Appendix 4 ARCHAEOLOGY ASSESSMENT

Proposed Yass Valley Wind Farm
Archaeological and Heritage Assessment

February 2009

A report to nghenvironmental on behalf of Epuron Pty Ltd

Julie Dibden
New South Wales Archaeology Pty Limited
PO Box 2135 Central Tilba NSW 2546
Ph/fax 02 44737947 mob. 0427074901
julie@nswarchaeology.com.au

TABLE OF CONTENTS

1. SUMMARY

1.1 Introduction

New South Wales Archaeology Pty Ltd was commissioned by nghenvironmental on behalf of Epuron Pty Ltd in September 2008 to undertake an archaeological and heritage assessment of the proposed Yass Valley Wind Farm Development.

The Yass Valley Wind Farm would be located at the interface of the Southern Tablelands and the South West Slopes, between 20 and 35 kilometres west and south-west of Yass, New South Wales.

The proposal consists of three geographically separate *precincts* that would contain wind turbine generators and electrical plants (substations and power lines) required to connect into the existing transmission network.

The Yass Valley Wind Farm would involve the construction and operation of up to 182 wind turbines across the three precincts. The turbines would be placed along a series of ridgelines and surrounding crests within the three precincts. They are likely to have a rated output of between 1.5MW and 3.6MW each. Accordingly, the wind farm could generate in excess of 450 Megawatts of clean, renewable energy.

The proposed wind farm is defined as a Major Project under Part 3A of the Environmental Planning and Assessment Act 1979. This report addresses the Director-General's requirements (DGRs) relating to archaeology and heritage for the preparation of the Environmental Assessment for the project.

1.2 Partnership with Aboriginal Communities

The field survey and assessment has been undertaken in partnership with Buru Ngunawal Aboriginal Corporation, Onerwal Local Aboriginal Land Council, and Young Local Aboriginal Land Council.

This assessment has been conducted in accordance with consultation process as outlined in the Interim Guidelines for Aboriginal Community Consultation - Requirements for Applicants (NSW DEC 2004).

1.3 Description of Impact

The proposed development is situated in three separate areas: Coppabella Hills, Marilba Hills and Carrolls Ridge. The proposal is comprised of the installation and construction, operation and decommissioning of the following infrastructure:

- Up to 182 wind turbines, each with three blades up to 112 metres diameter, mounted on a tubular steel tower measuring up to 100 metres high;
- Electrical connections between wind turbines using a combination of underground cabling and overhead pole power lines;
- Underground communication cabling;
- Substations and transmission connection linking the wind turbines to the existing transmission system;
- Temporary construction facilities, site compounds, storage areas and batching plants;
- Access roads for installation and maintenance of wind turbines; and
- Onsite control rooms and equipment storage facilities.

The proposed works entail ground disturbance and accordingly the project has the potential to cause impacts to any Aboriginal objects or Non-Indigenous items which may be present within the zones of direct impact. Impacts will be generally confined to cleared areas currently utilised for grazing and cultivation, and existing road easements; where possible existing access roads will be used for site access. Electrical connections and communications cabling will generally be installed within or adjacent to access roads.

The proposed impacts are discrete in nature and will occupy a relatively small footprint within the overall area; accordingly impacts to the archaeological resource across the landscape can be considered to be partial in nature, rather than comprehensive.

1.4 Objectives and Methods

The study has sought to identify and record Aboriginal objects and Non-Indigenous items, to assess the archaeological potential of the landscape and to formulate management recommendations based on the results and significance assessment.

The investigation has included a literature review, field survey and analysis of results. Field work was undertaken over an 18 day period in December 2008 and February 2009. The field survey was focused on investigating broad development envelopes and these were subject to a comprehensive survey.

Indigenous

The approach to archaeological recording in the current study has been a 'nonsite' methodology: the elementary unit recorded is an artefact (described as artefact locales) rather than a site. It is assumed that stone artefacts will be distributed across the landscape in a continuum with significant variations in artefact density and nature in different landform elements. While cultural factors will have informed the nature of land use, and the resultant artefact discard, environmental variables are those which can be utilised archaeologically in order to analyse archaeological variability across the landscape.

A landscape based approach and methodology has therefore been implemented during this study. The proposal area has been divided into a number of Survey Units defined on the basis of a landform morphological type. Survey Units are utilised as a framework of recording, analysis and the formulation of management and mitigation strategies.

The New South Wales National Parks and Wildlife Service has prepared a draft document which provides a series of guidelines regarding the assessment and management of Aboriginal cultural heritage in New South Wales. This report has been prepared in accordance with these draft guidelines (NSW NPWS 1997).

Additionally the study has been conducted in accordance with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (NSW DEC 2005). The Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation have been prepared specifically for development applications assessed under Part 3A of the Environmental Planning and Assessment Act 1979.

Non-Indigenous

The Non-Indigenous component of this assessment has been conducted with reference to literature relating to the European occupation area, a review of Parish maps and a field inspection aimed at locating historical items, features or potential archaeological sites.

The NSW Department of Urban Affairs and Planning and the NSW Heritage Office have produced guidelines for preparing archaeological and heritage assessments as set out in Archaeological Assessment Guidelines 1996 and Heritage Assessments 1996. Where relevant this report has been prepared in accordance with these guidelines and those most recently defined as a result of the 1998 amendments to the NSW Heritage Act 1977.

The historical component of this project aims to provide an assessment of the historical heritage status of the proposal area. Accordingly the project aims to document the results of relevant heritage database searches, conduct an archaeological surface survey, record potential heritage items identified, list statements of significance for recorded sites and to formulate a series of management recommendations.

1.5 Heritage Context

A review of previous archaeological investigations in the area has been undertaken in order to provide an analytical context to the assessment.

Searches of the New South Wales Department of Environment and Climate Change (the NSW DECC) Aboriginal Heritage Information Management System (AHIMS) has indicated that there are no previously recorded sites located within the proposed impact areas (AHIMS #23853; #23852; #23851: 1st October 2008).

Searches have also been undertaken of historical databases including the NSW Heritage Inventory; no Non-Indigenous items are listed on any heritage databases for the proposed impact area.

1.6 Survey Coverage and Results

Carrolls Ridge

The Carrolls Ridge development area has been divided into nine Survey Units. The Carrolls Ridge development envelope surveyed during the assessment measured approximately 137 hectares. It is estimated that approximately 70 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have measured 11 hectares. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been nine hectares. Effective survey coverage is therefore relatively high and calculated to have been 7.1% of the surveyed area.

A total of fifteen Aboriginal object locales were recorded. All locales are stone artefacts except for two which are micro topographic landforms in which artefacts are predicted to occur in a subsurface context. Artefacts were recorded in all Survey Units except SU3, SU5 and SU9.

Artefacts were recorded along the crests in which turbines are proposed; the majority of locales contain either single or otherwise very few artefacts. Given the very few artefacts recorded and the relatively high effective survey coverage, it is concluded that artefact density, is very low generally in the Carrolls Ridge proposal area. Exceptions to this trend have however been identified; three locales are predicted to contain artefacts in moderate or low/moderate density.

Coppabella Hills

The Coppabella Hills development area has been divided into 24 Survey Units. The Coppabella Hills development envelope surveyed during this assessment measured approximately 458 hectares. It is estimated that approximately 207 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have measured 46 hectares. Of that ground exposure area archaeological visibility is estimated to have been 31 hectares. Effective survey coverage is therefore relatively high and calculated to have been 6.9% of the surveyed area.

A total of 70 Aboriginal object locales were recorded. Artefacts were recorded in all Survey Units except SU4, SU8, SU10, SU12, SU13, SU14 and SU22, all of which are assessed to be of low archaeological potential on environmental grounds. Artefacts were recorded along the majority of crests in which turbines are proposed; the majority of locales contain either single or otherwise very few artefacts. Given the relatively large areas of exposure, and the very few artefacts recorded, it is concluded that artefact density is very low generally in the Coppabella Hills.

Several Survey Units and locales within some Survey Units have been predicted to contain subsurface artefacts in low/moderate density including several ridge saddles, a large upland basin and the valleys.

One potential Non-Indigenous heritage item was recorded in and adjacent areas of proposed impacts. This item is an area of ploughland (Coppabella SU24/H1) and is assessed to be of insufficient significance to warrant heritage listing.

Marilba Hills

The Marilba Hills development area has been divided into 33 Survey Units. The Marilba Hills development envelope surveyed during this assessment measured approximately 488 hectares. It is estimated that approximately 301 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have been 16 hectares. Of that ground exposure area archaeological visibility is estimated to have been 13 hectares. Effective survey coverage is therefore calculated to have been 2.7% of the surveyed area. The presence of thick grass cover accounts for the lower effective survey coverage in the Marilba Hills compared to the other precincts.

A total of 31 Aboriginal object locales were recorded in 15 of the Marilba Survey Units. It is recognised that Effective Survey Coverage was very low across the Marilba study area. Nevertheless the majority of Survey Units in which artefacts were not recorded are assessed to be of low archaeological potential on environmental grounds. Artefacts were recorded along many of the crests in which turbines are proposed. The majority of locales contain either single or otherwise very few artefacts. It is concluded that artefact density, generally is very low in the Marilba Hills proposal area. However several Survey Units and locales with some Survey Units have been predicted to contain subsurface artefacts in low/moderate density including several ridge saddles, and the valleys.

Two potential Non-Indigenous heritage item were recorded in and adjacent areas of proposed impacts. These items include a section of wooden fence (Marilba SU4/H1) and a small stone feature, possibly a hut platform (Marilba SU28/H1); they are both assessed to be of insufficient significance to warrant heritage listing.

1.7 Impact Assessment

As previously noted the majority of the Aboriginal object locales recorded in the proposal area are low or very low density stone artefact distributions; these are assessed to be of low archaeological significance. In addition a number of Aboriginal object locales have been identified which are assessed to be of low/moderate or moderate archaeological significance.

The construction of the Yass Valley Wind Farm will result in substantial physical impacts to any Aboriginal objects which may be located within direct impact areas - *irrespective of their archaeological significance*.

That is, any Aboriginal object situated within an area of direct impact will be comprehensively disturbed, and/or destroyed during construction.

As with any development the chances of impacting Aboriginal objects, particularly stone artefacts, is high given that they are present in a continuum across the landscape and located on or within ground surfaces. Yass Valley Wind Farm is no exception in this regard and it would be impossible to have a development of this nature without causing direct physical impact.

However in regard to the majority of Aboriginal object locales such as artefact scatters assessed to be of low significance, the impacts can be viewed as being correspondingly low. On the other hand, impacts to any object locales which are assessed to be of higher archaeological significance can be viewed as being of correspondingly higher. This assessment forms the basis for the formulation of management strategies which aim to mitigate development impact.

1.8 Mitigation and Management Strategies

The Survey Units and Aboriginal object locales recorded in the proposal area do not surpass scientific significance thresholds which would act to preclude the construction of the proposed wind farm.

Based on a consideration of the predictive model applicable to the environmental context in which impacts are proposed, and the results of the study, it is concluded that the proposed impact areas do not warrant further investigation such as subsurface test excavation. The environmental contexts in which the turbines (and associated impacts) are proposed contain eroded and disturbed soils as a result of high levels of environmental degradation; generally these soils have low potential to contain intact and/or stratified archaeological deposit. Furthermore, the generally the proposed impact areas are not predicted to contain artefact density sufficient to warrant test excavation. It is considered that subsurface testing is unlikely to produce results, different to predictions made in respect of the archaeological potential of the landforms in question.

Given the nature and density of the majority of artefact locales recorded in the proposal area and the generally low scientific significance rating they been accorded, unmitigated impacts is considered appropriate; a strategy of impact avoidance is not warranted in regard to these locales.

A number of Aboriginal object locales are assessed to be of low/moderate or moderate archaeological significance. Accordingly it is generally recommended that limiting the extent of impacts to these locales, if at all feasible, should be given consideration.

As a form of mitigation of overall construction impact to the archaeological resource within the proposal area it is proposed that a program of salvage archaeological excavation and analysis be undertaken in a sample of Survey Units (as outlined in see Tables 19, 20 and 20) prior to construction.

Management and mitigation strategies are outlined and justified in Sections 12 and 13 of this report. The following recommendations are provided in summary form:

- Management and mitigation recommendations are listed in respect of each Survey Unit, Aboriginal object locale and heritage item in Section 12 of this report.

- As a form of mitigation of overall construction impact to the archaeological resource within the proposal area it is proposed that a program of salvage archaeological excavation and analysis be undertaken in a sample of impact areas prior to construction.

  The development of an appropriate research project should be undertaken in consultation with an archaeologist, the relevant Aboriginal communities and the NSW Department of Conservation and Climate Change.

- No Survey Units have been identified in the proposal area to warrant further archaeological investigation such as subsurface test excavation; the Effective Survey Coverage achieved during the field survey was relatively high and can be considered to have been generally adequate for the purposes of determining the archaeological status of the proposed impact areas.

- None of the Survey Units in the proposal area have been assessed to surpass archaeological significance thresholds which would act to entirely preclude proposed impacts.

- The majority of the Aboriginal object locales recorded are very low or low density distributions of stone artefacts. The archaeological significance of these locales is assessed to be low. Accordingly a management strategy of unmitigated impact is considered to be appropriate.

- A number of the Aboriginal object locales and/or discrete areas within Survey Units are assessed to be of low/moderate or moderate archaeological significance. Accordingly, in regard to these areas it is generally recommended that limiting the extent of impacts to these locales, if at all feasible, should be given consideration.

  In regard to these locales it is recommended that a research program of subsurface excavation be undertaken as a form of Impact Mitigation.

- It is recommended that additional archaeological assessment is conducted in any areas which are proposed for impacts that have not been surveyed during the current assessment. It is predicted that significant Aboriginal objects can occur anywhere in the landscape and accordingly if present they need to be identified and impact mitigation strategies implemented prior to impacts.

- The proponent should, in consultation with an archaeologist, develop a Cultural Heritage Management Protocol, which documents the procedures to be followed for impact mitigation. The development of an appropriate Cultural Heritage Management Protocol should be undertaken in consultation with an archaeologist, the relevant Aboriginal communities and the NSW Department of Conservation and Climate Change.

- Personnel involved in the construction and management phases of the project should be trained in procedures to implement recommendations relating to cultural heritage where necessary.

- Cultural heritage should be included within any environmental audit of impacts proposed to be undertaken during the construction phase of the development.

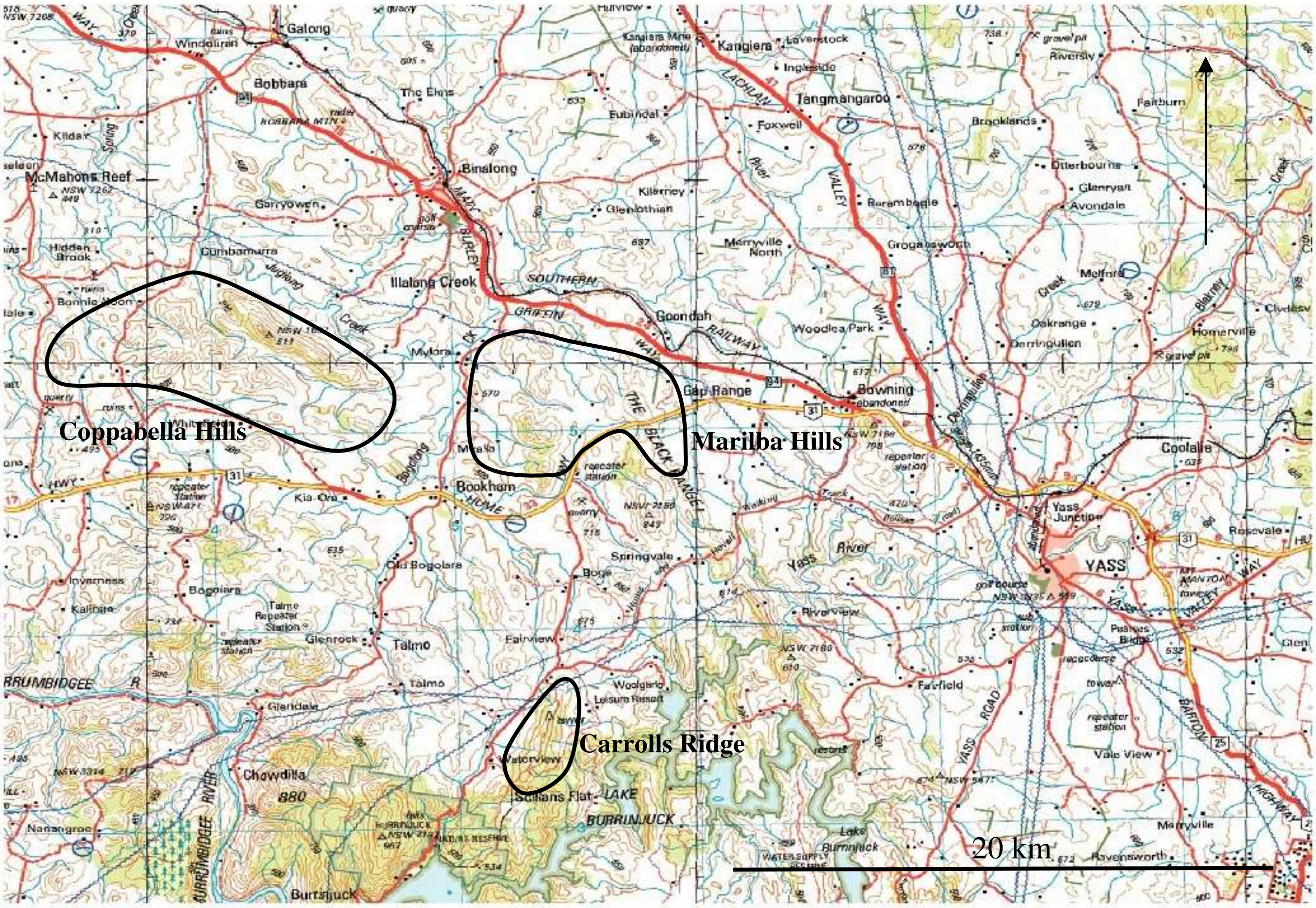


Figure 1. Location of the Yass Valley Wind Farm development envelopes. The individual localities are labelled (1:250,000 topographic map).

2. INTRODUCTION

2.1 Introduction

New South Wales Archaeology was commissioned by nghenvironmental on behalf of Epuron Pty Ltd in September 2008 to undertake an archaeological assessment of the proposed Yass Valley Wind Farm Development.

The proposal consists of three geographically separate *precincts* that would contain wind turbine generators and electrical plants (substations and power lines) required to connect into the existing transmission network (Figure 1): *Coppabella Hills*, *Marilba Hills* and *Carrolls Ridge*. All proposed impacts are situated within private grazing properties or crown road easements.

The Yass Valley Wind Farm would involve the installation and construction of up to 182 wind turbines across the three precincts. The turbines would be placed along a series of ridgelines and surrounding crests within the three precincts. The wind turbines are likely to have a rated output of between 1.5MW and 3.6MW. Accordingly, the wind farm could generate in excess of 450 Megawatts of clean, renewable energy.

The proposal is comprised of the construction, operation and decommissioning of the following infrastructure:

- Up to 182 wind turbines, each with three blades up to 112 metres diameter, mounted on a tubular steel tower up to 100 metres high;
- Electrical connections between wind turbines using a combination of underground cabling and overhead concrete pole power lines;
- Underground communication cabling;
- Substations and transmission connections linking the wind turbines to the existing transmission system;
- Temporary construction facilities, site compounds, storage areas and batching plants;
- Access roads for installation and maintenance of wind turbines; and
- Onsite control rooms and equipment storage facilities.

A full description of proposed impacts is outlined in Section 4. The project description is based on current planning; site layout may change as a result of issues which might arise in relation to ongoing assessments including biodiversity, archaeology, geology, wind regime, wind turbine availability and transmission connection design issues.

The proposed wind farm is defined as a Major Project under Part 3A of the Environmental Planning and Assessment Act 1979. The Director General, Department of Planning has issued requirements for the preparation of an Environmental Assessment in which it is stated that an archaeological/cultural heritage assessment is required to be prepared which addresses the potential impact of the proposal on Aboriginal heritage values and items.

In accordance with the NSW NPWS guidelines for archaeological reporting (NSW NPWS 1997) and the NSW DEC Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (NSW DEC 2005) this report aims to document:

- The Aboriginal consultation process undertaken for the project and the involvement in the project of the Aboriginal community (Section 3);
- A description of the proposal and whether or not it has the potential to result in impacts to Aboriginal cultural heritage (Section 4);
- A description of the impact history of the proposal area (Section 4);
- The methodology implemented during the study (Section 5);
- The landscape and natural resources of the study area in order to establish background parameters (Section 6);
- A review of archaeological and relevant literature and heritage listings on the NSW DECC Aboriginal Heritage Information Management System (Section 7);
- A synthesis of local and regional archaeology (Section 7);
- A predictive model of Aboriginal object type and location relevant to the proposal area (Section 7);
- The cultural and archaeological sensitivity of the landforms subject to proposed impacts (Section 7);
- A review of Non-Indigenous history of the proposal area and the results of relevant heritage database searches (Section 8);
- The field survey results (Section 9);
- The significance of Aboriginal objects and Non-Indigenous items (Section 11);

- An assessment of the impact of the proposal on Aboriginal objects and places (Section 12);
- A description and justification of the proposed outcomes and alternatives (Section 12); and
- A series of recommendations based on the results of the investigation (Sections 12 and 13).

The field work component of this project has been conducted by NSW Archaeology Pty Ltd and members of Buru Ngunawal Aboriginal Corporation, Onerwal Local Aboriginal Land Council and Young Local Aboriginal Land Council. This report has been written by Julie Dibden.

3. PARTNERSHIP WITH THE ABORIGINAL COMMUNITY

This project has been undertaken in accordance with the NSW DECC Interim Guidelines for Aboriginal Community Consultation - Requirements for Applicants (IGACC) (NSW DEC 2004). The NSW DECC requires proponents to undertake consultation with the Aboriginal community "…as an integral part of the impact assessment" process (NSW DEC 2004). While it is recognised that under Part 3A, Environmental Planning and Assessment Act, National Parks and Wildlife Act 1974 Part 6 approvals are not required, the consultation process as outlined in the IGACC policy document has nevertheless been implemented for this project.

The NSW DECC manages Aboriginal cultural heritage in NSW in accordance with the National Parks and Wildlife Act 1974. Part 6 of the Act provides protection for Aboriginal objects and Aboriginal Places. When an activity is likely to impact Aboriginal objects or declared Aboriginal Places approval of the Director-General of the NSW DECC under s90 or s87 of the NPW Act is usually required. The decision as to whether or not issue s90 or s87, *or general approval*, is based on the supply to the NSW DECC by a proponent of adequate information in regard to consultation to enable the Director-General to make an informed decision (NSW DEC 2004).

When administering its approval functions under the NPW Act the NSW DECC requires applicants to have consulted with the Aboriginal community about the Aboriginal cultural heritage values (cultural significance) of Aboriginal objects and places present in the area subject to development (NSW DEC 2004).

The NSW DECC requires consultation with the Aboriginal community because it recognises the following:

- That Aboriginal heritage has a cultural and archaeological significance and that both should be the subject of assessment to inform its decision process;
- That Aboriginal people are the primary determinants of the significance of their heritage;
- That Aboriginal community involvement *should occur early* in the assessment process to ensure that their values and concerns can be taken into account and so that their own decision making structures can function;
- That the information arising from consultation allows consideration of Aboriginal community views about significance and impact and allows for management and mitigation measures to be considered in an informed way (NSW DEC 2004).

The community consultation process as outlined in the IGACC document aims to improve the assessment by providing the Aboriginal community with an opportunity to:

- Influence the design of the assessment of cultural and scientific significance;
- Provide relevant information about cultural significance values of objects/places;
- Contribute to the development of cultural heritage management recommendations; and
- Provide comment on draft assessment reports (NSW DEC 2004).

The role of the Aboriginal Community is outlined by the NSW DECC (2004) as follows:

- The Aboriginal community is the primary determinant of the significance of their heritage;
- The Aboriginal community may participate in the process via comment on the assessment methodology, contribution of cultural knowledge; and
- The Aboriginal Community may comment on cultural significance of potential impacts and/or mitigation measures.

In order to fulfil the consultation requirements as outlined in the IGACC document NSW Archaeology Pty Ltd, on behalf of the proponent, has adopted the following procedure:

1. Notification and Registration of Interests

   NSW Archaeology Pty Ltd on behalf of the proponent has actively sought to identify stakeholder groups or people wishing to be consulted about the project and has invited them to register their interest as follows:

   Written notification about the project dated 30th September 2008 has been supplied to the following bodies:

   - Young Local Aboriginal Land Council;

- Onerwal Local Aboriginal Land Council;
- Native Title Services;
- Yass Valley and Harden Shire Councils; and
- The NSW Department Environment and Climate Change.

The Registrar of Aboriginal Owners was not notified of the project given that the proposal area is not situated within a National Park which possesses a register of Aboriginal owners.

In addition an advertisement has been placed in the 15th October 2008 edition of the Yass Tribune.

Buru Ngunawal Aboriginal Corporation, Ngunawal Heritage Aboriginal Corporation and Onerwal Local Aboriginal Land Council registered an interest in this project.

The proposal area is situated within both the Young Local Aboriginal Land Council and Onerwal Local Aboriginal Land Council boundaries. In accordance with Part C of the NSW DECC Interim Guidelines for Aboriginal Community Consultation - Requirements for Applicants, given the scale and nature of the project, the proponent engaged the services of the two Local Aboriginal Land Councils and additionally Buru Ngunawal Aboriginal Corporation to assist in fieldwork component of the project. A draft copy of this report has been provided to Aboriginal stakeholders for review and comment.

4. DESCRIPTION OF IMPACT

The information contained in this section of the report is provided in accordance with the NSW NPWS (1997) guidelines for archaeological survey reporting. Impact justification and a full description of the proposal and its potential impact on the landscape and heritage resource is described below.

This information includes a summary of the impact history of the study area. These prior and existing land uses have caused significant changes to geomorphological processes in the area, with an associated effect on the archaeological resource.

4.1 Impact justification

In Australia wind farms have become viable propositions because of renewable energy policies of the Federal and State Governments requiring electricity retailers to source a certain percentage of electricity from renewable sources. The NSW State Government has introduced legislation to parliament called the Renewable Energy (NSW) Bill as part of the Government's Greenhouse Policy to encourage additional generation of renewable energy. The NSW renewable energy target, referred to as NRET, requires NSW electricity retail companies to purchase a percentage of their power from renewable energy sources.

The NRET is a market based mechanism designed to encourage investment in renewable energy technologies that will provide the lowest cost generation of renewable electricity in the National Electricity Market. The proposed Yass Valley Wind Farm would provide renewable energy which is eligible for Renewable Energy Certificates under the NSW Government scheme. Projects such as the Yass Valley Wind Farm will encourage renewable energy investment in NSW and will reduce the costs of production by reducing transmission losses to the NSW load centres.

The Yass Valley Wind Farm will offer the following benefits to the environment and local community:

- The project will directly inject funds into the local economy (both during construction and during the operational phase);
- The project will provide an opportunity for regional investment in the Yass area as the renewable energy sector and the businesses that supply and service it, grow;
- The wind farm will provide electricity into the NSW grid that would assist in meeting ongoing load growth in NSW;
- The project will reduce greenhouse gas emissions, helping to reduce the impact of climate change;
- The project will supply renewable energy that would assist NSW electricity retailers fulfill their obligations under the NSW Greenhouse Plan and the NSW renewable energy target; and
- The proposal will include an annual funding allocation for community projects including environmental measures both on and off-site.

The Yass Valley Wind Farm proposal is fully self-funding, producing no drain on the public purse. The project maximises use of existing resources while being remote from high population centres, thereby reducing social impacts. The wind farm would have a minimal impact on capital investment in other forms of power generation.

4.2 Impact History

The proposed impacts relating to the Yass Valley Wind Farm are situated on farm land. The impact history of the area is therefore related to previous and current farming activities including grazing and cultivation. Given that the most common Aboriginal objects expected to be present within the proposal area are stone artefacts located in or on ground surfaces, the following review is focused on describing the impact to soils and soil profiles which has resulted from decades of agriculture practice.

Land clearance commenced in the region with its occupation by early settlers during the early to mid 1800s (see Section 8 for information relating to early European settlement of the region). Following clearance the arable land was utilised for both grazing and various cultivation endeavors including pasture improvement and cropping, while hilly land has been used exclusively for grazing. Currently the majority of the proposed impact areas including the ridges, hill slopes and valleys are cleared and contain scattered and isolated trees or small stands only (Plate 1). By and large all trees are mature or dying and saplings are not present.

Plate 1. Ridge in the Coppabella Hills proposal area.

As a result of the long history of grazing and cultivation the proposal area is located within a highly degraded landscape; similarly to other parts of Australia, vegetation, soils and geomorphological processes have been dramatically changed by clearing, cropping and grazing (Wasson *et. al* 1998). Tree clearance, the grazing of sheep and cultivation in the Southern Tablelands, has resulted in increased runoff and erosion, both on hill slopes and valley floors, much of which commenced very soon after initial European occupation (Wasson *et. al* 1998). These erosional processes have lead to significant changes to landscape processes. More recently dryland salinity has become a problem in the area as a result of earlier vegetation clearance.

The pre-European vegetation and landform context is reviewed in Section 6. The series of photos below show the erosional features currently present within the proposal area. Stream incision and widening is now present within the proposal area along valley floors (Plate 2). Additionally many gullies have cut into hillslopes and valley-side depressions (Plates 3 and 4) that previously, were unlikely to have been channeled (*cf* Wasson *et. al* 1998). The majority of active channel and gully formation in the Southern Tablelands is believed to have occurred up until c. 1900.

Plate 2. Channel incision in a drainage depression on the 'Marilba' property. This erosion is almost certainly a post European phenomenon. Note also the top yellow-brown soil layer visible in the channel section which is probably Post Settlement Alluvium deposited after the erosion of hillslopes.

Post Settlement Alluvium (PSA) is widely reported as covering the floodplains of creeks and streams in the region (Wasson *et. al* 1998). It is found to measure up to 1 - 3 metres in thickness and has been incised by modern channels rather than deposited overbank by these channels (see Plate 2).

While hillslope erosion (sheet and rill) and sediment accumulation in catchments of the region prior to European settlement is measurable, rates of erosion are considered to have been low (Olley *et.al* 2003). Similarly to stream incision and erosion, hillslope erosion increased significantly during the first 50 or so years of European occupation.

Valley floors are likely to have been severely eroded with changes to soil structure in the early years of grazing due to stock trampling, removal of vegetation (via grazing and drought processes – *the period between 1830 - 1850- was a time of below average rainfall*) and within the drainage lines themselves, by the onset of gullying (Dorrough *et. al* 2004; Olley *et. al* 2003). It is recognised that the effects of grazing on soils is most pronounced where livestock congregate close to watering points (Lunt *et. al* 2007); both now with dams and previously, these watering points are generally situated within valleys.

Erosion in the region continues to be a problem due to dryland salinity (Seddon *et. al* 2007). Salinity cause bare scalds and gullying. Mitigation measures in the form of tree plantings are being carried out in a number of properties within the proposal area. These actions in themselves have resulted in additional localized disturbance of soils and any artefactual material which may be present.

Land clearance and subsequent erosional processes are likely to have resulted in varying levels of prior impacts to Aboriginal objects. Trees hosting evidence of cultural scarring will have been completely destroyed while Aboriginal objects located in or on the ground will have been disturbed and/or moved, resulting in loss of their original depositional context (both spatially and vertically).

Plate 3. Gully erosion on the upper slopes of Black Range, Marilba Hills.

Plate 4. Gully erosion extending from the crest on the Coppabella Hills; note also stock tracks.

4.3 Proposed Impacts

The proposal would involve the construction, operation, and decommissioning of wind farms in each of the three precincts as described below. The proposed impact areas are shown below in Figures 2, 3 and 4.

Coppabella Hills – 86 Turbines

- The Coppabella Hills Wind Farm would be located on the ridges located to the north of the Hume Highway and south of Binalong.
- Coppabella Hills could contain up to 86 wind turbines.

Marilba Hills – 66 Turbines

- The Marilba Hills Wind Farm would be located on ridges in the northern part of Black Range (to the north of the previously approved Conroy's Gap Wind Farm project) and hills to the west of this ridge.
- Marilba Hills could contain up to 66 wind turbines.

Carrolls Ridge – 30 Turbines

- The Carrolls Ridge Wind Farm is located approximately 25 kilometres south-west of Yass and to the northwest of Burrinjuck Dam.
- Carrolls Ridge could contain up to 30 wind turbines.

Each turbine would have three blades likely to be up to 112m diameter mounted on a tubular steel tower up to 100 metres high, with capacity between 1.5 and 3.6 MW.

The proposal would also involve the construction, operation and decommissioning of:

- Electrical connections between wind turbines and on-site substations, which would be a combination of underground cable and overhead power lines.
- Onsite control buildings and equipment storage facilities for each precinct.
- A temporary concrete batching plant at each precinct.
- Access roads within the precincts in addition to minor upgrades to access on local roads, as required, for the installation and maintenance of wind turbines.
- A number of freestanding permanent monitoring masts for wind speed verification and monitoring.

A description of the individual components and their related impacts are outlined as follows:

- <u>Turbines</u>

  The ground disturbance associated with each turbine will include the construction of reinforced concrete footings excavated to a maximum size of 15 x 15 metres.

  A hardstand area adjacent to the turbine footings which could measure up to 40 x 22 metres is required for a crane. A delivery area for the various components is also necessary. In most cases it is anticipated that the turbine access track could be used as a delivery area.

  Each tower will have a transformer which will be housed either within the base of the tower, in the nacelle (located on the tower), or adjacent to the tower as a small pod mount transformer.

- <u>Electrical Connections</u>

  The onsite electrical works will include on-site power reticulation cabling (underground and overhead) linking the turbines to a Substation at each of the three precincts. Underground cabling is proposed between the turbines, with overhead cabling proposed in some locations to connect the turbines to the substation and/or the existing transmission system.

  Underground cabling would be laid out in trenches measuring 1 - 1.5 metres deep and 0.5 - 1 metres wide and where possible the trench routes will follow access tracks, with short spur connections to each turbine.

  Overhead cabling would require an easement of ca. 40 metres wide and is proposed to be erected on 17- 20 metres high single wood or concrete poles spaced 150 - 300 metres apart, with spans avoiding all wet areas. Postholes would be 1.5 - 2 metres deep and ca. 0.5 metres in diameter.

- Substation

  A substation is required at each of the three precincts to convert power from onsite reticulation voltage to a transmission voltage of 132kV suitable to connect to the existing transmission system.

  Substations will occupy an area measuring ca. 200 x 150 metres. The substation will be fenced and the ground covered with crushed rock and partly by concrete pads for equipment, walkways and cable covers.

- On-site Control and Facilities Building

  An on-site Control and Facilities Building which will house instrumentation, control and communications equipment is proposed for each precinct. The buildings will each measure up to 25 x 15 metres and will be built on a concrete slab. Control and communications cabling is also required to extend from the Control and Facilities Building to each turbine and to the site Substation. The control cabling will be installed using the same method and route as the power cabling.

4.4 Potential Impacts

Impacts will be located on land currently utilised for sheep and cattle grazing, and cultivation. Previous land uses in the region have resulted in significant environmental impacts and a generally highly degraded landscape. European activated geomorphological processes and other actions will have caused significant prior impacts to Aboriginal objects within the region.

However irrespective of prior impacts the proposed works entail ground disturbance and accordingly the project has the potential to cause additional impacts to any Aboriginal objects or historical items which may be present within the individual components of the proposal.

The construction of the Yass Valley Wind Farm will result in substantial physical impacts to any Aboriginal objects which may be located within direct impact areas - *irrespective of their archaeological significance*. That is, any Aboriginal object situated within an area of direct impact will be comprehensively disturbed, and/or destroyed during construction.

As with any development the chances of impacting Aboriginal objects, particularly stone artefacts, is high given that they are present in a continuum across the landscape and located on or within ground surfaces. Yass Wind Farm is no exception in this regard and it would be impossible to have a development of this nature without causing direct physical impact.

However in regard to Aboriginal object locales such as artefact scatters assessed to be of low significance, the impacts can be viewed as being of correspondingly low. On the other hand, impacts to any object locales which are assessed to be of higher archaeological significance can be viewed as being of correspondingly higher.

It is however noted that the proposed impacts are discrete in nature and will occupy a relatively small footprint within the overall area; accordingly impacts to the archaeological resource across the landscape can be considered to be partial in nature, rather than comprehensive.

