimise impact on view from the property. Subsequently objected in writing due to potential impacts on amenity (view and EMF), effects on value of property and ecological impacts.
Landowner 3 - Directly affected Easement would be required on property, which is unoccupied	Contacted by telephone and letter. No objections raised. Interested in compensation process.
Landowner 4 - Directly affected Easement would be required on property which is used for grazing and where future development is proposed.	Contacted by telephone and letter. No objections raised. Interested in compensation process.
Landowner 5 - Not directly affected Property near the alignment. Property unoccupied but building approval exists for property	Contacted by telephone and letter. No objections raised Expressed interest in selling.
Other correspondence	No responses to advertisement were received.

1.4 Structure of Report

This EA has been prepared in accordance with DoP guidelines and the Director General's EA requirements. A summary of the information contained within each chapter and appendix of this report is provided below.

- **Chapter 1** - introduces the proposed modification and provides background information on its broad strategic context. It also provides a description of the stakeholder engagement and community consultation process;
- **Chapter 2** – provides a detailed description of the proposed modification to the approved project;

- **Chapter 3** – provides the need for the proposed modification and a description the alternative options considered for the proposed modification;
- **Chapter 4** - identifies and discusses the key environmental issues for the proposed modification and the impact mitigation and management measures that would be implemented to address these issues. It also outlines additions to the Statement of Commitments that would be required, and identifies areas where conditions of approval may require modification;
- **Chapter 5** – provides the justification and conclusions resulting from this EA.

The EA report is supported by appendices, as follows:

- **Appendix A** – which contains the results of agency consultation, including the Director-General's Requirements.
- **Appendix B** – which contains the Biodiversity Report.
- **Appendix C** – which contains the Heritage Report.

2. Description of Proposed Modification

2.1 The approved project

Delta Electricity has been granted approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the construction and operation of a gas turbine power generation facility at Bamarang, near Nowra, on the South Coast of New South Wales (NSW). The approved Bamarang Gas Turbine Facility (the approved project) comprises two stages:

- Stage 1 - construction and operation of an open cycle gas turbine (OCGT) facility; and
- Stage 2 – construction and operation of a combined cycle gas turbine (CCGT) facility.

The Stage 1 plant would have a power generation capacity of approximately 300 MW and would be used as a peaking plant (that is to supply power during peak demand period). The Stage 2 works would increase the power generation capacity of the facility to approximately 400 MW and would allow the facility to be used for both intermediate and base-load supply.

Depending upon electricity demand and other power generation developments in NSW, the approved project could be implemented in stages, as envisaged in the concept design, or proceed directly to Stage 2. Details of the current approvals for each project stage are provided in **Table 2-1**.

Table 2-1: Existing Part 3A approvals for the Bamarang Gas Turbine Facility

Current approvals	Approval date	Works covered by the approval
Concept Approval	27 February 07	Stage 1 – Construction and operation of an OCGT facility and associated infrastructure, including two OCGTs, a 132 kV transmission line and gas supply, metering and compression works. Stage 2 – Construction and operation of a CCGT facility and all water supply infrastructure.
Project Approval	27 February 07	Stage 1 – Construction and operation of an OCGT facility and associated infrastructure, including two OCGTs, a 132 kV transmission line and gas supply, metering and compression works.
Project Approval	29 October 08	Stage 2 – Construction and operation of a CCGT facility and all water supply infrastructure.

2.2 The proposed modification to the approved project

2.2.1 Overview

The proposed modification to the approved project involves construction and operation of a 330 kV transmission line to connect the Bamarang Gas Turbine Facility to TransGrid Line 6, as an alternative to the already approved 132 kV line connecting to the Integral network. Approval of the 330 kV line would not void the existing 132 kV approval, rather it would offer an alternative. Only one option would be constructed. As part of the proposed modification, a new sub-station within the Bamarang Gas Turbine Facility site would also be required to convert the voltage output from the gas turbines to 330 kV, instead of the approved 132 kV switchyard. The proposed location of the new 330 kV transmission line is shown in **Figure 2-1**. The details of the proposed transmission line are summarised in **Table 2-2**.

Table 2-2: Details of the proposed transmission line

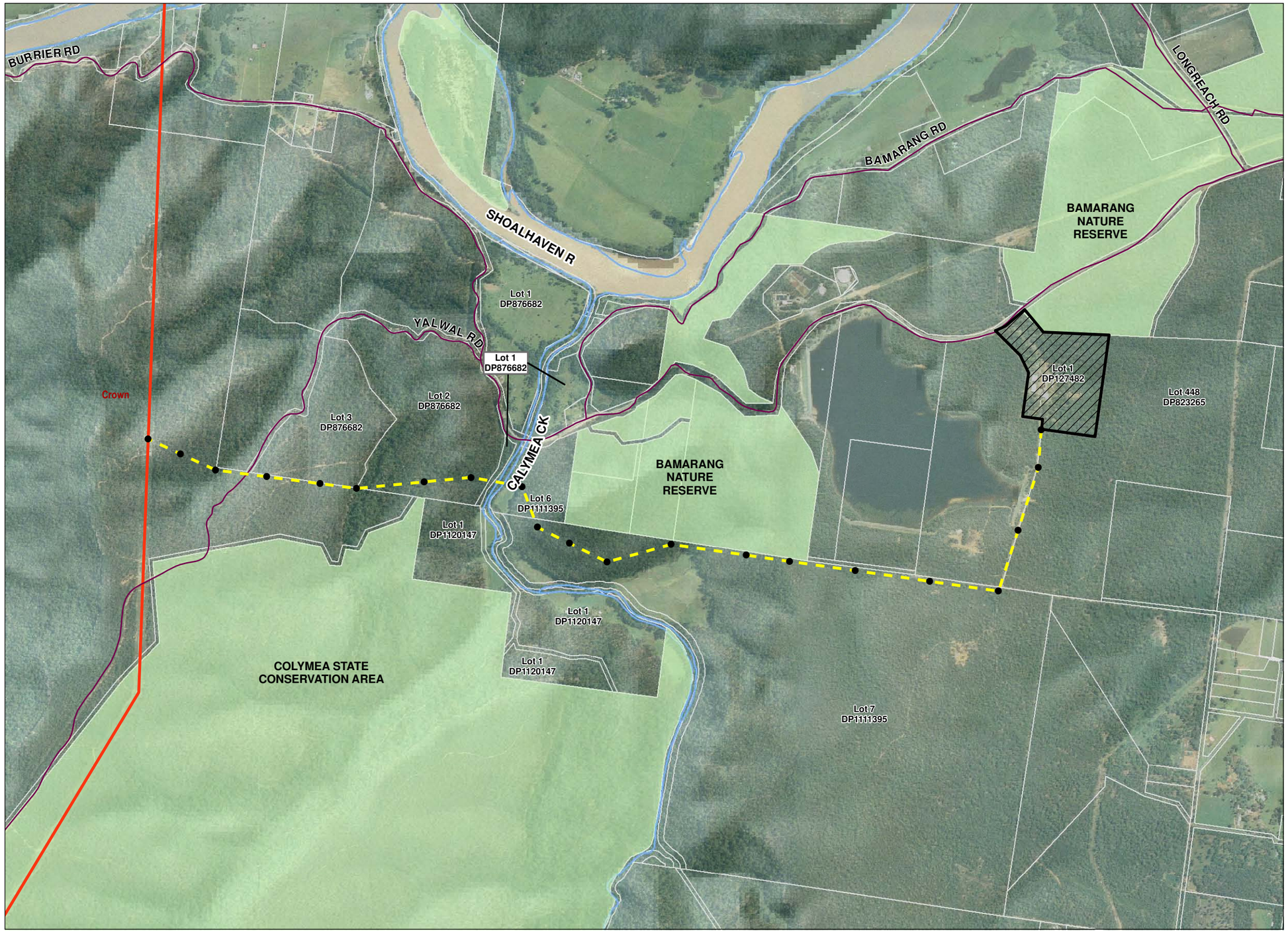
Voltage and circuit type	Grid connection location	Connection type	Tower height	Easement width	Line length	Associated infrastructure
330 kV double circuit / single tower (DCST)	TransGrid Line 6	Turn-in/Turn-out	42-47 m	60 m	5.2 km	Sub-station located at gas turbine site

2.2.2 Transmission Line Route

The new transmission line required from the Line 6 tie-in point to the Bamarang sub-station would follow the route shown in **Figure 2-1**, and the possible location and height of the structures is shown in **Figure 2-2a-d**.

The proposed 330kV route would travel from west to east from the existing TransGrid Line 6 across the northern boundary of Colymea SCA, crossing Calymea Creek, aligning with the southern boundary of Bamarang Nature Reserve and would enter the Bamarang Gas Fired Facility site at its south west corner.

A mix of steel towers and steel poles would be used (refer to **Figure 2-3**). Steel towers generally provide a more cost efficient solution but poles are expected to be used for the section of the line where a reduction of the visual impact is desired. An estimated 20% of the line length would be constructed with steel poles, these being at structures numbered from 8 to 13 inclusive (as shown in **Figure 2-2b**). Poles would have suspension insulators.