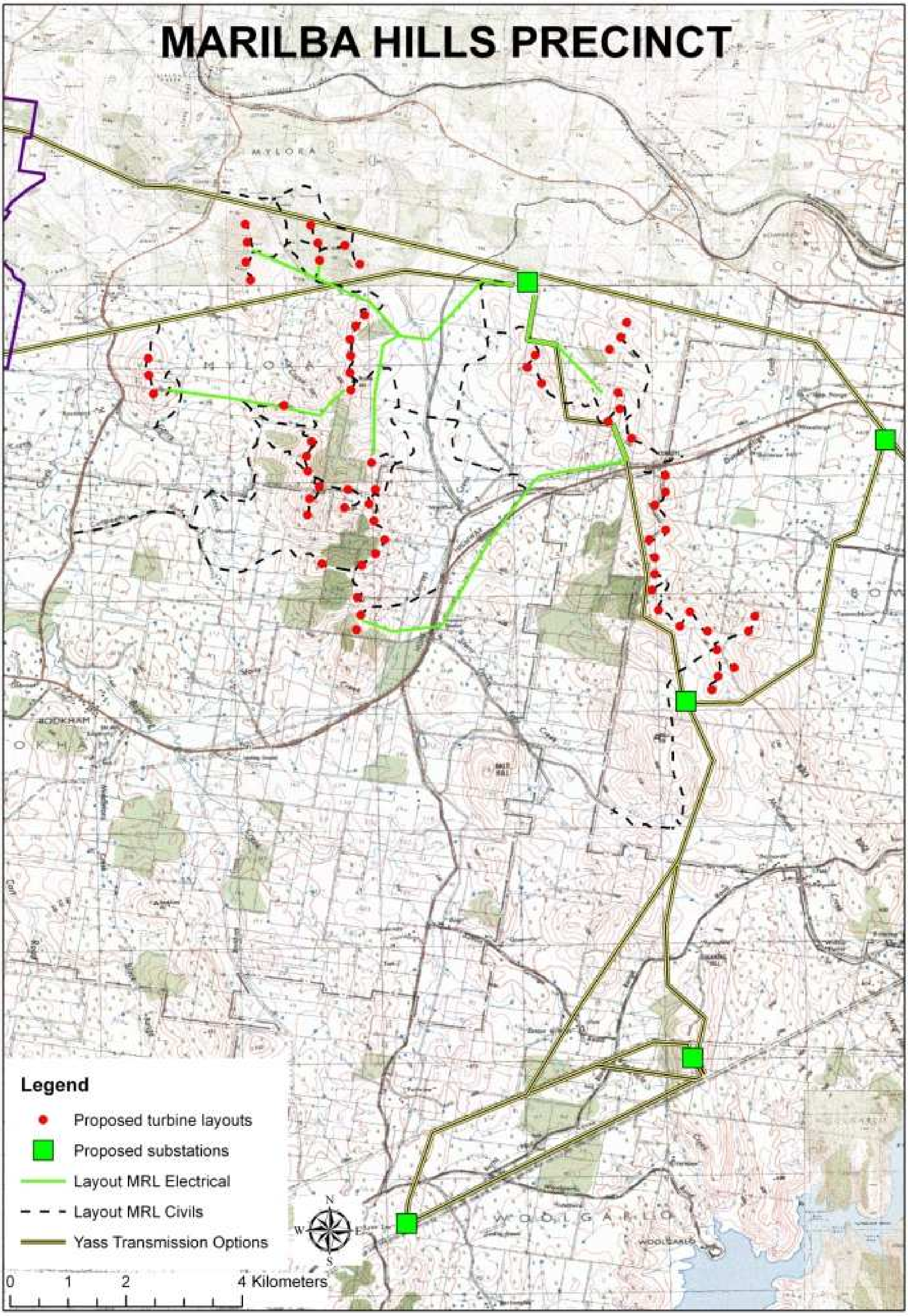


Figure 2. Marilba Hills Wind Farm layout (supplied by client).

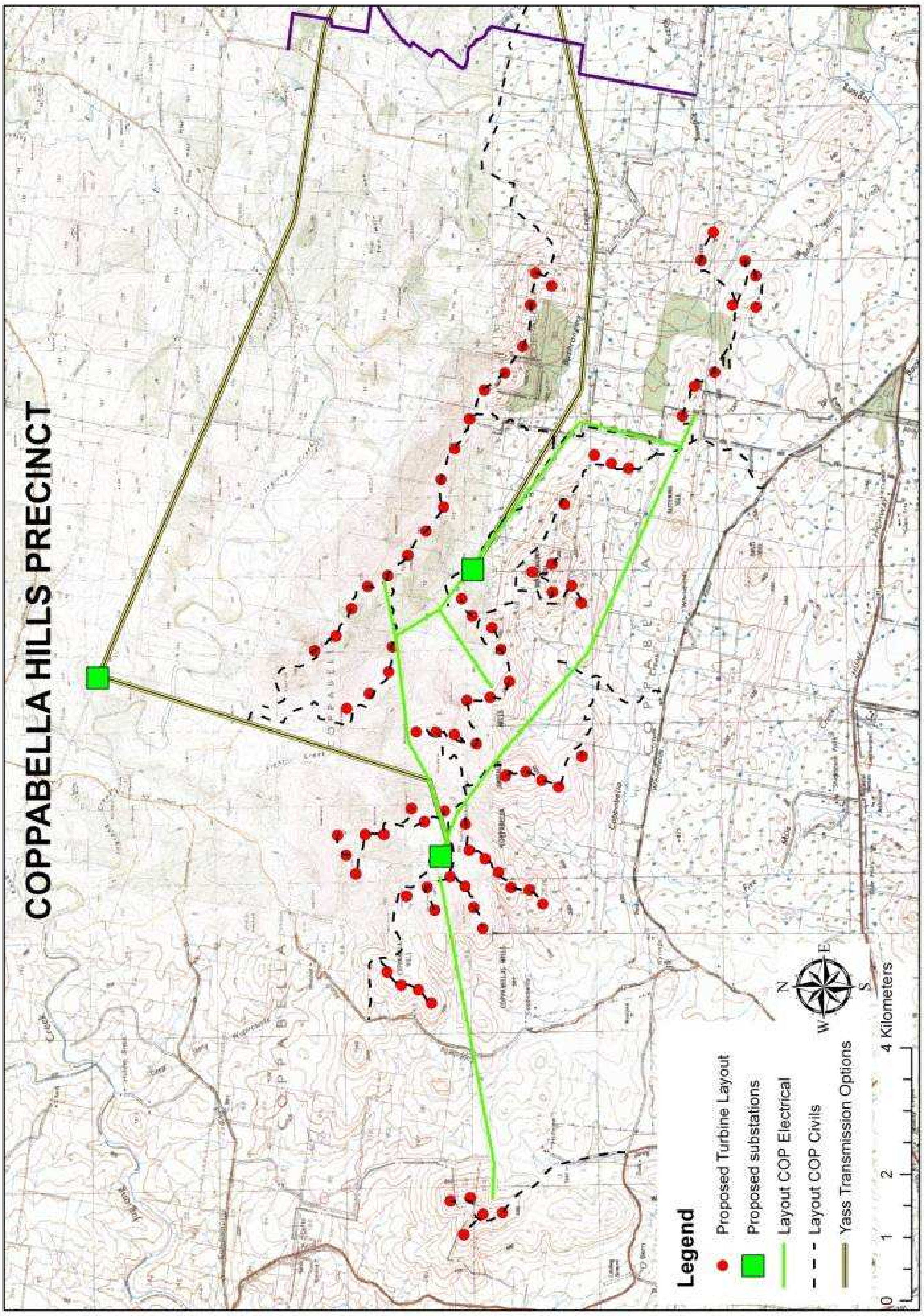


Figure 3. Coppabella Hills Wind Farm layout (supplied by client).

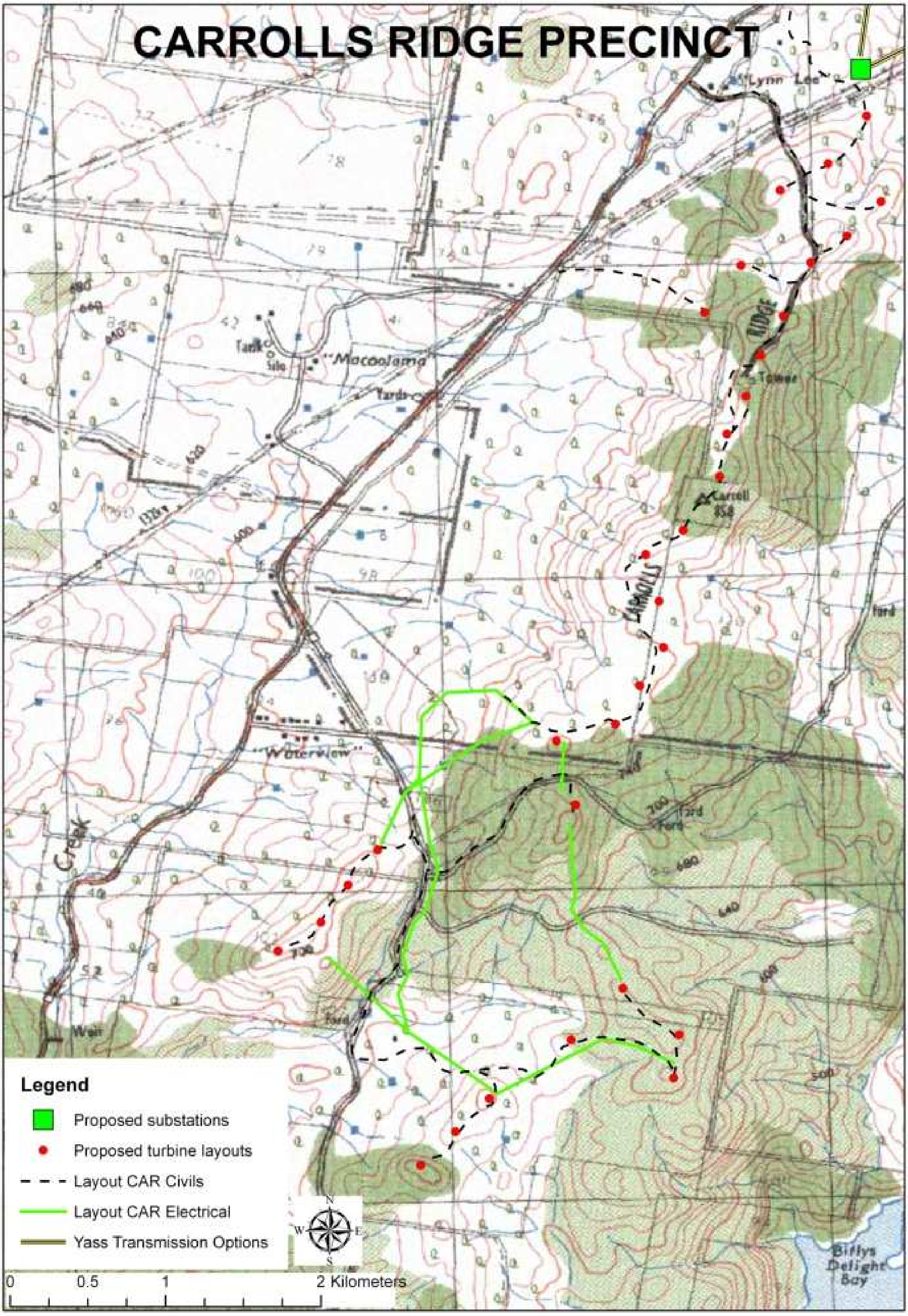


Figure 4. Carrolls Ridge Wind Farm layout (supplied by client).

5. STUDY METHODOLOGY

This archaeological and heritage study has included the following components:

- A NSW DECC Aboriginal Heritage Information Management System site search to determine whether or not previously recorded Aboriginal objects are present in the proposal area and to give consideration to the type of objects known to be present within the local area.
- A review of Non-Indigenous heritage registers to determine whether or not any historic items which may be present in the proposal area are listed.
- A review of local and regional archaeological reports and other relevant documents in order to provide a contextual framework to the study and heritage management process.
- A review of impacts relating to the construction of the Yass Valley Wind Farm aimed at determining the potential nature and extent of impacts to any potential Aboriginal objects which may be present.
- A comprehensive field survey of the proposal area aimed at locating Aboriginal objects and cultural values, Non-Indigenous items, recording survey coverage data and assessing the archaeological potential of the landforms present.
- Documentation of survey results.
- An analysis of survey results.
- A site significance assessment.
- The formulation of management and mitigation measures ensuing from the above.

5.1 Literature Review

Background research has been conducted to determine if known Aboriginal objects and Non-Indigenous items are located in the proposal area and to assist in the construction of a relevant model of site type and location.

The following information sources were accessed for this study:

- ❑ NSW DECC Aboriginal Heritage Information Management System
- ❑ Relevant archaeological reports held in the NSW DECC Cultural Heritage Unit
- ❑ Historical sources and databases
- ❑ Relevant topographic maps

5.2 Field Survey and Methodology

The field survey was designed to encompass all areas of proposed impacts as defined by the turbine envelopes, inclusive of a sample of additional components such as roads and transmission lines located outside each turbine envelope. The field survey was undertaken over an 18 day period and entailed a foot survey undertaken by 3-4 people on each day. Survey coverage is described in Section 9 of this report.

The field survey was aimed at locating Aboriginal objects and Non-Indigenous items. An assessment was also made of prior land disturbance, survey coverage variables (ground exposure and archaeological visibility) and the potential archaeological sensitivity of the land.

The survey methodology entailed walking parallel transects across individual Survey Units with each surveyor situated ca. 10 – 20 metres apart. Each Survey Unit was surveyed until the entire area had been systematically inspected. This methodology enabled direct visual inspection of as much of the ground surface of the proposal area as practicable.

The approach to recording in the current study has been a ‘nonsite’ methodology: the elementary unit recorded is an artefact rather than a site (*cf* Dunnell 1993; Shott 1995). The rationale behind this approach is that artefacts may be directly observed however ‘sites’ are a construction within an interpretative process. Given that it can be expected that full archaeological visibility will not be encountered during the survey the process of identifying site boundaries (if they exist at all) will not be possible.

However, it can be expected that artefacts will be distributed across the proposal area in a virtual continuum. This phenomenon is not anomalous; subsurface work conducted elsewhere in the south east confirms this pattern (see Dibden 2005a; 2005b and 2005c). Therefore in respect of stone artefact distribution the notion of site is itself a meaningless concept and cannot encompass or reflect the actual distribution of artefacts across the landscape. Given that artefacts are continuous in distribution and not discrete 'site' occurrences artefact distribution is better conceptualised in continuous terms.

The density and nature of the artefact distribution will vary across the landscape in accordance with a number of behavioural factors which resulted in artefact discard. While cultural factors will have informed the nature of land use, and the resultant artefact discard, environmental variables are those which can be utilised archaeologically in order to analyse the variability in artefact density and nature across the landscape. Accordingly in this study while the artefact is the elementary unit recorded, the Survey Unit which is utilised as a framework of recording, analysis and the formulation of management strategies (*cf* Wandsnider and Camilli 1992).

The study area has been divided into a number of Survey Units each of which have been defined on the basis of a combination of environmental variables which are assumed to relate to Aboriginal usage of the area. The rationale for employing this definition relates to its utility in regard to predicting the archaeological potential of landforms (*cf* Kuskie 2000: 67). Additionally, the archaeological evidence which has been located within individual Survey Units during the current study is assumed to be generally representative of the archaeological resource located within the entire Survey Unit.

The field recording and mapping has been conducted using a mobile GIS system. The location of Indigenous and Non-Indigenous locales and Survey Units has been made using ArcGIS software and a Trimble GPS. In order to ensure consistency in data collection all field records were made in Microsoft Access database's formulated specifically for the Yass Valley Wind Farm project. Three separate databases were used for recording Survey Unit data, Aboriginal Object data and Historical features data. The data collected forms the basis for the documentation of survey results outlined in Section 9. The variables recorded are defined below.

Survey Unit Variables

Landscape variables utilised are conventional categories taken from the *Australian Soil and Land Survey Field Handbook* (McDonald *et. al* 1998):

Landforms form the primary basis for defining Survey Unit boundaries. The following landform variables were recorded:

Morphological type:

- Crest: - element that stands above all or almost all points in the adjacent terrain – smoothly convex upwards in downslope profile. The margin is at the limit of observed curvature.
- Simple slope: - element adjacent below crest or flat and adjacent above a flat or depression.
- Flat: - planar element, neither crest or depression and is level or very gently inclined.
- Open depression: - extends at same elevation or lower beyond locality where it is observed.

Slope class and value:

- Level: 0 - 1%.
- Very gentle: 1 - 3%.
- Gentle: 3 - 10%.
- Moderate: 10 - 32%.
- Steep: 32 - 56%.

Geology

The type of geology was recorded and as well the abundance of rock outcrop – *as defined below*. The level of visual interference from background quartz shatter was noted.

- No rock outcrop: - no bedrock exposed.
- Very slightly rocky: - <2% bedrock exposed.
- Slightly rocky: - 2-10% bedrock exposed.
- Rocky : - 10-20 % bedrock exposed.
- Very rocky: - 20-50% bedrock exposed.
- Rockland: - >50% bedrock exposed.

Soil
Soil type and depth was recorded. The potential for soil to contain subsurface archaeological deposit (based on depth) was recorded as Low, Moderate or High. This observation is based solely on the potential for soil to contain artefacts; it does not imply that artefacts will be present or absent.

Geomorphological processes
The following gradational categories were recorded:

- eroded
- eroded or aggraded
- aggraded

Geomorphological agents
The following geomorphological agents were recorded:

- gravity: *collapse or particle fall*
- precipitation: *creep; landslide; sheet flow*
- stream flow: *channelled or unchannelled*
- wind
- biological: *human; nonhuman*

Survey coverage variables were also recorded; these are described further below in Section 5.3.

The archaeological sensitivity of each Survey Unit was defined according to assessed artefact density as negligible, very low, low, low/moderate or moderate.

The proposed impacts are also noted for each Survey Unit.

Aboriginal Object Recording

The proposal area was found to contain generally discrete distributions of stone artefacts despite usually continuous exposure. For the purposes of defining the artefact distribution in space it has been labeled as a locale (eg. Survey Unit 1/Locale 1). GPS referenced locational information was captured as WGS84 readings and transformed to GDA coordinates.

The measurable area in which artefacts are observed has been noted and if relevant, a broader area encompassing both visible and predicted subsurface artefacts has been defined. In addition locale specific assessments of survey coverage variables have been made. The prior disturbance to the locale has been noted as low, moderate or high. Artefact numbers in each locale have been recorded and a prediction of artefact density noted, based on observed density taking into consideration Effective Survey Coverage, and a consideration of the environmental context.

Artefact density has been defined in arbitrary categories (based on a consideration of artefact density calculated in detailed subsurface work conducted elsewhere) as follows;

- Negligible insignificant
- Very low: <1 artefact per square metre;
- Low: between 1 and 10 artefacts per square metre;
- Low/moderate: between 11 and 30 artefacts per square metre;
- Moderate: between 31 and 50 artefacts per square metre.

The potential for soil to contain subsurface archaeological deposit (based on depth) was recorded as Low, Moderate or High. Similarly to Survey Unit recordings this observation is based solely on the potential for soil to contain artefacts; it does not imply that subsurface artefacts will be present, nor does it refer to a prediction of artefact density.

5.3 Survey Coverage Variables

Survey Coverage Variables are a measure of ground surveyed during the study and the type of archaeological visibility present within that surveyed area. Survey coverage variables provide a measure with which to assess the effectiveness of the survey so as to provide an informed basis for the formulation of management strategies.

Specifically, an analysis of survey coverage is necessary in order to determine whether or not the opportunity to observe stone artefacts in or on the ground was achieved during the survey. In the event that it is determined that ground exposures provided a minimal opportunity to record stone artefacts it may be necessary to undertake archaeological test excavation for determining whether or not stone artefacts are present. Conversely, if ground exposures encountered provided an ideal opportunity to record the presence of stone artefacts, the survey results may be considered to be adequate and accordingly no further archaeological work may be required.

The survey coverage data includes an estimate of the area surveyed within a Survey Unit, that is, the area subject to actual inspection; the surveyed area is always less that the Survey Unit in area given that not all parts of a Survey Unit are physically inspected.

Two main variables were used to measure ground surface visibility during the study; the area of ground exposure encountered and the quality and type of ground visibility (archaeological visibility) within those exposures. The two primary survey coverage variables estimated during the survey are defined as follows:

Ground Exposure – an estimate of the total area inspected which contained exposures of bare ground; and

Archaeology Visibility – a percentage estimate of the average levels of potential archaeological surface visibility within those exposures of bare ground. Archaeological visibility is generally less than ground exposure as it is dependent on adequate breaching of the bare ground surface which provides a view of the sub-surface soil context. Based on subsurface test excavation results conducted in a range of different soil types across the New South Wales southeast it is understood that artefacts are primarily situated within 10 - 30 cm of the ground profile; reasonable archaeological visibility therefore requires breaching of the ground surface to at least a depth of 10 cm (see Dibden 2005b; 2005c, 2006c, 2006d).

Based on the two visibility variables as defined above, a net estimate (Net Effective Exposure) of the archaeological potential of exposure area within a survey unit or set of units has been calculated. The Effective Survey Coverage (ESC) calculation is defined and required by the NSW DECC. The ESC provides an estimate of the proportion of the total study area which provided a net 100% level of ground surface visibility (with archaeological potential).

6. LANDSCAPE CONTEXT

A consideration of the landscape is necessary in archaeological work in order to characterise and predict the nature of Aboriginal occupation across the land (NSW NPWS 1997). In Aboriginal society landscape could be both the embodiment of Ancestral Beings and the basis of a social geography and economic and technological endeavour. The various features and elements of the landscape are/were physical places, known and understood within the context of social and cultural practice.

Given that the natural resources that Aboriginal people harvested and utilised were not evenly distributed across landscapes, Aboriginal occupation and the archaeological manifestations of that occupation, will not be uniform across space. Therefore, the examination of the environmental context of a study area is valuable for predicting the type and nature of archaeological sites which might be expected to occur. Factors which typically inform the archaeological potential of a landform include the presence or absence of water, animal and plant foods, stone and other resources, the nature of the terrain and the cultural meaning associated with a place.

Additionally, geomorphological and humanly activated processes need to be defined as these will influence the degree to which archaeological sites may be visible and/or conserved. Land which is heavily grassed will prevent the detection of archaeological material while land which has suffered disturbance may no longer retain artefacts or stratified deposits. A consideration of such factors is necessary in formulating site significance and mitigation and management recommendations.

The following sections provide information in regard to the landscape context of the study area.

6.1 Topography, geology and vegetation

The proposed Yass Valley Wind Farm is situated on the Southern Tablelands of New South Wales and is part of the Eastern Uplands of southeastern Australia (Jennings and Mabbutt 1977). The Eastern Uplands consists of a wide plateau which extends from the coastal escarpment on the east, to the slopes of its western side. The landscape has low relative relief, lies generally below 600m altitude and possesses slopes generally less that 5º with about 20% of the area contains steeper hills and ranges. The area has a strongly seasonal thermal climate (Jennings and Mabbutt 1977).

The proposed wind farm is located west and southwest of Yass; the closest villages include Bowning, Binalong and Bookham (Figure 1). The area is currently a rural landscape and is predominantly utilised for sheep grazing.

The proposal area is situated on Silurian sedimentary sequences and Laidlaw volcanics (Branagan and Packham 2000). At Carrolls Ridge however a Devonian sedimentary formation including conglomerate is also present. Low outcrops are common across the proposal area, particularly on crests and hillslopes where, in many cases, bedrock is present at greater than 50% (Plates 5 and 6). The rocky nature of much of the turbine ridge lines is likely to have made these landforms unfavourable camp locations for Aboriginal people.

The dominant soils are red and yellow podzolic lithosols on crests and hillslopes, and red and yellow earths in valleys (Wasson *et. al* 1998). As discussed earlier in Section 4 and further below, soils within the proposal area are highly eroded. This has significant ramifications in regard to the stability and integrity or otherwise of artefact bearing soil formations in the proposal area, both on crests and within valleys. Plates 7 and 8 below exemplify the eroded, skeletal nature of soils on the turbine ridges. It is noted however that usually saddles between knolls on crests contain greater soil depth, albeit disturbed.

Soils within valleys are both alluvial and colluvial and while undoubtedly disturbed are, of significant depth. In areas adjacent to drainage lines Post Settlement Alluvium is likely to be present above the original land surface (see Plate 2).

Plate 5. Rocky slopes on crests typical of the turbine envelopes.

Plate 6. Coppabella Hills: Survey Unit 16: Rocky knolls on crests typical of the turbine envelopes.

Plate 7. Note typical exposures of ground surface showing erosion of topsoil to bedrock.

Plate 8. Note typical ground surface showing erosion of topsoil to bedrock and recent surface wash.

Prior to European settlement the vegetation on hill slopes was open forest dominated by Eucalyptus spp.; valley floors contained extensive grasslands and swamps (Wasson *et. al* 1998). As noted previously in Section 4 the proposal area in now cleared and contains scattered trees only. Of note given that they were a source of food (seeds) and fibre (bark) to Aboriginal people, Kurrajongs (*Brachychiton populneum*) are common on crests and hillslopes.

The botanist and explorer Allan Cunningham visited the region in 1824 and described the vegetation structure and stream character he observed at that time. From descriptions by Cunningham *and others*, Wasson *et. al* (1998) have concluded that streams in the region with a catchment of greater than 1000 km² possessed a continuous channel, while streams with smaller catchments had less distinct channels often described by early commentators as *chains of ponds*.

The naturalist Lhotsky, in 1834 described the ponds as follows: "They are commonly round or oval basins of from 20 – 200 feet in diameter or length, excavated or sunk in the superficies of an alluvial soil, which is commonly of a rich kind..." (cited in Wasson *et. al* 1998). Jugiong Creek rises in the Coppabella Hills. It was described in 1829 by the explorer Charles Sturt, as a creek containing "...large ponds which are skirted by reeds" (cited in Wasson *et. al* 1998). Now however this creek is incised with a sandy bed. The creeks located within the proposal area would all fall within the smaller catchment category as described above, and accordingly are likely to have similarly possessed indistinct channels and chains of ponds. Now however these features are absent and instead channel incision has created deep channels (see Plate 2).

No major rivers flow through the proposal area; it is noted that the Murrumbidgee River is located approximately three kilometres south and east of the Carrolls Ridge development envelope. Numerous creeks flow through the Coppabella and Marilba Hills. These creeks are likely to have been discontinuous channels with chains of ponds and possibly swamp features. While not necessarily being places of abundant water, they are likely to have provided Aboriginal land users with a reasonably reliable local water source. The elevated hill landforms (crests and slopes), by and large, are unlikely to have provided people with any water. The exception to this is a small, locally unusual 'basin' feature within the Coppabella Hills which may have provided some water either in the form of springs or in small pools within minor 1st order drainage lines (Plate 9). Similarly both Carrolls Ridge and the southern area of Black Range in the Marilba Hills development area each contain one or two comparable locales within the elevated hill contexts. These places are likely to have been locally significant as sources of water for people utilising the upper, elevated landforms.

The proposal area can be characterised as a woodland resource zone. The hills would have possessed limited biodiversity and a general lack of water; accordingly they are likely to have been utilised by Aboriginal people for a limited range of activities which may have included hunting and gathering, travel through country and possibly ceremonial. Such activities are likely to have resulted in low levels of artefact discard. Given the often steeply undulating nature of the crests, artefacts are likely to be located in spatially discrete areas such as knolls or saddles, rather being continuous in distribution. The nature of stone artefacts discarded can be expected to have been correspondingly limited in terms of artefact diversity and complexity.

By comparison the valleys between the hills are likely to have possessed greater levels of biodiversity given the likely presence of chains of ponds and possibly also swamp features along drainage lines; in addition a more reliable source of water is likely to have been present in valleys for much of the year. Such areas are likely to have been utilised more frequently and possibly by greater numbers of individuals at any one time; certainly the valleys are likely to have been the favoured camp locations while people occupied the broader local area. Accordingly the levels of artefact discard in valleys can be predicted to be correspondingly higher; artefact diversity and complexity is also likely to be greater.

The morphological landform types located within the zones of proposed impact include crests, hillslopes and drainage depressions.

The Coppabella and Marilba Hills turbine envelopes are undulating crests that vary in gradient between knolls and saddles from moderate to steep (Plates 10 and 11). The land falls from the crests as simple slopes which also vary in gradient from moderate to steep (Plates 12 and 13). The Carrolls Ridges envelope is significantly less steep (Plate 15).

Plate 9. Basin in the Coppabella Hills likely to have been a favoured camping site in the area due to the presence of some water at high elevation.

Plate 10. Coppabella Hills; Survey Unit 1 - main ridge; note knolls and saddles.

Plate 11. Coppabella Hills: Survey Unit 1; main ridge; note steeply undulating crest.

Plate 12. Coppabella Hills; note steep simple slope off crest (Survey Unit 15).

Plate 13. Coppabella Hills; main ridge; note steep slopes off crest.

Plate 14. Carrolls Ridge; note gentle terrain on the ridge crest (north end of SU1).

7. ARCHAEOLOGICAL CONTEXT - INDIGENOUS

7.1 Social geography

On the basis of archaeological research it is known that Aboriginal people have occupied Australia for at least 40,000 years and possibly as long as 60,000 years (Mulvaney and Kamminga 1999: 2). By 35,000 years before present (BP) all major environmental zones in Australia, including periglacial environments of Tasmania, were occupied (Mulvaney and Kamminga 1999:114).

At the time of early occupation Australia experienced moderate temperatures. However, between 25,000 and 12,000 years BP (a period called the Last Glacial Maximum) dry and either intensely hot or cold temperatures prevailed over the continent (Mulvaney and Kamminga 1999: 114). At this time the mean monthly temperatures on land were 6-10ºC lower; in southern Australia coldness, drought and winds acted to change the vegetation structure from forests to grass and shrublands (Mulvaney and Kamminga 1999: 115-116).

During the Last Glacial Maximum at about 24-22,000 years ago, sea levels fell to about 130 m below present levels and accordingly, the continent was correspondingly larger. With the cessation of glacial conditions, temperatures rose with a concomitant rise in sea levels. By ca. 6000 BP sea levels had more or less stabilised to their current position. With the changes in climate during the Holocene Aboriginal occupants had to deal not only with reduced landmass, but changing hydrological systems and vegetation; forests again inhabited the grass and shrublands of the Late Glacial Maximum. As Mulvaney and Kamminga (1999: 120) have remarked:

> *When humans arrived on Sahul's shores and dispersed across the continent, they faced a continual series of environmental challenges that persisted throughout the Pleistocene. The adaptability and endurance in colonising Sahul is one of humankinds' inspiring epics.*

In the late Pleistocene much of the land in the region was covered in snow, with glaciers in the mountains and the lower plains being treeless. Over time, the Aboriginal people experienced and adapted to steady and considerable changes in conditions associated with gradual climatic warming, including the alteration of vegetation and variation in the distribution of wildlife (Young 2000).

Human occupation of south east NSW dates from at least 20,000 years ago as evidenced by dated sites including the Burrill Lake rock shelter (Lampert 1971), Cloggs Cave (Flood 1980) and New Guinea 2 (Ossa *et al.* 1995). The Bulee Brook 2 site in the south coast hinterland ranges, excavated by Boot (1994), provides evidence that occupation of this zone had occurred by at least 18,000 years ago. In the south-eastern highlands of the ACT excavation of the Birrigai rock-shelter has provided dates of occupation from 21,000±200 years BP (Flood *et. al* 1987: 16).

Pleistocene occupation sites are however few with the majority of recorded sites dating from the mid to late Holocene. It is nevertheless reasonable to assume that the Yass area was occupied and utilised by Aboriginal people from the late Pleistocene onwards.

The earliest European reports regarding the Aborigines of the region are provided through the written observations of the first explorers, adventurers and settlers to the district. These sources present only fragmentary and incomplete accounts of the traditional culture of those Aboriginal groups who inhabited the area. Very soon after European contact, with increasing numbers of white settlers after the 1820s, much of the Aboriginal language and lifestyle had changed before it could accurately be recorded. Because of this, reliable information is limited regarding traditional Aboriginal culture and social geography at the time of European arrival.

The primary focus of archaeological research in Australia throughout the 1960s, 1970s and 1980s was the examination of the relationship between Aboriginal people and their environment and the mechanisms of adaptation in what was *apparently* a land of harsh conditions and scanty, or at best, seasonal resources. The bulk of archaeological research that has been undertaken in the region has been focused on examining these issues.

Prior to the 1960s most archaeological research was aimed at defining change in the archaeological record; this was before direct dating techniques became available and accordingly the issue of time was handled by identifying differences in archaeological materials in archaeological deposit – specific artefacts in different layers of deposits were used to define different cultural periods. With the application of direct dating techniques in 1960s research shifted away from the use of artefacts for defining different time periods, towards seeking to explain the nature of different artefacts and assemblages of artefacts and food remains in terms of adaptation to the environment. The 1960s also saw a shift towards the use of explicit scientific methods of reasoning in archaeological practice. This impetus influenced archaeologists to focus on research topics which were believed to be answerable within a scientific methodology. Topics dealing with site locational models, subsistence, technology and environmental adaptation were addressed. The following section outlines research conducted within the region.

Witter (1980) constructed a model of site distribution for the area situated between Canberra and Dalton. He argued that large lowland camps were found exclusively in river valleys or gently sloping land while medium sized lowland camps were found mainly on escarpments and saddles. Witter (1980) suggested that mid to late Holocene occupation of the area was focused around both tributary and major stream valleys. He argued that seasonal movement entailed occupation of the tributary valleys and lower slopes during winter in order to be above cold air drainage but below cooler elevations. Additionally these locations would have provided reliable water and the exploitation of a diversity of resource zones. During summer the larger valley bottoms and higher elevated zones would have been used.

Witter (1980) constructed two models of Holocene adaptation which he termed Riverine Oriented and Plateau Oriented. Witter (1980) defined the Riverine model as a subsistence regime based on the semi-arid plains which was focused on the exploitation of aquatic plants such as *Typha* and *Triglochia* and animals such as fish and crustacea. This economy was focused on the plains woodlands close to major rivers with seasonal usage of semi-arid and dry temperate uplands. Witter (1980) defined the Plateau subsistence regime as based on Acacia as a vegetable staple. This economy was focused on ridges slopes and flats, however with camp sites tethered to water.

Pearson (1981) completed a regionally based investigation of Aboriginal and early European settlement patterns in the Upper Macquarie River region. He excavated three rock shelters which revealed Aboriginal occupation of the area dating from 7000 years BP. Pearson characterised Aboriginal site patterning as follows;

- Aboriginal sites were strongly related to water sources. Distance to water varied from 10 to 500 m and generally the average distance to water decreased as site size increased.
- Sites were located on hilly and undulating landforms rather than on river flats or the banks of waterways. However, the regional incidence of landform variation biased this sample;
- Site location was influenced by good drainage and views over water courses and river flats;
- Most sites were located in open woodland contexts with smaller numbers being present in grassland or forest contexts;
- Burial sites and grinding grooves were situated close to habitation areas;
- Ceremonial sites were located away from habitation areas;
- Stone arrangements were located away from campsites in isolated places; they are associated with small hills and knolls or flat land;
- Quarry sites were located were suitable sources were present and reasonably accessible.

Based on an exploration of early historical material Pearson (1981) argued that the region was inhabited by a small number of clan groups each of which were comprised of 80 to 150 people. These larger groupings were divided into smaller ‘daily’ units of up to 20 people. Pearson (1981) suggests that the ‘daily’ units made short moves between camp sites which resulted in elongated site formation such as continuous artefact scatters along creeks. Pearson presented ethnographic evidence which suggested that camp sites were not used for longer than three nights and that large sites therefore probably represented accumulations of short term visits.

Pearson (1981) also considered the issue of the reliance upon food staples. He argued that rather than a reliance of a singular food type, a wider based economy was practised with the implication that such a non-specialised economy would probably not have been affected by periodic shortfalls in certain foods and that human movement would have been similarly unaffected.

According to Witter and Hughes (1983), the low hill areas of the Lachlan catchment contained sites which are generally situated on valley flanks. They have noted that sites are widely distributed with a higher frequency of sites situated along water courses than in less well drained areas away from creeks and rivers. They posited a model suggesting that the economic focus was within major streams and valleys with occasional usage of the dryer inland zones. Witter and Hughes (1983) suggested that during dry periods occupation was confined to major stream valleys and that in wetter times people would have moved along temporarily watered headwater streams and onto plateau areas.

White (1986) conducted a general study of the Wiradjuru in which the Witter model (as outlined above) was applied. White (1986) however, explored the basic notions of Riverine and Plateau further, emphasizing the regional division by stressing the comparative importance of less seasonally influenced terrestrial hunting in the east. In the Western Slopes region riverine plains “…interfinger with the higher land”, and White argued that the economy in such country probably consisted of an annual regime which was dependant on the use of both riverine and plateau environments.

The Yass region was occupied by Aboriginal speakers of at least two languages, Wiradjuri and Ngunawal. G.A. Robinson (in Mackaness 1941) noted that the people of Yass were called Onerwal [Ngunawal] (White and Cane 1986). White and Cane (1986) provide a review of traditional Aboriginal life in the area; it is not repeated here.

Following European occupation Aboriginal society changed from autonomy and economic independence to both economic dependence on, and enforced settlement, by Europeans (White and Cane 1986). It is possibly the latter situation which is now most recalled by Aboriginal people who were either directly affected, or now remembered on behalf of earlier generations; the local camps and reserves in Yass, and elsewhere, are now focal places in the memory of these times.

White and Cane (1986) have defined three phases of this history. When Europeans began to occupy the district, Aboriginal people moved seasonally between an autonomous economic practice based on hunting, fishing and so on, and engagement with the settler society whereby European foodstuffs were obtained; it is probable that during that time Europeans and Aborigines forged a mutually beneficial relationship entailing amongst other things, the exchange of labour, foods and protection. While engaging with settler society, this practice by Aboriginal people, was done so on their own terms. From 1851 Reserves of land were set aside for Aboriginal people however they were avoided and not used; instead people preferred living on stations located in their own country or the outskirts of towns such as Yass (White and Cane 1986). White and Cane (1986) note that reports in the Yass Courier of 1857 and 1858 refer to *the Blacks Camp* which may refer to the same Yass River Camp used later in the 19th century and earlier 20th century.

With the passing of the Robertson Land Acts in 1861, closer settlement by small-scale free selectors reduced the capacity for Aboriginal people to maintain their occupation of country. However from this time Aboriginal people began to acquire their own parcels of land by purchase or gazettal, and to farm it.

By the 1880s the European community began to demand that Aboriginal people around the town should be controlled. A parcel of land measuring 6 ½ acres at Oak Hill near the water works at Yass was set aside. With timber and iron provided by the Aborigines Protection Board 13 houses were built in 1888. One year later the land area of Oak Hill was reduced to 2 ½ acres. The following year 2 ½ was returned to the reserve (White and Cane 1986). By 1890 78 people were recorded as living at this site in 12 houses and four bark huts. Similarly to earlier times the occupation of the Oak Hill site was mutually beneficial to both Aborigines and Europeans. Aboriginal people were able to have ready access to the town economy, continue to live in family groups while being separate from whites, and work within the local economy; on the other hand Europeans were happy to have Aborigines away from town but close enough to have access to their labour (White and Cane 1986).

However in 1899 pressure mounted to remove the Aboriginal people from Yass. Inducements to encourage people to move to other reserves failed and by 1909 the Edgerton site, located 20 kilometres from Yass, was selected by the Aborigines Protection Board. While some people moved to Edgerton, others petitioned to remain at Oak Hill. This request was refused and the North Yass site was revoked. By 1916 however Edgerton was abandoned with the people having moved back into Yass and camped at Yass Junction with the men working on railway works (White and Cane 1986). People moved back to Oak Hill and at a location at the bottom of the hill called *The Rocks* on the Yass River (White and Cane 1986).

This period until 1930, continued to be one of great difficulty for Aboriginal people, both elsewhere in the state but specifically at Yass (White and Cane 1986). It was during this time that children were removed from their families; between 1900 and 1915 fifteen children were removed from Aboriginal families in Yass. With the proposal to construct water works at Oak Hill at around 1925 Aboriginal people were again asked to leave the site. A new reserve was established in an attempt to remove people. This site known as *Hollywood* is located south of Yass near the cemetery; in 1834 people were moved to the new site, although one or two families remained at Oak Hill.

The Hollywood site was a failure from many points of view and by 1840 Aborigines had begun to return to North Yass; this was objected to by whites. However the situation for the remaining families at Hollywood was becoming untenable also due to the recognition of its inadequate situation (White and Cane 1986). Thereafter a period of resettlement including placing people in a limited number of houses in the town and movement to other reserves located well away from Yass began; Oak Hill also continued to be occupied.

Aboriginal people continue to live in Yass and surroundings areas. They continue to maintain strong links with the area and the sites of their ancestors.

7.2 Previously Recorded Sites

Three searches of the NSW DECC Aboriginal Heritage Management Information System have been conducted for this project on the 1st October 2008 (Coppabella Hills: AHIMS # 23853; Marilba Hills: AHIMS # 23852; Carrolls Ridge: AHIMS # 23851). The results of these searches are listed below:

Coppabella Hills

The search area measured 221 km² and encompassed eastings: 631000 – 648000, and northings: 6149000 – 6162000. No previously recorded sites are listed on AHIMS for this area.

Marilba Hills

The search area measured 156 km² and encompassed eastings: 650000 – 663000, and northings: 6144000 – 6156000. 17 previously recorded Aboriginal objects are listed on AHIMS for this area, none of which are located within the proposal area.

Carrolls Ridge

The search area measured 63 km² and encompassed eastings: 648000 – 655000, and northings: 6131000 – 6140000. No previously recorded sites are listed on AHIMS for this area.

While there are no previously recorded Aboriginal objects in the proposal area, the AHIMS register only includes sites which have been reported to NSW DECC. Accordingly, this search cannot be considered to be an actual or exhaustive inventory of Aboriginal sites situated within the local area. Generally, sites are only recorded during targeted surveys undertaken in either development or research contexts. It can be expected that additional sites will be present within the local area but that to date they have not been recorded and/or reported to NSW DECC.

The most common Aboriginal object recordings in the region are distributions of stone artefacts. Rare site types include rock shelters, scarred trees, quarry and procurement sites, burials, stone arrangements, contact sites, carved trees and traditional story or other ceremonial places. The distribution of each site type is related, at least in part, to variance in topography and ground surface geology.

The following discussion in Section 7.3 will present a review of previous archaeological work in the region for the purposes of producing a predictive model of site type and location relevant to the study area.

7.3 Archaeology – The local area

There have been no previous archaeological studies conducted within the study area itself and few have been undertaken within the immediate local area. However, a number of studies have been undertaken in the broader region in response to statutory requirements for environmental impact assessment. The following discussion includes a review of archaeological work and its results conducted within the regional area.

Witter (1980) surveyed a proposed natural gas pipeline route from Dalton to Canberra. The survey crossed the Yass River and hilly country in the centre of the Upper Yass River catchment. Witter recorded 11 open campsites and 32 isolated finds. The majority of artefacts were comprised of quartz. Witter (1981) subsequently excavated one site and collected a total of 400 artefacts from six others. Backed blades were a prominent element in these collections. Silcrete was the principal raw material. Other raw materials included felsite, volcanics and quartz. Witter (1981:46) concluded that quartz was probably the predominant stone type utilised in the region.

Koettig and Silcox (1983) surveyed the route of the proposed freeway bypass north and east of Yass. Eight artefact scatters and 50 isolated finds were found within the 14 km x 200 m survey area. Seven of the sites were located on low ridges and slopes and one on creek flats. All of the sites were found within 200 m of a watercourse.

Witter and Hughes (1983) began a survey of transmission lines from Wagga Wagga to Yass. The survey was completed by Packard and Hughes (1983). Two 'land systems' were identified in the study area: the plateau consisting of gently rolling hills, largely cleared of timber, and major stream valleys. Archaeological sites were rare in the hills and occurred mainly in areas close to major valleys. Witter and Hughes (1983) argued that this association probably reflects more than simply access to drinking water noting that the valleys have the greatest vegetational diversity and contain a variety of aquatic food plants in streams. The initial survey located four Aboriginal sites, 13 isolated finds and a possible Aboriginal scarred tree. Packard and Hughes (1983) recorded five small artefact scatters, eight isolated finds and two possible Aboriginal scarred trees. Artefactual material was principally debitage. Quartz was the most common lithic material, with negligible percentages of acid volcanics and chert. Sites were located mainly in ploughed paddocks near creeks.

Packard (1984) conducted an investigation of the association of Aboriginal archaeological sites with modern areas of salinisation and salt scalding in the Yass River Basin. Of the 61 known salting sites, 35 were included in the analysis. Site location was found to range in elevation from 560 m-755 m asl, slope gradient less than 5^o and most of the sites had northwest, north or easterly aspects (Packard 1984:50). A wide range of artefact and stone types was found at most of the sites, suggesting that a range of activities had been carried out (Packard 1984:54).

In 1985 Silcox and Koettig surveyed the route of the proposed alternate Yass bypass. The survey located three surface and two subsurface artefact scatters and six isolated finds. Eighty percent of the sites were situated on ridgeline slopes or crests within 200 m of creeks. This site locational pattern was noted to reflect in part the fact that creek or river valleys were not usually flat and that spurs and slopes usually terminated immediately adjacent to creeks. Surface artefact densities ranged from $1/30^2$ to $1/40m^2$. Subsurface densities averaged $18/m^2$. Ninety percent of the artefacts were unmodified flakes and flaked pieces; quartz was the dominant raw material. Silcox and Koettig concluded from the Yass By-pass studies that the pattern of distribution of sites in the Southern Tablelands was a predominance of small sites (less than 50 artefacts and often less than 10) interspersed with occasional medium sites of up to 300 artefacts, and on occasion, very large sites.

Koettig (1986a) investigated a proposed water pipeline route between Bowning and Yass and located two small artefact scatters and two Aboriginal scarred trees near Derringullen Creek, a permanent water course. The two artefacts scatters consisted of three artefacts each. Subsequent subsurface testing was carried out at an area identified to be of high potential to contain archaeological material near Derringullen Creek. The area was relatively flat ground consisting of a series of three main spurs separated by shallow drainage channels and extending c. 700m adjacent to the creek. The testing located a consistent however very low density artefact distribution (Koettig 1986b).

Silcox and Koettig (1988) carried out a survey and test excavation within a 6 km proposed alternative route for the Barton Highway extension at Yass. Five isolated finds and a surface scatter of >150 artefacts were recorded during the survey, with two additional sites located during subsurface testing. Average artefact density of excavated sites was found to vary between very low and low; density varied between $2.3/m^2$ to $12/m^2$. No artefacts were retrieved from one of the test locations, a broad end of a spur overlooking a wide valley of an ephemeral creek. Artefacts comprised flakes, flaked pieces, cores and a backed blade. Fifty seven percent of the artefacts were of silcrete. Other raw materials recorded were quartz, indurated mudstone, volcanic and chert.

Dean-Jones (1990) conducted an assessment of a proposed hard rock quarry near Gunning. The study area included a crest and upper slopes of a hill north of the Lachlan River. No sites were recorded and this result was seen to be consistent with the predictive model of site location relevant to the area.

During a survey of a proposed fibre optic cable route between Cootamundra, NSW, and Hall, ACT, Kuskie (1992) located a small artefact scatter on a broad elevated terrace on the southern side of the Yass River. The site comprised a retouched chert flake, a chert flaked piece and a broken acid volcanic flake.

Paton (1993) surveyed a proposed optical fibre cable route from Gunning to Dalton and Dalton to Flacknell Creek Road on the Southern Tablelands. The route traversed 21km of undulating hills in the Upper Lachlan River catchment. No Aboriginal sites were recorded and this result was deemed to be consistent with the predictive model of site location relevant to the area.

Klaver (1993) recorded seven artefact scatters near Bookham in respect of the proposed Hume Highway Bypass. The study area is located to the south of Marilba and Coppabella Hills study areas. The sites were all low density artefact scatters consisting of mostly chert and quartzite flakes.

Navin and Officer (1995) conducted a survey of the Bogo Quarry situated on Black Range situated southwest of the Marilba Hills study area. The study area consisted of a low hill. One artefact scatter and two isolated finds were recorded. The scatter was found on low gradient basal slopes 400-500 m south of Stony Creek.

Oakley (1995) surveyed a number of proposed Optus towers in the region, one of which was Mt Bowning east of the Marilba study area. No sites were found; the site was highly eroded and found to be of low potential.

Saunders (2000) recorded an Aboriginal open campsite of eight stone artefacts located by Ngunawal ACT and District Aboriginal Council of Elders Association monitors in the Powertel fibre optic cable easement approximately 20m south of the Yass River and 200m north of Yass River Road, northwest of Gundaroo. Saunders also recorded an Aboriginal artefact scatter located by Ngunawal ACT and District Aboriginal Council of Elders Association monitors 50m north of Dalton Open Camp Site (NPWS Site 51-5-003). The monitors collected 50 stone artefacts from the site.

Navin Officer Heritage Consultants (2001) investigated the site of the Yass substation located in an area of low gradient slopes, drainage lines and alluvial flats along the middle reaches of Booroo Ponds Creek. A small low density artefact scatter was located along a spur crest. The scatter comprised three flakes and a flaked piece. Raw materials were volcanic, silcrete and chert. The spur crest in the vicinity of the exposed artefacts was considered to have archaeological potential.

Jo McDonald Cultural Heritage Management Pty Ltd (2003) undertook a survey of the Gunning Wind Farm, situated on the Cullerin Range. The Gunning Wind Farm proposal area consists of range crest and valley topography elevated at 840 meters (asl). Four sites containing stone artefact scatters and three isolated artefacts were recorded across the proposal area (Jo McDonald Cultural Heritage Management Pty Ltd 2003). One of the scatters was identified as a quartz quarry; blocky quartz was found to outcrop at the site. The majority of recorded artefacts were identified as quartz, however, quartzite, silcrete and red agate was also recorded. Steep hill tops were considered to be of low archaeological potential, while elevated contexts close to water were considered to be of higher sensitivity.

Austral Archaeology Pty Ltd (2005) conducted a program of subsurface test excavation at the proposed Gunning Wind farm site. The works entailed grader scrapes and no artefacts were recovered.

Dibden (2006a) recorded nine locales containing stone artefacts during an assessment of the proposed Conroys Gap Wind farm located immediately to the south of the Marilba hills study area. Artefact density calculations based on surface indicators indicate that all artefact locales contain low density artefact distributions. The Survey Units present in the study area were each assessed to be of low or very low archaeological potential based on various factors including nature of the topography, steep gradients and the distance from reliable water.

Dibden (2006b) recorded four locales containing stone artefacts during the study of the proposed Cullerin Wind Farm, situated north of Yass. Four locales containing stone artefacts were recorded. Artefact density calculations based on a consideration of effective survey coverage indicate that all artefact locales, and the Survey Units in which they are situated, contain low density artefact distributions.

OzArk Environmental and Heritage Management (2007) conducted a survey of the Wagga Wagga – Yass 132kV transmission line, a section of which traverses the northern part of the Carrols Ridge study area. The proposal relates to pole replacement works in an existing easement. Four Aboriginal artefact scatters only were recorded during the field survey of the entire route.

Austral Archaeology Pty Ltd (2008) surveyed a transmission line associated with the Gunning Wind farm and a number of other small discrete impact proposals. 25 sites were recorded defined as 13 open artefacts scatters, 9 isolated finds, two areas of PAD and a scarred tree. The majority of finds were located on ridgetops which Austral Archaeology Pty Ltd (2008) suggest reflects the use of these landforms for vantage points and movement through country. Austral Archaeology Pty Ltd (2008) argued that the diversity of the raw materials, lack of conjoined artefacts and related materials found in proximity suggested sporadic use over a long time rather than focused activities which might be expected to have taken place in more permanent habitation sites.

Based on the above review and a consideration of the elevation, geology, hydrology and topography of the study area the type of sites known to occur in the region and the potential for their presence within the study area are set out below.

7.4 Predictive Model of Site Type and Location

Stone artefact scatter sites are the most common site type found within the region. In the wider region a general correlation between different types of watercourses and the nature of the evidence of past Aboriginal occupation is evident. Higher artefact density sites are located near to permanent water sources and low density artefact distributions are found elsewhere.

The type of sites known to occur in the region and the potential for their presence within the study area are listed as follows:

Stone Artefacts

Stone artefacts are found either on the ground surface and/or in subsurface contexts. Stone artefacts will be widely distributed across the landscape in a virtual continuum, with significant variations in density in relation to different environmental factors. Artefact density and site complexity is expected to be greater near reliable water and the confluence of a number of different resource zones.

The detection of artefact scatters depends on ground surface factors and whether or not the potential archaeological bearing soil profile is visible. Prior ground disturbance, vegetation cover and surface wash can act to obscure artefact scatter presence.

Given the environmental context of the proposed Yass Valley Wind Farm stone artefacts are predicted to be present in variable density across the landscape. On hill crests and slopes artefacts are likely to be present in low to very low densities only; given the undulating nature of hill crest it is predicted that artefacts will be concentrated on knolls and saddles. In wide valleys it is predicted that artefact density is likely to be higher; also artefacts can be expected to be distributed continuous occurrence especially close to streams.

Grinding Grooves

Grinding grooves are found in rock surfaces and result from the manufacture and maintenance of ground edge tools. Grinding grooves are only found on sedimentary rocks such as sandstone. Given the absence of suitable rock exposures in the study area grinding groove sites are unlikely to be present.

Burials Sites

In the Yass district traditionally Aboriginal people buried their dead in dug graves in rocky soils, usually on the tops of stony hills (White and Cane 1986). Other practices included the disposal of dead in caves (such as that on the Murrumbidgee near Burrinjuck described by Bennett in 1834), hollow trees and in graves dug into antbeds.

White and Cane (1986) note that traditional burial practices continued throughout the early period of European occupation into the 1870s.

The potential for burials to be present is always possible. Given the nature of this site type they are rarely located during field survey. However given that burials in the local area were reportedly on stony hills it is likely, given the high erosional contexts of these landforms, that if present, they will be identified during the survey.

Rock Shelter Sites

Rock shelters sites are unlikely to be present in the study area given the absence of large vertical stone outcrops.

Scarred and Carved Trees

Scarred and Carved trees result from either domestic or ceremonial bark removal. Carved trees associated with burial grounds and other ceremonial places have been recorded in the wider region. In an Aboriginal land use context this site type would most likely have been situated on flat or low gradient landform units in areas suitable for either habitation and/or ceremonial purposes.

Bark removal by European people through the entire historic period and by natural processes such as fire blistering and branch fall make the identification of scarring from a causal point of view very difficult. Accordingly, given the propensity for trees to bear scarring from natural causes their positive identification is impossible unless culturally specific variables such as stone hatchet cut marks or incised designs are evident and rigorous criteria in regard to tree species/age/size and it specific characteristics in regard to regrowth is adopted.

Nevertheless, the likelihood of trees bearing cultural scarring remaining extant and *in situ* is low given events such as land clearance and bushfires. Generally scarred trees will only survive if they have been carefully protected (such as the trees associated with Yuranigh's grave at Molong where successive generations of European landholders have actively cared for them).

The study area has been extensively cleared. While not impossible this site type is unlikely to have survived and therefore be extant in the study area.

Stone Quarry and Procurement Sites

A lithic quarry is the location of an exploited stone source (Hiscock & Mitchell 1993:32). Sites will only be located where exposures of a stone type suitable for use in artefact manufacture occur. Quarries are rare site types in the region. One has been recorded near Galong north of the proposal area. This site is an intrusive dike of a dacite-like material which was extracted for flaked stone (Witter and Hughes 1983).

Ceremonial Places and Sacred Geography

Burbung and ceremonial sites are places which were used for ritual and ceremonial purposes. Possibly the most significant ceremonial practices known were those which were concerned with initiation and other rites of passage such as those associated with death. Sites associated with these ceremonies are burbung grounds and burial sites. Additionally, secret rituals were undertaken by individuals such as clever men. Such rituals were commonly undertaken in 'natural' locations such as water holes. Pearson (1981) made the following predictions in regard to ceremonial site patterning in the region:

- Burial sites were situated close to habitation areas;
- Ceremonial sites were located away from habitation areas;
- Stone arrangements were located away from campsites in isolated places; they are associated with small hills and knolls or flat land.

In addition to site specific types and locales Aboriginal people invested the landscape with meaning and significance; this is commonly referred to as a sacred landscape. Natural features are those physical places which are intimately associated with spirits or the dwelling/activity places of certain mythical beings. Tom Knight has recently identified Binalong Hill, which is located to the north of the proposal area, to be an important natural feature which was encompassed within the sacred landscape the region (Phil Boot pers. comm. February 2009).

Knight's (2001) Masters research conducted in the area of the Weddin Mountains was oriented differently to prior research conducted in the region. Knight's (2001) focus moved away from previous research which emphasised the economic and subsistence dimensions of movement and land usage towards an examination of the cultural construction and social practice of inhabiting a sacred landscape. This approach is a departure from a consideration of the land and its resources as being a determinant of behaviour, to one in which land is regarded as a *text* – within this conception, land and its individual features, are redolent with meanings and significances which are religiously and ritually centred, rather than economically based.

Knight's (*cf* 2001:1) work was possible in great measure by the historical record which explicitly defines Weddin as a site of ritual significance. However, the research was additionally driven by a theoretical approach to 'cultural landscapes'. Landscape is redefined away from considerations of its material features which provide a backdrop to human activity, towards a view that a landscape *is rather*, a conceptual entity. According to this view the natural world does not exist outside of its conceptual or cognitive apprehension. The landscape becomes known within a naming process or narrative; thus the landscape is brought into being and understanding – within this process: - "…explanatory parables…" such as legends and mythology are the embodiment of the landscape narrative (Knight 2001: 6). *These narratives are relative to a particular culture.*

It is this, which makes an archaeological investigation of the cultural landscape such a thorny one: At distance in time and cultural geography, and especially in the absence of specific ethnographic information, how can the archaeologist attempt to investigate and know these narratives? Knight (2001: 11) employed the concept of the landscape as *mentifact* whereby archaeological interpretation is concerned with the reconstruction of the landscape as a reflection of prehistoric cosmologies. He argued that this can be reconstructed by exploring the systematic relationships between sites and their topographic setting. This is defined as an *inherent* approach as it is concerned with the role of landscape in both everyday and sacred life. This view is concerned with an integration of the sacred and profane rather than their existence as separate categories of social life: - where "Cult activity may have existed as an inextricably 'embedded' component of daily life, where significant locations and ritual aspects of material culture were thoroughly incorporated into secular ranges and uses" (Knight 2001:13). In this regard Knight (2001: 14) correctly points out that no dichotomy between the material and ideational world existed within Aboriginal life.

Knight (2001: 15) argued that the notion of sacred space is of central concern within an inherent perspective on interpreting cultural landscape. Within human cosmologies locales within the landscape are constructed as being sacred space; this process of the construction of sacred space has been termed *hierophany* by Eliade (1961 in Knight 2001: 15). However, while Knight (2001: 15) suggests that physical entities such as stones, trees, or topographic features such as mountains, caves and rocky outcrops may be subject to such processes of transformation or construction, in reality in Aboriginal society any natural feature of less obvious significance can and should be included within this listing. Aboriginal constructions of heirophany can include the most insignificant landscape feature and objects of less fixed temporal existence such as animals and plants. While the outside observer readily 'sees' and apprehends mountains and rocky features, more subtle elements of the natural world are easily passed 'unseen'. This point is one which suggests that the personal cultural geography of the archaeologist can severely impact upon the interpretation of the sacred landscape. Knight (2001) does acknowledge this to some extent illustrating the issue by referring to the example of "Jump Up Rock" situated north of Weddin. This place is only understood to have been an important landscape feature by recourse to prior knowledge regarding the meaning of the site name; the hill itself is insignificant and therefore not readily apprehended through an outsiders gaze as being of special significance.

Knight (2001: 16) refers to the issue of peculiarities of form (eg shape, colour, size or texture) and natural distinctiveness (eg isolated mountains or rocky features within a plains context) as being an important distinguishing feature of sacred locales. Knight (2001: 16) argues that the construction of sacred space in such a manner is particularly relevant to people for whom the natural domain is the dwelling place of/or the manifestation of their deities. Knight (2001: 16) again draws from Eliade (1964) to suggest that it is at the sacred place that the three fundamental cosmological worlds, the everyday, the upper and underworld may converge; typically the upper world will be associated as a point of 'access' with tall things such as trees while the underworld will be associated with pools and caves. Eliade contends that places where all three worlds can possibly connect, the *axis mundi*, are of a heightened order of sacredness. Hierophanies are therefore natural features which are ascribed sacredness. Additionally, Knight (2001: 17) refers to their ability to provide a landscape based opportunity for people to commune with other worldly deities and associated power because they may constitute spatial access between worlds via ritual.

Guided by these theoretical considerations Knight (2001: 20) engaged with Bradley's (cited in Knight 2001) model of the 'archaeology of natural places' in order to provide guidance for investigating the cultural landscape of the Weddin Mountains and its environs. Bradley (2000) has argued that natural places can be explored archaeologically in order to determine the nature of their role in human cosmologies by attending to four archaeological categories: - Votive offerings, rock art, production sites and monuments. This model was developed within a European context, with its attendant biases of concepts and archaeological categories; clearly not all concepts, some of which are clearly Eurocentric, will be applicable in Australia. Nor will all these data sets, will be found within the Australian context.

Knight (2001) gives consideration to the types of natural places which might be ascribed sacred significance. These include mountains, woodlands and groves, springs pools and lagoons, rock outcrops and caves and sinkholes. He argues that Aboriginal cosmology is expressed via the natural landscape and sacred places were those which were directly related to the Dreaming. He says that these sacred sites typically are those which are remarkable or important physiographically such as caves, rocks and so on.

Given the potential for natural features to have been important places within an Aboriginal cosmological frame of reference, the survey has sought to identify outstanding natural features present in the study area. It is however noted that the landscape of entire proposal area is expressed as an abundance of hills and ridges and that therefore high places are unlikely to standout as unusual or significant.

Contact Sites

These sites are those which contain evidence of Aboriginal occupation during the period of early European occupation in a local area. Evidence of this period of "contact' could potentially be Aboriginal flaked glass, burials with historic grave goods or markers, and debris from "fringe camps' where Aborigines who were employed by, or traded with, the white community may have lived or camped. The most likely location for contact period occupation sites would be camp sites adjacent to permanent water, and located in relative proximity to centres of European occupation such as towns and homesteads. The potential for such sites to be present in the proposal area is possible however considered to be unlikely given the location of impacts away from towns or homesteads.

8. NON-INDIGENOUS HERITAGE CONTEXT

8.1 Regional history

European Exploration and Settlement

European discovery of the Yass district was initially by Hamilton Hume in 1821. Hume then travelled through the area again in 1824 as part of his famous expedition with Captain William Hovell, when they explored from Sydney to Port Philip. Following this expedition, Henry O'Brien made one of the first applications to graze cattle in the Yass area. This was soon followed by his brother Cornelius. Henry was also one of the first settlers in the region, settling at Douro. Early stations in the district were "Henry O'Brien's, Barber's, Belle Vale, Terry's Kenilworth, Dr Harris at Underaligo, Hume's at Gunning and Broughton's at Burrowa" (Bayley 1973: 17). During these early years the area around Yass and beyond also began to be squatted. By 1830 Ned Ryan had settled at Galong, James Roberts at Currawong and Dr John Harris at Callangan (HMDHA n.d.). Hume received various land grants for his efforts in exploration and in 1829 he selected land on the Yass River at Borroo Springs (Bayley 1973; Irving 1982; Mission Australia 2000). He later bought Cooma Cottage and 100 acres of Cornelius Brown's original 960 acre grant. Hume and his descendants lived at Cooma Cottage until at least the late 1870s. During Hume's lifetime the cottage underwent numerous renovations and extensions. By the 1890s the house was in use as a sanatorium for consumptives. It is currently owned by the National Trust and is operated as a museum.

The nineteen counties, which corresponded to the areas of permissible settlement in New South Wales were defined by Governor Sir Ralph Darling in 1829. In the southwest, the limits were marked by a ploughline across the Port Philip track at Bowning Hill; this point was known as the Limits of Location. Yass was located just inside these limits; however there was nothing to physically stop settlement expanding beyond Yass. The lands beyond were squatted on for grazing cattle and were effectively outside the jurisdiction of the British Empire. This situation was changed however in 1837 when squatting licences were introduced (Maher 2003). On an expedition outside the 19 counties in 1836, Major Mitchell noted:

> *"1836, Oct. 27 …we had arrived on the Murrumbidgee River, 75 miles below where the river quitted the settled districts…I found the upper portion of this fine stream fully occupied as cattle stations…"*

Around present day Binalong, which was beyond the Limits of Location, the earliest record of a grazing lease is that of Matthew Conroy on the Balgalal property in 1840, although he is similarly believed to have settled earlier than this (Maher 2003). These records of early settlement beyond Yass are thanks in part to the information collected by the Border Police, who were set up to collect licence rates on properties and taxes on livestock following the introduction of the 1837 squatting licences. The Border Police were based in Binalong from 1841 and were later replaced in 1846 by permanent officers who were also responsible for dealing with criminal offences (Maher 2003).

Development of Towns

By the time that Hume was settling on the Yass River there was already a substantial European settlement in the area comprising agriculturalists, tradespeople and shop keepers. Businesses had set up initially on the southern side of the Yass River just down from Walsh's Crossing and then also on the northern side at a location known as the Mudflat. The government survey of the settlement took place in 1834 and a gaol and courthouse were built in 1836, which was the same year that a post office agency was established (Irving 1982). One of the reasons why Yass developed so quickly as a settlement is that by the late 1830s it was an important point on the main route between Sydney and Melbourne (YDHS 2008). The road from Sydney to Yass had developed initially as a bridle trail before it became a rough road for drays and eventually was a major route through the region.

In 1837 a call was made for an official site for the township and it was around this time that the various Churches began to be established. A two acre site was surveyed for the Roman Catholic Church in 1838, while the Church of England services were at that time held in the courthouse. The first dedicated church structure for the Church of England was a slab building on the river bank at the foot of Church Street, however this site was subject to flooding, and the building eventually burnt down in 1850, which was the same year that the existing Anglican church was opened (Bayley 1973).

The year 1850 also saw the destruction of numerous houses and businesses due to flooding. As a result of this there was a shift in the town centre to higher ground and a push for a suitable bridge to be built to link the northern and southern settlements. The first bridge, which was wooden, needed various repairs and eventually succumbed to white ants in 1867. Construction of an iron bridge began in 1870 but floods destroyed it in April of that year. The bridge was then redesigned to be higher and longer and work began again in January 1871. It was completed in July of that year and following the death of Hamilton Hume in 1873 it was named the Hume Bridge (Irving 1982). A footbridge was then opened downstream in 1878 with another later built upstream in 1933 (Mission Australia 2000).

Settlement in the region as a whole increased with the gold rushes of the 1850s and 1860s. Then with the introduction of the Robertson Land Acts in 1861 there was a further increase in settlement in the district. In particular there was an increase in sheep runs and the wool industry began to develop in earnest (STNSW 2008). In 1873 Yass became a municipality, affirming the town's role as an administrative centre and stimulating further growth in the town, including construction of the famous courthouse that was designed by Colonial Architect James Barnet (Irving 1982).

Although Binalong was beyond the Limits of Location, it was an important centre in the early years of European expansion as it was the base for the Border Police. A permanent police office was later established with the arrival of Chief Constable John Fitzpatrick in 1847 and the Court of Petty Sessions was set up soon after. The establishment of a court increased the need for an inn at Binalong as people attending court required basic services such as food and accommodation. Miles Murphy applied to buy or rent two acres of land for just such a venture and when the town was officially gazetted he bought up multiple blocks of land. Prior to that however he opened a local store and the Swan Inn in 1847. In 1850 the town of Binalong was officially gazetted and land could be sold. In the same year County Harden was proclaimed and mapped; this county included the settlements of Binalong, Murrumburrah, Jugiong, Cootamundra, Bookham, Wombat and Coolac (Maher 2003).

Railway

During the late nineteenth century the arrival of the railway changed the face of transportation in NSW. Settlements flourished or floundered depending on whether they were part of the railway network or bypassed. As such there was considerable local pressure for Yass to be included on the Great Southern Railway Line. Despite the efforts of local residents, the railway from Sydney initially bypassed the town because of the prohibitive cost associated with the two bridges necessary to cross and recross the Yass River. Nevertheless, the Yass Railway Committee did have some success in ensuring that the Yass Junction station was established at a location that would allow relatively easy construction of a branch line at a later date. The first train from Sydney arrived at Yass Junction on the 3rd July 1876. Not one of the Yass residents went to welcome the train due to their disgust with the fact that the town had effectively been bypassed. Efforts to build a tramline linking the town with the railway station began in 1878. Following many years of government lobbying a tramline was finally opened in 1892 and upgraded to a train line in 1917. Passenger services ended in 1958 and thirty years later the use of the line for freight also ceased (Carlos 2008).

With the arrival of rail transport in the late 1800s commercial and industrial businesses on the Port Philip road needed to relocate closer to the railway. Construction of the railway necessitated a series of settlements for workers and their families to be set up at various points along the rail route with settlements springing up and subsequently being abandoned as construction progressed south and west. The railway arrived in Binalong in 1876 and an initial timber railway station was built prior to the opening of the rail line. This structure burnt down and was replaced in 1882/83. A deviation to the rail alignment was then constructed in the early twentieth century due to problems with the gradient rising from the old station to the south and a new station was built higher up and further from the town in 1915 (Maher 2003).

Agricultural Industry

Agriculture has played an important role in the development of the Yass district since the early 1800s when superfine merino was first produced locally (DPWS HDS 2001). Hume himself bred merinos and others such as George Merriman at the Ravensworth Stud were instrumental in the development of the wool industry. Wheat production has also played a significant role; it was first grown on a large scale in the 1830s and construction of the first steam mill, which was built for Hamilton Hume, was in 1842 (Bayley 1973). Wheat was sent from the local district to Sydney and exported overseas. The wheat industry was however eclipsed by the wool industry in the early twentieth century and milling had ceased by the 1950s (STNSW 2008). The descendants of the early pioneers are still producing much of the wool that continues to gain international awards (DPWS HDS 2001).

With the introduction of the Robertson Land Acts in the 1860s there was fierce competition for land between the original squatters and the new selectors trying to establish themselves in the region. By the late 1870s most of the big runs had been replaced to some extent by smaller freehold properties, although many of the squatter families continued to be very influential in the agricultural industry.

Other important developments in the local agricultural scene were related to the Murrumbidgee Irrigation Area. The benefits of irrigation were clearly demonstrated in the late nineteenth century by Sir Samuel McCaughney, an important settler in the region of Burrinjuck. McCaughney purchased a property named North Yanko in 1889 and showed that irrigation was possible by building 100km of supply channels and irrigating 300ha of lucerne, 100ha of sorghum and running 16,000 head of sheep. Eventually he set up 300km of channels that supplied even larger areas of irrigated land and significantly increased the production at North Yanko.

Other industrial ventures had varying successes in the Yass region. While there was a degree of gold mining that took place during the late nineteenth and early twentieth centuries, the region was not particularly well known for such ventures and benefited more indirectly from the increased traffic associated with the mining successes at places such as Kiandra, Gundagai and Young (HMDHA n.d.).

Burrinjuck Dam

Burrinjuck or Barren Jack Dam was built for water storage for the Murrumbidgee Irrigation Area, where farms were made available from 1912 onwards. Construction of the dam had been considered by various governments in the late nineteenth century and the scheme was again investigated in the early 1900s with formal planning and cost estimates submitted in 1905. At the time it was proposed it was to be the second largest dam in the world and required 50,000 tons of cement (DPWS HDS 2001). The Barren Jack Scheme was officially known as *The Northern Murrumbidgee Irrigation Scheme* and was one of the most ambitious Government sponsored irrigation schemes in the world with a catchment area of 5000 square miles (Newland 1994).

Because of the remote location of the dam access was difficult and an engineering solution was necessary to solve the problem of bringing in building materials and machinery. Eventually it was decided that the best solution would be a narrow gauge railway. The 610mm gauge railway (43km long) was the first part of the dam works to be constructed. It extended from Goondah on the Great Southern Railway Line, south to the dam site. Construction of the line, which was possibly the longest narrow gauge light railway in NSW, was completed in June 1908 (DPWS HDS 2001). The railway line not only brought materials in to the site, it was also used to transport workers in and out and to bring food supplies into Burrinjuck City (Newland 1994). Following construction of the dam the railway was removed and the right of way converted to a motor road in 1929. Surviving evidence for what was NSW's only government constructed and operated narrow gauge railway with passenger service comprises the existing road alignment and one remaining locomotive known as Jack (DPWS HDS 2001).

At the same time that the railway was being built the settlement known as Burrinjuck City was also constructed on a grassy flat adjacent the river, just over a mile upstream from the dam site. Those employed on construction of the dam had to live in Burrinjuck City and many of them brought their families with them. There were various commercial stores, a police station, hospital, churches, post office, boarding houses, cottages, single men's barracks, offices, workshops and a water supply in the town (DPWS HDS 2001; Newland 1994). At the height of its occupation the population of Burrinjuck City was approximately 2500 (DPWS HDS 2001).