Legend

- Transmission Line Poles
- Proposed 330 kV Transmission Line
- Existing TransGrid Kangaroo Valley to Canberra 330 kV Transmission Line
- Roads
- Waterways
- National Parks
- Bamarang Gas Turbine Site
- Property Boundaries

Data Sources

Aerial Photograph - LPI, NSW
Topodata - Streetworks
Cadastre - LPI, 2007

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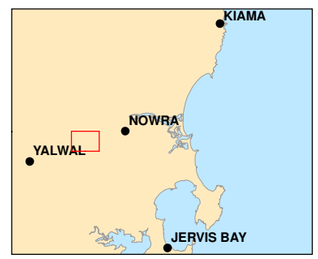

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FIGURE 2-1: LOCATION OF THE PROPOSED MODIFICATION TO THE APPROVED PROJECT

BAMARANG GENERATION 330 kV NETWORK CONNECTION

GDA 94 MGA 56

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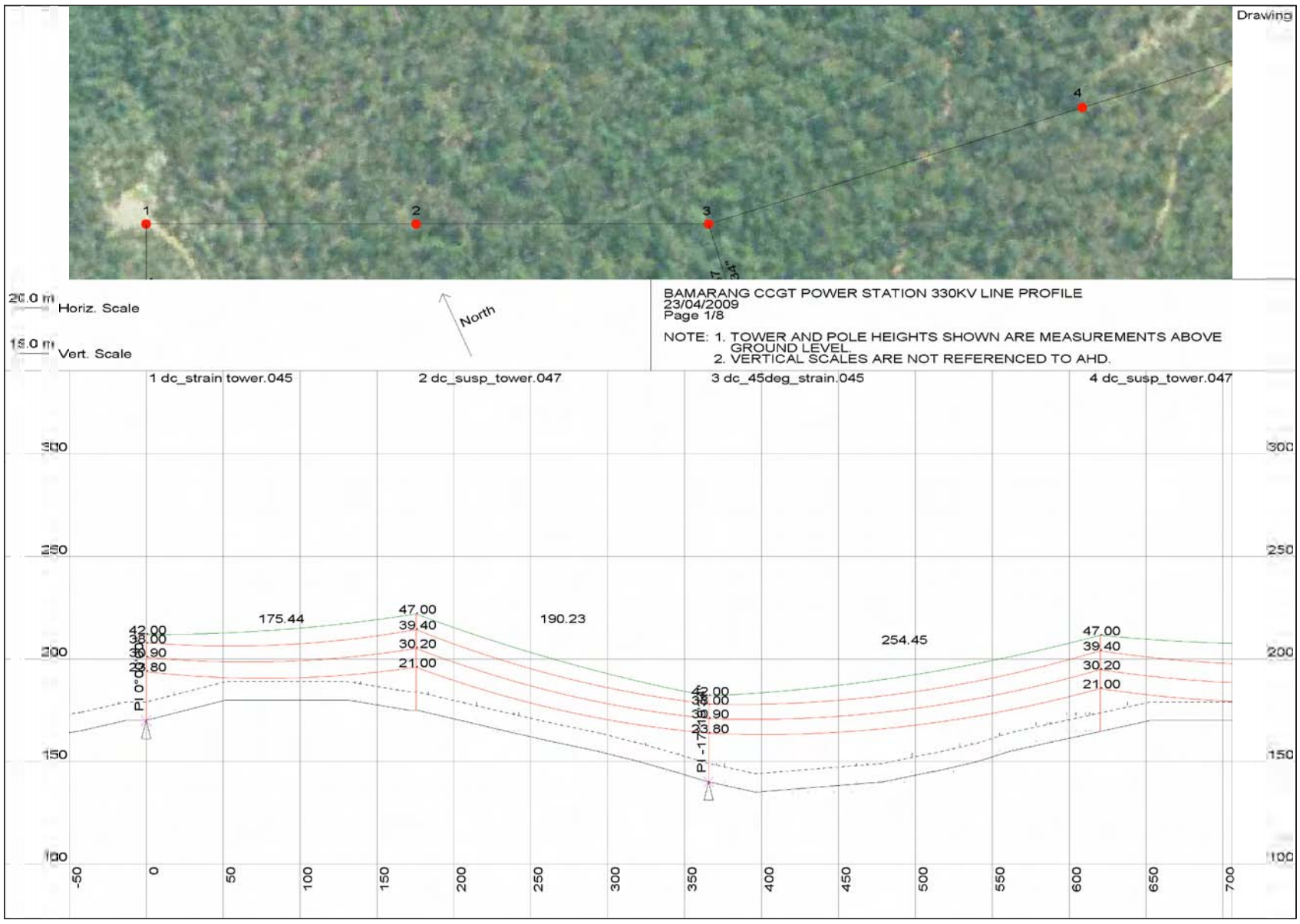


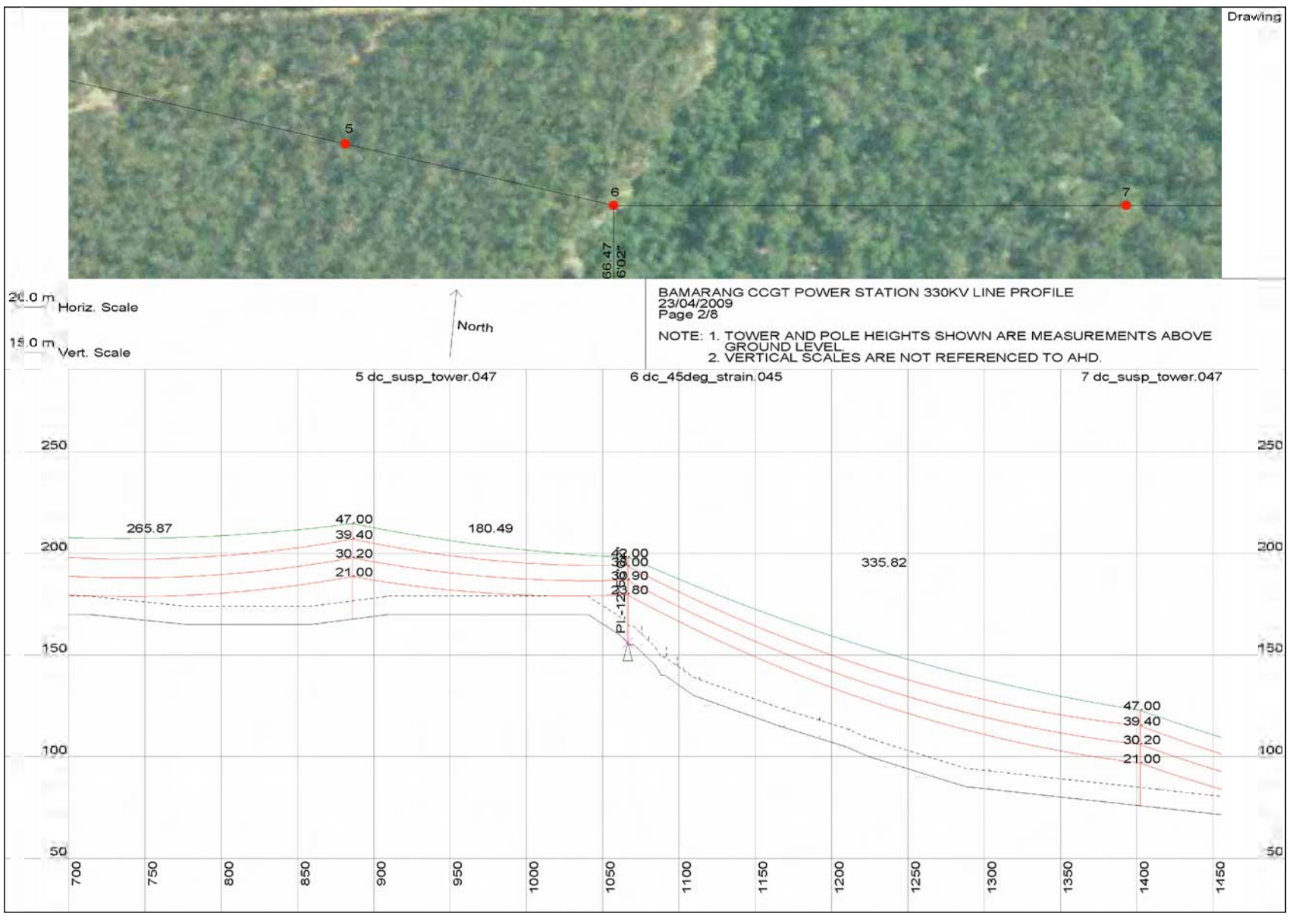
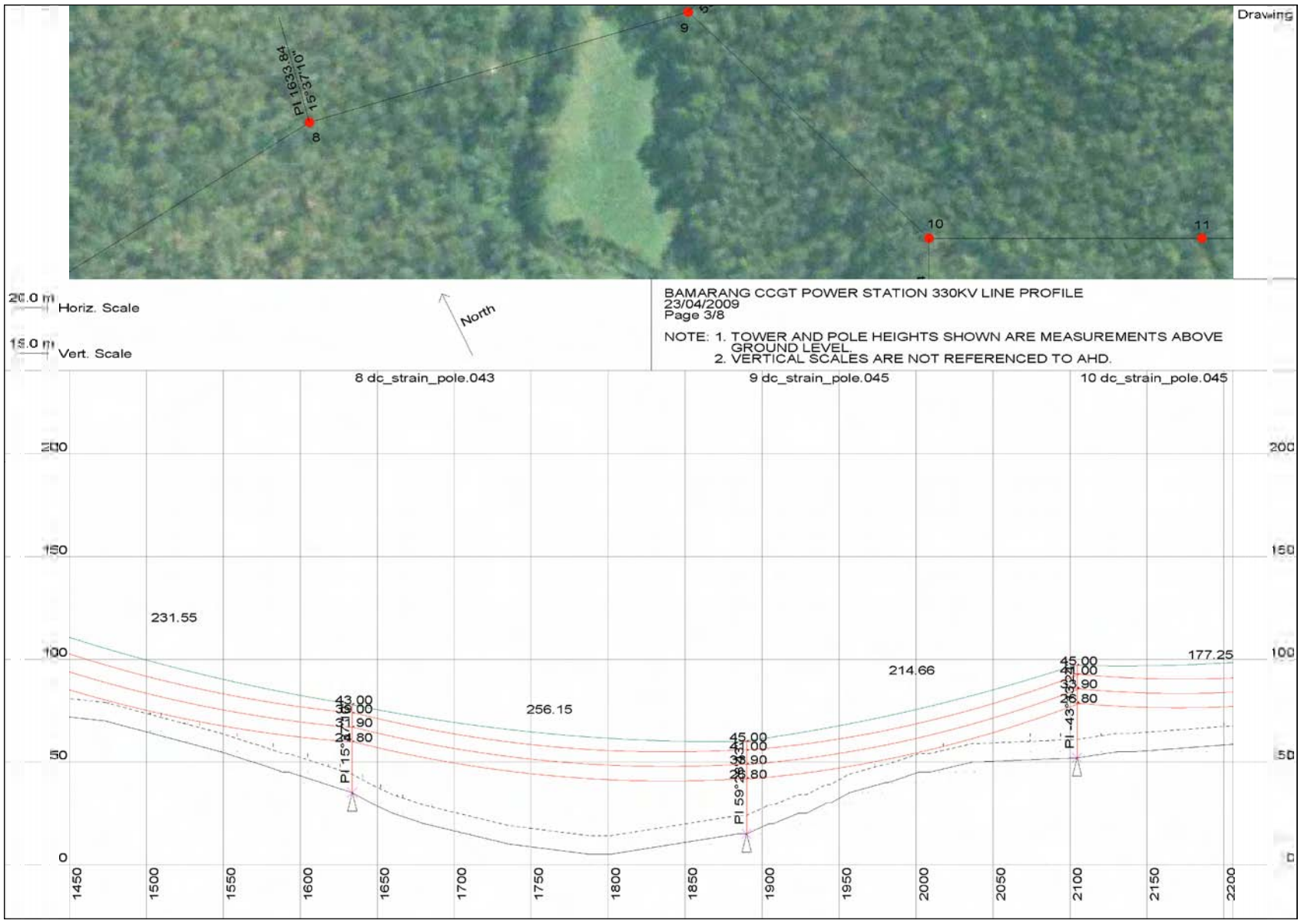


Figure 2-2a: Location and height of the structures



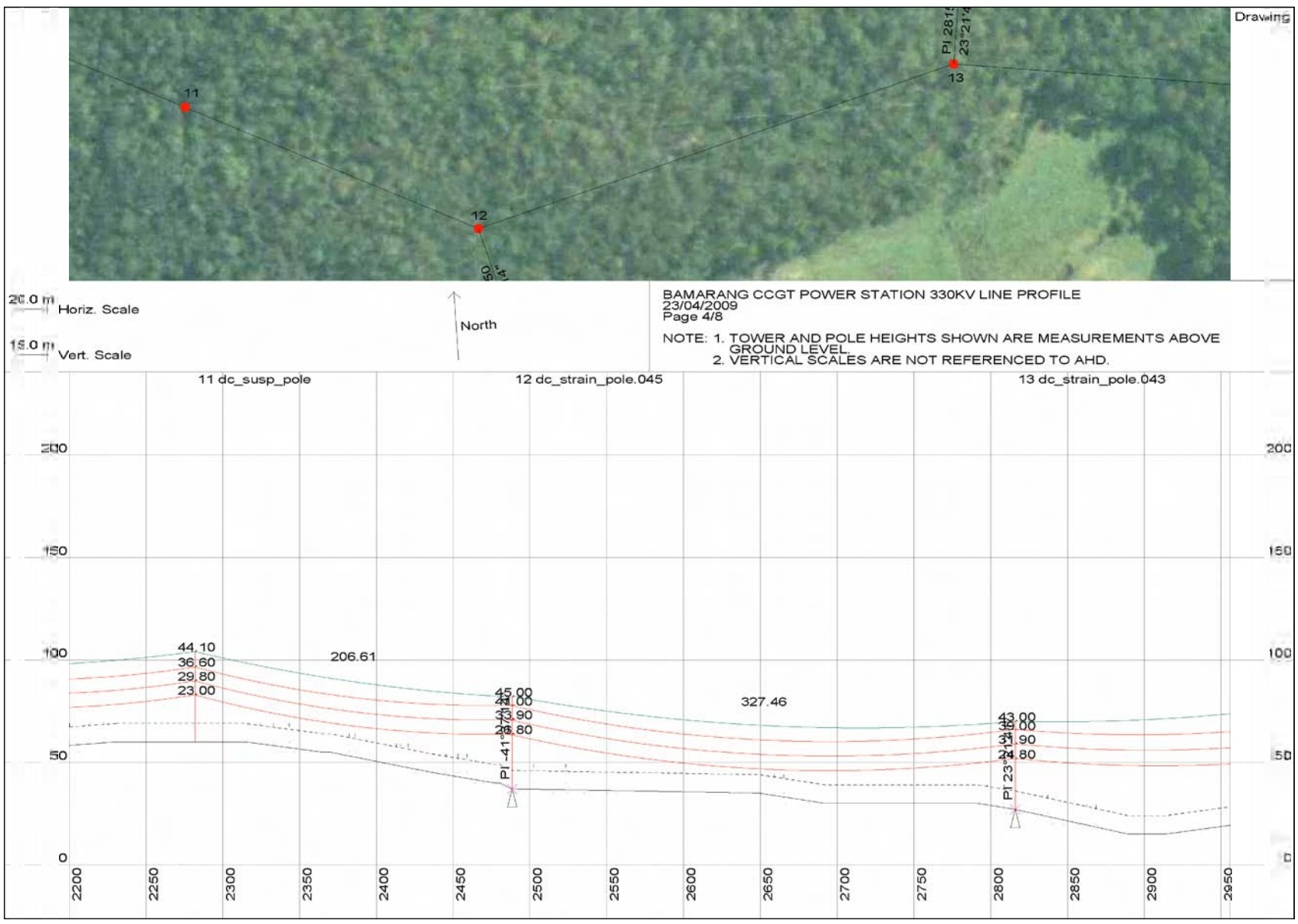
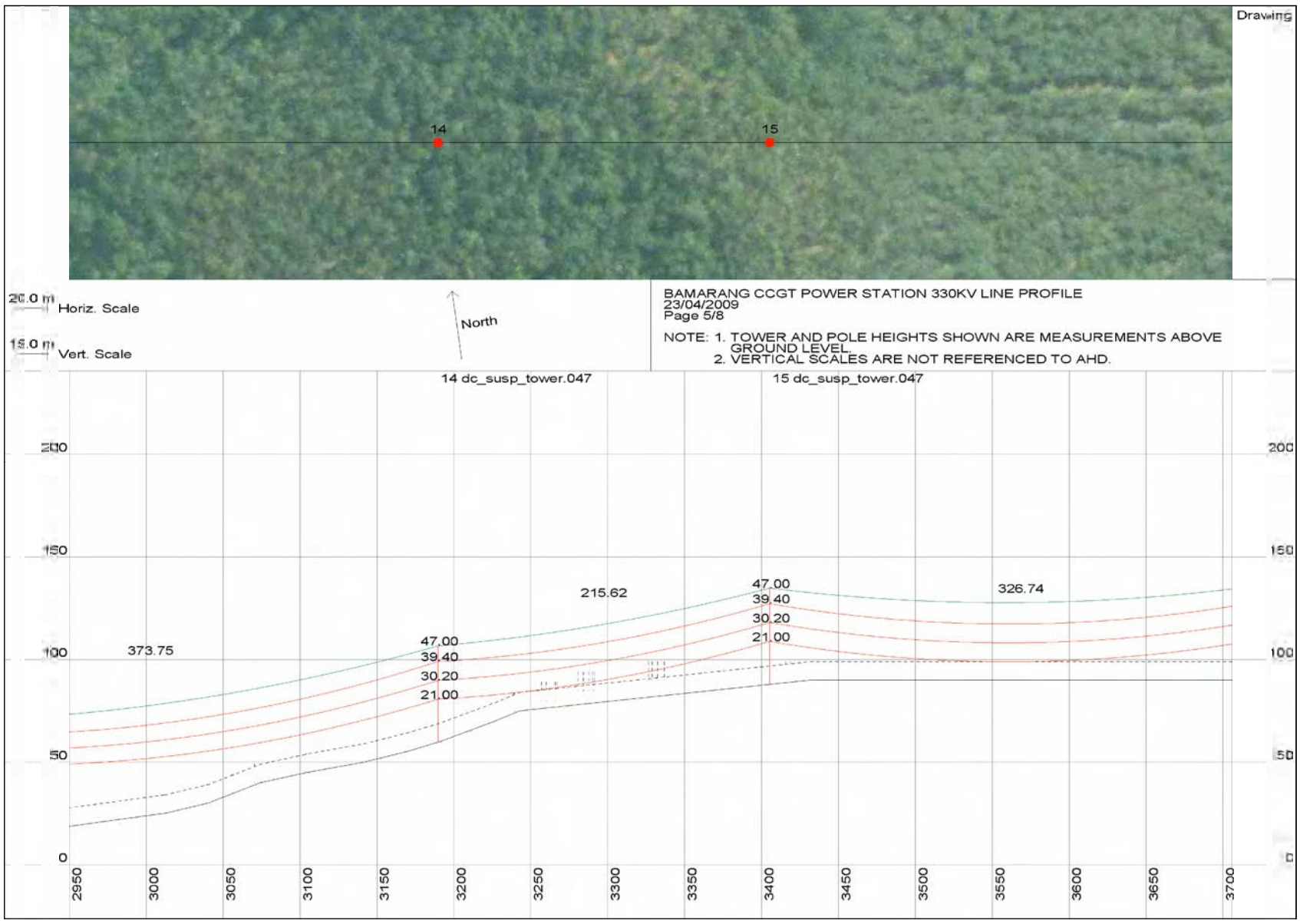