Tenders for construction of the dam itself closed on 18 January 1909; the contract was then awarded on 23 January to Messrs Lane and Peters, Civil Engineers and Contractors of Sydney. Construction of the dam was due for completion in 1913 although it was later extended until 1914 due to difficulties with foundations for the abutments. On 1 January 1913 the Water Conservation and Irrigation Commission was established and construction of the dam and administration and operation of the railway was transferred to them from the Public Works Department. The dam was eventually completed in 1928, with further delays occurring due to the First World War and various floods in the 1920s (Newland 1994). Hydroelectric development at the dam was first proposed in 1912. It was again proposed in 1916 and 1919, following which recommendations were made for construction of a hydroelectric station at Barren Jack. Tenders were accepted in 1923 and work began the same year (DPWS HDS 2001). It has thus had the dual role of water storage and electricity supply for almost the entire life of the project.

8.2 Historical Register searches

Searches have been conducted for previous heritage listings in and around the study area; these searches have included all of the relevant heritage registers for items of local through to world significance. Details of these searches are provided below.

Australian Heritage Database

This database contains information about more than 20 000 natural, historic and Indigenous places.

The database includes places in:

- the World Heritage List
- the National Heritage List

- the Commonwealth Heritage list
- the Register of the National Estate

and places under consideration for any one of these lists. A search of this database (11th December 2008) revealed that there are 4 items listed on the Register of the National Estate as being in or near the Binalong/Burrinjuck area; a summary of the search results is provided below in Table 1. None of these items are in or directly adjacent the Yass Valley Wind Farm study areas.

Heritage Item	Location	Register and Status
Binalong Courthouse Queen St	Binalong, NSW, Australia	Register of the National Estate (Registered)
Binalong Courthouse Group Queen St	Binalong, NSW, Australia	Register of the National Estate (Registered)
Burrinjuck Dam Burrinjuck Dam Access Rd	Burrinjuck, NSW, Australia	Register of the National Estate (Indicative Place)
Galong Railway Station and Yard Group Main Southern Railway	Galong, NSW, Australia	Register of the National Estate (Indicative Place)

Table 1. Australian Heritage Database search results.

The following is taken from the Department of Environment, Heritage, Water and the Arts website (DEHWA 2007)

Status of the Register of the National Estate - February 2007

The Australian Heritage Council can no longer add places to or remove places or a part of a place from the Register of the National Estate (Register).

In 2006, the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act), and the Australian Heritage Council 2003 were amended to, among other things, stop changes to the Register.

Places may be protected under appropriate States, Territories and Local Governments heritage legislation. Under an agreement between the Commonwealth and States and Territories it is intended that Registered places will be considered for inclusion in appropriate Commonwealth, State /Territory heritage lists.

Registered places can be protected under the EPBC Act if they are also included in another Commonwealth statutory heritage list. For example, Registered places owned or leased by the Commonwealth are protected from any action likely to have a significant impact on the environment.

There is no provision in the EPBC Act for Register of the National Estate places to be transferred to the National Heritage List or the Commonwealth Heritage List.

Indicative

Data provided to or obtained by the Australian Heritage Council or the former Australian Heritage Commission has been entered into the database.

Identified

The former Australian Heritage Commission has assessed the values of this place and decided that it should be entered in the Register. The place had not reached the Interim List stage by 1 January 2004 when the Commission was abolished.

Interim list

The place was in the Interim List at 1 January 2004 when the Australian Heritage Commission was abolished. The place had been publicly proposed for entry in the Register.

Registered

The place is in the Register of the National Estate. Although some places may be legally registered because they are within a larger registered area they may not necessarily possess intrinsic significance.

Removed from Register

The place has been removed from the Register

Destroyed

The place has been destroyed before being assessed or listed.

Rejected

The Australian Heritage Council or the former Australian Heritage Commission has assessed the place and found that it does not warrant entry in the Register in its own right.

Duplicate record

The place has another record in the database.

Identified through state processes

The place is entered in a state/territory heritage register. The Australian Heritage Commission had formally recognised the standards of historic assessment of the relevant state or territory heritage body and acknowledged that the place has National Estate historic values.

Of itself listing on the Register of the National Estate does not afford legal protection for a heritage item. None of the abovementioned identified items listed on the Register of the National Estate are included in another Commonwealth statutory heritage list and as such are not afforded protection under the EPBC Act.

State Heritage Inventory

The *NSW heritage databases* contain over 20,000 statutorily-listed heritage items in New South Wales. This includes items protected by heritage schedules to local environmental plans (LEPs), regional environmental plans (REPs) or by the State Heritage Register.

The information is supplied by local councils and State agencies and includes basic identification details and listing information. Consequently listings should be confirmed with the responsible agency.

A search of this database (27^{th} November 2008) revealed that there are 7 items that are listed as being present in the Binalong/Burrinjuck region (Table 2). It should be noted that none of these items are in or directly adjacent the Yass Valley Wind Farm study areas.

Item Name	Address	Suburb	LGA	Significance
Binalong Footbridge	At Station	Binalong	Harden	Local
Binalong Railway Station Group		Binalong	Yass Valley	Local
Bowning Railway Station Group	Main Southern Railway	Bowning	Yass Valley	State and Local
Burrinjuck Dam		Burrinjuck	Yass Valley	State
Burrinjuck Dam Site (Greater)		Burrinjuck	Yass Valley	State
Burrinjuck Dam Site – Barren Jack Creek Water Supply		Burrinjuck	Yass Valley	State
Galong Railway Station and Yard Group		Galong	Harden	State and Local

Table 2. State Heritage Inventory search results

The NSW Heritage Act (1977)

The purpose of the NSW Heritage Act 1977 is to ensure that the heritage of New South Wales is adequately identified and conserved. In practice the Act has focused on items and places of non-indigenous heritage to avoid overlap with the NSW National Parks & Wildlife Act, 1974, which has primary responsibilities for nature conservation and the protection of Aboriginal objects and places in NSW. In recent years, however, the Heritage Council has targeted these other areas, working with relevant state agencies such as NPWS to identify gaps in the protection of Aboriginal and natural heritage places (for example the Cyprus Hellene Club was protected under the Heritage Act as a place of historic significance to Aboriginal people amongst other values).

Section 4 of the Act considers a heritage item to include *any place, building, work, relic, movable object, which may be of historic, scientific, cultural, social, archaeological, natural or aesthetic value.*

The Heritage Amendment Act 1998 came into effect in April 1999. This Act instigated changes to the NSW heritage system, which were the result of a substantial review begun in 1992. A central feature of the amendments was the clarification and strengthening of shared responsibility for heritage management between local government authorities, responsible for items of local significance, and the NSW Heritage Council. The Council retained its consent powers for alterations to heritage items of state significance.

The Heritage Act is concerned with all aspects of conservation ranging from the most basic protection against damage and demolition, to restoration and enhancement. It recognises two levels of heritage significance, State significance and Local significance across a broad range of values.

Generally this Act provides protection to items that have been identified, assessed and listed on various registers including State government section 170 registers, local government LEPs and the State Heritage Register. The Interim Heritage Order provisions allow the minister or his delegates (local government may have delegated authority) to provide emergency protection to threatened places that have not been previously identified. The only 'blanket' protection provisions in the Act relate to the protection of archaeological deposits and relics greater than 50 years old.

The Heritage Council of NSW

The role of the Heritage Council is to provide the Minister with advice on a broad range of matters relating to the conservation of the heritage of NSW. It also has a role in promoting heritage conservation through research, seminars and publications. The membership of the Heritage Council is designed to reflect a broad range of interests and areas of expertise.

Interim Heritage Orders

Under the provisions of Part 3 of the Act, the Minister can make an interim heritage order (IHO). A recommendation with respect to an order can come from the Heritage Council, either based on a request for the Minister, or the Council's own considerations. The Minister can also authorise Local Councils to make IHOs within their area. An interim conservation order may remain in force for up to 12 months, until such time as it is revoked or the item is listed on the State Heritage Register. A heritage order may control activities such as demolition of structures, damage to relics, places or land, development and alteration of buildings, works or relics.

The State Heritage Register

Changes to the Heritage Act in the 1998 amendments established the State Heritage Register which includes all places previously protected by permanent conservation orders (PCOs) and items identified as being of state significance in heritage and conservation registers prepared by State Government instrumentalities. Sites or places which are found to have a state level of heritage significance should be formally identified to the Heritage Council and considered for inclusion on the State Heritage Register.

National Trust of Australia (NSW) Register

The National Trust of Australia (NSW) is a non-government Community Organisation which promotes the conservation of both the built and natural heritage (for example, buildings, bushland, cemeteries, scenic landscapes, rare and endangered flora and fauna, and steam engines may all have heritage value). The Trust has approximately 30,000 members in New South Wales.

Following its survey and assessment of the natural and cultural environment, the Trust maintains a Register of landscapes, townscapes, buildings, industrial sites, cemeteries and other items or places which the Trust determines to have heritage significance and are worthy of conservation. Currently there are some 11,000 items listed on the Trust's Register. They are said to be 'Classified'.

The Trust's Register is intended to perform an advisory and educational role. The listing in the Register has no legal force. However, it is widely recognised as an authoritative statement of the heritage significance of a place. The Trust does not have any control over the development or demolition of the Classified Places or Items in its Register.

While the National Trust Register does not provide any statutory obligations for protection of a site as such, the acknowledgment of a place being listed on the Register as a significant site lends weight to its heritage value. Also, the fact that the actual data for sites may be minimal does not diminish the significance of a place. In fact, many sites were listed with only basic data added, especially in the early developmental stages of the Register.

The Trust, over the last few years has been upgrading the information for places listed, with criteria for assessment for listing based on the Australian Heritage Commission Criteria of assessment for entry to the Register of the National Estate.

A search of the National Trust of Australia (NSW) Register (11th December 2008) revealed that there is only one item in the vicinity of the Yass Valley Wind Farm proposal area that is currently listed with the National Trust (Table 3). The item in question is the General Cemetery at Galong, which is outside the Wind Farm study areas.

Item name	Address
General Cemetery	Galong-Boorowa Rail Line, 3.2km north of Galong

Table 3. National Trust of Australia (NSW) Register search results.

8.3 Historical Themes

A historical theme is a way of describing a major historical event or process that has contributed to the history of NSW. Historical themes provide the background context within which the heritage significance of an item can be understood. Themes have been developed at National and State levels, but corresponding regional and local themes can also be developed to reflect a more relevant historical context for particular areas or items.

The table below (Table 4) summaries the historical themes that are applicable to the Binalong/Burrinjuck study area.

Australian Theme	NSW Theme	Local Theme
Peopling Australia	Aboriginal cultures and interactions with other cultures	Day-to-day life
		Mythological and ceremonial
		Natural resources
		Contact period
Developing local, regional and national economies	Agriculture	Fencing
		Sheds
		Pasture
		Water provision
		Farmsteads
		Shearing
		Machinery
	Commerce	Banking
		Trade routes
		Shops
		Inns
	Communication	Postal services
		Telephone and telegraph services
		Newspapers
		Transport networks
	Environment – cultural landscape	Tree plantings
		Picnic areas
		Fishing spots
	Events	Floods
	Exploration	Camp sites
		Exploration routes
		Water sources
	Industry	Mills
		Shearing sheds
		Workshops
		Transport network
	Pastoralism	Pastoral homesteads
		Sheds and yards
		Travelling stock reserves
		Fencing and boundaries
		Pastoral workers' camps
		Water sources
	Technology	Communication networks
	Transport	Railways
		Early roads
		Private tracks
		Coaches and teamsters
		Bridges
Building settlements, towns and cities	Towns, suburbs and villages	Town plan
		Neighbourhoods
	Land tenure	Fencing and other boundary markers
	Utilities	Burrinjuck Dam
		Water distribution
		Garbage disposal
		Sewage/septic systems
		Provision of electricity
		Bridges
		Culverts
	Accommodation	Inns and hostels
		Domestic residences
		Temporary encampments
		Homesteads
		Humpies
Developing Australia's cultural life	Domestic life	Domestic artefact scatters
		Residences
		Food preparation
		Gardens
		Domesticated animals
	Leisure	Show grounds
		Picnic/camping areas
		Racecourse
		Scenic lookouts
		Town halls

Australian Theme	**NSW Theme**	**Local Theme**
		Tourism
	Religion	Churches
	Social institutions	Public hall
		Social groups/associations
	Sport	Sports grounds
		Sports teams
Marking the phases of life	Birth and death	Graves
	Persons	Individual monuments
		Significant individuals/families
		Place names

Table 4. National, state and local historical themes applicable to the study area and surrounds.

8.4 Predictive Statements

As the above table indicates there is an enormous array of themes and hence potential site types that might occur in and around the Yass Valley Wind Farm study areas although many of these correspond to heritage items in urban contexts. Given that there are no known historical villages or towns within the proposal areas it is unlikely that most of these themes will be represented within the proposed turbine envelopes and other areas of direct impacts. There is however potential for sites associated with agriculture, such as fences, stockyards, ploughfields, sheds and water tanks. More generally there is the potential for roads, tracks and paths. There is also a limited potential for evidence of small mining ventures. Given that the majority of impacts associated with the proposed wind farm are located on exposed ridge tops, the potential for evidence of early settlement, such as homesteads and huts, is relatively low.

9. SURVEY RESULTS

9.1 Carrolls Ridge: Results

Carrolls Ridge - Survey Units

The Carrolls Ridge development area has been divided into nine Survey Units. These Survey Units are described in Table 5; their location is shown in Appendix 3.

Carrolls Ridge is both grassed and forested; much if not all of the forest is regrowth. It has accordingly been cleared and its current landuse is grazing. Slopes at the north end have been cultivated (parts of SU2). The existing Transgrid Yass 330/132kV transmission line passes across the northern section of the development area. The electricity harvested from the Carrolls Ridge site will be transferred to this line.

The site possesses evidence of active erosion especially on crests and hillslopes apparent by both evidence of surface movement and bare earth in erosional floors and sides (*cf* McDonald *et. al* 1998). Erosional features caused by wind and water vary across the area between moderate and severe.

The underlying geology is shale which is present as low boulders and cobbles, and shatter within the soil exposures across the majority of the site. Larger outcrops are present within the forest in the southern end of Survey Unit 8 and also the northern end of Survey Unit 4.

Soils across the area are generally rocky and given the accelerated erosional context are generally deflated with most or the entire surface removed leaving hard material and/or shattered weathered bedrock (Appendix 1: Plates 2 and 3).

The Carrolls Ridge development area consists of a long central ridge extending southward from the northern end of the envelope (encompassed by SU1 and SU8). Towards the south end two separate ridges form, one extends to the southwest (SU7) and the other to the southeast at its northern end and to the southwest at its southern end (SU4).

The long central ridge has been divided into two Survey Units (SU1 and SU8). Survey Unit 1 at the northern end is a gently to moderately undulating crest of variable width (ca. 50 – 150 m wide). Survey Unit 1 contains patches of regrowth forest separating grassed, grazing land (Appendix 1: Plate 1). A formed track runs southward along its entire length; presumably formed to service an existing communication tower situated near to the south end of the Survey Unit. Numerous table drains extend from the track and much of crest displays evidence of mechanical alteration and disturbance.

Survey Unit 8 situated at the southern end of the central ridge end is similarly comprised of a gently to moderately undulating crest. It is generally much wider than the crest in Survey Unit 1 especially in the middle section (up to 250-300 m). Survey Unit 8 contains area of regrowth forest separating grassed, grazing land (Appendix 1: Plate 4). Survey Unit 7 is a particularly narrow, gently to moderately undulating crest (ca. 20 - 40 m wide) and is very rocky (Appendix 1: Plate 5); it is mostly cleared. Survey Unit 4 contains area of regrowth forest separating grassed, grazing land (Appendix 1: Plate 6). Survey Unit 4 is a gently to moderately undulating crest.

The remaining Survey Units in Carrolls Ridge are located on simple slopes in which roads and transmission lines are proposed. These slopes are typically broad, amorphous landforms of moderate gradient. Survey Unit 2 slopes generally to the north; a turbine and substation is also proposed in this Survey Unit (Appendix 1: Plate 7); a Transgrid transmission line traverses the Survey Unit. Survey Unit 3 is part of a simple slope of moderate gradient facing west (Appendix 1: Plate 8). An existing formed road traverses the landform providing access from Burrinjuck Road to the turbine ridge. A Transgrid transmission line crosses Survey Unit 3. Survey Unit 5 is part of a simple slope of moderate gradient with a westerly aspect. An unformed vehicle access track traverses part of the slope (Appendix 1: Plate 9). Survey Units 6 and 9 follow existing formed roads through forest; road access is proposed.

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorph-ology	Agents	Erosion Type	Predicted artefact density
SU1	Turbines, roads & electrical	crest; gently to moderately undulating	gently to moderately inclined	open	Shale	Rocky	low	lithosol; generally eroded to bedrock	eroded	precipitation; wind; also mechanical	sheet, surface wash	generally very low to low
SU2	Turbine, roads, electrical & substation	simple slopes	moderately inclined	north	Shale	Rocky	low	silty loam; eroded to bedrock in some areas	eroded or aggraded	Precipitation; wind	sheet, surface wash	generally very low to low
SU3	Road	simple slope	moderately inclined	northwest	Shale	Rockland	low	lithosol; generally eroded to bedrock	eroded	precipitation; also mechanical	sheet, surface wash	negligible
SU4	Turbines, roads & electrical	crest; gently to moderately undulating	gently to moderately inclined	open	Shale	Rocky	low	lithosol; generally eroded to bedrock	eroded	precipitation; wind	sheet, surface wash	generally very low to low
SU5	Road	simple slope	moderately inclined	west	Shale	Uncertain	uncertain	lithosol	eroded	precipitation	sheet, surface wash	negligible
SU6	Road	simple slope	moderately inclined	south	Shale	Rocky	moderate	silty loam	eroded	precipitation; also mechanical	sheet, surface wash	negligible
SU7	Turbines, roads & electrical	crest; narrow; gently to moderately undulating	gently to moderately inclined	open	Shale	Rocky	moderate	lithosol; generally eroded to bedrock	eroded	precipitation; wind; also mechanical	sheet, surface wash	very low
SU8	Turbines, roads & electrical	crest; broad; gently to moderately undulating	gently to moderately inclined	open	Shale	Very rocky	low	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low to low
SU9	Road	simple slope	moderately inclined	west	Shale	Rocky	low	silty loam	eroded	precipitation; also mechanical	sheet, surface wash	negligible

Table 5. Survey Unit descriptions: Carrolls Ridge.

Carrolls Ridge - Survey Coverage

The Carrolls Ridge development envelope surveyed during this assessment measured approximately 137 hectares (Table 6). It is estimated that approximately 70 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have been 11 hectares. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 9 hectares. Effective Survey Coverage is therefore relatively high and calculated to have been 7.1% of the development envelope.

SU	Area Sq m	Area inspected %	Area inspected Sq m	Ground exposure %	Ground exposure Sq m	Archaeological visibility %	Archaeological visibility Sq m	ESC %
SU1	380392	60	228235	20	45647	90	41082	10.8
SU2	177585	40	71034	10	7103	80	5683	3.2
SU3	25913	60	15548	10	1555	90	1399	5.4
SU4	224816	60	134889	20	26978	90	24280	10.8
SU5	37331	20	7466	10	747	20	149	0.4
SU6	54542	20	10908	10	1091	50	545	1
SU7	61639	60	36983	20	7397	90	6657	10.8
SU8	390523	50	195262	10	19526	90	17574	4.5
SU9	25185	20	5037	10	504	90	453	1.8
total	**1377926**		**705363**		**110547**		**97823**	**7.1**

Table 6. Carrolls Ridge: Survey Coverage Data.

Carrolls Ridge – Survey Results: Indigenous

A total of fifteen Aboriginal object locales were recorded within the Carrolls Ridge survey area. As noted previously there are no previous site recordings for the area; these are all new recordings. These sites are listed in Table 7; their location is shown in Appendix 3. All locales are stone artefacts except for two which are areas in which artefacts are predicted to occur in low/moderate or moderate density in a subsurface context. Stone artefacts are listed and described in Appendix 2.

Artefacts were recorded in all Survey Units except SU3, SU5 and SU9. It is recognised that Effective Survey Coverage was very low in each of these Survey Units. Nevertheless they are assessed to be of low archaeological potential on environmental grounds; they are each located on broad, amorphous simple slopes of moderate gradient. These landforms are not known to be archaeologically sensitive; that is, while they may contain artefacts, their density is likely to be very low to negligible.

Artefacts were recorded along the crests in which turbines are proposed inclusive of SU1, SU2, SU4, SU7 and SU8. The majority of locales contain either single or otherwise very few artefacts. The survey coverage variables recorded at each of these artefact locales is listed in Table 7. Given the relatively large areas of exposure at these locales, and the very few artefacts recorded, it is concluded that artefact density, generally is very low in the Carrolls Ridge proposal area. This result is not unexpected and indeed consistent with the predictive model of Aboriginal land use.

Several exceptions to this trend have however been identified. Locales SU1/4 (Appendix 1: Plate 12) and SU8/5 (Appendix 1: Plate 15) are predicted to contain artefacts in moderate density. SU1/L4 contained negligible exposure and no artefacts were recorded in this location. It is a broad, relatively flat saddle, possibly associated with a spring and appears to be relatively undisturbed. Such a landform can be predicted to have been utilised as a camping area during occupation of the ridge landform. SU8/L5 is similarly a broad, relatively flat saddle, possibly associated with a spring. More than 50 artefacts were observed in exposures associated with a dam at this locale. While the area in which the artefacts are recorded at the dam is highly disturbed, the remainder of the saddle to the east appears relatively undisturbed. SU1/L5 is a low, flat, broad knoll situated in close proximity to SU1/L4. This area has the potential to contain a low/moderate subsurface density distribution of stone artefacts.

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure Type	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU1	L1 Appendix 1: Plate 10	653913	6135839	1 x 1	erosion bare earth	20 x 20	70	90	1	very low	moderately disturbed: erosion	No	No
SU1	L2 Appendix 1: Plate 11	653897	6136086	70 x 30	bare earth erosion	150 x 50	80	90	6	very low	moderately disturbed: erosion	No	No
SU1	L3	654076	6136146	1 x 1	Mechanical table drain off road	20 x 10	80	50	1	very low	highly disturbed in table drain	No	Yes However probably very low - low density
SU1	L4 Appendix 1: Plate 12	654106	6136477	n/a PAD in saddle	bare earth	200 x 200	1	5	nil	moderate	relatively undisturbed	Yes aggrading saddle	No
SU1	L5 Appendix 1: Plate 13	654252	6136792	n/a PAD on knoll	bare earth	200 x 150	2	20	nil	low moderate	apparently relatively undisturbed with some topsoil	Yes some topsoil	No
SU2	L1	654577	6137156	1 x 1	bare earth erosion	20 x 20	15	90	1	low	moderately disturbed	No	No
SU4	L1 Appendix 1: Plate 14	652125	6130565	1 x 1	animal tracks erosion bare earth	20 x 10	40	90	1	very low	moderately disturbed	No	No
SU6	L1	651890	6131411	2 x 1	vehicle bare earth	50 x 3	95	80	3	low	highly disturbed	No	Yes To north of track However probably low density
SU7	L1	651960	6132484	10 x 5	animal tracks erosion	30 x 10	50	90	6	low	moderately disturbed	No	No
SU8	L1	653089	6133829	1 x 1	animal tracks	20 x 1	50	90	1	low	moderately disturbed	Yes	Yes However probably low density
SU8	L2	653129	6133693	1 x 1	animal tracks	20 x 0.2	90	90	1	low	relatively intact	Yes	Yes However probably low density
SU8	L3	653153	6133673	1 x 1	animal tracks erosion	25 x 3	70	80	1	low	moderately disturbed	No	Yes However probably low density
SU8	L4 Appendix 1: Plate 15	653105	6133601	3 x 3	erosion	15 x 6	40	70	3	low	moderately disturbed	No	Yes However probably low density

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure Type	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU8	L5 Appendix 1: Plate 16	653074	6133544	15 x 15	mechanical bare earth	40 x 10	20	70	6 recorded c. 50 counted	moderate	poor disturbed by dam construction	No	Yes To east of dam; predicted to be moderate density
SU8	L6	653026	6133277	1 x 1	erosion	30 x 10	30	90	1	very low	moderately disturbed	No	No

Table 7. Summary of stone artefact recordings in the Carrolls Ridge development area.

9.2 Coppabella Hills: Results

Coppabella Hills - Survey Units

The Coppabella Hills development area has been divided into 24 Survey Units. These Survey Units are described in Table 8; their location is shown in Appendix 3.

The Coppabella Hills area is mostly cleared, grazing land (Plate 15 below). On lower slopes in valleys areas have been cultivated. The existing Transgrid 330/132kV transmission line crosses to the north of the development area. The electricity harvested from the Coppabella Hills site will be transferred to this line.

The site possesses evidence of active erosion especially on crests and hillslopes apparent by both evidence of surface movement and bare earth in erosional floors and sides (*cf* McDonald *et. al* 1998). Erosional features caused by wind and water vary across the area between moderate and severe. The underlying geology is volcanic which is present as low boulders, cobbles, and shatter within the soil exposures across the majority of the site (Appendix 1: Plates 17 and 18). In the northeast ridge (Survey Unit 2) in the east of the Coppabella Hills area bedrock geology almost entirely encompasses the crest (Appendix 1: Plates 19).

Soils across the area are generally rocky and given the accelerated erosional context are generally deflated with most or the entire surface removed leaving hard material and/or shattered weathered bedrock (Appendix 1: Plate 20).

The Coppabella Hills development area consists of a long, central and narrow ridge extending east/west (encompassed by SU1 and SU3) and numerous surrounding ridge clusters. The majority of the Coppabella Ridges are moderately to steeply undulating separated by steep slopes, and narrow, “v” shaped valleys (Appendix 1: Plate 21). Generally where crests are of moderate or steep gradient the erosional context is high; similarly knolls are usually deflated and eroded to hard material and/or bedrock. Saddles on crests contain deeper soil profiles due to aggradation of deposit onto these lower elements. Saddles however are generally highly disturbed as a result of stock treadage and other natural processes.
.
The remaining Survey Units in Coppabella Hills are located on lower elevation, simple slopes or valleys in which roads and transmission lines are proposed (Appendix 1: Plates 22 & 23).

Plate 15. Coppabella Hills; from east end of SU1 looking west.

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorph-ology	Agents	Erosion Type	Predicted artefact density
SU1	Turbines, roads & electrical	crest; narrow and undulating	Moderately to steeply inclined	open	volcanic	Very Rocky	Negligible	sandy loam	eroded	Precipitation; wind	sheet surface wash	generally very low to low
SU2	Turbines, roads & electrical (part TL)	crest; undulating	Moderately to steeply inclined	open	volcanic	Very Rocky	Negligible	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU3	Turbines, roads & electrical	crest; narrow and undulating	Moderately to steeply inclined	open	volcanic	Very Rocky	Negligible	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU4	Road, and electrical	simple slope	moderately inclined	west	volcanic	Very rocky	Negligible	sandy loam	eroded	precipitation	Sheet surface wash vehicle	negligible
SU5	Turbines, roads & electrical	crest; narrow and undulating	Gently to moderately inclined	open	volcanic	Rocky	Negligible	sandy loam	eroded	Precipitation; wind	Sheet surface wash vehicle	generally low
SU6	Road, transmission line and substation	simple slope	Gently inclined	west	volcanic	Rocky	Negligible	sandy loam	eroded	precipitation	Sheet surface wash gully	generally low
SU7	Turbines, roads & electrical	crest; narrow and undulating	Moderately to steeply inclined	open	volcanic	Very rocky	Negligible	sandy loam	eroded	Precipitation; wind	Sheet surface wash mechanical	generally very low to low
SU8	Transmission line	simple slope	moderately inclined	open	volcanic	Rocky	Negligible	sandy loam	eroded	precipitation	Sheet surface wash mechanical	very low
SU9	Turbines, roads & electrical	crest; narrow and undulating	Moderately to steeply inclined	open	volcanic	Very rocky	Negligible	sandy loam	eroded	precipitation	Sheet surface wash	generally very low to low
SU10	Transmission line	simple slope	Moderately to steeply inclined	west	volcanic	Very Rocky	Negligible	sandy loam	eroded	precipitation	Sheet surface wash gully	generally very low to low
SU11	Road	simple slope	Very gently inclined	Open	volcanic	Very slightly rocky	low	sandy loam	eroded or aggraded	precipitation	Surface wash mechanical	low
SU12	Turbines, roads & electrical	crest; undulating	Moderately to steeply inclined	open	volcanic	Very Rocky	Negligible	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU13	Transmission line	simple slope	Gently to moderately inclined	open	volcanic	Very slightly rocky	low	sandy loam	eroded or aggraded	precipitation	Sheet surface wash	generally very low to low
SU14	Turbines, roads &	crest; undulating	Gently to moderately	open	volcanic	Very slightly	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorph-ology	Agents	Erosion Type	Predicted artefact density
	electrical		inclined			rocky						
SU15	Turbines, roads & electrical	crest; undulating	Gently to moderately inclined	open	volcanic	Rockland	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU16	Turbines, roads & electrical	crest; undulating	Gently to moderately inclined	open	volcanic	Rockland	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU17	Turbines, roads, electrical & substation	crest: “basin”	Gently to moderately inclined	open	volcanic	Slightly rocky	low	sandy loam	eroded or aggraded	Precipitation; wind	Sheet surface wash	low to moderate
SU18	Transmission line	simple slope	Gently to moderately inclined	west	volcanic	Rocky	low	sandy loam	eroded	precipitation	Sheet surface wash	generally very low to low
SU19	Turbines, roads & electrical (part TL)	crest; undulating	Gently to moderately inclined	open	volcanic	Very rocky	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU20	Turbines, roads & electrical (part TL)	crest; undulating	Gently to moderately inclined	open	volcanic	Very rocky	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU21	Turbines, roads & electrical	crest; undulating	Gently to moderately inclined	open	volcanic	Very rocky	low	sandy loam	eroded	Precipitation; wind	Sheet surface wash	generally very low to low
SU22	Turbines, roads & electrical	crest; undulating	moderately inclined	open	volcanic	Slightly rocky	low	sandy loam	eroded	precipitation	Sheet surface wash	low
SU23	Transmission line	simple slope	Gently inclined	east	volcanic	No rock outcrop	Negligible	sandy loam	eroded or aggraded	Precipitation; mechanical	Sheet surface wash	low to moderate
SU24	Transmission line	simple slope	Gently inclined	north	volcanic	Very slightly rocky	Negligible	sandy loam	eroded or aggraded	Precipitation	Sheet surface wash	moderate

Table 8. Survey Unit descriptions: Coppabella Hills.

Coppabella Hills - Survey Coverage

The Coppabella Hills development envelope surveyed during this assessment measured approximately 458 hectares (Table 9). It is estimated that approximately 207 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have been 46 hectares. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 31 hectares. Effective Survey Coverage is therefore relatively high and calculated to have been 6.9% of the development envelope.

SU	Area Sq m	Area Inspected %	Area Inspected Sq m	Ground Exposure %	Ground Exposure Sq m	Archaeological Visibility %	Archaeological Visibility Sq m	ESC %
SU1	418830	60	251298	5	12565	80	10052	2.4
SU2	803153	50	401576	10	40158	60	24095	3
SU3	131728	60	79037	5	3952	80	3161	2.4
SU4	15348	20	3070	5	153	80	123	0.8
SU5	119398	50	59699	20	11940	70	8358	7
SU6	75894	40	30358	80	24286	70	17000	22.4
SU7	170692	40	68277	20	13655	80	10924	6.4
SU8	67897	20	13579	20	2716	90	2444	3.6
SU9	82906	50	41453	40	16581	90	14923	18
SU10	172475	20	34495	10	3450	80	2760	1.6
SU11	106700	50	53350	10	5335	70	3735	3.5
SU12	187855	60	112713	20	22543	80	18034	9.6
SU13	321095	20	64219	30	19266	20	3853	1.2
SU14	96650	50	48325	30	14498	70	10148	10.5
SU15	277146	60	166288	20	33258	80	26606	9.6
SU16	80449	60	48270	50	24135	90	21721	27
SU17	144255	30	43276	15	6491	50	3246	2.25
SU18	73976	10	7398	30	2219	60	1332	1.8
SU19	249638	50	124819	60	74891	80	59913	24
SU20	203656	70	142559	40	57024	70	39917	19.6
SU21	144660	60	86796	30	26039	70	18227	12.6
SU22	205922	50	102961	30	30888	20	6178	3
SU23	87694	20	17539	20	3508	80	2806	3.2
SU24	349911	20	69982	20	13996	50	6998	2
Total	**4587930**		**2071337**		**463546**		**316554**	**6.9**

Table 9. Carrolls Ridge: Survey Coverage Data.

Coppabella Hills – Survey Results: Indigenous

A total of 70 Aboriginal object locales were recorded within the Coppabella Hills survey area. As noted previously there are no previous site recordings for the area; these are all new recordings. These sites are listed in Table 10; their location is shown in Appendix 3. All locales are stone artefacts; stone artefacts are listed and described in Appendix 2.

Artefacts were recorded in all Survey Units except SU4, SU8, SU10, SU12, SU13, SU14 and SU22 all of which are assessed to be of generally low archaeological potential on environmental grounds. SU22 could be an exception and possess a relatively higher density distribution given its proximity to a valley encompassed by SU24; nevertheless artefact distribution is not likely to exceed low density.

Artefacts were recorded along the crests in which turbines are proposed; the majority of locales contain either single or otherwise very few artefacts. Given the relatively large areas of exposure, and the very few artefacts recorded, it is concluded that artefact density, generally is very low in the Coppabella Hills proposal area. This result is not unexpected and indeed consistent with the predictive model of Aboriginal land use. Artefacts were commonly found in saddles (Appendix 1: Plate 24) and on knolls along crests. The majority of locales on crests are situated on deflated and eroded soil profiles.

Several Survey Units and locales within some Survey Units have been predicted to contain subsurface artefacts in low/moderate density including several ridge saddles in SU2 and SU20, a large upland basin in SU17 and the valleys in which SU23 and SU24 are located.

Coppabella Hills – Survey Results: Non-Indigenous

During the field survey one potential Non-Indigenous heritage item was recorded in Survey Unit 24. This item is an area of ploughland located on the south side of an unnamed creek (Marilba SU28/H1).

Coppabella Hills SU24/H1 (grid reference at south end: 643347.6153051) occupies an area measuring c. 4 hectares. It consists of old ploughlines which extend in a north/south orientation. The ploughlines are particularly visible from the surrounding crests. They are likely to date to the late 1800s or early-mid 1900s.

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU1	L1 Appendix 1: Plate 24	642819	6154584	40 x 40	animal tracks erosion under trees	70 x 70	2	90	7	low	relatively intact	Yes	Yes In saddle However probably low density
SU1	L2	633703	6154378	1 x 1	erosion	50 x 40	2	90	1	low	moderately disturbed	Yes	Yes In saddle However probably low density
SU1	L3	644253	6153990	1 x 1	erosion	20 x 1	2	90	1	negligible	moderately disturbed	No	No
SU1	L4	645389	6153125	1 x 1	erosion	nil exp on grass	2	90	1	very low	moderately disturbed	Yes	Yes However probably low density
SU1	L5	645333	6153158	15 x 5	animal tracks	100 x 20	2	90	2	low	relatively intact	Yes	Yes However probably low density
SU1	L6	642729	6154727	1 x 1	animal tracks	100 x 20	4	90	1	negligible	moderately disturbed	No	No
SU2	L1	644323	6150581	1 x 1	erosion	20 x 20	80	70	1	very low	moderately disturbed	No	No
SU2	L2 Appendix 1: Plate 25	644896	6150090	20 x 15	vehicle	60 x 3	70	80	25	low	moderately disturbed	Yes	Yes In saddle However probably low density
SU2	L3 Appendix 1: Plate 26	646005	6149548	10 x 5	erosion	30 x 20	80	80	4	very low	moderately disturbed	No	No
SU2	L4	646036	6149982	3 x 3	under trees	3 x 3	20	90	7	low	relatively undisturbed	Yes	Yes In saddle However probably low density
SU2	L5	646503	6150176	2 x 2	bare earth	20 x 20	50	70	2	very low	poor	No	No
SU3	L1	641827	6155876	20 x 20	animal tracks bare earth	40 x 40	10	90	2	low	moderately disturbed	Yes	Yes In saddle However probably low density
SU3	L2 Appendix 1: Plates 27/28	641472	6156158	30 x 30	animal tracks bare earth erosion	50 x 50	30	90	20	low	moderately disturbed	Yes	Yes In saddle However possibly low/moderate density
SU3	L3	641288	6156280	1 x 1	bare earth	50 x 50	20	50	1	very low	moderately disturbed	Yes	Yes
SU3	L4	641707	6156002	1 x 1	animal tracks	20 x 0.4	10	90	1	very low	moderately disturbed	Yes	Yes
SU5	L1	641084	6155360	10 x 10	animal tracks	30 x 30	10	90	5	low	moderately	No	No

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
	Appendix 1: Plate 29				bare earth erosion						disturbed		
SU5	L2	641008	6155364	15 x 5	animal tracks bare earth erosion	50 x 50	90	70	3	low	moderately disturbed	Yes	Yes
SU5	L3	640835	6155471	20 x 10	animal tracks bare earth erosion	50 x 20	90	90	4	very low	moderately disturbed	No	Yes
SU6	L1 Appendix 1: Plate 30	640209	6157045	60 x 60	animal tracks bare earth erosion	100 x 80	60	80	32	low	moderately disturbed	Yes	Yes
SU6	L2	640294	6157581	1 x 1	erosion	100 x 50	40	80	1	very low	moderately disturbed	Yes	Yes
SU6	L3	640342	6157439	1 x 1	erosion	100 x 50	cont	90	1	very low	moderately disturbed	No	Yes
SU6	L4	640339	6157674	12 x 5	animal tracks bare earth erosion under tree	20 x 20	40	40	2	very low	moderately disturbed	Yes	Yes
SU6	L5	640339	6157816	15 x 5	animal tracks bare earth erosion under trees	50 x 20	50	60	7	low	moderately disturbed	Yes	Yes
SU6	L6	640453	6157793	4 x 4	animal tracks bare earth erosion under trees	50 x 20	60	80	4	low	moderately disturbed	Yes	Yes
SU7	L1	638080	6156655	1 x 1	vehicle	50 x 10	70	80	1	very low	highly disturbed	No	No
SU7	L2	638017	6156556	1 x 1	bare earth	50 x 10	20	90	1	very low	moderately disturbed	No	No
SU7	L3	638434	6156064	5 x 5	bare earth erosion	50 x 50	60	90	3	low	moderately disturbed	No	No
SU7	L4	638282	6155984	5 x 5	bare earth	50 x 50	60	90	3	low	moderately disturbed	No	No
SU9	L1 Appendix 1: Plate 31	637855	6154746	25 x 10	bare earth erosion	50 x 50	50	90	6	very low	moderately disturbed	No	No
SU11	L1	634419	6152505	10 x 1	vehicle graded road	100 x 10	100	80	2	low	highly disturbed	No	Yes
SU11	L2	634321	6152869	1 x 1	erosion	10 x 10	90	80	1	low	moderately	No	Yes

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
					bare earth						disturbed		
SU15	L1 Appendix 1: Plate 32	638378	6153948	10 x 5	Erosion bare earth	50 x 50	90	90	2	very low	moderately disturbed	No	No
SU15	L2	637864	6153147	1 x 1	erosion bare earth animal tracks	90 x 90	90	90	1	Very low	moderately disturbed	No	No
SU15	L3	639064	6155097	1 x 1	bare earth	10 x 10	50	80	1	very low	moderately disturbed	No	No
SU16	L1	637737	6154110	4 x 2	Erosion bare earth animal tracks	50 x 50	70	90	2	very low	moderately disturbed	No	No
SU16	L2 Appendix 1: Plate 33	637801	6154132	15 x 4	Erosion bare earth animal tracks	50 x 50	70	90	2	very low	moderately disturbed	No	No
SU16	L3	638024	6154255	1 x 1	animal tracks	20 x 0.3	30	90	1	very low	moderately disturbed	No	No
SU17	L1	638683	6154636	2 x 2	bare earth	5 x 5	50	70	3	low moderate	uncertain	Yes	Yes
SU17	L2	638709	6154712	1 x 1	erosion	5 x 5	40	60	1	low moderate	uncertain	Yes	Yes
SU17	L3	638847	6154749	1 x 1	animal tracks bare earth	10 x 10	30	70	2	low moderate	uncertain	Yes	Yes
SU17	L4	638874	6154783	1 x 1	animal tracks bare earth	10 x 10	30	70	1	low moderate	uncertain	Yes	Yes
SU17	L5	638844	6154932	25 x 25	Mechanical dam	25 x 25	20	50	27	low moderate	highly disturbed	No	Yes
SU17	L6	638959	6154781	25 x 15	animal tracks bare earth	50 x 50	50	60	8	low moderate	uncertain	Yes	Yes
SU18	L1	639229	6154275	1 x 1	animal tracks	10 x 10	50	80	1	very low	moderately disturbed	No	No
SU18	L2	639395	6154281	10 x 10	bare earth animal tracks	50 x 20	60	80	15	low	moderately disturbed	No	No
SU19	L1	640167	6154207	1 x 1	vehicle	20 x 10	90	70	1	very low	highly disturbed	No	No

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU19	L2	639639	6153716	40 x 40 saddle	bare earth animal tracks erosion vehicle	60 x 60	40	90	17	low moderate	highly disturbed	No	No
SU20	L1	640920	6153539	50 x 50	animal tracks bare earth	70 x 70	50	70	44	low moderate	moderately disturbed	Yes	No
SU20	L2	641683	6154204	1 x 1	erosion	50 x 50	80	30	1	low	moderately disturbed	Yes	No
SU20	L3 Appendix 1: Plate 34	640486	6153798	20 x 20	bare earth animal tracks	50 x 50	60	70	11	low moderate	uncertain	Yes	No
SU20	L4	640265	6154202	1 x 1	bare earth animal tracks erosion	20 x 20	70	70	1	low	moderately disturbed	No	No
SU21	L1	641693	6153406	70 x 40	bare earth animal tracks erosion	80 x 50	20	70	3	low moderate	moderately disturbed	Yes	No
SU21	L2	641821	6153340	30 x10	bare earth animal tracks erosion	50 x 40	30	70	5	low moderate	moderately disturbed	Yes	No
SU23	L1	643822	6151618	40 x 3	vehicle	100 x 3	30	80	2	low	moderately disturbed	No	Yes
SU23	L2	643698	6151244	50 x 10	vehicle bare earth	30 x 10	40	80	15	low	moderately disturbed	No	Yes
SU24	L1	642211	6154076	80 x 20	animal tracks	80 x 20	10	80	36	low moderate	uncertain	Yes	Yes
SU24	L2	642257	6154017	50 x 5	animal tracks	70 x 5	10	80	6	low moderate	uncertain	Yes	Yes
SU24	L3	642397	6153909	2 x 2	vehicle	50 x 3	20	50	3	low moderate	uncertain	Yes	Yes
SU24	L4	642754	6153595	45 x 3	vehicle	50 x 3	20	50	23	low moderate	uncertain	Yes	Yes
SU24	L5	642848	6153502	20 x 5	animal	50 x 3	20	50	2	low moderate	uncertain	Yes	Yes
SU24	L6	643036	6153332	15 x 10	bare earth animal tracks	50 x 10	10	50	9	low moderate	uncertain	Yes	Yes
SU24	L7	643037	6153228	20 x 3	vehicle	50 x 3	20	70	3	low moderate	moderately disturbed	Yes	Yes
SU24	L8 Appendix 1: Plate	643111	6153329	10 x 10	bare earth under trees	20 x 20	5	70	3	low moderate	moderately disturbed	Yes	Yes

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure Area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
	35												
SU24	L9	643186	6153216	1 x 1	animal tracks	50 x 3	20	50	1	low moderate	moderately disturbed	Yes	Yes
SU24	L10	643226	6153181	1x 1	animal tracks vehicle	50 x 3	30	50	1	low moderate	moderately disturbed	Yes	Yes
SU24	L11	643299	6153075	30 x 10	animal tracks vehicle bare earth	80 x 10	30	50	15	low moderate	moderately disturbed	Yes	Yes
SU24	L12	643495	6152972	30 x 30	mechanical dam	30 x 30	10	90	37	low moderate	highly disturbed	No	Yes
SU24	L13	643554	6152908	20 x 10	vehicle erosion	50 x 10	80	80	6	low moderate	moderately disturbed	No	Yes
SU24	L14	643640	6152844	100 x 3	vehicle	100 x 3	80	80	10	low moderate	moderately disturbed	Yes	Yes
SU24	L15	643850	6152583	80 x 3	vehicle	100 x 3	80	80	2	low moderate	moderately disturbed	Yes	Yes

Table 10. Summary of stone artefact recordings in the Coppabella Hills development area.

9.3 Marilba Hills: Results

Marilba Hills - Survey Units

The Marilba Hills development area has been divided into 33 Survey Units. These Survey Units are described in Table 11; their location is shown in Appendix 3.

The Marilba Hills area is mostly cleared, grazing land (Plate 16 below). On lower slopes in valleys areas have been cultivated. The existing Transgrid 330/132kV transmission line crosses to the north of the development area. The electricity harvested from the Marilba Hills site will be transferred to this line.

The site possesses evidence of active erosion especially on crests and hillslopes apparent by both evidence of surface movement and bare earth in erosional floors and sides (*cf* McDonald *et. al* 1998). Erosional features caused by wind and water vary across the area between moderate and severe. The underlying geology is volcanic which is present as low boulders and cobbles, and shatter within the soil exposures across the majority of the site (Appendix 1: Plate 36).

Soils across the area are generally rocky and given the accelerated erosional context are generally deflated with most or the entire surface removed leaving hard material and/or shattered weathered bedrock.

The Marilba Hills development area consists of two, long, narrow ridges extending north/south (Appendix 1: Plate 36) and several ridge clusters in the northwest. The majority of the Marilba ridges are moderately to steeply undulating separated by moderate to steep slopes (Appendix 1: Plates 40 and 41), and wide valleys (Appendix 1: Plates 38 and 39). Generally where crests are of moderate or steep gradient the erosional context is high; similarly knolls are usually deflated and eroded hard material and/or bedrock. Saddles on crests contain deeper soil profiles due to aggradation of deposit onto these lower elements. Saddles however are generally highly disturbed as a result of stock treadage.
.
The remaining Survey Units in Marilba Hills are located on simple slopes or valleys in which roads and transmission lines are proposed (Appendix 1: Plate 42). Simple slopes are broad amorphous landforms generally assessed to be of low to very low archaeological potential. The wide valley located between the two central ridges is assessed to be of moderate archaeological potential.

Plate 16. Marilba Hills Survey Unit 32; note moderately undulating, rocky, narrow crest.

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorphology	Agents	Erosion Type	Predicted artefact density
SU1	Turbines, roads & electrical	crest	gently inclined	open	volcanic	Very rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low
SU2	Road	simple slope	gently inclined	SE	volcanic	Slightly rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	low moderate
SU3	Road	crest	very gently inclined	open	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation; wind	sheet, surface wash	low moderate
SU4	Turbines, roads & electrical	crest; narrow	moderately inclined	open	volcanic	Very rocky	Negligible	lithosol	eroded	precipitation; wind	sheet, surface wash	generally very low
SU5	Turbines, roads & electrical	crest; narrow	moderately inclined	N	volcanic	Rockland	Negligible	lithosol	eroded or aggraded	precipitation; wind	sheet, surface wash	generally very low
SU6	Road	simple slope	moderately inclined	W	volcanic	Slightly rocky	Negligible	silty loam	eroded	precipitation	sheet, surface wash	generally very low
SU7	Road	lower slope	gently inclined	W	volcanic	Slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low
SU8	Road	simple slope	moderately inclined	W	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low moderate
SU9	Road	crest	gently inclined	open	volcanic	No rock outcrop	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low moderate
SU10	Road	simple slope	moderately inclined	E	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	generally very low
SU11	Turbines, roads & electrical	crest	moderately inclined	open	volcanic	Very rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low
SU12	Road	simple slope	steep	N	volcanic	Rockland	Negligible	lithosol	eroded	gravity	sheet, surface wash	negligible
SU13	Turbines, roads & electrical	crest	moderately inclined	open	volcanic	Very rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low
SU14	Road	open depression	very gently inclined	SW	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low
SU15	Road	simple slope	steep	E	volcanic	Rocky	Negligible	silty loam	eroded	precipitation	sheet, surface	negligible

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorphology	Agents	Erosion Type	Predicted artefact density
											wash	
SU16	Turbines, roads & electrical	crest	moderately inclined	open	volcanic	Very rocky	Negligible	lithosol	eroded	precipitation; wind	sheet, surface wash	generally very low
SU17	Transmission line	open depression	gently inclined	open	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low moderate
SU18	Transmission line & road	simple slope	very gently inclined	N	volcanic	Slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	generally very low
SU19	Substation	crest	moderately inclined	N	volcanic	Very rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low
SU20	Transmission line	simple slope	moderately inclined	N	volcanic	Rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	generally very low
SU21	Transmission line & road	simple slope	steep	N	volcanic	Very rocky	Negligible	lithosol	eroded	precipitation	sheet, surface wash	generally very low
SU22	Turbines, roads & electrical	crest	moderately inclined	open	volcanic	Very rocky	Negligible	lithosol	eroded	precipitation	sheet, surface wash	generally very low
SU23	Transmission line	open depression	gently inclined	W	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	stream flow	sheet, surface wash	low moderate
SU24	Turbines, roads & electrical	crest	steep	open	volcanic	Very rocky	Negligible	silty loam	eroded	precipitation	sheet, surface wash	generally very low
SU25	Transmission line and road	crest	moderately inclined	N	volcanic	Very slightly rocky	Negligible	silty loam	eroded	precipitation	sheet, surface wash	low
SU26	Transmission line and road	simple slope	gently inclined	E	volcanic	Slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low moderate
SU27	Road	open depression	gently inclined	W	volcanic	Slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	low moderate
SU28	Turbines, roads & electrical	crest	steep	open	volcanic	Very rocky	Negligible	lithosol	eroded	precipitation; wind	sheet, surface wash, wind	generally very low
SU29	Substation, transmission line & road	simple slope	moderately inclined	west	volcanic	Very slightly rocky	Negligible	silty loam	eroded	precipitation	sheet, surface wash;	low moderate

SU	Proposed Impacts	Morphological Landform	Slope	Aspect	Geology	Abundance Rock	Abundance Quartz	Soil	Geomorphology	Agents	Erosion Type	Predicted artefact density
											gully	
SU30	Turbines, roads & electrical	crest	moderately inclined	open	volcanic	Rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low
SU31	Road	simple slope	moderately inclined	NE	volcanic	Very slightly rocky	Negligible	silty loam	eroded	precipitation	sheet, surface wash	generally very low
SU32	Turbines, roads & electrical	crest	moderately to steeply inclined	open	volcanic	Rocky	Negligible	silty loam	eroded	precipitation; wind	sheet, surface wash	generally very low
SU33	Road	simple slope	gently inclined	open	volcanic	Very slightly rocky	Negligible	silty loam	eroded or aggraded	precipitation	sheet, surface wash	generally very low

Table 11. Survey Unit descriptions: Marilba Hills.

Marilba Hills - Survey Coverage

The Marilba Hills development envelope surveyed during this assessment measured approximately 488 hectares (Table 12). It is estimated that approximately 301 hectares of that area was subject to survey inspection. Ground exposures inspected are estimated to have been 16 hectares. Of that ground exposure area archaeological visibility (the potential artefact bearing soil profile) is estimated to have been 13 hectares. Effective Survey Coverage is therefore relatively low and calculated to have been 2.7% of the development envelope. High grass cover accounts for the low ESC in the Marilba Hills.

SU	Area Sq m	Area Inspected %	Area Inspected Sq m	Ground Exposure %	Ground Exposure Sq m	Archaeological Visibility %	Archaeological Visibility Sq m	ESC %
SU1	78153	80	62523	5	3126	70	2188	2.8
SU2	18815	80	15052	1	151	70	105	0.56
SU3	6763	80	5410	2	108	60	65	0.96
SU4	41673	80	33339	50	16669	80	13335	32
SU5	48000	70	33600	5	1680	60	1008	2.1
SU6	28051	50	14025	1	140	50	70	0.25
SU7	32731	60	19639	1	196	50	98	0.3
SU8	32119	80	25695	2	514	70	360	1.12
SU9	12424	70	8697	2	174	80	139	1.12
SU10	23574	70	16502	2	330	70	231	0.98
SU11	85771	80	68617	40	27447	80	21957	25.6
SU12	10886	20	2177	40	871	80	697	6.4
SU13	85908	60	51545	5	2577	80	2062	2.4
SU14	56694	50	28347	1	283	40	113	0.2
SU15	75595	10	7560	5	378	80	302	0.4
SU16	58831	50	29416	10	2942	80	2353	4
SU17	1115920	70	781144	2	15623	80	12498	1.12
SU18	84320	10	8432	2	169	60	101	0.12
SU19	76302	70	53411	10	5341	90	4807	6.3
SU20	55574	10	5557	5	278	60	167	0.3
SU21	43123	10	4312	10	431	80	345	0.8
SU22	90851	80	72681	10	7268	90	6541	7.2
SU23	378841	40	151537	2	3031	20	606	0.16
SU24	381359	70	266952	2	5339	80	4272	1.12
SU25	169256	60	101554	5	5078	70	3554	2.1
SU26	229410	60	137646	5	6882	50	3441	1.5
SU27	84366	60	50619	2	1012	50	506	0.6
SU28	624320	70	437024	5	21851	80	17481	2.8
SU29	145073	60	87044	5	4352	50	2176	1.5
SU30	108980	80	87184	1	872	90	785	0.72
SU31	11060	40	4424	5	221.2	80	176.96	1.6
SU32	553181	60	331909	10	33191	90	29872	5.4
SU33	34200	20	6840	2	136.8	80	109.44	0.32
Total	4882126		3010412		168663		132524	2.7

Table 12. Marilba Hills: Survey Coverage Data.

Marilba Hills – Survey Results: Indigenous

A total of 31 Aboriginal object locales were recorded within the Marilba Hills survey area. As noted previously there are no previous site recordings for the area. These sites are listed in Table 13; their location is shown in Appendix 3. All locales comprise stone artefacts which are listed and described in Appendix 2.

Artefacts were recorded in 15 of the Marilba Survey Units. It is recognised that Effective Survey Coverage was very low across the Marilba study area. Nevertheless the majority of Survey Units in which artefacts were not recorded are assessed to be of low archaeological potential on environmental grounds. The majority of the landform in which artefacts were not recorded are not known to be archaeologically sensitive; that is, while they may contain artefacts, their density is likely to be very low to negligible. The exception however is SU3 (a simple slope with some subsurface potential) and SU23 (an open drainage depression).

Artefacts were recorded along many of the crests in which turbines are proposed. The majority of locales contain either single or otherwise very few artefacts. The survey coverage variables recorded at each of these artefact locales is listed in Table 13. Given the relatively large areas of exposure, and the very few artefacts recorded, it is concluded that artefact density, generally is very low in the Marilba Hills proposal area. This result is not unexpected and indeed consistent with the predictive model of Aboriginal land use.

Several exceptions to this trend have however been identified. Survey Unit 3, SU9, SU17 and SU29 are predicted to contain subsurface artefacts in low/moderate density.

Marilba Hills – Survey Results: Non-Indigenous

During the field survey two potential Non-Indigenous heritage items were recorded in and adjacent areas of proposed impacts. These items include a section of wooden fence (Marilba SU4/H1) and a small stone feature, possibly a hut platform (Marilba SU28/H1).

Marilba SU4/H1 (grid ref: 658129.61499723) comprises the partial remains of an old wooden fence line (Plate 17). The fence extends along a ridge crest for a distance of several hundred metres. The majority of posts are fallen however several remain upright. The post contains holes for five strands of plain wire.

Plate 17. Marilba SU4/H1.

Marilba SU28/H1 (grid ref: 654024.6153943) comprises a square outline of basalt cobbles on the side of a knoll in SU28 (Plate 18). The feature measures c. 3 x 3 metres. It is situated on a slope which would indicate that it is not the remains of a hut. There are no associated artefacts. The function of the feature is uncertain.

Plate 18. Marilba SU28/H1.

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU2	L1	658045	6151897	3 x 3	under trees	5 x 4	80	80	4	low moderate	relatively intact	No	Yes
SU2	L2	658053	6151917	4 x 4	under trees	4 x 4	60	80	3	low moderate	relatively intact	No	Yes
SU4	L1	654024	6153937	1 x 1	bare earth	100 x 50	60	80	1	very low	moderately disturbed	No	No
SU4	L2	654000	6153947	1 x 1	bare earth	100 x 50	70	90	1	very low	moderately disturbed	No	No
SU5	L1	653304	6155050	1 x 1	under trees	10 x 5	70	70	1	very low	moderately disturbed	No	No
SU8	L1	652944	6154710	1 x 1	vehicle	20 x 4	80	50	2	low moderate	relatively intact	No	Yes
SU9	L1	652964	6154238	1 x 1	animal tracks	100 x 2	80	70	1	low moderate	relatively intact	Yes	Yes
SU17	L1	656017	6150525	1 x 1	animal tracks bare earth erosion	10 x 2	80	80	1	low moderate	moderately disturbed	No	Yes
SU17	L2 Appendix 1: Plate 43	655946	6150458	8 x 3	erosion	50 X 10	80	80	3	low moderate	poor	No	Yes
SU17	L3 Appendix 1: Plate 44	654993	6151999	30 x 30	dam	50 x 50	70	30	11	low moderate	highly disturbed	No	Yes
SU17	L4	654945	6152085	2 x 2	erosion	20 x 3	70	80	27	low moderate	poor	Yes	Yes
SU17	L5	654980	6152758	1 x 1	erosion	20 x 5	80	70	1	low moderate	poor	No	Yes
SU17	L6	655036	6152765	1 x 1	animal tracks	8 x 3	70	50	1	low moderate	relatively undisturbed	Yes	Yes
SU17	L7	655054	6152667	1 x 1	under trees	5 x 5	70	60	1	low moderate	relatively intact	Yes	Yes
SU17	L8	655274	6153183	1 x 1	bare earth dam	30 x 20	30	60	1	very low	poor	No	Yes
SU17	L9	655376	6151182	20 x 20	bare earth erosion	50 x 50	50	80	3	low moderate	moderately disturbed	No	Yes
SU19	L1	656207	6153483	1 x 1	animal tracks	20 x 3	80	80	1	low	poor	No	Yes
SU24	L1	654054	6148866	15 x 15	animal tracks	15 x 15	20	80	2	very low	relatively intact	Yes	No
SU25	L1 Appendix 1: Plate 45	654798	6151158	10 x 10	animal tracks under trees erosion	30 x 30	20	80	2	low	poor	No	Yes

SU	Locale	Easting GDA	Northing GDA	Area m	Exposure	Exposure area m	Ground Exposure %	Archaeological Visibility %	Artefact #	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale
SU26	L1 Appendix 1: Plate 46	654590	6151720	10 x 0.3	animal tracks	30 x 0.3	90	80	4	low moderate	relatively intact	Yes	Yes
SU26	L2	654596	6151806	1 x 1	animal tracks	20 x 0.3	90	80	1	low moderate	relatively intact	Yes	Yes
SU27	L1	654855	6151254	1 x 1	under trees	10 x 4	30	70	1	low moderate	relatively intact	No	Yes
SU28	L1	658187	6148120	1 x 1	animal tracks	20 x 0.3	80	90	1	very low	relatively intact	No	Yes
SU28	L2	658882	6147341	20 x 5	dam	50 x 50	10	80	2	low	highly disturbed	No	Yes
SU28	L3	658979	6146765	10 x 10	bare earth	50 x 50	10	90	1	very low	moderately disturbed	No	No
SU29	L1	658408	6146486	10 x 10	erosion	20 x 5 adj d line	40	80	17	low moderate	poor	No	Yes
SU29	L2 Appendix 1: Plate 47	658648	6146758	10 x 10	dam; animal tracks	60 x 60	10	60	9	low moderate	highly disturbed	No	Yes
SU29	L3 Appendix 1: Plate 47	658593	6146792	10 x 10	dam; erosion	50 x 40	80	80	2	low moderate	poor	No	Yes
SU30	L1	657765	6150956	20 x 20	animal tracks	20 x 20	5	90	2	low	moderately disturbed	Yes	Yes
SU30	L2	657693	6151067	30 x 30	bare earth animal tracks	50 x 50	1	50	2	low	relatively intact	Yes	Yes
SU32	L1	653613	6150050	1 x 1	animal tracks erosion	50 x 50	90	30	1	negligible	poor	No	No

Table 13. Summary of stone artefact recordings in the Marilba Hills development area.

10. STATUTORY CONTEXT

The Environmental Planning and Assessment Act 1979

The Environmental Planning and Assessment Act 1979 (EP&A Act), its regulations, schedules and guidelines provides the context for the requirement for environmental impact assessments to be undertaken during land use planning (NPWS 1997).

Part 3A of the Environmental Planning and Assessment Act 1979

On 9 June 2005 the NSW Parliament passed the Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Bill. The Act was assented to on 16 June 2005 and commenced on 1 August 2005. This amendment contains key elements of the NSW Government's planning system reforms and makes major changes to both plan-making and major development assessment.

A key component of the amendments is the insertion of a new Part 3A (Major Projects) into the EP&A Act. The new Part 3A consolidates the assessment and approval regime for all major developments which previously were addressed under Part 4 (Development Assessment) or Part 5 (Environmental Assessment).

Part 3A applies to all major State government infrastructure projects, developments previously classified as State significant and other projects, plans or programs of works declared by the Minister. The amendments aim to provide a streamlined assessment and approvals regime and also to improve the mechanisms available under the EP&A Act to enforce compliance with approval conditions of the Act.

Under Part 3A Major infrastructure and other projects, the following relevant definitions apply:

approved project means a project to the extent that it is approved by the Minister under this Part, but does not include a project for which only approval for a concept plan has been given.

critical infrastructure project means a project that is a critical infrastructure project.

development includes an activity within the meaning of Part 5.

major infrastructure development includes development, whether or not carried out by a public authority, for the purposes of roads, railways, pipelines, electricity generation, electricity or gas transmission or distribution, sewerage treatment facilities, dams or water reticulation works, desalination plants, trading ports or other public utility undertakings.

project means development that is declared under section 75B to be a project to which this Part applies.

proponent of a project, means the person proposing to carry out development comprising all or any part of the project, and includes any person certified by the Minister to be the proponent.

The current report has been compiled for inclusion within an Environmental Assessment Report

Under the terms of Part 3A of the Environmental Planning and Assessment Act 1979 the following authorizations are not required for an approved project (and accordingly the provisions of an Act that prohibit an activity without such an authority do not apply):

- a permit under section 87 or a consent under section 90 of the *National Parks and Wildlife Act 1974;*
- an approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*.

11. SIGNIFICANCE ASSESSMENT

The information provided in this report and the assessment of significance provides the basis for the proponent to make informed decisions regarding the management and degree of protection which should be undertaken in regard to the Aboriginal objects and Non-Indigenous items located within the study area.

11.1 Significance Assessment Criteria - Indigenous

The NPWS (1997) defines significance as relating to the meaning of sites: "meaning is to do with the values people put on things, places, sites, land". The following significance assessment criteria is derived from the relevant aspects of ICOMOS Burra Charter and NSW Department of Urban Affairs and Planning's 'State Heritage Inventory Evaluation Criteria and Management Guidelines'.

Aboriginal archaeological sites are assessed under the following categories of significance:

- cultural value to contemporary Aboriginal people,
- archaeological or scientific value,
- aesthetic value,
- representativeness, and
- educational value.

Aboriginal cultural significance

The Aboriginal community will value a place in accordance with a variety of factors including contemporary associations and beliefs and historical relationships. Most heritage evidence is valued by Aboriginal people given its symbolic embodiment and physical relationship with their ancestral past.

Archaeological value

The assessment of archaeological value involves determining the potential of a place to provide information which is of value in scientific analysis and the resolution of potential archaeological research questions. Relevant research topics may be defined and addressed within the academy, the context of cultural heritage management or Aboriginal communities. Increasingly, research issues are being constructed with reference to the broader landscape rather than focusing specifically on individual site locales. In order to assess scientific value sites are evaluated in terms of nature of the evidence, whether or not they contain undisturbed artefactual material, occur within a context which enables the testing of certain propositions, are very old or contain significant time depth, contain large artefactual assemblages or material diversity, have unusual characteristics, are of good preservation, or are a part of a larger site complex. Increasingly, a range of site types, including low density artefact distributions, are regarded to be just as important as high density sites for providing research opportunities.

Representativeness

Representative value is the degree to which a "class of sites are conserved and whether the particular site being assessed should be conserved in order to ensure that we retain a representative sample of the archaeological record as a whole" (NPWS 1997). Factors defined by NPWS (1997) for assessing sites in terms of representativeness include defining variability, knowing what is already conserved and considering the connectivity of sites.

Educational value

The educational value of cultural heritage is dependent on the potential for interpretation to a general visitor audience, compatible Aboriginal values, a resistant site fabric, and feasible site access and management resources.

Aesthetic value

Aesthetic value relates to aspects of sensory perception. This value is culturally contingent.

11.2 Significance Value of the Aboriginal Objects in the Study Area

The scientific significance of the recorded Aboriginal artefact locales in the project area are listed below in Tables 14, 15 and 16:

Carrolls Ridge

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
SU1	L1	very low	moderately disturbed: erosion	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU1	L2	very low	moderately disturbed: erosion	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU1	L3	very low	highly disturbed in table drain	No	Yes However probably very low - low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU1	L4	moderate	relatively undisturbed	Yes aggrading saddle	No	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted moderate artefact density in apparently undisturbed context: excavation potential
SU1	L5	low moderate	apparently relatively undisturbed with some topsoil	Yes some topsoil	No	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in relatively undisturbed context
SU2	L1	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU4	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU6	L1	low	highly disturbed	No	Yes To north of track However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU7	L1	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
							low artefact density; eroded: no excavation potential
SU8	L1	low	moderately disturbed	Yes	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU8	L2	low	relatively intact	Yes	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU8	L3	low	moderately disturbed	No	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU8	L4	low	moderately disturbed	No	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU8	L5	moderate	poor disturbed by dam construction	No	Yes To east of dam	Potentially moderate, local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted moderate artefact density in apparently undisturbed context away from dam with excavation potential
SU8	L6	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density

Table 14. Scientific significance of Aboriginal objects recorded in the Carrolls Ridge development area.

Coppabella Hills

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
SU1	L1	low	relatively intact	Yes	Yes In saddle However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU1	L2	low	moderately disturbed	Yes	Yes In saddle However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU1	L3	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU1	L4	very low	moderately disturbed	Yes	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU1	L5	low	relatively intact	Yes	Yes However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU1	L6	negligible	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU2	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU2	L2	low	moderately disturbed	Yes	Yes In saddle However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Research potential: predicted low artefact density
SU2	L3	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU2	L4	low	relatively undisturbed	No	Yes In saddle However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Research potential: predicted low artefact density
SU2	L5	very low	poor	No	No	Low local scientific	Common Aboriginal object and site type

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
						significance	Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU3	L1	low	moderately disturbed	Yes	Yes In saddle However probably low density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU3	L2	low	moderately disturbed	No	Yes In saddle However possibly low/moderate density	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU3	L3	very low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU3	L4	very low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU5	L1	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU5	L2	low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU5	L3	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU6	L1	low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU6	L2	very low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU6	L3	very low	moderately disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU6	L4	very low	moderately disturbed	Yes	Yes	Low local scientific	Common Aboriginal object and site type

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
						significance	Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU6	L5	low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU6	L6	low	moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU7	L1	very low	highly disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU7	L2	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU7	L3	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU7	L4	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU9	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU11	L1	low	highly disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU11	L2	low	moderately disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU15	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded:

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
							no excavation potential
SU15	L2	Very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU15	L3	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU16	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU16	L2	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU16	L3	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU17	L1	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU17	L2	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU17	L3	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU17	L4	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU17	L5	low	highly	No	Yes	Potentially	Common Aboriginal object and

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
		moderate	disturbed			moderate scientific significance	site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU17	L6	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU18	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU18	L2	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density; eroded: no excavation potential
SU19	L1	very low	highly disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density; eroded: no excavation potential
SU19	L2	low moderate	highly disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low/moderate artefact density; eroded: no excavation potential
SU20	L1	low moderate	moderately disturbed	Yes	No	Low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density
SU20	L2	low	moderately disturbed	Yes	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low artefact density
SU20	L3	low moderate	uncertain	Yes	No	Low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU20	L4	low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
							low artefact density
SU21	L1	low moderate	moderately disturbed	Yes	No	Low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density
SU21	L2	low moderate	moderately disturbed	Yes	No	Low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density
SU23	L1	low	moderately disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU23	L2	low	moderately disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU24	L1	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L2	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L3	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L4	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L5	low moderate	uncertain	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L6	low moderate	uncertain	Yes	Yes	Potentially moderate	Common Aboriginal object and site type

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
						scientific significance	Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in potentially relatively undisturbed context
SU24	L7	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L8	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L9	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L10	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L11	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L12	low moderate	highly disturbed	No	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density
SU24	L13	low moderate	moderately disturbed	No	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density
SU24	L14	low moderate	moderately disturbed	Yes	Yes	Potentially moderate scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context
SU24	L15	low	moderately	Yes	Yes	Potentially	Common Aboriginal object and

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
		moderate	disturbed			moderate scientific significance	site type Low educational value Low aesthetic value Moderate research potential: predicted low/moderate artefact density in a potentially relatively undisturbed context

Table 15. Scientific significance of Aboriginal objects recorded in the Coppabella Hills development area.

Marilba Hills

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
SU2	L1	low moderate	relatively intact	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU2	L2	low moderate	relatively intact	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU4	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU4	L2	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU5	L1	very low	moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU8	L1	Low moderate	relatively intact	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU9	L1	low moderate	relatively intact	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L1	low moderate	moderately disturbed	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate density
SU17	L2	low moderate	poor	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L3	low moderate	highly disturbed	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
SU17	L4	low moderate	poor	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L5	low moderate	poor	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L6	low moderate	relatively undisturbed	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L7	low moderate	relatively intact	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU17	L8	very low	poor	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU17	L9	low moderate	moderately disturbed	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU19	L1	low	poor	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU24	L1	very low	relatively intact	Yes	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU25	L1	low	poor	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU26	L1	low moderate	relatively intact	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU26	L2	low moderate	relatively intact	Yes	Yes	low/moderate local	Common Aboriginal object and site type Low educational value

SU	Locale	Predicted Density	Condition	Subsurface potential at locale	Subsurface potential away from locale	Significance	Criteria
							Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU27	L1	low moderate	relatively intact	No	Yes	low/moderate local	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU28	L1	very low	poor	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density
SU28	L2	low	highly disturbed	No	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU28	L3	low	Moderately disturbed	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU29	L1	low moderate	poor	No	Yes	low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU29	L2	low moderate	Highly disturbed	No	Yes	low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact density
SU29	L3	low moderate	poor	No	Yes	low/moderate local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low/moderate research potential: predicted low/moderate artefact
SU30	L1	low	Moderately disturbed	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU30	L2	low	Relatively intact	Yes	Yes	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted low artefact density
SU32	L1	very low	poor	No	No	Low local scientific significance	Common Aboriginal object and site type Low educational value Low aesthetic value Low research potential: predicted very low artefact density

Table 16. Scientific significance of Aboriginal objects recorded in the Marilba Hills development envelope.

11.3 Significance Assessment Criteria – Non-Indigenous

The NSW Heritage Office and Planning NSW have defined a set of criteria and methodology for the assessment of cultural heritage significance for items and places, where these do not include Aboriginal heritage from the pre-contact period (NSW Heritage Office & DUAP 1996, NSW Heritage Office 2001, Heritage Council of NSW 2008).

The Heritage Council of NSW recognises only the following four levels of significance for heritage in NSW:

- Local
- State
- National
- World

These four levels refer to the context in which a heritage item is important and does not refer to a ranking of significance. A heritage item may have significance at more than one level; items of local significance are by far the most common in New South Wales and make the greatest contribution to our living historic environment (Heritage Council of NSW 2008).

The following heritage assessment criteria are those set out for Listing on the State Heritage Register. In many cases items will be significant under only one or two criteria. The State Heritage Register was established under Part 3A of the Heritage Act (as amended in 1999) for listing of items of environmental heritage which are of state heritage significance. Environmental heritage means those places, buildings, works, relics, moveable objects, and precincts, of state or local heritage significance (section 4, Heritage Act 1977).

An item will be considered to be of State (or local) heritage significance if, in the opinion of the Heritage Council of NSW, it meets one or more of the following criteria:

Criterion (a) an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area) – known as *historic significance*;

Criterion (b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area) – known as *historic associations*;

Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area) – known as *aesthetic* or *technical significance*;

Criterion (d) an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons– known as *social significance*;

Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area) – known as *research potential* or *educational significance*;

Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area) – known as *rarity*;

Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places or cultural or natural environments (or a class of the local areas) – known as *representative significance*.

An item is not to be excluded from the Register on the ground that items with similar characteristics have already been listed on the Register. Only particularly complex items or places will be significant under all criteria.