Figure 2-2b: Location and height of the structures



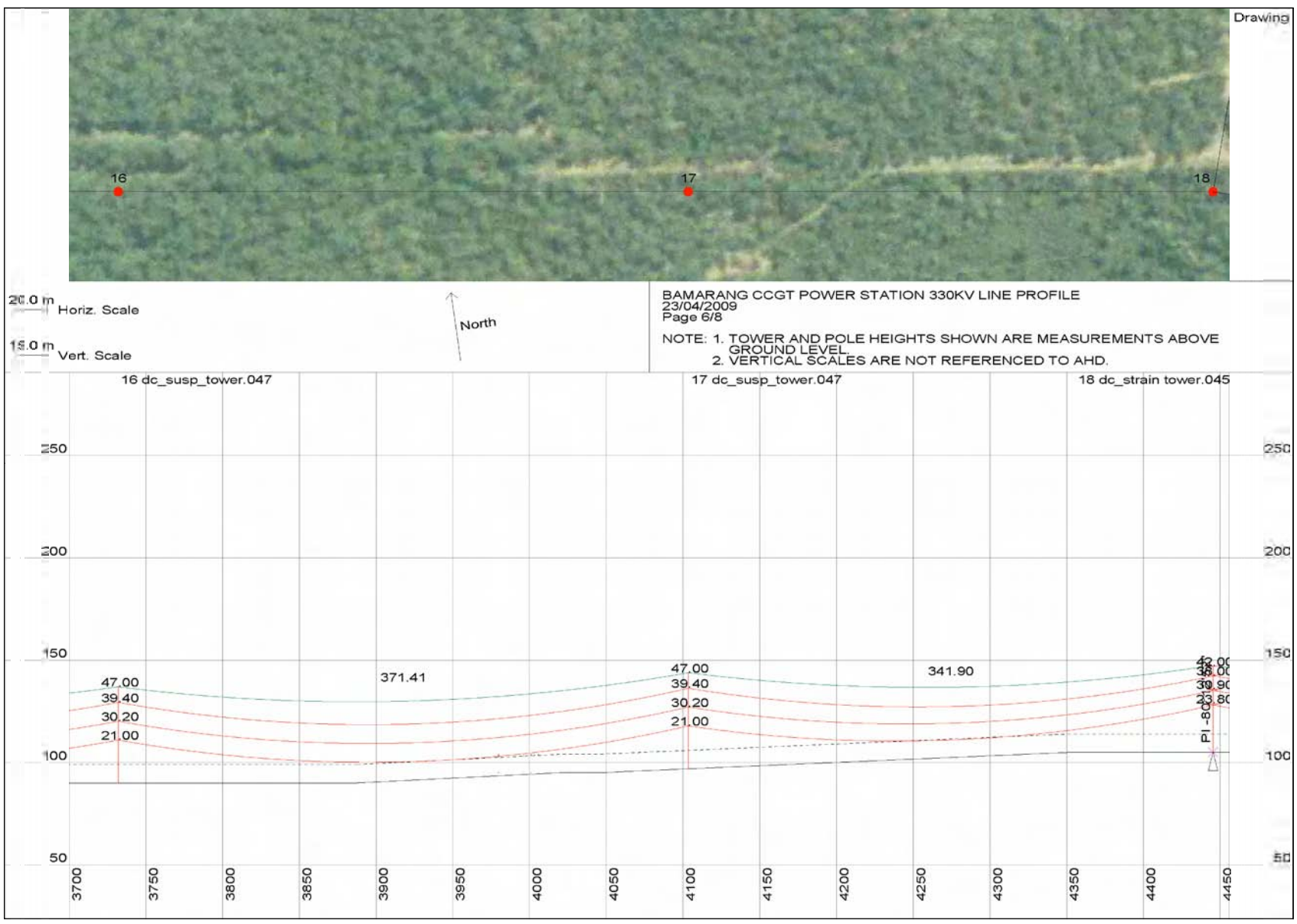
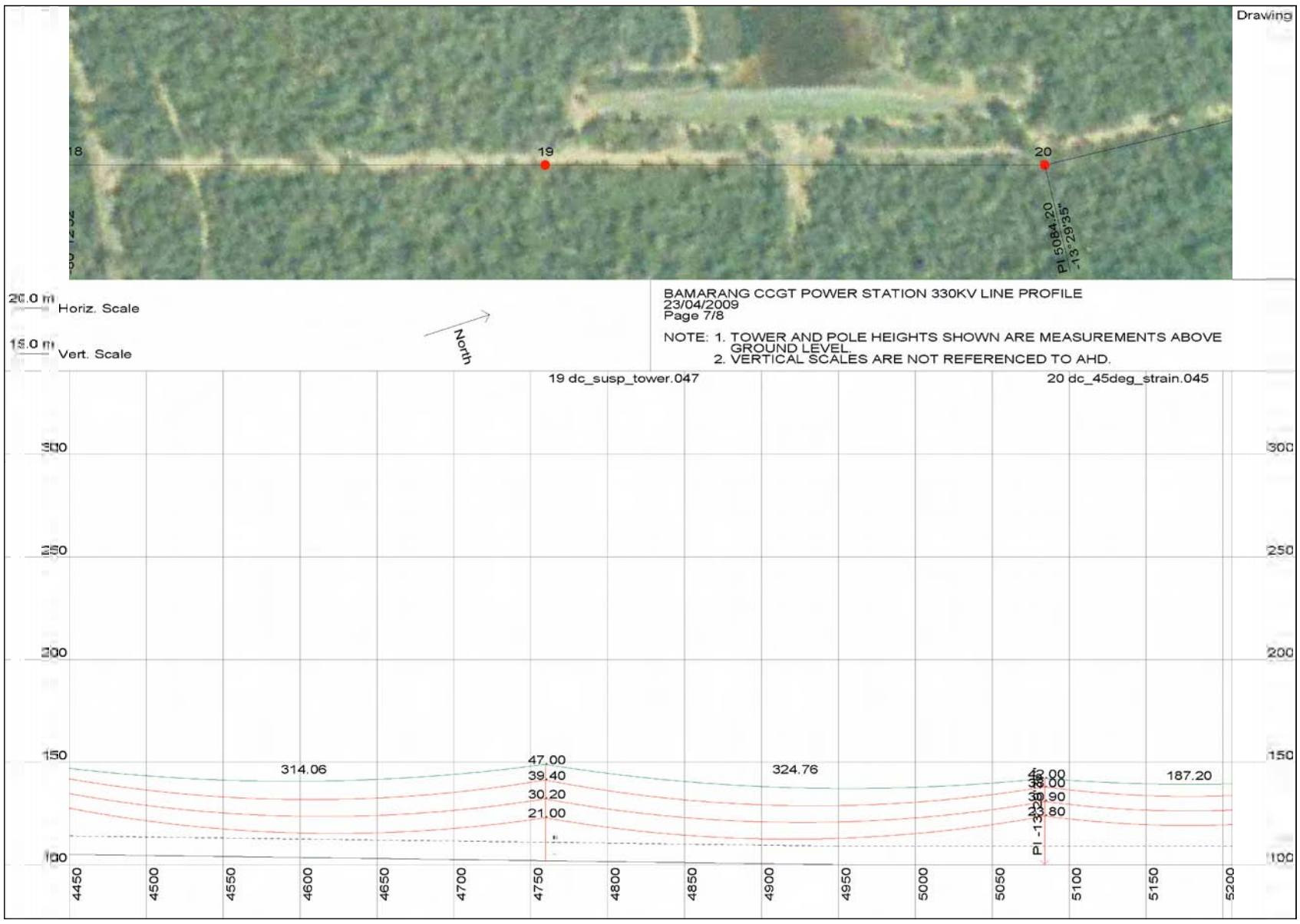