In using these criteria it is important to assess the values first, then the local or State context in which they may be significant. In instances where a heritage item is complex and/or comprises numerous elements a hierarchy of significance may be useful in assigning significance to individual elements or areas of a site as different components of a place may make a different relative contribution to its heritage value. For example, loss of integrity or condition may diminish significance. In some cases it is constructive to note the relative contribution of an item or its components. Table 17 below provides a guide to ascribing relative values for components of an individual item.

Grading	Justification	Status
Exceptional	Rare or outstanding item of local or State significance. High degree of intactness Item can be interpreted relatively easily.	Fulfils criteria for local or State listing.
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
Moderate	Altered or modified elements. Elements with little heritage value, but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
Little	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
Intrusive	Damaging to the item's heritage significance.	Does not fulfil criteria for local or State listing.

Table 17. Significance grading.

11.4 Significance Value of the Non-Indigenous Heritage Item in the Study Area

The potential heritage items recorded during this survey have been assessed against the State Heritage Register criteria and have been guided by the NSW Heritage Office update *Assessing Heritage Significance* (2001), the Heritage Council of NSW update *Levels of Heritage Significance* (2008). A statement of significance for each item is provided below in Table 18; a brief description of the reasoning behind the significance assessment is included in the table.

The potential heritage items recorded in the proposal area are assessed to not meet the criteria for heritage listing. These items do not have clear social or historical significance or associations, do not display technical or aesthetic values, they are not rare site types or particularly exemplary examples of their type and they present very little research or educational potential. As such they do not meet the criteria for listing.

Item	Significance	Criteria
Coppabella SU24/H1 *ploughlands*	*Does not meet the criteria for heritage listing*	This item is assessed to not have significance against any of the criteria
Marilba SU4/H1 *fence*	*Does not meet the criteria for heritage listing*	This item is assessed to not have significance against any of the criteria
Marilba SU28/H1 *stone feature*	*Does not meet the criteria for heritage listing*	This item is assessed to not have significance against any of the criteria

Table 18. Significance assessment of potential heritage items.

12. MITIGATION AND MANAGEMENT STRATEGIES

The aim of this study has been to identify Aboriginal objects and Non-Indigenous items and to predict the archaeological potential within each Survey Unit, to assess site significance and thereafter, to consider the potential impact of the proposal upon this heritage.

In the following section a variety of strategies that can be considered for the mitigation and management of development impact to Aboriginal objects, Non-Indigenous items and Survey Units (including those without Aboriginal object recordings) are listed and discussed.

12.1 Management and Mitigation Strategies

Further Investigation

The field survey has been focused on recording artefactual material present on visible ground surfaces. Further archaeological investigation entails subsurface excavation which is generally undertaken as test pits for the purposes of identifying the presence of artefact bearing soil deposits and their nature, extent, integrity and significance.

Further archaeological investigation in the form of subsurface test excavation can be appropriate in certain situations. Such situations generally arise when the proposed development is expected to involve ground disturbance in areas which are assessed to have potential to contain high density artefactual material and when the Effective Survey Coverage achieved during a survey of a project area is low due to ground cover, vegetation etc. In certain situations subsurface investigation provides a necessary level of surety in regard to the archaeological status of a place so that informed management decisions can be duly made.

A strategy of subsurface test excavation is pro-active and enables the proponent to properly understand the nature of archaeological deposits prior to development activity occurring. However no Survey Units have been identified in the proposal area to warrant further archaeological investigation in order to formulate appropriate management and mitigation strategies. Based on a consideration of the predictive model of site type applicable to the environmental context in which impacts are proposed the archaeological potential of the proposed impact areas does not warrant further investigation.

The ridges in which the turbines and their associated impacts will be located contain eroded and skeletal soils as a result of high levels of erosion; generally these soils have low potential to contain intact and/or stratified archaeological deposit. Given the skeletal nature of these soils the potential to physically conduct subsurface excavation is limited. Furthermore, the ridges generally are not predicted to contain artefact density which would warrant test excavation.

Elsewhere in locations which contain deeper soil deposits such as landforms located in the lower valley contexts a number of additional factors have been taken into consideration to determine whether or not further investigation is necessary. Proposed impacts in these landforms are small scale, discrete and generally linear impacts (road access, transmission line construction etc); accordingly impacts are low. In addition, it is considered that in regard to the archaeology itself, subsurface testing is unlikely to produce results different to predictions made in respect of the subsurface potential of these landforms. Accordingly a program of subsurface testing is not considered to be necessary or warranted in regard to the proposal.

Conservation

Conservation is a suitable management option in any situation however, it is not always feasible to achieve. Such a strategy is generally adopted in relation to sites which are assessed to be of high cultural and scientific significance, but can be adopted in relation to any site type.

When conservation is adopted as a management option it may be necessary to implement various strategies to ensure sites and 'Aboriginal objects' are not inadvertently destroyed or disturbed during construction works or within the context of the life of the development project. Such procedures are essential when development works are to proceed within close proximity to identified sites.

In the case at hand, conservation of the artefacts locales is considered to be desirable if at all possible. However, given the nature and density of the stone artefacts recorded in the proposal area and the low scientific significance rating each artefact locale has been accorded, none are assessed to warrant conservation if impacts are proposed.

Mitigated Impacts

Mitigated impact usually takes the form of partial impacts only (ie conservation of part of an Aboriginal object locale or Survey Unit, and limiting the extent of impacts) and/or salvage in the form of further research and archaeological analysis prior to impacts. Such a management strategy is generally appropriate when Aboriginal objects are assessed to be of moderate or high significance to the scientific and/or Aboriginal community and when avoidance of impacts and hence full conservation is not feasible. Salvage can include the surface collection or subsurface excavation of Aboriginal objects and subsequent research and analysis.

Some of the recorded Aboriginal object locales and/or discrete areas within wider Survey Units (including those which are predicted to contain subsurface archaeological deposit) are assessed to be of low/moderate or moderate archaeological significance. Accordingly it is generally recommended that limiting the extent of impacts to these locales, if at all feasible, should be given consideration.

For many Aboriginal object locales and/or discrete areas within wider Survey Units avoidance of impacts is unlikely to be feasible. Accordingly it is recommended a strategy of impact mitigation is appropriate.

It is proposed that where necessary an appropriate overall impact mitigation strategy would be a program of salvage archaeological excavation and analysis.

Unmitigated Impacts

Unmitigated Impacts to Aboriginal objects can be given consideration when they are assessed to be of low or low/moderate archaeological and cultural significance, in situations where conservation is simply not feasible and when mitigation is not warranted.

Given the nature and density of the majority of artefact locales recorded in the proposal area and the low scientific significance rating they been accorded, unmitigated impacts would be appropriate if impacts are proposed.

12.2 Management options - Indigenous

The tables below summarise the management and mitigation strategies considered to be relevant to proposal areas. Management and mitigation strategies are addressed in relation to all Survey Units recorded during the study (noting that not all Survey Units contain Aboriginal object locales) and where relevant individual locales located within each Survey Unit. The assessed archaeological significance of each Aboriginal object locale is listed given that site significance forms the basis for rationalizing the proposed management strategy. The recommended management strategy listed for each Survey Unit and Aboriginal object locale is selected from the various management options as discussed above in Section 12.1. Finally the rationale behind each recommendation is outlined, taking into consideration the nature of the Aboriginal object and its archaeological significance rating.

SU	Locales	Artefact density (predicted and as per analysis of ESC)	Significance	Recommended management strategy	Rationale
SU1	-	Generally very low/low	-	Generally no constraints except for SU1/L4 and SU1/L5 (see below)	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU1	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU1	L2	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU1	L3	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU1	L4	moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted moderate artefact density. Archaeological significance potentially moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU1	L5	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU2	-	Generally very low/low	-	No constraints **Unmitigated impacts**	Generally low artefact density in survey unit
SU2	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU3	Nil	negligible	-	No constraints **Unmitigated impacts**	Very low/negligible artefact density. Generally no excavation potential across survey unit
SU4	-	Generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit
SU4	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU5	Nil	negligible	n/a	No constraints **Unmitigated impacts**	Very low/negligible artefact density.
SU6	-	Generally negligible	-	No constraints **Unmitigated impacts**	Generally very low/negligible artefact density in survey unit; generally no excavation potential across survey unit
SU6	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU7	-	very low	-	No constraints **Unmitigated impacts**	Very low artefact density. Generally no excavation potential across survey unit
SU7	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU8	-	Generally very low/low	-	Generally no constraints except for SU8/L5 (see below)	Generally very low/low artefact density in survey unit; generally no or limited excavation potential across survey unit
SU8	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU8	L2	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU8	L3	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU8	L4	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU8	L5	moderate	Potentially moderate	**Mitigated impacts: Incorporate within research**	Predicted moderate artefact density. Archaeological significance potentially

SU	Locales	Artefact density (predicted and as per analysis of ESC)	Significance	Recommended management strategy	Rationale
			scientific significance	**program including excavation; however avoid disturbance to as much of area as practicable**	moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU8	L6	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. No excavation potential. Archaeological significance assessed to be low.
SU9	Nil	negligible	n/a	No constraints **Unmitigated impacts**	Very low/negligible artefact density. Generally no excavation potential across survey unit

Table 19. Recommended management strategies relating to Survey Units and Aboriginal object locales in Carrolls Ridge development area.

Coppabella Hills

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
SU1	-	Generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU1	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU1	L2	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU1	L3	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU1	L4	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU1	L5	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU1	L6	negligible	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU2	-	Generally very low/low	-	Generally no constraints except for SU2/L2 and SU2/L4 (see below)	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU2	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU2	L2	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU2	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU2	L4	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU2	L5	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU3	-	Generally very low/low	-	Generally no constraints except for SU3/L2 (see below)	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU3	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU3	L2	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU3	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU3	L4	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU4	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low/negligible artefact density.
SU5	-	generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low/low artefact density in survey unit; generally no excavation

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
					potential across survey unit
SU5	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU5	L2	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU5	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU6	-	generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU6	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU6	L2	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU6	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU6	L4	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU6	L5	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU6	L6	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU7	-	generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU7	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU7	L2	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU7	L3	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU7	L4	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU8	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU9	-	generally very low/low	-	No constraints **Unmitigated impacts**	Generally very low/low artefact density in survey unit; generally no excavation potential across survey unit
SU9	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU10	Nil	negligible	n/a	No constraints **Unmitigated impacts**	Very low/negligible artefact density.
SU11	-	generally low	-	No constraints **Unmitigated impacts**	Generally low artefact density in survey unit
SU11	L1	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU11	L2	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU12	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density; generally no excavation potential across survey unit.
SU13	Nil	negligible	n/a	No constraints **Unmitigated impacts**	Very low/negligible artefact density.
SU14	Nil	very low	n/a	No constraints	Very low artefact density; generally no

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
				Unmitigated impacts	excavation potential across survey unit.
SU15	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU15	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU15	L2	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU15	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU16	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU16	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU16	L2	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU16	L3	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU17	-	generally low moderate	-	**Mitigated impacts**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L1	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L2	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L3	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L4	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L5	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU17	L6	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU18	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU18	L1	very low	Low local scientific	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
			significance		be low.
SU18	L2	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU19	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU19	L1	very low	Low local scientific significance	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low.
SU19	L2	low moderate	Low local scientific significance	No constraints **Unmitigated impacts**	Low moderate density artefact distribution however highly disturbed; no excavation potential. Archaeological significance assessed to be low.
SU20	-	generally very low	-	Generally no constraints except for SU20/L1, SU20/L2 & SU20/L3 (see below)	Generally very low artefact density in survey unit; generally no excavation potential across survey unit.
SU20	L1	low moderate	Low/moderate local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU20	L2	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially low. Excavation potential on ridges rare; therefore of archaeological value.
SU20	L3	low moderate	Low/moderate local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU20	L4	low	Low local scientific significance	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low.
SU21	-	generally very low	-	Generally no constraints except for SU21/L1 & SU21Ll2 (see below)	Generally very low artefact density in survey unit; generally no excavation potential across survey unit.
SU21	L1	low moderate	Low/moderate local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Low moderate density artefact distribution. Archaeological significance assessed to be low.
SU21	L2	low moderate	Low/moderate local scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially low/moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU22	Nil	low	n/a	No constraints **Unmitigated impacts**	Low artefact density.
SU23	-	generally low	-	Generally no constraints except for SU23/L1 & SU23Ll2 (see below)	Generally very low artefact density in survey unit; generally no excavation potential across survey unit.
SU23	L1	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation**	Predicted low artefact density. Excavation potential; therefore of archaeological value.
SU23	L2	low	Low local scientific significance	**Mitigated impacts: Incorporate within research program including excavation**	Predicted low artefact density. Excavation potential; therefore of archaeological value.
SU24	-	generally low moderate	-	**Mitigated impacts**	Predicted low/moderate artefact density. Archaeological significance potentially

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
					moderate.
SU24	L1	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L2	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L3	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L4	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L5	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L6	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L7	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L8	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L9	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L10	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L11	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L12	low moderate	Potentially moderate	**Mitigated impacts: Incorporate within research**	Predicted low/moderate artefact density. Archaeological significance potentially

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
			scientific significance	**program including excavation; however avoid disturbance to as much of area as practicable**	moderate.
SU24	L13	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L14	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	L15	low moderate	Potentially moderate scientific significance	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.

Table 20. Recommended management strategies relating to Survey Units and Aboriginal object locales in the Coppabella Hills development area.

Marilba Hills

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
SU1	Nil	low	n/a	No constraints **Unmitigated impacts**	Predicted low artefact density. Generally no excavation potential across survey unit.
SU2	-	generally low moderate	-	**Mitigated impacts**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU2	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU2	L2	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU3	Nil	Low/moderate	n/a	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. Excavation potential on ridges rare; therefore of archaeological value.
SU4	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU4	L1	very low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low; no excavation potential
SU4	L2	very low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low; no excavation potential
SU5	-	generally very low	-	No constraints **Unmitigated impacts**	Generally very low artefact density in survey unit; no excavation potential across survey unit.
SU5	L1	very low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low; no excavation potential
SU6	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density. Generally no excavation potential across survey unit.
SU7	Nil	low	n/a	No constraints **Unmitigated impacts**	Low artefact density.
SU8	-	low/moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. .
SU8	L1	low/moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU9	-	low/moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. .
SU9	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
SU10	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU11	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU12	Nil	negligible	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU13	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU14	Nil	low	n/a	No constraints **Unmitigated impacts**	Low artefact density.
SU15	Nil	Negligible	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU16	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU17	-	low/moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate. .
SU17	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L2	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L3	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L4	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L5	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L6	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L7	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU17	L8	very low	low local	**Mitigated impacts: subsurface excavation in proposed impact area**	Predicted very low artefact density; disturbed. Archaeological significance low.
SU17	L9	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid**	Predicted low moderate artefact density. Archaeological significance potentially moderate.

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
				disturbance to as much of area as practicable	
SU18	Nil	Very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU19	-	low	-	No constraints **Unmitigated impacts**	Low artefact density.
SU19	L1	low	low local	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low
SU20	Nil	Very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU21	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU22	Nil	very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit
SU23	Nil	low/moderate	n/a	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low/moderate artefact density. Archaeological significance potentially moderate.
SU24	-	very low	-	No constraints **Unmitigated impacts**	Very low artefact density.
SU24	L1	low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low
SU25	-	low	-	No constraints **Unmitigated impacts**	Low artefact density.
SU25	L1	low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low
SU26	-	low/moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate. .
SU26	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU26	L2	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU27	-	low/moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate. .
SU27	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU28	-	very low	-	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential across survey unit.
SU28	L1	very low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low. No excavation potential.
SU28	L2	low	low local	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low. No excavation potential.

SU	Locale	Predicted Density	Significance	Recommended management strategy	Rationale
SU28	L3	low	Low local	No constraints **Unmitigated impacts**	Low density artefact distribution. Archaeological significance assessed to be low. No excavation potential.
SU29	-	low moderate	-	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate. .
SU29	L1	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU29	L2	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU29	L3	low moderate	low/moderate local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low moderate artefact density. Archaeological significance potentially moderate.
SU30	-	low	-	Generally no constraints except for SU30/l2 (see below)	Low artefact density.
SU30	L1	low	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low
SU30	L2	low	low local	**Mitigated impacts: Incorporate within research program including excavation; however avoid disturbance to as much of area as practicable**	Predicted low artefact density. Archaeological significance potentially moderate. Excavation potential rare on ridges.
SU31	Nil	Very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.
SU32	-	Very low	-	No constraints **Unmitigated impacts**	Very low artefact density. No excavation potential.
SU32	L1	negligible	low local	No constraints **Unmitigated impacts**	Very low density artefact distribution. Archaeological significance assessed to be low
SU33	Nil	Very low	n/a	No constraints **Unmitigated impacts**	Very low artefact density.

Table 21. Recommended management strategies relating to Survey Units in the Marilba Hills development area.

12.3 Management Recommendations – Non-Indigenous

Management recommendations relating to Non-Indigenous potential heritage items are listed below in Table 22.

Item	**Significance level**	**Recommended management strategy**	**Rationale**
Coppabella SU24/H1 *ploughlands*	n/a	**No constraints** No further archaeological investigation. Unmitigated impacts; however avoid impacts if feasible.	Limited archaeological research potential. *Does not meet the criteria for heritage listing*
Marilba SU4/H1 *Fence*	n/a	**No constraints** No further archaeological investigation. Unmitigated impacts; however avoid or minimise impacts if feasible.	Limited archaeological research potential. *Does not meet the criteria for heritage listing*
Marilba SU28/H1 *stone feature*	n/a	**No constraints** No further archaeological investigation. Unmitigated impacts; however avoid impacts if feasible.	Limited archaeological research potential. *Does not meet the criteria for heritage listing*

Table 22. Recommended management strategies relating to Non-Indigenous items.

13. RECOMMENDATIONS

The following recommendations are made on the basis of:

- A consideration of the Part 3A amendment to the Environmental Planning and Assessment Act (see Section 10 Statutory Information).
- The results of the investigation as documented in this report.
- Consideration of the type of development proposed and the nature of proposed impacts.

Management and mitigation strategies are outlined and justified in Section 12 of this report. The following recommendations are provided in summary form:

- As a form of mitigation of overall construction impact to the archaeological resource within the proposal area it is proposed that a salvage program of archaeological excavation and analysis be undertaken in a sample of impact areas prior to construction (see Tables 19, 20 and 21).

  The development of an appropriate salvage project should be undertaken in consultation with an archaeologist, the relevant Aboriginal communities and the NSW Department of Conservation and Climate Change.

- No Survey Units have been identified in the proposal area to warrant further archaeological investigation such as subsurface test excavation; the Effective Survey Coverage achieved during the field survey was relatively high and can be considered to have been generally adequate for the purposes of determining the archaeological status of the proposed impact areas.

- None of the Survey Units in the proposal area have been assessed to surpass archaeological significance thresholds which would act to entirely preclude proposed impacts.

- The majority of the Aboriginal object locales recorded are very low or low density distributions of stone artefacts. The archaeological significance of these locales is assessed to be low. Accordingly a management strategy of unmitigated impact is considered to be appropriate.

- A number of the Aboriginal object locales and/or discrete areas within Survey Units are assessed to be of low/moderate or moderate archaeological significance. Accordingly, in regard to these areas it is generally recommended that limiting the extent of impacts to these locales, if at all feasible, should be given consideration.

  In regard to these locales it is recommended that a salvage program of subsurface excavation be undertaken as a form of Impact Mitigation.

- It is recommended that additional archaeological assessment is conducted in any areas which are proposed for impacts that have not been surveyed during the current assessment. It is predicted that significant Aboriginal objects can occur anywhere in the landscape and accordingly if present they need to be identified and impact mitigation strategies implemented prior to impacts.

- The proponent should, in consultation with an archaeologist, develop a Cultural Heritage Management Protocol, which documents the procedures to be followed for impact mitigation. The development of an appropriate Cultural Heritage Management Protocol should be undertaken in consultation with an archaeologist, the relevant Aboriginal communities and the NSW Department of Conservation and Climate Change.

- Personnel involved in the construction and management phases of the project should be trained in procedures to implement recommendations relating to cultural heritage where necessary.

- Cultural heritage should be included within any environmental audit of impacts proposed to be undertaken during the construction phase of the development.

- Copies of this report should be provided to the Aboriginal stakeholders who have registered in interest in this project.

14. REFERENCES

Austral Archaeology Pty Ltd 2005 *Archaeological Test Excavation at Proposed Gunning Wind Farm NSW, Test Excavation Report*. Prepared for Connell Wagner PPI.

Austral Archaeology Pty Ltd 2008 *Aboriginal Archaeological and Cultural heritage Assessment Gunning Wind Farm NSW Additional Assessment Report*. Prepared for ACCIONA Energy.

Bayley, W. A. 1973 *Yass Municipal Centenary History*, Yass Municipal Council, Yass.

Boot, P. 1994 Recent Research into the Prehistory of the Hinterland of the South Coast of New South Wales. In Sullivan, M, Brockwell, S. and Webb, A. (eds) *Archaeology in the North: Proceedings of the 1993 Australian Archaeological Association Conference.* NARU: Darwin.

Boot, P. personal communication February 2009.

Branagan, D. and G. Packham 2000 *Field Geology of New South Wales*. NSW Department of Mineral Resources: Sydney.

Carlos, G. 2008 A short history of Yass Tramway, *Yass Tribune* http://yass.yourguide.com.au/news/local/news/general/a-short-history-of-yass-tramway/1335550.aspx?storypage=0 (accessed 27th November 2008)

DPWS Heritage Design Services 2001, *Greater Burrinjuck Dam Precinct Heritage Assessment*, report for State Water.

Dean-Jones, P. 1990 *Report of an archaeological survey of a proposed hard rock quarry near Gunning*.

Dibden, J. 2005a *Proposed Residential Subdivision at the Bermagui Country Club. Archaeological Subsurface Test Excavation. S87 Permit # 2144*. Report to Paynter Dixon Golf Pty Ltd.

Dibden, J. 2005b *Proposed Wind Farm – Snowy Plains Subsurface Test Excavation s87 Permit # 2199*. A report to Taurus Energy.

Dibden, J. 2005c *Proposed Residential Subdivision Moruya Subsurface Test Excavation*. A report to Patent Developments.

Dibden, J. 2006a *Taurus Energy Proposed Wind Farm – Cullerin, via Goulburn Aboriginal Archaeological Assessment*. A report to nghenvironmental.

Dibden, J. 2006b *Taurus Energy Proposed Wind Farm –Conroys Gap, via Yass Aboriginal Archaeological Assessment*. A report to nghenvironmental.

Dibden, J 2006c Proposed Re-Development at Kalorama Caravan Park, Millingandi, near Merimbula, NSW. Subsurface Test Excavation. Preliminary Research Permit #2402. Report to Driftwood Village.

Dibden, J. 2006d *Proposed Commercial, Residential and Industrial Subdivision Lot 4 DP1077434, Lot 1510 DP 1977898 & Lot 2432 DP 793758 South Bega NSW Subsurface Test Excavation*. A report to Planning Initiatives.

Dorrough, J., A Yen, V. Turner, S. Clark, J. Crosthwaite and J. Hirth 2004 Livestock grazing management and biodiversity conservation in Australian temperate grassy landscapes. *Australian Journal of Agricultural Research*. Vol 55; pp 279 – 295.

Dunnell, R. 1993 The Notion Site in J. Rossignol and L. Wandsnider eds *Space, Time and Archaeological Landscapes*. New York: Plenum, pgs 21-41.

Eades, D. 1976 *The Dharawal and Dhurga Languages of the New South Wales South Coast*. Canberra: Australian Institute of Aboriginal Studies.

Flood, J. 1980 *The Moth Hunters*. Australian Institute of Aboriginal Studies: Canberra.

Flood, J. 1995 *Archaeology of the Dreamtime* (Revised ed.) Angus and Robertson, Sydney.

Flood, J., David, B., Magee, J. & English, B. 1987 Birrigai: A Pleistocene Site in south-eastern highlands. *Archaeology in Oceania*. 22: 9-26.

Harden Murrumburrah District Historical Association, n.d. *Brief history of the Harden Murrumburrah district*, Harden.

Heritage Council of New South Wales 2008 *Levels of Heritage Significance* Heritage Office, NSW Department of Planning, Sydney.

Heritage Office and Department of Urban Affairs and Planning 1996 *Regional histories: regional histories of New South Wales* Department of Urban Affairs and Planning, Sydney.

Hiscock, P. & Mitchell, S. 1993 *Stone Artefact Quarries and Reduction Sites in Australia: Towards a Type Profile*. AGPS: Canberra.

Irving, R. 1982 *Reader's Digest book of historic Australian towns*, Reader's Digest, Surry Hills.

Jeans, D. N. 1966 *A Historical Geography of New South Wales*. Reed Education: Sydney.

Jennings, J. and J. Mabbutt 1977 Physiographic outlines and regions. In: Jeans, D. (ed): *Australia: a Geography*. Sydney University Press; Sydney: PP 38 – 52.

Jo McDonald Cultural Heritage Management Pty Ltd 2003 *Archaeological Survey for an Aboriginal Heritage Assessment Gunning Wind Farm, Gunning, NSW*. Report prepared for Connell Wagner PPI.

Klaver, J. 1993 *Duplication of Hume Highway Carriageway and Bypass of Bookham, NSW. Archaeological Survey for Aboriginal Sites*. Report to Mitchell McCotter.

Koettig, M. 1986a *Survey for Aboriginal Sites Along the Proposed Water Pipeline Between Bowning and Yass.* Report to Public Works Department, New South Wales.

Koettig, M. 1986b *Test Excavations at Derringullen Creek Near Yass*. Report to Public Works Department, New South Wales.

Koettig, M. and R. Silcox 1983 *Survey for Archaeological Sites along the Proposed Yass By-Pass Rout*e. Report to NSW Department of Main Roads.

Knight, T. 2001 *Stepping Stones to the Sky Archaeological Perspectives on the Cultural Significance of the Weddin Mountains in Recent Prehistory*. Unpublished Master of Arts by Research Thesis. School of Archaeology and Anthropology Australian National University, Canberra.

Kuskie, P. 1992 *An Archaeological Assessment of the Proposed Route of Optus Commission's Fibre Optic Cable Between Cootamundra, NSW, and Hall, ACT*. Report to Landscan Pty Ltd.

Kuskie, P. 2000 *An Aboriginal Archaeological Assessment of the Proposed Mount Arthur North Coal Mine, Near Muswellbrook, Hunter Valley, New South Wales*. Unpublished report to Dames and Moore.

Lampert, R. 1971 *Burrill Lake and Currarong: Coastal Sites in Southern New South Wales*. Terra Australia 1 Department of Prehistory. ANU: Canberra.

Lunt, I., D. Eldridge, J. Morgan and G. Witt 2007 A framework to predict the effects of livestock grazing and grazing exclusion on conservation values in natural ecosystems in Australia. *Australian Journal of Botany*. Vol 55; No 4; pp 401 -415.

Maher, B. 2003 *Binalong: beyond the limits*. Rev. Brian Maher, Canberra.

McDonald, R. Isbell, R, Speight, J. Walker, J. and M. Hopkins 1998 *Australian Soil and Land Survey Field Handbook*. CSIRO Australia.

Mission Australia 2000 *History in the Making: Yass, picture and memories.* Mission Australia, Canberra.

Navin, K. and K. Officer 1995 *Archaeological survey proposed extension to Bogo Quarry, South of Yass, NSW.* Report to David Hogg Pty Ltd.

Navin Officer Heritage Consultants 2001 *Yass 330/132kV Substation Reconstruction Project Archaeological Assessment.* Report to Pacific Power.

Newland, J. R. 1994 *The Goondah – Burrinjuck Railway.* Australian Railway Historical Society, St James, NSW.

Mulvaney, J. and J. Kamminga 1999 *Prehistory of Australia*. Allen and Unwin: St Leonards.

New South Wales National Parks and Wildlife Service. 1997 DRAFT *Aboriginal cultural heritage standards and guidelines kit.*

New South Wales Department of Environment and Conservation 2004 *Interim Guidelines for Aboriginal Community Consultation - Requirements for Applicants*.

New South Wales Department of Environment and Conservation 2005 DRAFT *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation.*

New South Wales Heritage Office and Department of Urban Affairs 1996, *Heritage Assessments, NSW Heritage Manual*, HO/DUAP, Sydney.

New South Wales Heritage Office 2001 *Assessing Heritage Significance*, HO/DUAP, Sydney.

Oakley, B. 1995 *Archaeological investigation Optus Communications*. Report to Optus Communications.

Olley, J. and R. Wasson 2003 Changes in the flux of sediment in the Upper Murrumbidgee catchment, Southeastern Australia, since European settlement. *Hydrological Processes*. Vol 17; pp 3307 – 3320.

Ossa, P., Marshall, B. & Webb, C. 1995 New Guinea 2 cave: A Pleistocene site on the Snowy River, Victoria. *Archaeology in Oceania* 30(1):22-35.

OzArk Environment & Heritage Management P/L 2007 *Ecology and Heritage Assessment: Wagga Wagga – Yass Line 990 132 kV Transmission Line.* Report to International Environmental Consultants PL on behalf of TransGrid

Packard, P. 1984 *With a Pinch of Salt - The Archaeology of Saline-Seepage erosion in the Yass River Basin*. B. Litt thesis, The Australian National University, Canberra.

Packard, P. and P. Hughes 1983 *Stage 2 of an Archaeological Survey of the Murrumburrah-Yass Electricity Transmission Line*. Anutech report to NPWS.

Paton, R. 1993 *An archaeological survey of the proposed optical fibre cable route from Gunning to Dalton and Dalton to Flacknell Creek Road Turnoff, Southern Tablelands, NSW*. A report to Telecom Australia.

Pearson, M. 1981 *Seen Through Different Eyes: Changing Landuse and Settlement Patterns in the Upper Macquarie River Region of NSW from Prehistoric Times to 1860*. Unpublished PhD Thesis. Dept of Prehistory and Anthropology: The Australian National University.

Perry, T. M. 1965 *Australia's first frontier*. Melbourne University Press: Melbourne.

Seddon, J., A. Zerger, S Doyle and S Briggs 2007 The extent of dryland salinity in remnant woodland and forest within an agricultural landscape. *Australian Journal of Botany*. Vol. 55; No. 5; pp 533- 540.

Saunders, P. 2000 *Investigation of Dalton Open Campsite North and Yass River Open Campsite*. Report to Energy Australia.

Shaw, A. G. L. 1970 *The Economic Development of Australia*. Longman: London.

Shott, M. 1995 Reliability of Archaeological Records on Cultivated Surfaces: A Michigan Case Study. *Journal of Archaeological Field Archaeology*. Vol 22; pgs 475 – 490.

Silcox, R. and M. Koettig 1985 *Survey for Aboriginal and Historic Sites along the Proposed Alternative Yass By-Pass Route, N.S.W.* Report to DMR.

Silcox, R. and M. Koettig 1988 *Barton Highway Extension at Yass: Survey and Test Excavations on the Proposed Alternative Route*. Report to Kinhill Stearns Pty Ltd.

Southern Tablelands of NSW 2008 *Towns and villages: Yass* http://www.argylecounty.com.au/towns/yass.html (accessed 27th November 2008)

White, I. 1986 *Dimensions of Wiradjuri An Ethnohistoric Study*. B. Litt thesis, The Australian National University, Canberra.

White, I. and S. Cane 1986 *An Investigation of Aboriginal Settlements and Burial Patterns in the Vicinity of Yass.* Report to the NSW NPWS, Queanbeyan.

Witter, D. 1980 *An Archaeological Pipeline Survey between Dalton and Canberra. Aboriginal and Historical* Resources Section, National Parks and Wildlife Service, Sydney, NSW.

Witter, D. 1981 *Archaeological Salvage Investigations on the Dalton to Canberra Pipeline*. Aboriginal and Historical Resources Section, National Parks and Wildlife Service, Sydney, NSW.

Witter, D. and P. Hughes 1983 *Stage 1 of an Archaeological Survey of the Murrumburrah-Yass and Murrumburrah-Wagga Wagga Electricity Transmission Lines*. Anutech report to NPWS.

Wandsnider, L and E. Camilli 1992 The Character of Surface Archaeological Deposits and Its Influence on Survey Accuracy. *Journal of Field Archaeology*. Vol. 19 pgs 169 - 188.

Wasson, R., R. Mazari, B Starr and G. Clifton 1998 The recent history of erosion and sedimentation on the Southern Tablelands of southeastern Australia: sediment flux dominated by channel incision. *Geomorphology* Vol: 24; pp 291 – 308.

Yass and District Historical Society 2008 *History and Timeline*. http://www.yasshistory.org.au/history.htm (accessed 27th November 2008).

Yass Valley Council 2008 *Historic Yass* Valley http://www.yass.nsw.gov.au/about/1573/1582.html (accessed 27th November 2008).

Young, M. (ed.), 2000 *The Aboriginal People of the Monaro*, NSW NPWS.

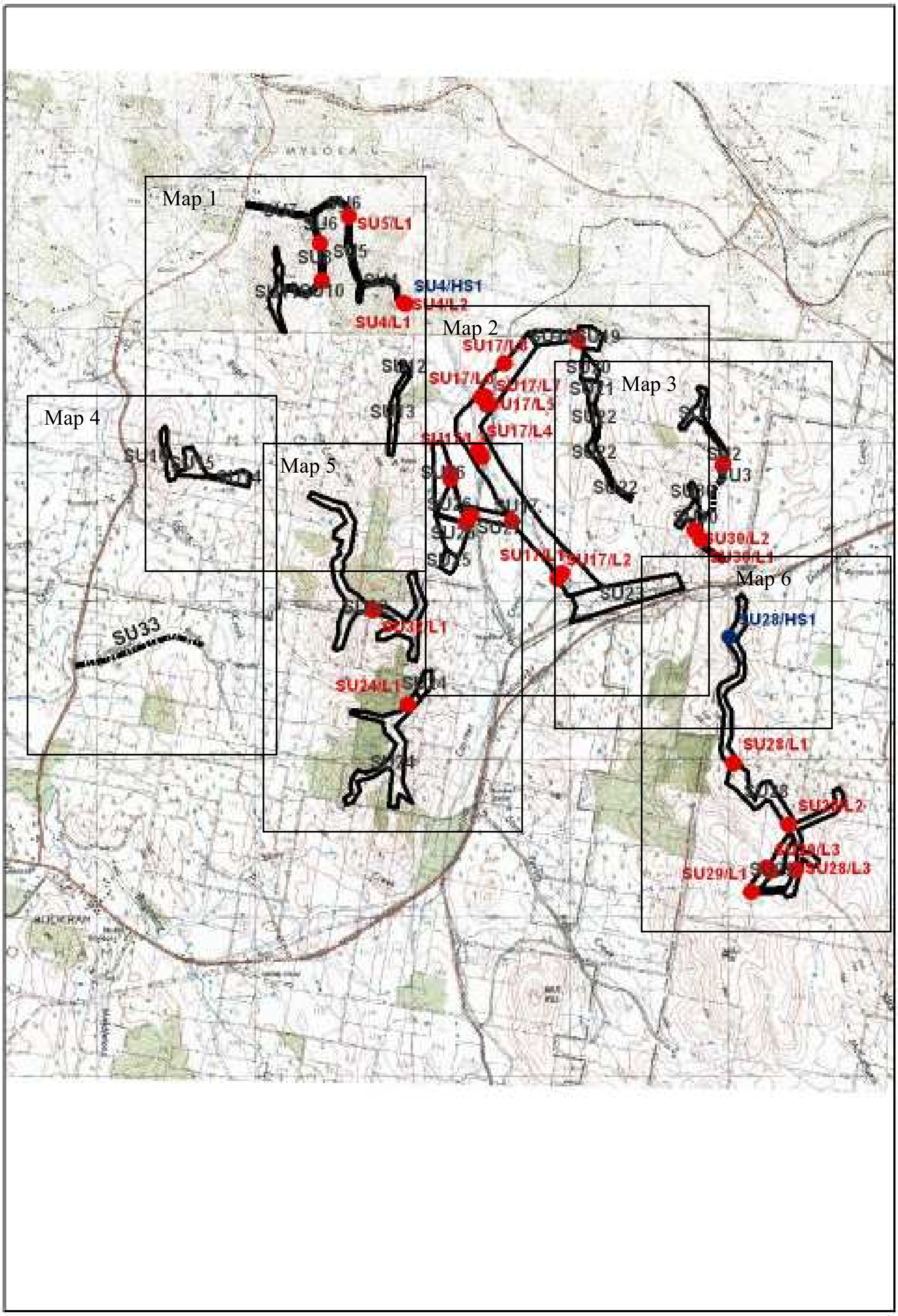


Figure 13. Marilba Hills Key Map.