Figure 2-2c: Location and height of the structures



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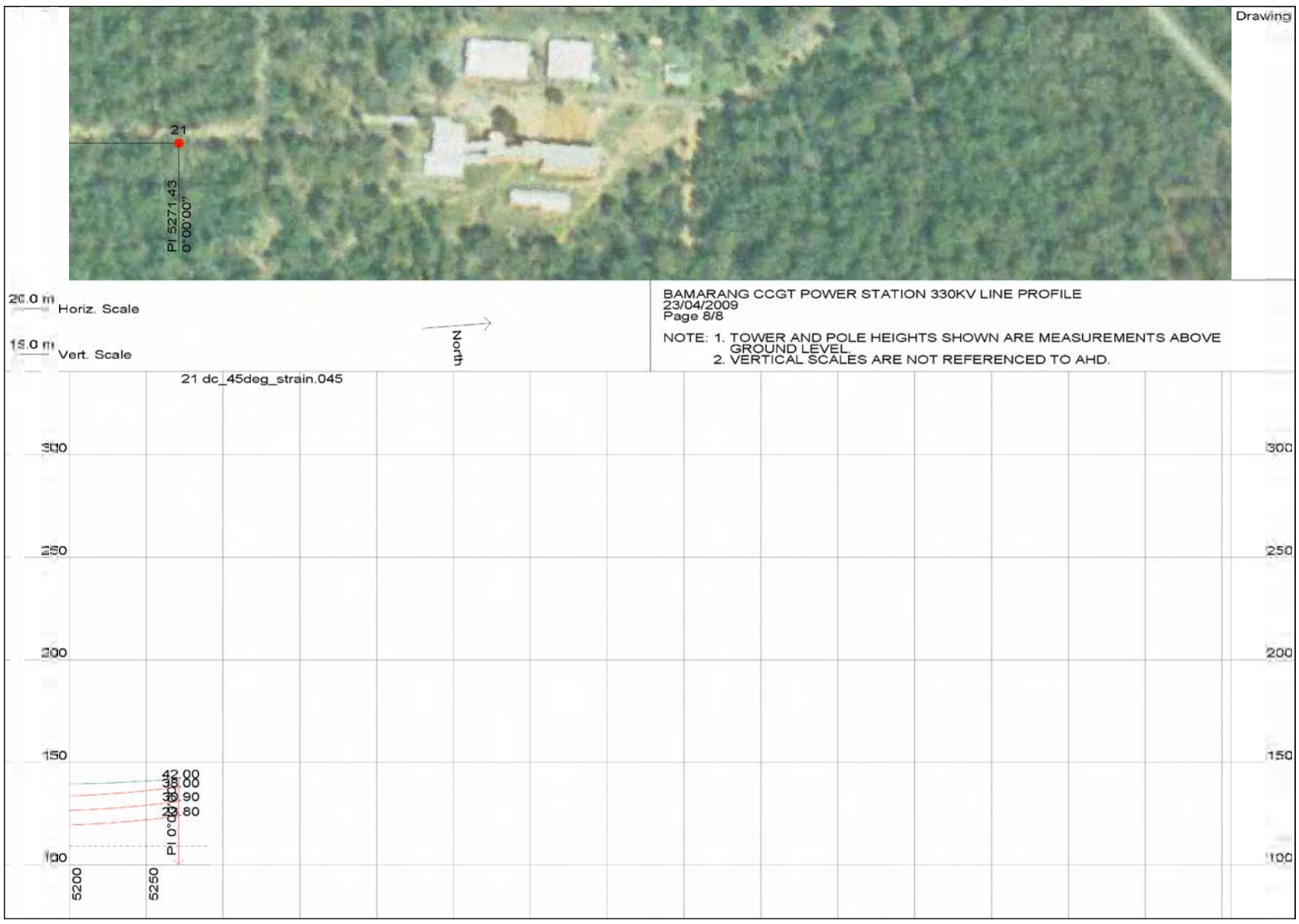

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Figure 2-2d: Location and height of the structures

BAMARANG GENERATION 330 kV NETWORK CONNECTION

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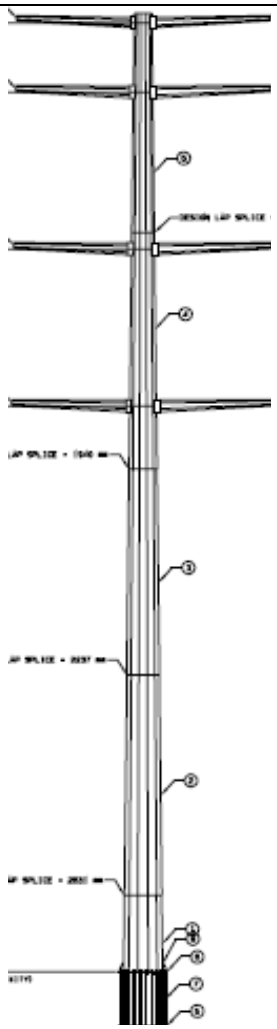
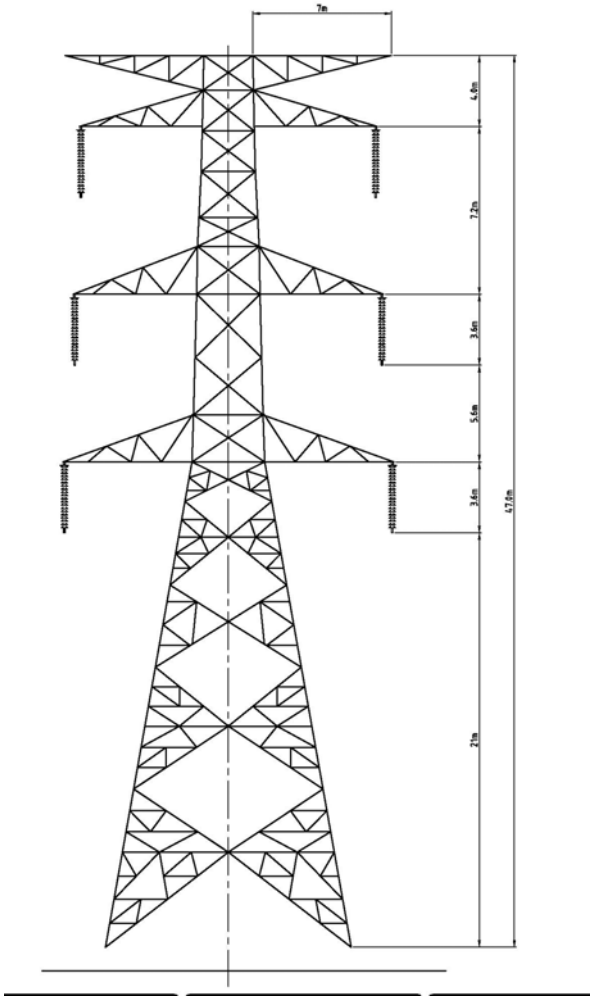
Future maintenance of the line would require the establishment of suitable access tracks for equipment and machinery. It is expected the new transmission line would require an easement of approximately 5.2km length with a width of 60m. The easement requirement for the new 330kV line is based on TransGrid's official easement requirements.

- **Figure 2-3: Transmission Line Construction – Structures**

Steel Pole	Steel Tower
	

The new easement would be cleared in accordance with standard requirements and TransGrid policies. An access track for construction and maintenance purposes would be established along the line route. Depending on topography, ground conditions and environmental considerations,

and subject to later detailed design and survey, more than one access track from established road infrastructure to the easement track may be required. The location and construction of access tracks outside the identified easement boundary would require further survey to ensure environmental impacts are minimised. This can only be done when detailed design is completed.

2.2.3 Transmission Line Construction

Construction of the line would require the establishment of suitable access tracks for equipment and machinery. Pending detailed design and survey, certain sections with difficult access may require equipment and machinery to be airlifted by means of helicopter.

Tower foundations will be either pre-cast or in-situ cast concrete pad foundations, four for each tower. Poles will be either drilled, in-situ cast gravity foundations, or rock anchor design, depending on actual ground conditions.

An area of up to 50 m x 50 m at each typical pole / pylon location (within the proposed 60 m easement width) would be required as a work site for assembly and other construction activities, although some areas would be less if the pole were to be located in a difficult area, for example on a slope.

A track would be provided along the proposed alignment to enable the lines to be laid out before being lifted up to the towers. This track would typically be about 20m wide. This track would then become the maintenance track along the alignment although in difficult access locations some form of track may be needed to the pole site from an existing road. As noted above, these locations would be determined at detailed design phase and would be subject to verification of environmental impact before clearance. Along the alignment the remaining vegetation would be managed so that it does not threaten the transmission line. Ground and low level cover (say up to 10m) would be retained and only tall trees would be lopped or removed.