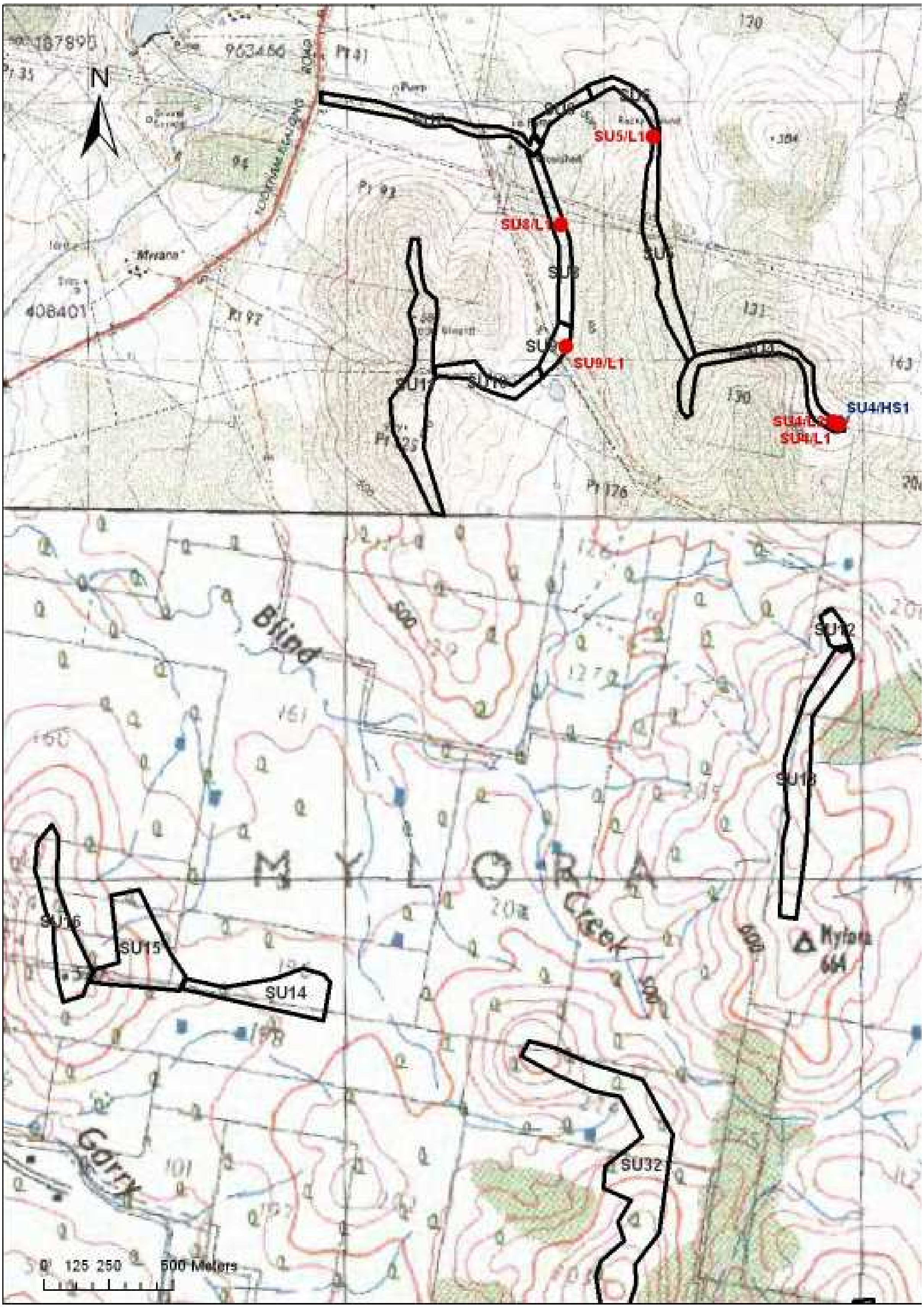


Figure 14. Marilba Hills Map 1.

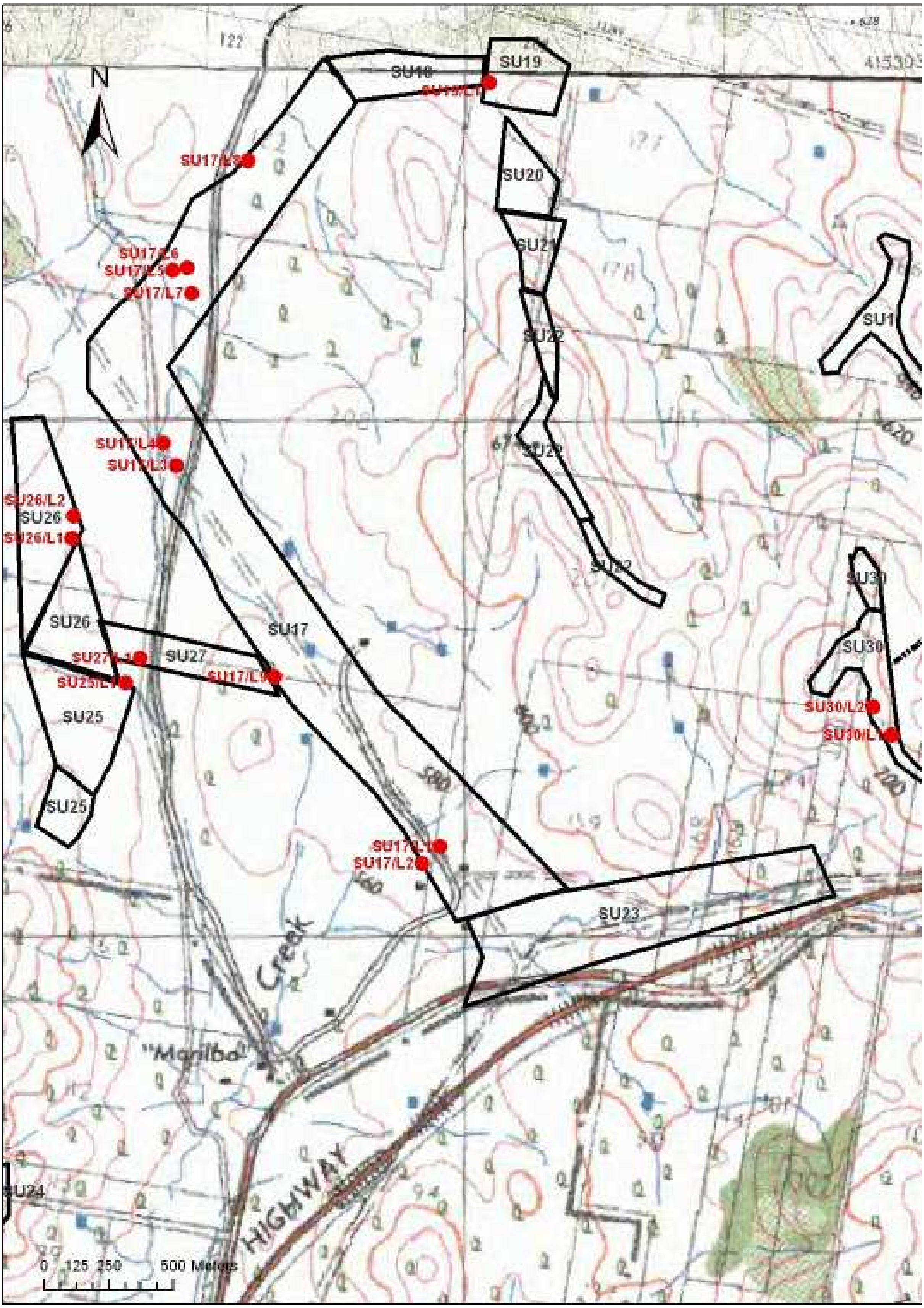


Figure 15. Marilba Hills Map 2.

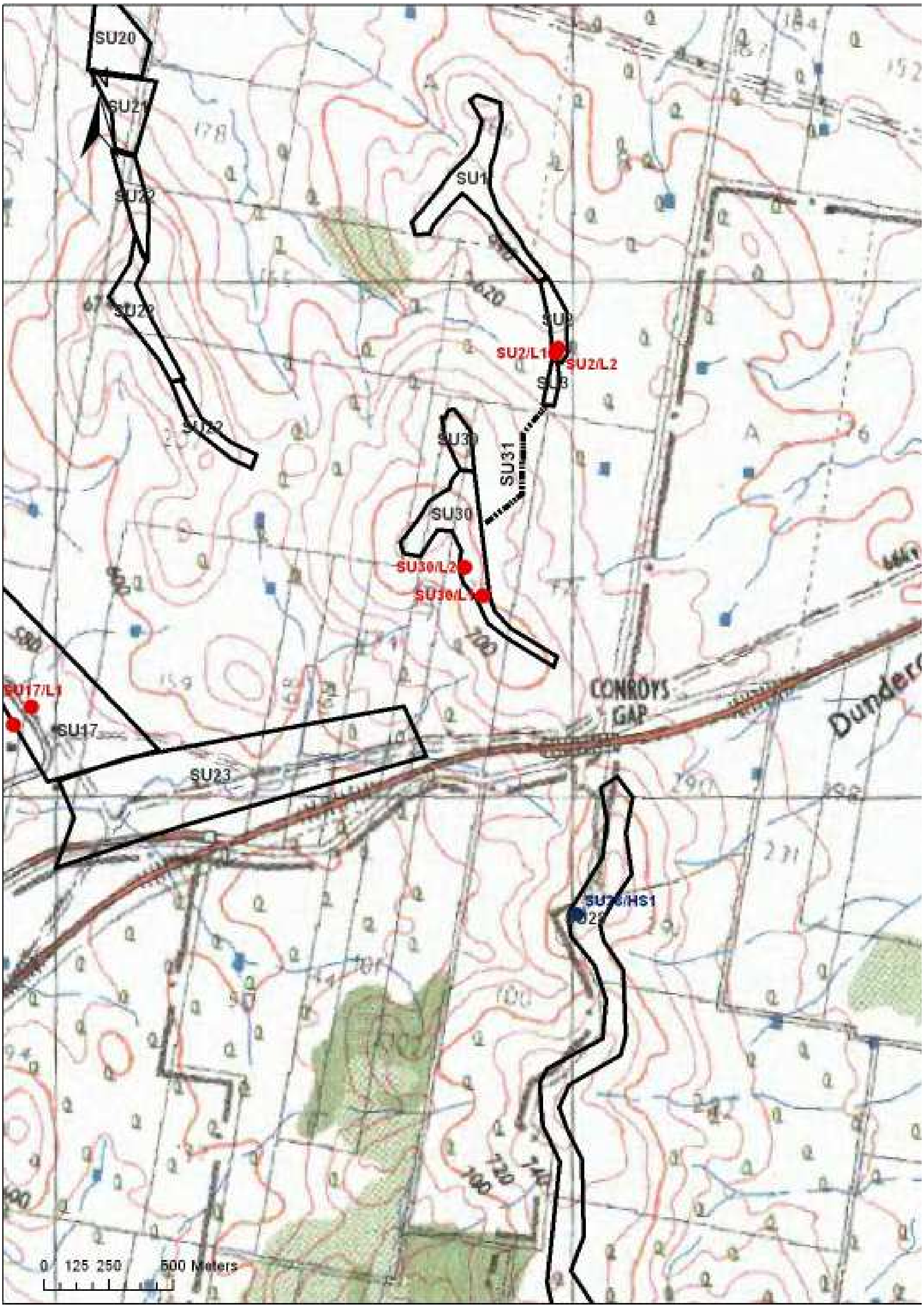


Figure 16. Marilba Hills Map 3.

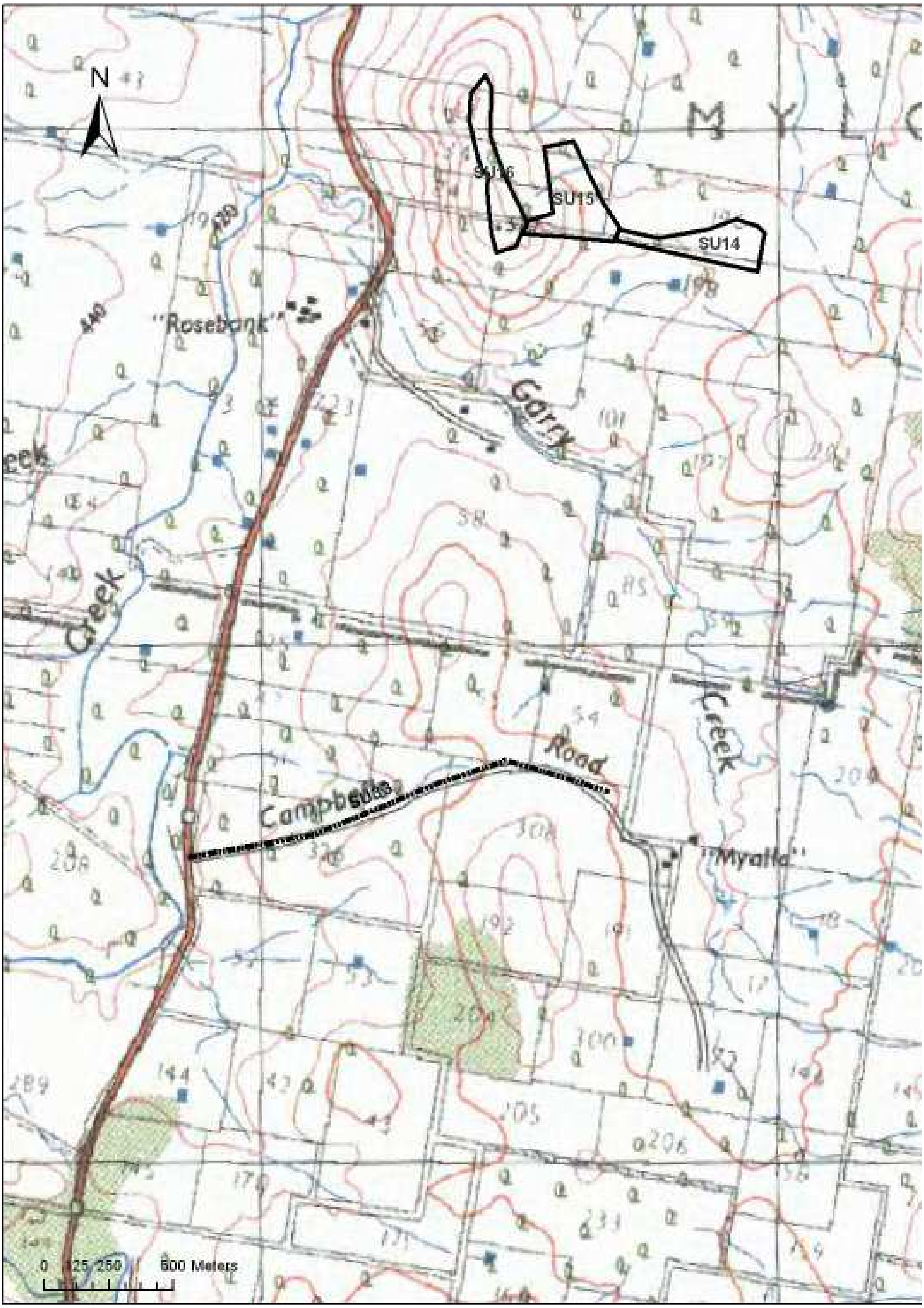


Figure 17. Marilba Hills Map 4.

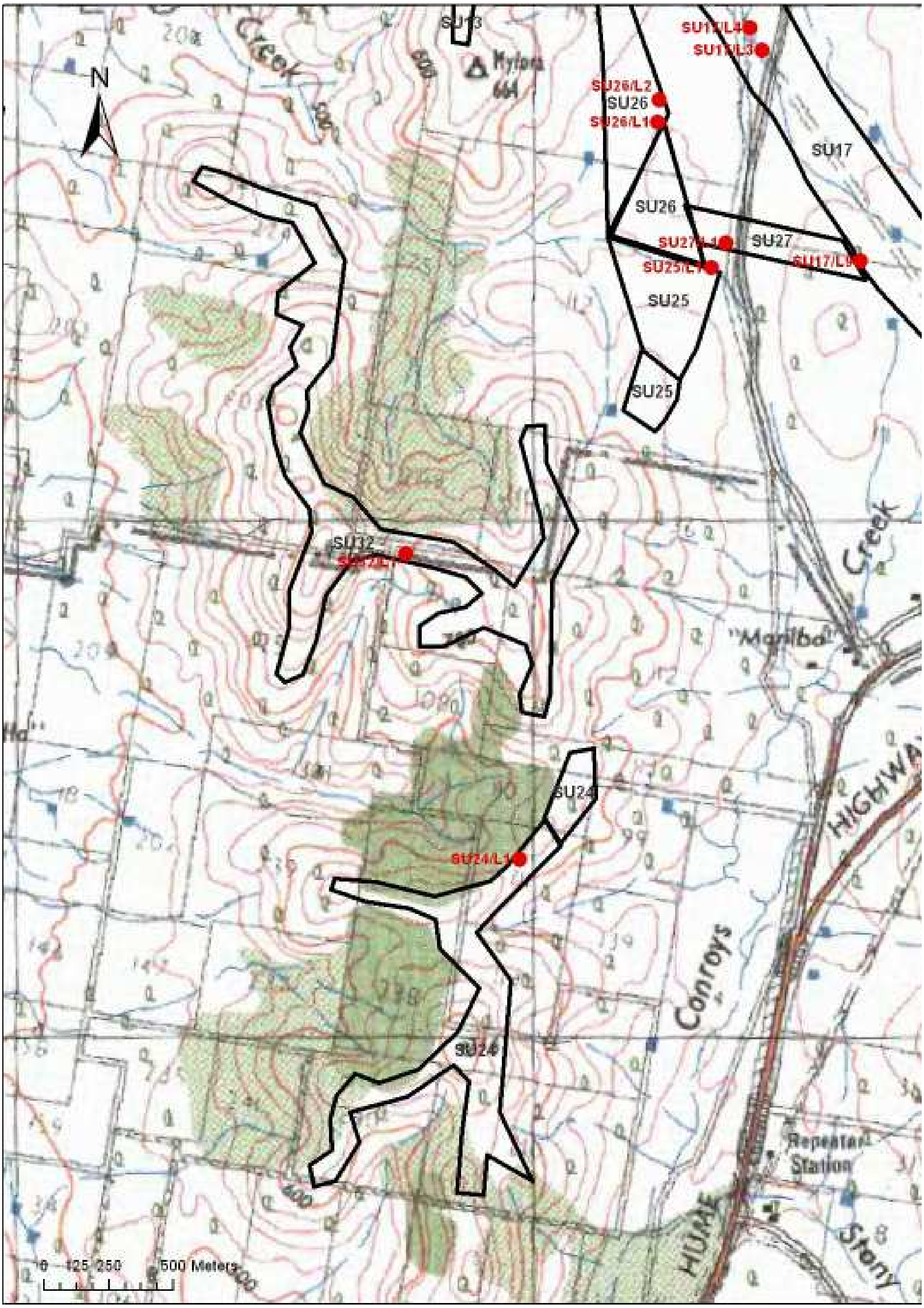


Figure 18. Marilba Hills Map 5.

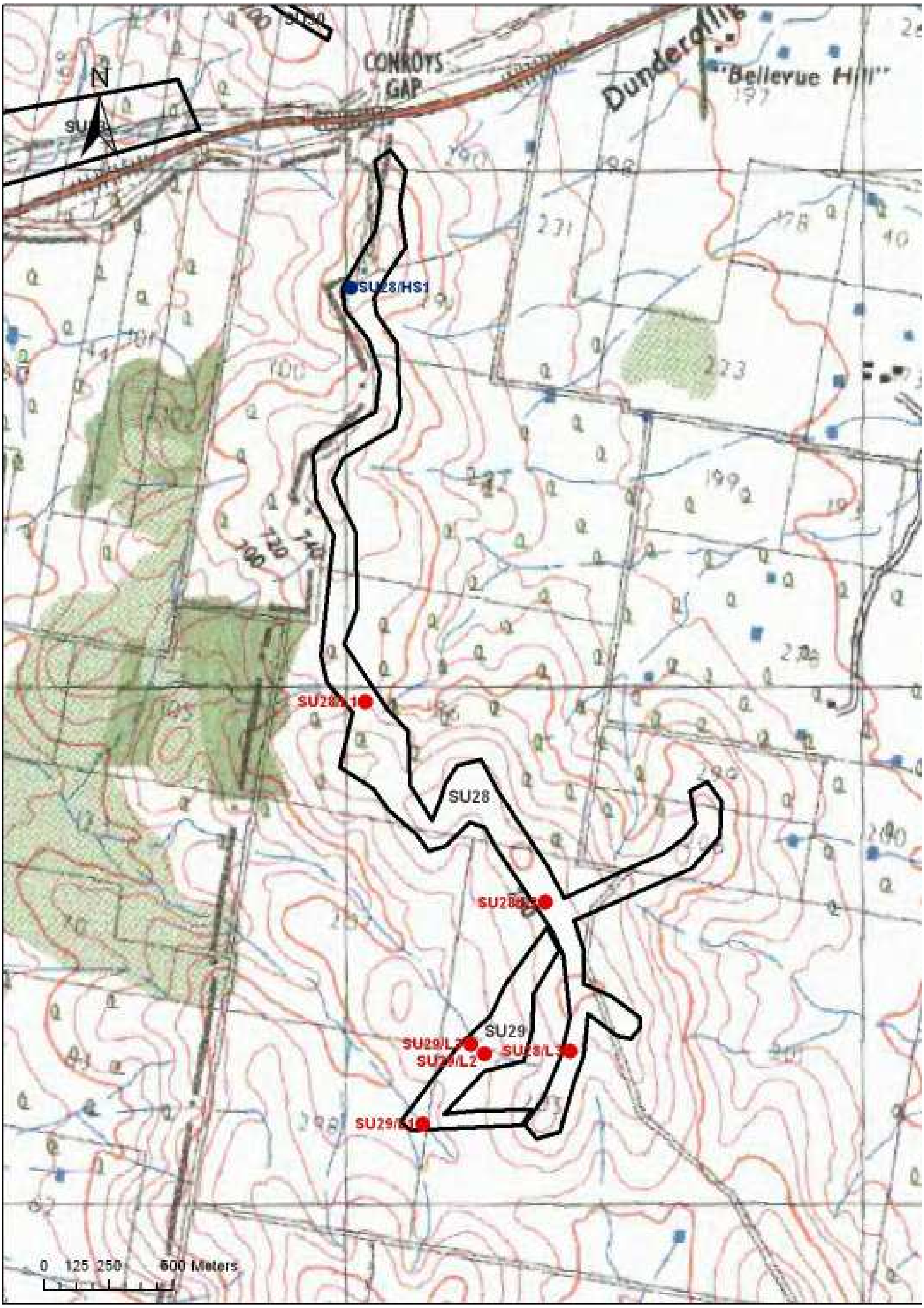


Figure 19. Marilba Hills Map 6.

Appendix 1: Photographic record

Plate 1. Carrolls Ridge Survey Unit 1 looking north.

Plate 2. Close up of ground surface in Carrolls Ridge Survey Unit 2. Note severe erosion where most of the surface is removed leaving hard subsoil material and weathered bedrock.

Plate 3. Carrolls Ridge Survey Unit 3. Note severe erosion where most of the surface is removed leaving hard subsoil material and weathered bedrock.

Plate 4. Carrolls Ridge Survey Unit 8 looking south.


Plate 5. Carrolls Ridge Survey Unit 7 looking north.


Plate 6. Carrolls Ridge Survey Unit 4 in middle distance (south end) taken from SU7 looking southeast.

Plate 7. Carrolls Ridge Survey Unit 2 looking east along proposed road and towards proposed substation adjacent to existing transmission line.

Plate 8. Carrolls Ridge Survey Unit 3 looking west along proposed road access.

Plate 9. Carrolls Ridge Survey Unit 5 looking east towards SU4.

Plate 10. Location of Carrolls Ridge SU1/L1 looking west. Artefact located near tree closest to camera.

Plate 11. Location of Carrolls Ridge SU1/L2 looking south.

Plate 12. Location of Carrolls Ridge SU1/L4 (saddle) looking northwest.

Plate 13. Location of Carrolls Ridge SU1/L5 (knoll on far side of road) looking northeast.

Plate 14. Location of Carrolls Ridge SU4/L1 (in saddle) looking south.

Plate 15. Location of Carrolls Ridge SU8/L4 looking south.

Plate 16. Location of Carrolls Ridge SU8/L5 looking south.

Plate 17. Coppabella Hills SU1 looking southeast. Note narrow; rocky crest.

Plate 18. Coppabella Hills SU15 looking south. Note rock abundance and bare earth.

Plate 19. Coppabella Hills SU2 (north ridge) looking west. Note bedrock abundance.

Plate 20. Coppabella Hills SU15 looking south. Note erosional context.

Plate 21. Coppabella Hills looking southwest from SU1 to SU20. Note crests and steep, “v” shaped valleys.

Plate 22. Coppabella Hills: Survey Unit 10 (transmission line); looking east. Note and steep, “v” shaped valley.

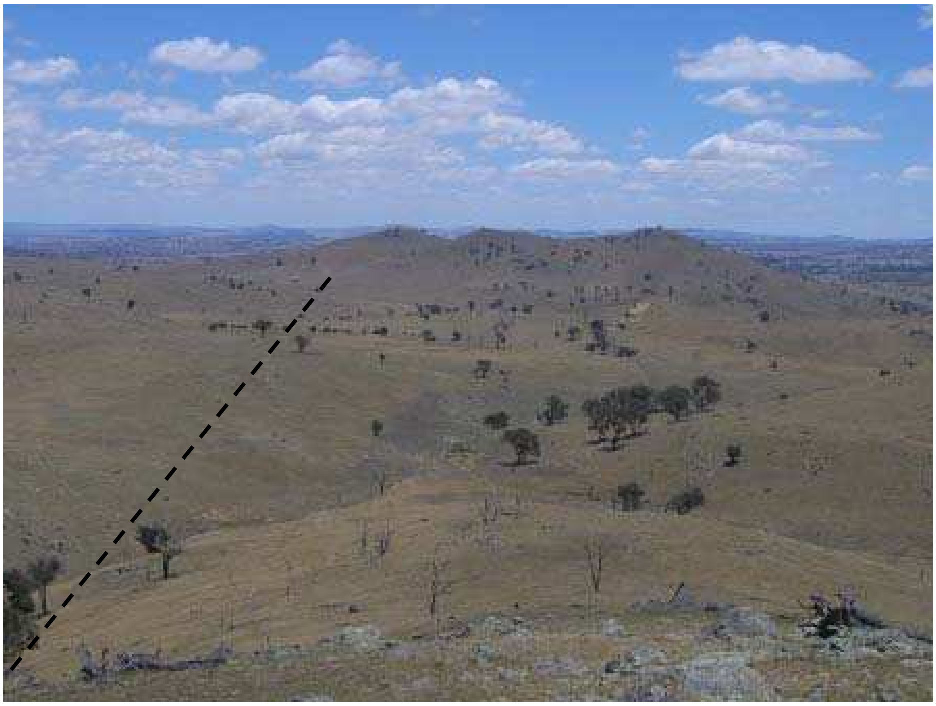


Plate 23. Coppabella Hills: Survey Units 10 and 13 (transmission line); looking west towards turbine ridge in distance (SU12).

Plate 24. Location of Coppabella Hills Survey Unit 1/Locale 1 looking southeast: locale in saddle.

Plate 25. Location of Coppabella Hills Survey Unit 2/Locale 2 looking east: locale in saddle.

Plate 26. Location of Coppabella Hills Survey Unit 2/Locale 3 looking northwest: note high exposure.

Plate 27. Location of Coppabella Hills Survey Unit 3/Locale 2 looking northwest: note high exposure and locale in saddle.

Plate 28. Pebble artefact: pounder; Coppabella Hills Survey Unit 3/Locale 2.

Plate 29. Location of Coppabella Hills Survey Unit 5/Locale 1 looking east: note high exposure.

Plate 30. Location of Coppabella Hills Survey Unit 6/Locale 1 looking southwest.

Plate 31. Location of Coppabella Hills Survey Unit 9/Locale 1 looking west.

Plate 32. Location of Coppabella Hills Survey Unit 15/Locale 1 looking west; note high exposure.

Plate 33. Location of Coppabella Hills Survey Unit 16/Locale 2 looking south; note high exposure.

Plate 34. Location of Coppabella Hills Survey Unit 20/Locale 3 looking south.

Plate 35. Location of Coppabella Hills Survey Unit 24/Locale 8 looking west.

Plate 36. Marilba Hill study area; looking south from SU4 to the western north/south ridge.

Plate 37. Marilba Hill study area; looking southeast from SU11 to SU12 and SU13.

Plate 38. Marilba Hill study area; looking northwest along SU17 in the wide valley between the two north/south ridges.

Plate 39. Marilba Hill study area; looking west from SU22 across in the wide valley between the two north/south ridges to SU13.

Plate 40. Marilba Hill study area; looking south along the steeply undulating ridge crest encompassed by SU24.

Plate 41. Marilba Hill study area; looking north from SU24 to the steeply undulating ridge crest encompassed by SU32.

Plate 42. Marilba Hill study area; looking northwest from SU29; note broad amorphous slopes in which transmission line is proposed.

Plate 43. Location of Marilba Hills Survey Unit 17/Locale 2 looking north.

Plate 44. Location of Marilba Hills Survey Unit 17/Locale 3 looking southeast.

Plate 45. Location of Marilba Hills Survey Unit 25/Locale 1 looking southeast; locale on far side of dam.

Plate 46. Location of Marilba Hills Survey Unit 26/Locale 1 looking south.

Plate 47. Location of Marilba Hills Survey Unit 29/Locale 2 near left dam and Survey Unit 29/Locale 3 near right dam looking southwest.