2.2.4 Line 6 Tie-in Arrangement

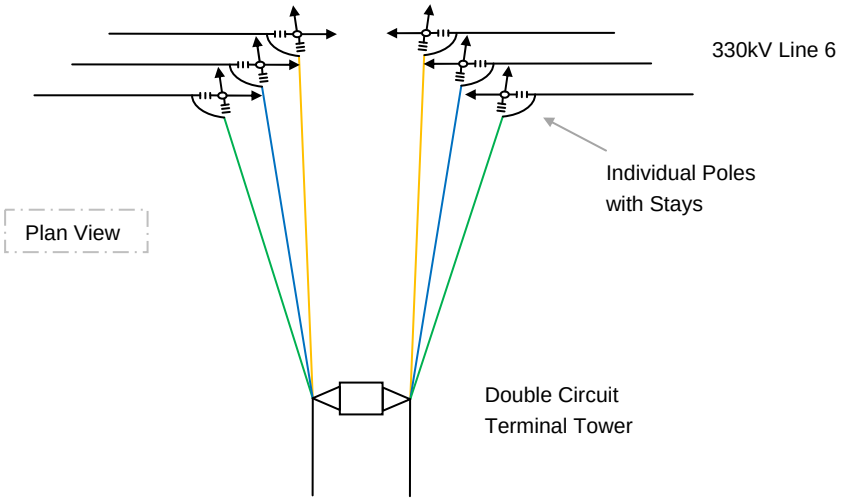
The approximate location of the Line No 6 tie-in point would be north of Pole 533 on the existing TransGrid line. The 330kV Line 6 is of older construction with a horizontal phase conductor arrangement. The ability of the existing Line 6 structures to take on the additional strain due to a deflection of the line is uncertain. It is therefore assumed that the Line 6 tie-in would be done using new deflecting structures in line of route of the Line 6.

Two alternatives designs for the Line 6 cut-in structures could be applied:

A. Common gantry structure for all phase conductors and earth wires;

B. Individual single strain poles with supporting stays (see **Figure 2-4** below).

Individual single strain poles is the favoured solution as this may allow shorter outage times by deviating one phase at the time.



- **Figure 2-4: Proposed Tie-In Arrangement At Existing 330kV Line No. 6**

2.2.5 Bamarang 330kV Sub-station

The proposed 330kV sub-station would be constructed on the existing Delta Electricity property adjacent to the gas fired turbine facility. It would have air insulated switchgear configured in a 'One and a half breaker' configuration. The third diameter of the switchgear, associated with the Stage 2 of the power station, would not be fully equipped for Stage 1 but may enable a further connection of one additional line bay.

The location and arrangement of the sub-station would be chosen such that future extension of the 330kV busbars would be possible. With an extension of the busbars, additional switchgear diameters may be added and accommodate additional feeders and connections to the sub-transmission system via suitably located 330/132kV transformers.

The 330kV sub-station work includes the following main components:

- Civil works including earthworks and benching, drainage, foundations, oil containment facilities (if required), trenching and fencing;
- Structural works posts and insulators, aerial conductors, and power, control and communications cabling;
- 330kV Switchgear, CTs, CVTs, Line Traps and Surge Arresters;
- Switchyard Services Building with ancillary services;

- Protection, control and monitoring systems including communication systems;
- National Grid Metering system;
- Switchyard earthing system;
- Switchyard lighting protection and direct-stroke lightning shielding.

The layout would facilitate maintenance access and benched areas would be appropriately compacted to allow maintenance vehicles all weather access. The site would be benched to ensure water run-off from surrounding areas would not inundate the sub-station.

A lightning aerial shield, earth grid and fence grading ring would be provided for the sub-station.

Design of the lightning shielding would be based on calculations applying the rolling sphere method. The lightning shield would be coordinated with the 330kV transmission lines' overhead earth wires. The earth grid design would be in accordance with applicable Australian and TransGrid design requirements.

A service building would be located within the sub-station area. The building would accommodate the switchyard services and have the following key features:

- 415V Power Main Distribution Panel with incoming power supply selection utilising an Auto Transfer Switch;
- UPS system, battery chargers and batteries and DC Power Distribution Panels;
- SCADA RTUs and communication equipment;
- Protection and metering panels;
- An amenities area provided with all services including water and sewerage complete with appropriately designed waste disposal system;
- Engineer's / Maintenance work place and storage area;
- Miscellaneous small power and lighting services;
- Building climate control system;
- Intrusion detection, fire detection and fire fighting systems.

The building layout and construction would provide compartmentalisation between different equipment systems so as to minimise risk of consequential damage and complete loss of redundant functions.

The building would have a fire rated construction in order to minimise risk of damage and loss of function to any equipment and system accommodated within the building due to fire outside the building.

Power supply to the sub-station and its facilities would be provided from the Integral Energy (IE) 33kV distribution system. Exterior lighting of the building and switchyard area would be provided in accordance with normal industry practice.

A fire water supply, either from mains water system or a tank with diesel driven pump and hydrants, would be provided in accordance with TransGrid requirements for fire protection of switchyards.

3. Strategic Justification

3.1 Need for the project modification

The approval for Stage 1 of the works includes the construction and operation of a 132 kV transmission line to enable the facility to connect into the grid and export its output into the National Electricity Market (NEM). Two main factors have been identified which constrain the Stage 2 capacity of the power station into the NEM via the 132kV network, namely:

- The thermal rating of the Shoalhaven to Mt Terry 132kV line; and
- The level of local demand in the Shoalhaven region.

During low level of local demand in the Shoalhaven region, power flows from Bamarang are "forced" upstream through the Shoalhaven to Mt Terry 132kV line. This line is thermally constrained, however, and the additional power flows above the rating of the line would cause the conductors to sag below safe levels, potentially causing ground clearance issues and hence preventing any further power flows through that line.

Preliminary design studies have shown that the threshold for these constraints is 320-360 MW, which is above the generated output of the Stage 1 works but below the generated output of the Stage 2 works. Under certain contingencies, the generator output could be constrained to as low as 250MW.

Therefore, while the 132 kV line would facilitate the transmission of the output of electricity from the Stage 1 plant, it is likely that under low demand conditions on the South Coast, output from the facility may be constrained, effectively limiting the facility's ability to operate reliably at the full capacity of the Stage 2 works.

Due to these potential constraints, a higher voltage electricity grid connection (330kV) was investigated. A 330kV connection would minimise export constraints and ensure the full capacity of the Stage 2 works would be able to be dispatched into the NEM.

Furthermore, a preliminary costing has been carried out to compare a 330kV connection to No. 6 line with a 132kV connection to the Shoalhaven region. This revealed 132kV costs directly related to the connection of the Bamarang plant are significantly greater than a 330kV connection, due to the additional complexities involved with integrating into an existing distribution network. These costs included Shoalhaven substation expansion costs and substantial 132kV network infrastructure refurbishment, while the 330kV connection to No. 6 line would require no substation establishment as the works would involve cutting into the existing line and minimal 330kV network infrastructure refurbishment.

3.2 Consideration of Alternatives

Delta Electricity has considered a range of alternatives for connecting the approved Bamarang Gas Turbine Facility to TransGrid Line 6, including alternatives for the grid connection configuration and transmission line route. A summary of the options considered is provided below.

3.2.1 Grid Connection Configuration Options

There are two grid connection arrangements by which the Bamarang Gas Turbine Facility can be connected to TransGrid Line 6 (**Figure 3-1**):

- a 'tee' connection, which involves construction of a new switchyard immediately adjacent to Line 6 and construction of a new transmission line running between the Bamarang Gas Turbine Facility and Line 6 via the new switchyard; and
- a 'turn-in/turn-out' connection, which equates to extending TransGrid Line 6 to the Bamarang Gas Turbine Facility using a single circuit 'line-in' and single-circuit 'line-out' arrangement.

Both the 'tee' and 'turn-in/turn-out' arrangements require a new substation to be constructed within the gas turbine site.

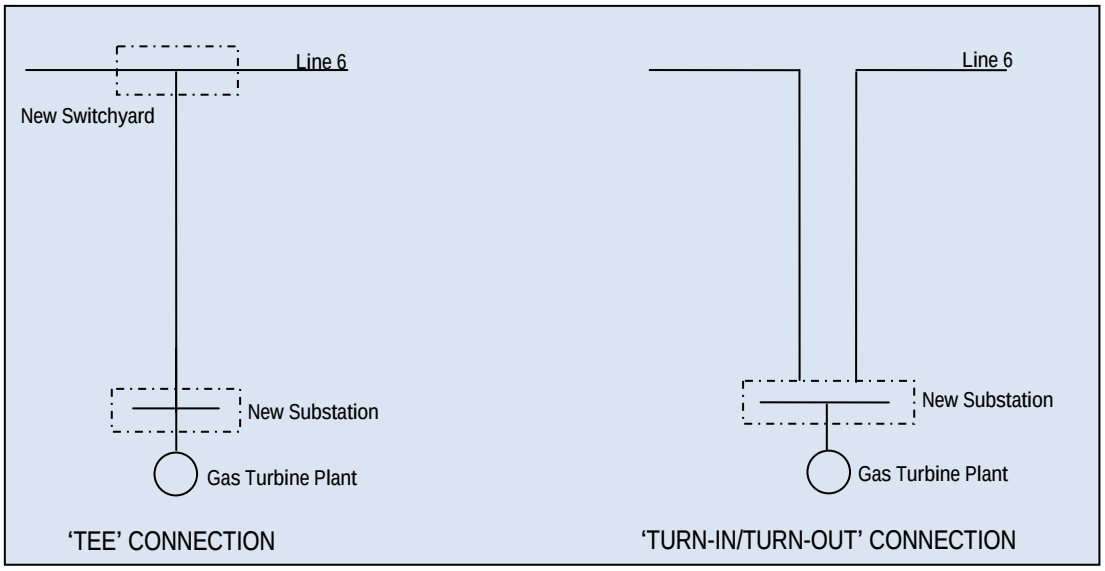


Figure 3-1: Simplified schematic of the two basic grid connection options

Based on the two available options for the grid connection arrangement, there are a total of four feasible options for the overall grid connection configuration, with three configuration options available for the 'tee' arrangement and one configuration option available for the 'turn-in/turn-

out' arrangement. Specifically, for the 'tee' arrangement, the connecting transmission line can be a single circuit 330 kV line, a double circuit 330 kV line or a double circuit 132 kV transmission line. For the 'turn-in/turn-out' arrangement, which is effectively an extension of the existing 330 kV line, the only feasible configuration is two single circuit 330 kV lines (one line in and one line out). These single circuit lines would be strung on the same transmission line structure. The four grid connection configuration options are described in **Table 3-1**.

Table 3-1: Summary of the four grid connection configuration options

Configuration option	Description
Configuration Option 1 - Three breaker mesh tee-off, single circuit 330 kV	Connects the gas turbine facility to Line 6 via a new single circuit 330 kV line and a 'tee' connection arrangement. A new switchyard would need to be constructed adjacent to Line 6. The existing easement of Line 6 would need to be extended to accommodate the new switchyard.
Configuration Option 2 - Four breaker mesh tee-off, double circuit 330 kV	Connects the gas turbine facility to Line 6 via a new double circuit 330 kV line and a 'tee' connection arrangement. As for Option 1, a new switchyard would need to be constructed adjacent to Line 6 and the existing Line 6 easement would need to be extended to accommodate the new switchyard.
Configuration Option 3 - Four breaker mesh tee-off, double circuit 132 kV	Connects the gas turbine facility to Line 6 via a new double circuit 132 kV line and a 'tee' connection arrangement. A new 330/132 kV substation and switching station would need to be constructed adjacent to Line 6 and the existing Line 6 easement would need to be extended to accommodate the substation and switchyard. The area of land required to accommodate the new substation and switchyard would be greater than that required to accommodate the switchyards for Configuration Options 1 and 2.
Configuration Option 4 – Turn-in/turn-out, two single circuit 330 kV	Connects the gas turbine facility to the existing grid via a 330 kV 'turn-in/turn-out' arrangement and two single circuit 330 kV lines strung on the same transmission line structure. In contrast to the other configuration options, Option 4 does not require a new switchyard or substation adjacent to Line 6.

The grid connection configuration options were compared in terms of economic, technical and environmental factors, including system reliability, flexibility for future increases in power transfer, the amount of land-take required for new switchyard and substation infrastructure, and the construction and operational costs (**Table 3-2**). In summary, Configuration Option 4, involving the 'turn-in/turn-out' arrangement with two single circuit 330 kV lines, would be the preferred option for the grid connection due to the following factors:

- it does not require the construction of switchyard or substation infrastructure adjacent to Line 6 and therefore avoids the need for additional land-take and vegetation clearing at this location;
- it is superior to the other options in terms of system reliability, system robustness and flexibility for future power transfer expansion, and;
- it is the least expensive of the four options, which is largely because it does not require the switchyard or substation infrastructure at the Line 6 connection point.

Table 3-2: Comparison of the grid connection configuration options

Comparison criteria	Option 1	Option 2	Option 3	Option 4
Transmission line easement width	60 m	60 m	45 m	60 m
Additional land-take requirements	Yes – land take required for new switching station adjacent to Line 6	Yes – land take required for new switching station adjacent to Line 6	Yes – land take required for new switching station adjacent to Line 6	No
Technical and system considerations	Not favourable in terms of reliability, system robustness and flexibility for future increases in power transfer	Not favourable in terms of reliability, although it offers greater reliability than Option 1. Inferior to option 4 in terms of system robustness and flexibility for future increases in power transfer.	Not favourable in terms of reliability, system robustness and flexibility for future increases in power transfer. Offers no improvements in reliability over options 1 and 2. More vulnerable to system failure than options 1 and 2 due to reliance on a single 132/330 kV transformer.	Superior the other options in terms of reliability, system complexity/robustness and flexibility for future expansion, increase in power transfer requirements and provisions for bulk supply arrangement to Integral Energy
Cost ranking	2nd highest	2nd lowest	Highest	Lowest

3.2.2 Transmission Line Route Options

Overview

Given the environmental constraints within the study area, the eastern part of the new transmission line route from the Bamarang gas turbine facility to Calymea Creek would need to be located within one of the following two land corridors (refer to **Figure 3-2**):

- the narrow corridor of land dissecting Bamarang Nature Reserve to the west of the Bamarang off-river water supply storage reservoir, which coincides with an existing 33 kV transmission line and Yalwal Road (the northern corridor); or
- the corridor of land located between the southern boundary of Bamarang Nature Reserve and the northern boundary of Colymea State Conservation Area (the southern corridor).

Route options within these two corridors were therefore explored for the four grid connection configuration options identified in **Table 3-1**. Based on the combined consideration of transmission line route and connection configuration constraints, four feasible route options for the new transmission line have been identified:

- Route Option A (the Blue Route);
- Route Option B (the Black Route);

- Route Option C (the Yellow Route); and
- Route Option D (the Red Route).

Two of the above-listed routes fall within the northern corridor, with the remaining two falling within the southern corridor. All four route options are approximately 5 km in length and span Calymea Creek and Yalwal Road. The transmission line route options are presented in **Figure 3-2** and detailed in the following sections.

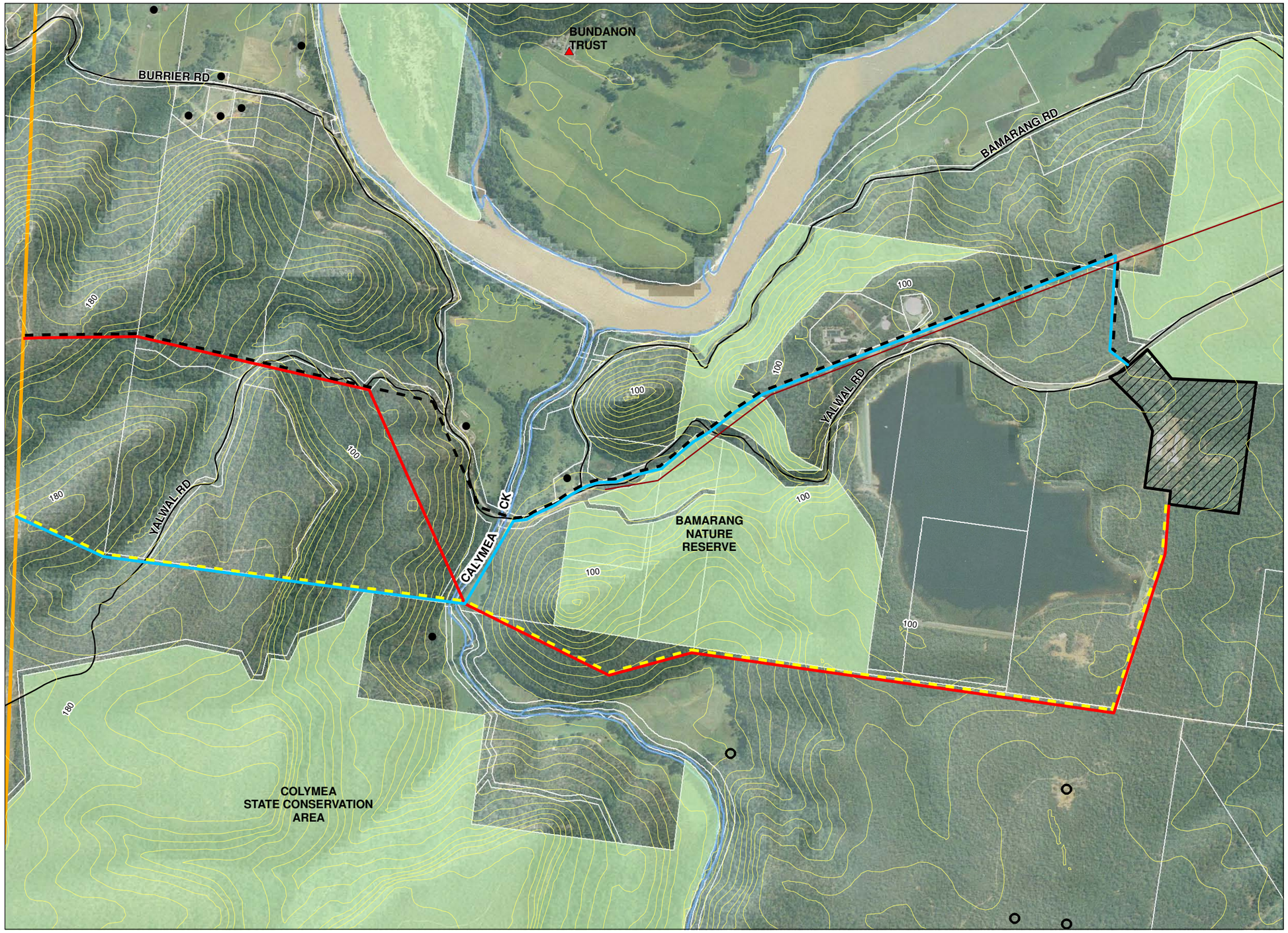
Northern Corridor Route Options – Route Options A (Blue) and B (Black)

Route Options A and B follow the northern corridor. The first 3 km of these routes (between the Bamarang gas turbine site and Calymea Creek) are identical, running initially northwards from the gas turbine site along an existing road, then south-westwards to Calymea Creek along an existing 33 kV transmission line route that passes to the north of Bamarang Reservoir and through a small section of Bamarang Nature Reserve (**Figure 3-2**). Upon reaching Calymea Creek, Route Options A (Blue) and B (Black) diverge as follows:

- Route Option A runs southwards along the eastern side of Calymea Creek before crossing the creek and running westwards to the existing 330 kV line, with the final section of the route (west of Calymea Creek) coinciding with Route Option C (Yellow); and
- Route Option B crosses Calymea Creek immediately then runs north-westwards and westwards to the existing 330 kV line, with the final section of the route (west of Calymea Creek) coinciding with Route Option D (Red).

The main environmental issues associated with Route Options A (Blue) and B (Black) are:

- potential for direct impacts on Bamarang Nature Reserve;
- direct impacts on private land holdings, including agricultural land, and on Crown land;
- potential for water quality impacts on Bamarang Reservoir;
- potential for impacts on Calymea Creek, flora and fauna, and Aboriginal heritage; and
- potential for visual impacts on the surrounding landscape, including residential dwellings and Bundanon heritage listed homestead and landscape.



Legend

- Proposed Residences
- Residences
- 330 kV
- 33 kV
- Roads
- 10m Contours
- Waterways
- National Parks
- Proposed PS Site

Transmission Line Route Options

- 132 kV Option A
- 132 kV Option B
- 330 kV Option C
- 330 kV Option D

Data Sources

Aerial Photograph - LPI, NSW
Topodata - Streetworks
Cadastre - LPI, 2007

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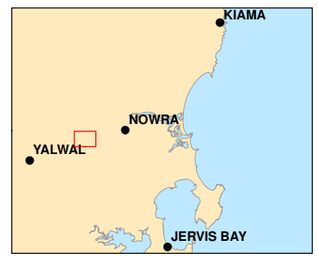

FIGURE 3.2 TRANSMISSION ROUTE LINE OPTIONS

BAMARANG GENERATION 330 kV NETWORK CONNECTION

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Both of the northern corridor route options would pass through a small section (about 180 m in length) of Bamarang Nature Reserve and run directly adjacent to the reserve for a further 600 m. Both routes would also pass through the water catchment area of Bamarang Reservoir and therefore pose a potential risk to water quality during the construction period. This risk is considered to be minor given the relatively low relief of the landscape in this location and the existence of a vegetation buffer between the transmission line routes and the reservoir. The potential risk of sediment run-off during construction could be managed with the implementation of erosion and sediment controls.

The majority of environmental issues are common to routes A and B, although Route Option B is anticipated to present higher potential risks to Calymea Creek and the adjacent riparian vegetation and agricultural land given that it runs directly adjacent to the creek for 370 m (**Figure 3-2**).

Southern Corridor Route Options – Route Options C (Yellow) and D (Red)

Route Options C and D would follow the southern corridor described above. The first 3.5 km of these routes (between the Bamarang gas turbine site and Calymea Creek) are identical, running initially in a general southwards direction along an existing road, then in a general westwards direction to Calymea Creek following roads and property fence lines where possible (**Figure 3-2**). Both route options would meet Route Option A at Calymea Creek. Upon reaching Calymea Creek, Route Options C and D would diverge as follows:

- Route Option C would continue in a general westwards direction to the existing 330 kV line along the same alignment as Route Option A (including the same Calymea Creek crossing point as Route Option A); and
- Route Option D would turn north-westwards, crosses Calymea Creek, continue north-westwards for approximately 900 m, then turn westwards along the same alignment as Route Option B.

The majority of environmental issues are common to routes C and D. The main environmental issues associated with Route Options C and D are:

- direct impacts on private land holdings, including agricultural land, and on Crown land;
- potential for impacts on Calymea Creek, flora and fauna, and Aboriginal heritage; and
- potential for visual impacts on the surrounding landscape, including residential dwellings along Calymea Creek and Bundanon heritage listed homestead and landscape.

In general, the northern corridor was considered to present a greater environmental constraint to transmission line development due the presence of Bamarang Nature Reserve and Bamarang Reservoir, although the extent of vegetation clearance required would be less. The locations of

Bamarang Nature Reserve and Bamarang Reservoir within the northern corridor would leave only a narrow corridor of land for transmission line installation.

3.2.3 Identification of Feasible Transmission Line Alternatives

Combined Consideration of Grid Connection and Route Options

The feasibility of each grid connection option (**Table 3-1**) was examined in the context of the northern and southern route option corridors and corresponding route options. Given the need to avoid or minimise impacts on Bamarang Nature Reserve and Bamarang Reservoir, the area of land within the northern corridor that is suitable for transmission line installation is much narrower than that of the southern corridor. The principal advantage of the northern corridor is the presence of an existing 33 kV transmission line between the Bamarang gas turbine site and the junction of Bamarang Road and Yalwal Road, which would provide a potential opportunity for co-installation of a new transmission line. The size of transmission line that could feasibly be installed along the existing 33 kV transmission line alignment is limited, however, to a 132 kV line. As such, Route Options A and B were only considered to be suitable for the 132 kV configuration, being Configuration Option 3 (**Table 3-1**).

The southern corridor route options, Route Options C (Yellow) and D (Red), would be suitable for either a 132 kV or 330 kV line. Nevertheless, whilst a 132 kV line could be installed along Route Options C and D, this option would require the construction of a substation at the existing 330 kV line 'tie-in' point, which is considered to present a major disadvantage in terms of additional land-take and vegetation clearance requirements and construction costs.

In summary, the 132 kV configuration option is not deemed to be feasible and based on the combined consideration of transmission line route and connection configuration constraints, six feasible 330kV transmission line alternatives have been identified (**Table 3-3**).

Table 3-3: Feasible transmission line alternatives

Alternatives	Configuration	Route
Alternative 1	Configuration Option 1 Single circuit 330 kV with 'Tee' connection	Route Option C Southern corridor, Yellow Route
Alternative 2	Configuration Option 1 Single circuit 330 kV with 'Tee' connection	Route Option D Southern corridor, Red Route
Alternative 3	Configuration Option 2 Double circuit 330 kV with 'Tee' connection	Route Option C Southern corridor, Yellow Route
Alternative 4	Configuration Option 2 Double circuit 330 kV with 'Tee' connection	Route Option D Southern corridor, Red Route
Alternative 5	Configuration Option 4 'Turn-in/turn-out' 330 kV connection	Route Option C Southern corridor, Yellow Route
Alternative 6	Configuration Option 4 'Turn-in/turn-out' 330 kV connection	Route Option D Southern corridor, Red Route

The six transmission line alternatives involve the installation of a 330 kV line using one of three potential grid connection options and one of two potential 330 kV routes through the southern corridor of the study area. In all cases, the 330 kV lines would be constructed using a mix of steel towers and steel poles. Steel towers generally provide a more cost efficient alternative, although poles would be anticipated for certain sections of the line where the potential for high visual impact exists.

Results of Route Alternatives Assessment

The transmission line alternatives identified in **Table 3-3** were assessed in terms of a number of environmental and cost criteria to allow a direct comparison of their relative advantages and disadvantages. The outcomes of this assessment were then used to identify the preferred transmission line route alternative for connection of the Bamarang gas turbine facility to Line 6. The assessment criteria are listed in **Table 3-4**. The choice of the preferred route alignment was also assessed in the context of grid connection options assessment.

In conclusion, Alternatives 1, 3 and 5 (the Yellow Route) would be preferred as the 330kV transmission alignment as they are more direct and would result in a lesser impact on vegetation. The 330 kV Option 4 (turn in / turn out, double circuit 330 kV) is the preferred option due to no switchyard or substation and associated vegetation clearance being required at the 330kV Line 6 tie-in. Option 4 is also assessed to be superior to the other 330 kV options in terms of reliability, system complexity/robustness and flexibility for future expansion, increase in power transfer requirements and provisions for future bulk supply arrangement to Integral Energy.

On the basis of the above, Alternative 5 was determined to be the preferred route alternative.

Table 3-4: Options assessment criteria

Criteria category	Detailed criteria
Impact footprint	Length of transmission line Easement clearance width Easement clearance area Substations required Switching stations required Footprint of sub stations and switching stations Total footprint
Land use	Number of private properties traversed Distance to residential dwellings Visibility of transmission line from dwellings Potential impacts on cleared agricultural land? Potential impacts on public infrastructure? Consistent with local planning objectives?
Matters of National Environmental Significance (NES)	Potential impacts on matters of NES Need for EPBC Act referral to Commonwealth
Biodiversity	Total vegetation clearance for transmission line easement Additional clearing for switching station/ substation Potential effects on conservation reserves Potential effects on EECs Potential effects on threatened species Potential for fragmentation of fauna habitat
Topography and soil landscapes	Erosion and mass movement hazard Likelihood of disturbance of Acid Sulphate Soils
Water and drainage	Flood liability Potential for impacts on Calymea Creek Potential for impacts on Bamarang Reservoir
Heritage	Potential effects on Aboriginal heritage Potential for effects on non-Aboriginal heritage
Visual and scenic values	Potential effects on private land holdings and dwellings Potential effects on 'Scenic Preservation Area'
Costs	Construction costs Land acquisition/ easement costs Total cost