Appendix 2: Lithic Database

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Carrolls Ridge	SU1	L1	Flake	volcanic	3	weathered tuff
Carrolls Ridge	SU1	L2	Flake	chert	4	
Carrolls Ridge	SU1	L2	Flaked Piece	chert	3	
Carrolls Ridge	SU1	L2	Flaked Piece	chert	2	
Carrolls Ridge	SU1	L2	Flake	chert	3	
Carrolls Ridge	SU1	L2	hammerstone	quartzite	>10	broken pebble with crushing on one end consistent w hammer/pounding use
Carrolls Ridge	SU1	L2	Flake fragment	chert	3	longitudinal break
Carrolls Ridge	SU1	L3	Flake	chert	5	
Carrolls Ridge	SU2	L1	Flake	volcanic	3	weathered tuff
Carrolls Ridge	SU4	L1	Flake	chert	3	
Carrolls Ridge	SU7	L1	Flake	volcanic	4	weathered tuff
Carrolls Ridge	SU7	L1	Flaked Piece	volcanic	4	weathered tuff
Carrolls Ridge	SU7	L1	Flake	volcanic	3	weathered tuff
Carrolls Ridge	SU7	L1	Flaked Piece	volcanic	4	weathered tuff
Carrolls Ridge	SU7	L1	Flake fragment	volcanic	2	weathered tuff
Carrolls Ridge	SU7	L1	Flake fragment	volcanic	2	weathered tuff
Carrolls Ridge	SU8	L1	Flake	volcanic	2	weathered tuff
Carrolls Ridge	SU8	L2	Flake fragment	chert	2	proximal
Carrolls Ridge	SU8	L3	Flake	chert	1	
Carrolls Ridge	SU8	L4	Flake	chert	3	
Carrolls Ridge	SU8	L4	Flake fragment	volcanic	3	weathered tuff
Carrolls Ridge	SU8	L4	Flake fragment	volcanic	2	
Carrolls Ridge	SU8	L5	Flake fragment	chert	2	distal
Carrolls Ridge	SU8	L5	Flake	volcanic	4	purple rhyolite
Carrolls Ridge	SU8	L5	Flake	chert	3	
Carrolls Ridge	SU8	L5	Flake	silcrete	2	
Carrolls Ridge	SU8	L5	Flake fragment	chert	3	
Carrolls Ridge	SU8	L5	Flake	chert	3	
Carrolls Ridge	SU8	L6	Flake fragment	volcanic	4	ground facet of hatchet; fragment
Carrolls Ridge	SU6	L1	Flake	chert	2	also 2 qtz non diagnostic
Carrolls Ridge	SU6	L1	Flake	chert	4	
Carrolls Ridge	SU6	L1	Flake	chert	2	
Coppabella	SU1	L1	Flake	chert	4	
Coppabella	SU1	L1	Flaked Piece	chert	4	
Coppabella	SU1	L1	Flake	chert	2	
Coppabella	SU1	L1	Flake	chert	2	
Coppabella	SU1	L1	Flake fragment	chert	1	
Coppabella	SU1	L1	Flake	chert	2	
Coppabella	SU1	L1	Flake fragment	chert	3	
Coppabella	SU1	L2	Flake	volcanic	4	weathered tuff
Coppabella	SU1	L3	Flake	volcanic	4	weathered tuff
Coppabella	SU1	L4	Flake	chert	5	
Coppabella	SU1	L5	Flake fragment	chert	3	
Coppabella	SU1	L5	Flaked Piece	chert	4	
Coppabella	SU1	L6	Flake	chert	2	blade
Coppabella	SU2	L1	Core	chert	3	single platform; 6 scars
Coppabella	SU2	L2	Flaked Piece	chert	4	
Coppabella	SU2	L2	Flake	chert	3	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake	chert	3	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	1	
Coppabella	SU2	L2	Flaked Piece	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	1	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	4	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	volcanic	3	Weathered tuff
Coppabella	SU2	L2	Flake	chert	2	
Coppabella	SU2	L2	Flake	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	3	
Coppabella	SU2	L2	Flake	chert	3	
Coppabella	SU2	L2	Flake fragment	chert	3	
Coppabella	SU2	L2	Flaked Piece	chert	3	
Coppabella	SU2	L2	Flake	chert	3	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	2	
Coppabella	SU2	L2	Flake fragment	chert	4	
Coppabella	SU2	L3	Flaked Piece	chert	4	
Coppabella	SU2	L3	Flake	chert	4	
Coppabella	SU2	L3	Flake	chert	3	
Coppabella	SU2	L3	Flake fragment	chert	3	longitudinal break
Coppabella	SU2	L4	Flake	volcanic	3	weathered tuff
Coppabella	SU2	L4	Flaked Piece	volcanic	2	
Coppabella	SU2	L4	Flaked Piece	volcanic	2	
Coppabella	SU2	L4	Flaked Piece	volcanic	4	
Coppabella	SU2	L4	Flake	chert	3	
Coppabella	SU2	L4	Flaked Piece	volcanic	4	
Coppabella	SU2	L4	Flake	volcanic	3	
Coppabella	SU2	L5	Flake fragment	chert	3	LB
Coppabella	SU2	L5	Flake	chert	3	
Coppabella	SU3	L1	manuport	other	>10	broken pebble; 130mm long; no usewear
Coppabella	SU3	L1	Flake	chert	2	
Coppabella	SU3	L2	Flake	volcanic	3	
Coppabella	SU3	L2	Flake	volcanic	5	
Coppabella	SU3	L2	Flake	chert	3	
Coppabella	SU3	L2	Flaked Piece	chert	3	
Coppabella	SU3	L2	Flake fragment	volcanic	4	80% pebble cortex
Coppabella	SU3	L2	Flake	chert	2	
Coppabella	SU3	L2	Flake fragment	chert	3	
Coppabella	SU3	L2	Flake	chert	3	
Coppabella	SU3	L2	Flake	chert	2	
Coppabella	SU3	L2	hammerstone	other	10	pebble with crushing on broad end consistent with pounding use; 95 x 75 x 65mm
Coppabella	SU3	L2	Flaked Piece	chert	2	
Coppabella	SU3	L2	Flake fragment	chert	2	
Coppabella	SU3	L2	Flake fragment	chert	2	black
Coppabella	SU3	L2	Flake fragment	chert	2	
Coppabella	SU3	L2	Flake	chert	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU3	L2	Flake	chert	3	black
Coppabella	SU3	L2	Flake	chert	3	
Coppabella	SU3	L2	Flake	volcanic	4	
Coppabella	SU3	L2	Flake	volcanic	4	
Coppabella	SU3	L2	Flake fragment	volcanic	4	
Coppabella	SU3	L3	Core	quartz	3	single platform
Coppabella	SU3	L4	Flake	chert	2	
Coppabella	SU5	L1	Flake fragment	chert	2	medial
Coppabella	SU5	L1	Flake fragment	chert	2	
Coppabella	SU5	L1	Flake fragment	chert	2	
Coppabella	SU5	L1	Flake fragment	chert	2	
Coppabella	SU5	L1	Flake fragment	chert	2	
Coppabella	SU5	L2	Flake fragment	chert	1	
Coppabella	SU5	L2	Flake	chert	2	
Coppabella	SU5	L2	Flaked Piece	volcanic	2	
Coppabella	SU5	L3	Flake	chert	4	
Coppabella	SU5	L3	Flake fragment	chert	2	
Coppabella	SU5	L3	Flaked Piece	volcanic	4	
Coppabella	SU5	L3	Core	volcanic	3	single platform
Coppabella	SU6	L1	Flake fragment	volcanic	2	weathered tuff
Coppabella	SU6	L1	Flaked Piece	chert	4	
Coppabella	SU6	L1	Flake fragment	chert	2	
Coppabella	SU6	L1	Flake	chert	3	
Coppabella	SU6	L1	Core	chert	5	microblade core
Coppabella	SU6	L1	Flaked Piece	chert	3	
Coppabella	SU6	L1	Flake fragment	chert	1	
Coppabella	SU6	L1	Flake	chert	1	
Coppabella	SU6	L1	Flake	chert	2	
Coppabella	SU6	L1	Flake fragment	chert	3	
Coppabella	SU6	L1	Flake fragment	chert	3	longitudinal break
Coppabella	SU6	L1	Flake fragment	chert	2	
Coppabella	SU6	L1	Flake	chert	3	
Coppabella	SU6	L1	Flake fragment	chert	3	
Coppabella	SU6	L1	Flake	chert	4	
Coppabella	SU6	L1	Flake	volcanic	4	
Coppabella	SU6	L1	Flaked Piece	chert	3	
Coppabella	SU6	L1	Core	chert	5	bifacial core
Coppabella	SU6	L1	Flake	chert	6	
Coppabella	SU6	L1	Flake	chert	3	
Coppabella	SU6	L1	Core fragment	chert	3	
Coppabella	SU6	L1	Flake	chert	2	
Coppabella	SU6	L1	Flake	chert	2	
Coppabella	SU6	L1	Flake	chert	3	
Coppabella	SU6	L1	Flake	chert	4	
Coppabella	SU6	L1	Flake fragment	chert	2	
Coppabella	SU6	L1	Flake	chert	4	
Coppabella	SU6	L1	Flake	chert	3	
Coppabella	SU6	L1	Flake fragment	chert	3	
Coppabella	SU6	L1	Flake fragment	chert	2	
Coppabella	SU6	L1	Flake fragment	volcanic	2	
Coppabella	SU6	L2	Flake fragment	volcanic	4	weathered tuff
Coppabella	SU6	L3	Flaked Piece	volcanic	3	weathered tuff
Coppabella	SU6	L4	Flake	chert	2	
Coppabella	SU6	L4	Flake fragment	chert	2	
Coppabella	SU6	L5	Flaked Piece	volcanic	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU6	L5	Flake fragment	volcanic	1	proximal
Coppabella	SU6	L5	Flake fragment	volcanic	2	
Coppabella	SU6	L5	Flake fragment	volcanic	1	
Coppabella	SU6	L5	Flake fragment	volcanic	1	
Coppabella	SU6	L5	Flaked Piece	volcanic	2	
Coppabella	SU6	L5	Flake fragment	volcanic	2	
Coppabella	SU6	L6	Flake	volcanic	2	20% pebble cortex
Coppabella	SU6	L6	Flake fragment	volcanic	2	
Coppabella	SU6	L6	Flake fragment	volcanic	2	45% terrestrial cortex
Coppabella	SU6	L6	Flake fragment	volcanic	2	
Coppabella	SU7	L1	Flake fragment	volcanic	2	longitudinal break
Coppabella	SU7	L2	Flake	chert	3	black
Coppabella	SU7	L3	Flake	chert	3	terrestrial cortex
Coppabella	SU7	L3	Flake	chert	3	terrestrial cortex
Coppabella	SU7	L3	Flake	chert		
Coppabella	SU7	L4	Flake	chert	1	
Coppabella	SU7	L4	Flake fragment	chert	3	terrestrial cortex
Coppabella	SU7	L4	Flaked Piece	chert	4	"
Coppabella	SU9	L1	Flake	chert	4	terrestrial cortex
Coppabella	SU9	L1	Flake fragment	chert	2	
Coppabella	SU9	L1	Flake fragment	chert	2	
Coppabella	SU9	L1	Flake fragment	chert	2	
Coppabella	SU9	L1	Flake	volcanic	4	
Coppabella	SU9	L1	Flake	chert	2	
Coppabella	SU11	L1	Flake fragment	chert	4	black
Coppabella	SU11	L1	Flake fragment	chert	2	
Coppabella	SU11	L2	Flake	chert	3	
Coppabella	SU15	L1	Flake	chert	3	
Coppabella	SU15	L1	Flake	chert	2	
Coppabella	SU15	L2	Retouched artefact	chert	5	broken Bondi Point
Coppabella	SU15	L3	Flake fragment	chert	2	
Coppabella	SU16	L1	Flake fragment	chert	1	
Coppabella	SU16	L1	Flake	chert	4	
Coppabella	SU16	L2	Flake	quartz	3	30% pebble cortex
Coppabella	SU16	L2	Flake fragment	chert	3	
Coppabella	SU16	L3	Flake	chert	3	10% terrestrial cortex
Coppabella	SU17	L1	Core fragment	volcanic	4	
Coppabella	SU17	L1	Flake fragment	volcanic	5	
Coppabella	SU17	L1	Flake fragment	chert	2	
Coppabella	SU17	L2	Flake fragment	chert	2	
Coppabella	SU17	L3	Flake	chert	5	
Coppabella	SU17	L3	Flake fragment	chert	3	proximal
Coppabella	SU17	L4	Flake fragment	quartz	2	
Coppabella	SU17	L5	Flake fragment	chert	3	
Coppabella	SU17	L5	Flake	chert	2	broken in 2 pieces
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	chert	1	
Coppabella	SU17	L5	Flake fragment	chert	1	
Coppabella	SU17	L5	Flake	chert	3	
Coppabella	SU17	L5	Flake	chert	3	
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	volcanic	4	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU17	L5	Flake	volcanic	2	
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake	quartz	1	
Coppabella	SU17	L5	Flake fragment	volcanic	2	
Coppabella	SU17	L5	Flake	chert	2	
Coppabella	SU17	L5	Flake fragment	volcanic	2	distal
Coppabella	SU17	L5	Flake	volcanic	3	
Coppabella	SU17	L5	Flake fragment	quartz	2	
Coppabella	SU17	L5	Flake fragment	quartz	3	
Coppabella	SU17	L5	Flake	chert	3	
Coppabella	SU17	L5	Flake	chert	2	
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	volcanic	3	95% pebble cortex
Coppabella	SU17	L5	Flake fragment	chert	2	
Coppabella	SU17	L5	Flake fragment	silcrete	2	
Coppabella	SU17	L6	Flake fragment	volcanic	2	
Coppabella	SU17	L6	Flake	chert	4	
Coppabella	SU17	L6	Flake fragment	chert	4	
Coppabella	SU17	L6	Flake fragment	chert	1	
Coppabella	SU17	L6	Flake	chert	3	
Coppabella	SU17	L6	Flake	chert	3	
Coppabella	SU17	L6	Flake fragment	chert	2	proximal
Coppabella	SU17	L6	Core	chert	6	
Coppabella	SU18	L1	Flake fragment	chert	3	distal; blade
Coppabella	SU18	L2	Flake	volcanic	2	tuff
Coppabella	SU18	L2	Flake fragment	volcanic	2	tuff; medial
Coppabella	SU18	L2	Flake fragment	volcanic	2	tuff
Coppabella	SU18	L2	Flake	volcanic	3	tuff
Coppabella	SU18	L2	Flake	volcanic	3	tuff
Coppabella	SU18	L2	Flake fragment	volcanic	2	tuff
Coppabella	SU18	L2	Flake fragment	volcanic	1	tuff
Coppabella	SU18	L2	Flake fragment	volcanic	3	tuff; proximal
Coppabella	SU18	L2	Flake	chert	3	
Coppabella	SU18	L2	Flake fragment	chert	3	
Coppabella	SU18	L2	Flake fragment	chert	1	proximal
Coppabella	SU18	L2	Flake	chert	2	
Coppabella	SU18	L2	Flake fragment	chert	1	
Coppabella	SU18	L2	Flake fragment	chert	2	
Coppabella	SU18	L2	Flake fragment	chert	2	
Coppabella	SU19	L1	Flake fragment	chert	2	
Coppabella	SU19	L2	Flake fragment	chert	3	
Coppabella	SU19	L2	Core	volcanic	6	
Coppabella	SU19	L2	Flake fragment	chert	2	
Coppabella	SU19	L2	Flake	chert	2	
Coppabella	SU19	L2	Flake	chert	2	
Coppabella	SU19	L2	Flake	chert	3	
Coppabella	SU19	L2	Flake fragment	chert	2	
Coppabella	SU19	L2	Flake fragment	chert	3	
Coppabella	SU19	L2	Flake	chert	2	
Coppabella	SU19	L2	Flake piece	chert	3	
Coppabella	SU19	L2	Flake piece	chert	3	
Coppabella	SU19	L2	Flake	chert	2	
Coppabella	SU19	L2	Flake	chert	3	
Coppabella	SU19	L2	Flake fragment	chert	2	
Coppabella	SU19	L2	Flake	chert	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU19	L2	Flake fragment	chert	2	
Coppabella	SU19	L2	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake	chert	2	
Coppabella	SU20	L1	Flake fragment	chert	3	distal
Coppabella	SU20	L1	Flake fragment	chert	3	distal
Coppabella	SU20	L1	Flake fragment	chert	1	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake fragment	volcanic	3	tuff
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake fragment	volcanic	3	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake	chert	6	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake fragment	chert	3	
Coppabella	SU20	L1	Flake	quartz	3	
Coppabella	SU20	L1	Flake	chert	2	
Coppabella	SU20	L1	Flaked Piece	chert	2	
Coppabella	SU20	L1	Flake fragment	chert	4	
Coppabella	SU20	L1	Flake	chert	3	
Coppabella	SU20	L1	Flake	chert	2	
Coppabella	SU20	L1	Flake fragment	volcanic	3	tuff
Coppabella	SU20	L1	Flake fragment	volcanic	2	tuff
Coppabella	SU20	L1	Flake fragment	chert	3	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake fragment	chert	3	
Coppabella	SU20	L1	manuport	uncertain	13	1 corner slightly smooth; possible usewear
Coppabella	SU20	L1	Core fragment	chert	10	
Coppabella	SU20	L1	Flake	chert	4	
Coppabella	SU20	L1	Flake	chert	4	
Coppabella	SU20	L1	Flaked Piece	chert	4	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flake	volcanic	2	tuff
Coppabella	SU20	L1	Core	chert	3	
Coppabella	SU20	L1	Flake fragment	volcanic	3	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Flaked Piece	chert	4	
Coppabella	SU20	L1	Flaked Piece	chert	5	
Coppabella	SU20	L1	Flake fragment	volcanic	5	
Coppabella	SU20	L1	Flake	chert	3	
Coppabella	SU20	L1	Flake fragment	chert	2	
Coppabella	SU20	L1	Core	volcanic	5	
Coppabella	SU20	L1	Flake fragment	chert	3	
Coppabella	SU20	L1	Flake	chert	2	
Coppabella	SU20	L1	Flake	chert	3	
Coppabella	SU20	L1	Flake	chert	3	
Coppabella	SU20	L1	Flake fragment	chert	3	longitudinal break
Coppabella	SU20	L2	Flake fragment	chert	3	
Coppabella	SU20	L3	Flake	chert	3	
Coppabella	SU20	L3	Core	volcanic	5	tuff
Coppabella	SU20	L3	Core	volcanic	5	
Coppabella	SU20	L3	Flake	chert	3	
Coppabella	SU20	L3	Flake fragment	chert	1	
Coppabella	SU20	L3	Flake fragment	chert	2	longitudinal break
Coppabella	SU20	L3	Flake fragment	chert	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU20	L3	Flake fragment	chert	1	
Coppabella	SU20	L3	Flake	chert	3	
Coppabella	SU20	L3	Flake fragment	chert	2	
Coppabella	SU20	L3	Flake fragment	chert	2	
Coppabella	SU20	L4	Flake fragment	chert	2	
Coppabella	SU21	L1	Flake fragment	chert	3	proximal
Coppabella	SU21	L1	Flake fragment	chert	2	
Coppabella	SU21	L1	Flake fragment	chert	2	40% terrestrial cortex
Coppabella	SU21	L2	Flake fragment	volcanic	3	proximal
Coppabella	SU21	L2	Flake	chert	3	
Coppabella	SU21	L2	Flake fragment	chert	3	longitudinal break
Coppabella	SU21	L2	Flake	chert	2	
Coppabella	SU21	L2	Flake fragment	chert	2	
Coppabella	SU23	L1	Core	chert	4	
Coppabella	SU23	L1	Flake fragment	chert	3	medial
Coppabella	SU23	L2	Flaked piece	chert	4	
Coppabella	SU23	L2	Flake	chert	3	
Coppabella	SU23	L2	Flake fragment	chert	2	distal
Coppabella	SU23	L2	Flake fragment	chert	3	
Coppabella	SU23	L2	Flake	chert	2	
Coppabella	SU23	L2	Flaked piece	chert	2	
Coppabella	SU23	L2	Flake fragment	chert	3	
Coppabella	SU23	L2	Flake fragment	chert	2	
Coppabella	SU23	L2	Flake fragment	chert	2	
Coppabella	SU23	L2	Flake fragment	chert	2	
Coppabella	SU23	L2	Flake	chert	3	
Coppabella	SU23	L2	Flake fragment	chert	2	
Coppabella	SU23	L2	Flake fragment	chert	1	
Coppabella	SU23	L2	Flake	chert	5	
Coppabella	SU24	L1	Flake fragment	chert	1	
Coppabella	SU24	L1	Flake fragment	chert	3	
Coppabella	SU24	L1	Core	chert	4	
Coppabella	SU24	L1	Flake fragment	chert	1	
Coppabella	SU24	L1	Flake	chert	1	
Coppabella	SU24	L1	Flake	chert	2	
Coppabella	SU24	L1	Flake	chert	3	
Coppabella	SU24	L1	Flake fragment	chert	1	distal
Coppabella	SU24	L1	Flake fragment	chert	3	
Coppabella	SU24	L1	Flake	chert	3	
Coppabella	SU24	L1	Flake fragment	chert	2	
Coppabella	SU24	L1	Flake	chert	2	sample: 24 others observed
Coppabella	SU24	L2	Core	chert	4	
Coppabella	SU24	L2	Core	chert	4	
Coppabella	SU24	L2	Flake fragment	chert	1	
Coppabella	SU24	L2	Flake	chert	2	
Coppabella	SU24	L2	Flake fragment	chert	2	
Coppabella	SU24	L2	Flaked piece	chert	2	
Coppabella	SU24	L3	Flake	chert	3	
Coppabella	SU24	L3	Flake	chert	3	
Coppabella	SU24	L3	Flaked Piece	chert	5	
Coppabella	SU24	L4	Flake fragment	chert	3	
Coppabella	SU24	L4	Flake	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	1	
Coppabella	SU24	L4	Flake	chert	3	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU24	L4	Flake fragment	chert	1	
Coppabella	SU24	L4	Flaked Piece	chert	4	
Coppabella	SU24	L4	Flake	chert	3	
Coppabella	SU24	L4	Flake	chert	4	
Coppabella	SU24	L4	Flake	chert	2	
Coppabella	SU24	L4	Flake	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	3	
Coppabella	SU24	L4	Flake fragment	chert	3	
Coppabella	SU24	L4	Flake	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	3	
Coppabella	SU24	L4	Flaked Piece	chert	4	
Coppabella	SU24	L4	Flake fragment	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	1	proximal
Coppabella	SU24	L4	Flake	chert	3	
Coppabella	SU24	L4	Flake fragment	chert	2	
Coppabella	SU24	L4	Flake	chert	2	
Coppabella	SU24	L4	Flake fragment	chert	3	
Coppabella	SU24	L5	Flake	chert	4	
Coppabella	SU24	L5	Flake	chert	2	
Coppabella	SU24	L6	Flake fragment	chert	3	
Coppabella	SU24	L6	Flaked Piece	chert	3	
Coppabella	SU24	L6	Flake fragment	chert	1	
Coppabella	SU24	L6	Flake	chert	2	
Coppabella	SU24	L6	Flake fragment	chert	2	
Coppabella	SU24	L6	Flaked Piece	chert	4	
Coppabella	SU24	L6	Flake fragment	chert	3	
Coppabella	SU24	L6	Flaked Piece	chert	2	
Coppabella	SU24	L6	Flaked Piece	chert	3	
Coppabella	SU24	L7	Flake fragment	chert	2	
Coppabella	SU24	L7	Flake	chert	2	
Coppabella	SU24	L7	Flake	chert	2	
Coppabella	SU24	L8	Anvil	uncertain	15	
Coppabella	SU24	L8	Flake	chert	4	
Coppabella	SU24	L8	Flake fragment	chert	2	proximal
Coppabella	SU24	L9	Flake	chert	4	
Coppabella	SU24	L10	Flaked piece	chert	3	
Coppabella	SU24	L11	Flake fragment	chert	1	pebble: 145 x 110 x 35mm; pitting one face consistent with anvil use; opposite face very smooth (possible top stone); all edges pitted: (uncertain if weathered or use)
Coppabella	SU24	L11	Flake fragment	chert	2	
Coppabella	SU24	L11	Flaked piece	chert	3	proximal
Coppabella	SU24	L11	Flake	volcanic	3	
Coppabella	SU24	L11	Flake fragment	chert	3	
Coppabella	SU24	L11	Flake fragment	chert	3	
Coppabella	SU24	L11	Flake	chert	3	medial
Coppabella	SU24	L11	Core fragment	chert	6	
Coppabella	SU24	L11	Flake fragment	chert	1	
Coppabella	SU24	L11	Flake fragment	chert	1	
Coppabella	SU24	L11	Flake fragment	silcrete	2	proximal
Coppabella	SU24	L11	Flake	chert	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Coppabella	SU24	L11	Flaked piece	volcanic	8	
Coppabella	SU24	L11	Flake fragment	chert	1	
Coppabella	SU24	L11	Flake	chert	3	
Coppabella	SU24	L12	Flake fragment	chert	2	
Coppabella	SU24	L12	Flaked piece	chert	4	
Coppabella	SU24	L12	Flake fragment	chert	2	10% pebble cortex
Coppabella	SU24	L12	Flake fragment	chert	3	
Coppabella	SU24	L12	Flake	chert	3	20% terrestrial cortex
Coppabella	SU24	L12	Core	chert	5	
Coppabella	SU24	L12	Flake	chert	3	
Coppabella	SU24	L13	Flake fragment	chert	3	distal
Coppabella	SU24	L13	Flake	chert	5	proximal
Coppabella	SU24	L13	Hatchet	volcanic	5	
Coppabella	SU24	L13	Flake fragment	chert	3	
Coppabella	SU24	L13	Flake fragment	chert	2	
Coppabella	SU24	L13	Flake	chert	3	medial
Coppabella	SU24	L14	Flaked piece	chert	4	sample: c. 30 more observed
Coppabella	SU24	L14	Flake	chert	3	broken: ground edge section; part one margin missing; part of edge missing
Coppabella	SU24	L14	Flake fragment	chert	5	distal
Coppabella	SU24	L14	Flake fragment	chert	1	
Coppabella	SU24	L14	Flake fragment	chert	3	
Coppabella	SU24	L14	Flake fragment	chert	3	
Coppabella	SU24	L14	Flake fragment	chert	2	
Coppabella	SU24	L14	Flake fragment	chert	3	distal
Coppabella	SU24	L14	Flake fragment	chert	2	
Coppabella	SU24	L14	Flake fragment	chert	4	
Coppabella	SU24	L15	Flake	quartz	1	
Coppabella	SU24	L15	Flake fragment	chert	1	proximal
Marilba	SU2	L1	Flake	chert	3	40% terrestrial cortex
Marilba	SU2	L1	Flake	chert	2	mottled; grey
Marilba	SU2	L1	Flake fragment	chert	1	
Marilba	SU2	L1	Flake fragment	volcanic	3	
Marilba	SU2	L2	Flake	chert	2	
Marilba	SU2	L2	Flake	chert	2	broken in 2 pieces
Marilba	SU2	L2	Flake	chert	1	
Marilba	SU4	L1	Flake fragment	silcrete	2	distal
Marilba	SU4	L2	Flake fragment	silcrete	2	
Marilba	SU5	L1	Flake	quartz	2	
Marilba	SU8	L1	Flake fragment	chert	3	
Marilba	SU8	L1	Flake fragment	chert	2	15% terrestrial cortex
Marilba	SU9	L1	Flake fragment	volcanic	2	patination on dorsal surface
Marilba	SU17	L1	Flake fragment	silcrete	3	longitudinal break
Marilba	SU17	L2	hatchet	volcanic	9	small: 85 x 63 x 15mm; ground edge
Marilba	SU17	L2	Flake	chert	3	
Marilba	SU17	L2	Flake	chert	4	
Marilba	SU17	L3	Flake fragment	quartz	4	
Marilba	SU17	L3	Flake	quartz	3	
Marilba	SU17	L3	Flake	chert	3	
Marilba	SU17	L3	Flake	chert	8	
Marilba	SU17	L3	Flaked Piece	chert	6	
Marilba	SU17	L3	Flake fragment	chert	4	
Marilba	SU17	L3	Flake	quartz	3	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Marilba	SU17	L3	Flake	quartz	2	
Marilba	SU17	L3	retouched artefact	quartz	2	retouched from ventral; bondi point
Marilba	SU17	L3	Flake	chert	3	
Marilba	SU17	L3	Flake	chert	4	blade w possible usewear from ventral on distal
Marilba	SU17	L4	Flake fragment	silcrete	2	2 artefacts of 27 only recorded: part of knapping event
Marilba	SU17	L4	Flaked Piece	silcrete	3	terrestrial cortex
Marilba	SU17	L5	Flake	chert	5	blade
Marilba	SU17	L6	Flake	chert	3	
Marilba	SU17	L7	Flake	volcanic	5	weathered patina
Marilba	SU17	L8	Flaked Piece	quartz	2	
Marilba	SU17	L9	Flake fragment	silcrete	3	
Marilba	SU17	L9	Core	volcanic	3	single platform
Marilba	SU17	L9	Core	volcanic	5	tuff bifacial core; patination
Marilba	SU19	L1	Flake	quartz	2	
Marilba	SU24	L1	Flake	silcrete	5	with blade scars on dorsal
Marilba	SU24	L1	Flake	chert	2	with patination
Marilba	SU25	L1	Flake	volcanic	4	
Marilba	SU25	L1	Flake	volcanic	4	tuff with patination
Marilba	SU26	L1	Flake fragment	volcanic	2	tuff with patination
Marilba	SU26	L1	Flake fragment	volcanic	3	tuff with patination
Marilba	SU26	L1	Flake fragment	volcanic	3	tuff with patination
Marilba	SU26	L1	Flaked Piece	volcanic	1	tuff with patination
Marilba	SU26	L2	Flake fragment	volcanic	2	tuff with patination
Marilba	SU27	L1	Flake fragment	quartz	2	
Marilba	SU28	L1	Flake	volcanic	2	
Marilba	SU28	L2	Flaked Piece	silcrete	5	pebble cortex
Marilba	SU28	L2	Flake	chert	4	
Marilba	SU28	L3	Flake	chert	3	
Marilba	SU29	L1	Flake	quartzite	3	
Marilba	SU29	L1	Flaked Piece	chert	3	part of knapping event; terrestrial cortex
Marilba	SU29	L1	Flake fragment	chert	2	proximal
Marilba	SU29	L1	Flake	chert	3	
Marilba	SU29	L1	Flake	chert	3	
Marilba	SU29	L1	Flake fragment	chert	2	
Marilba	SU29	L1	Flake fragment	chert	2	
Marilba	SU29	L1	Flake	chert	3	
Marilba	SU29	L1	Flake	chert	2	
Marilba	SU29	L1	Flake	chert	3	
Marilba	SU29	L1	Flake fragment	chert	2	
Marilba	SU29	L1	Flake fragment	silcrete	2	distal
Marilba	SU29	L1	Flake	volcanic	4	
Marilba	SU29	L1	Flake	chert	2	
Marilba	SU29	L1	Flake fragment	silcrete	2	
Marilba	SU29	L1	Flaked Piece	volcanic	3	tuff with patination
Marilba	SU29	L1	Flaked Piece	volcanic	5	terrestrial cortex
Marilba	SU29	L2	Flaked Piece	volcanic	4	
Marilba	SU29	L2	Flake	volcanic	4	
Marilba	SU29	L2	Flake	chert	4	terrestrial cortex
Marilba	SU28	L2	Flake	chert	3	
Marilba	SU28	L2	Flake	chert	4	
Marilba	SU28	L2	Flake fragment	chert	2	

Precinct	SU #	Locale #	Type	Material	Size Class	Comments
Marilba	SU28	L2	Flaked Piece	chert	2	
Marilba	SU28	L2	Flaked Piece	quartz	2	
Marilba	SU28	L2	Flake	chert	2	
Marilba	SU28	L3	Flake	volcanic	4	
Marilba	SU28	L3	Core	volcanic	4	
Marilba	SU30	L1	Flake fragment	volcanic	3	tuff with patination
Marilba	SU30	L1	Flake	volcanic	4	
Marilba	SU30	L2	Flake fragment	volcanic	4	tuff with patination
Marilba	SU30	L2	Flake fragment	volcanic	3	tuff with patination
Marilba	SU32	L1	flake	silcrete	4	

Appendix 3: Survey Unit and Site Mapping

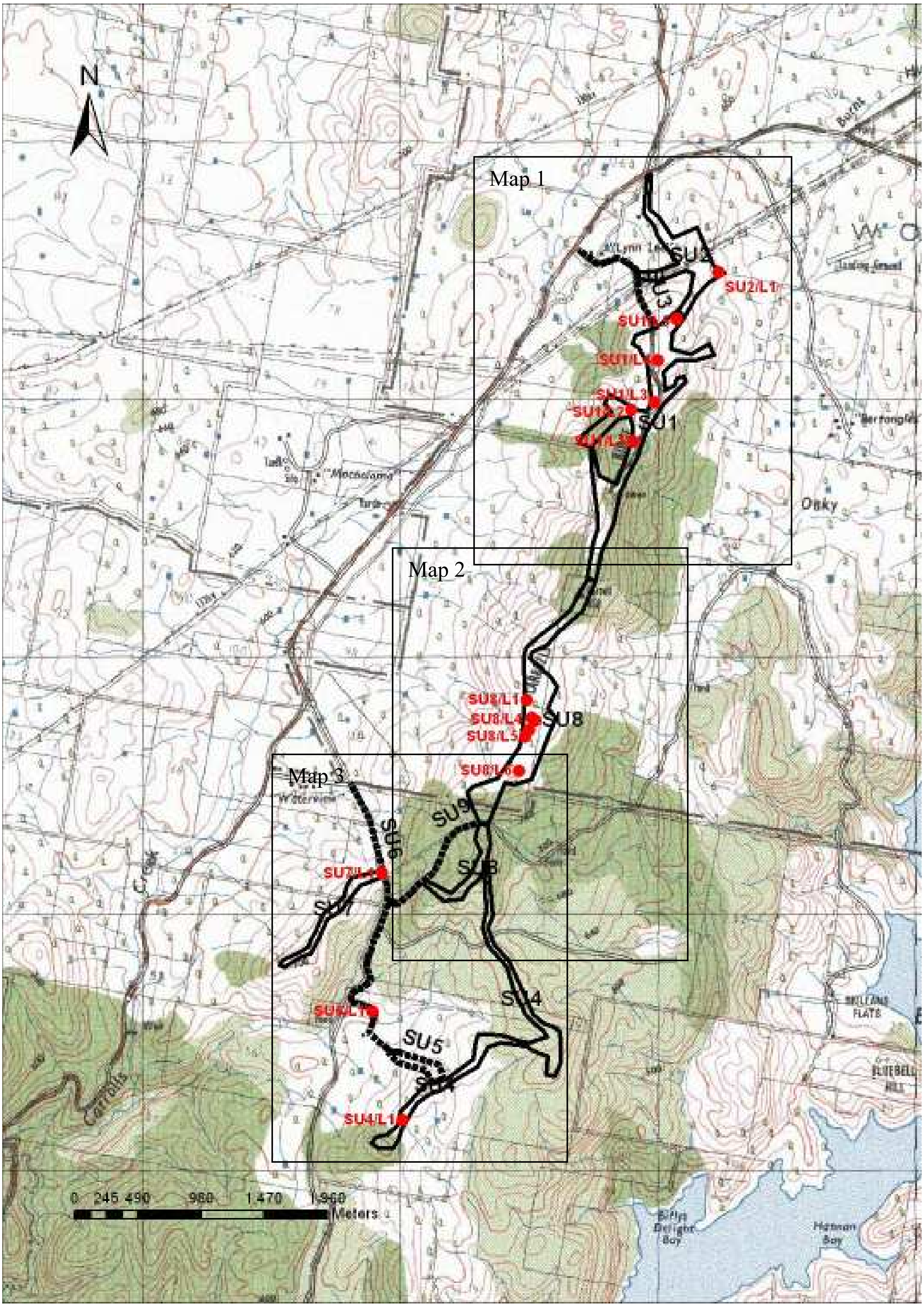


Figure 1. Carrolls Ridge Key Map.

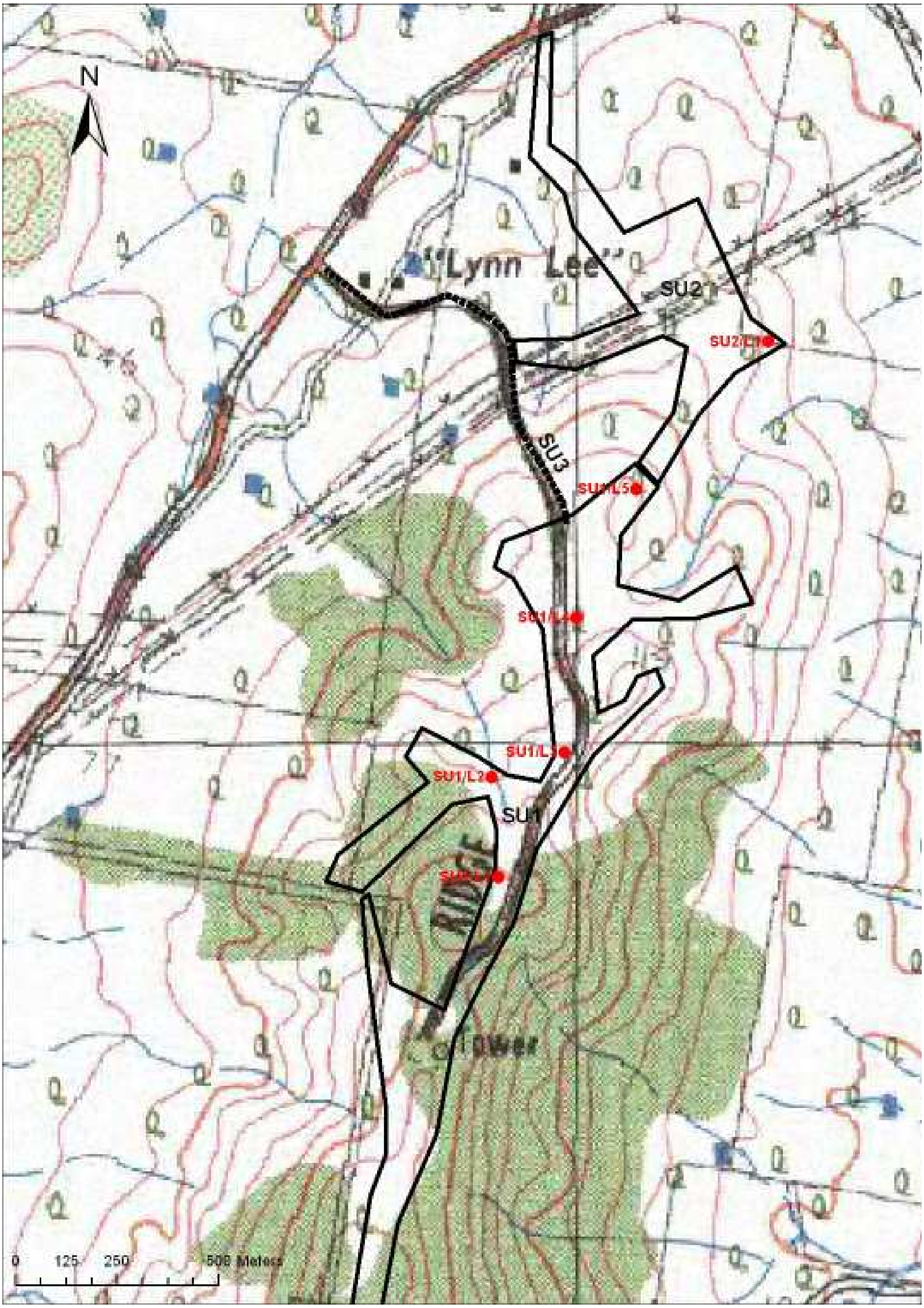


Figure 2. Carrolls Ridge Map 1

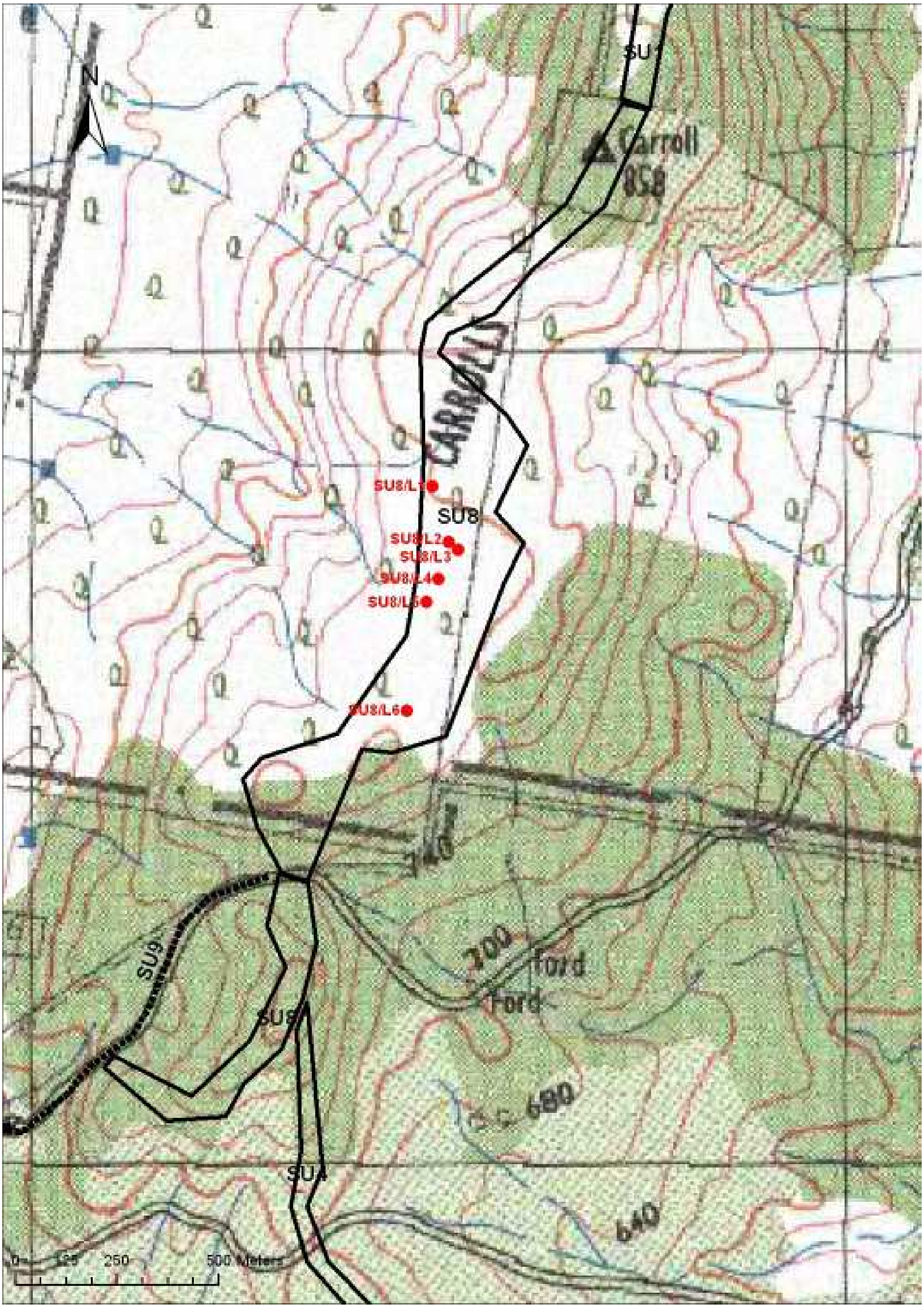


Figure 2. Carrolls Ridge Map 2

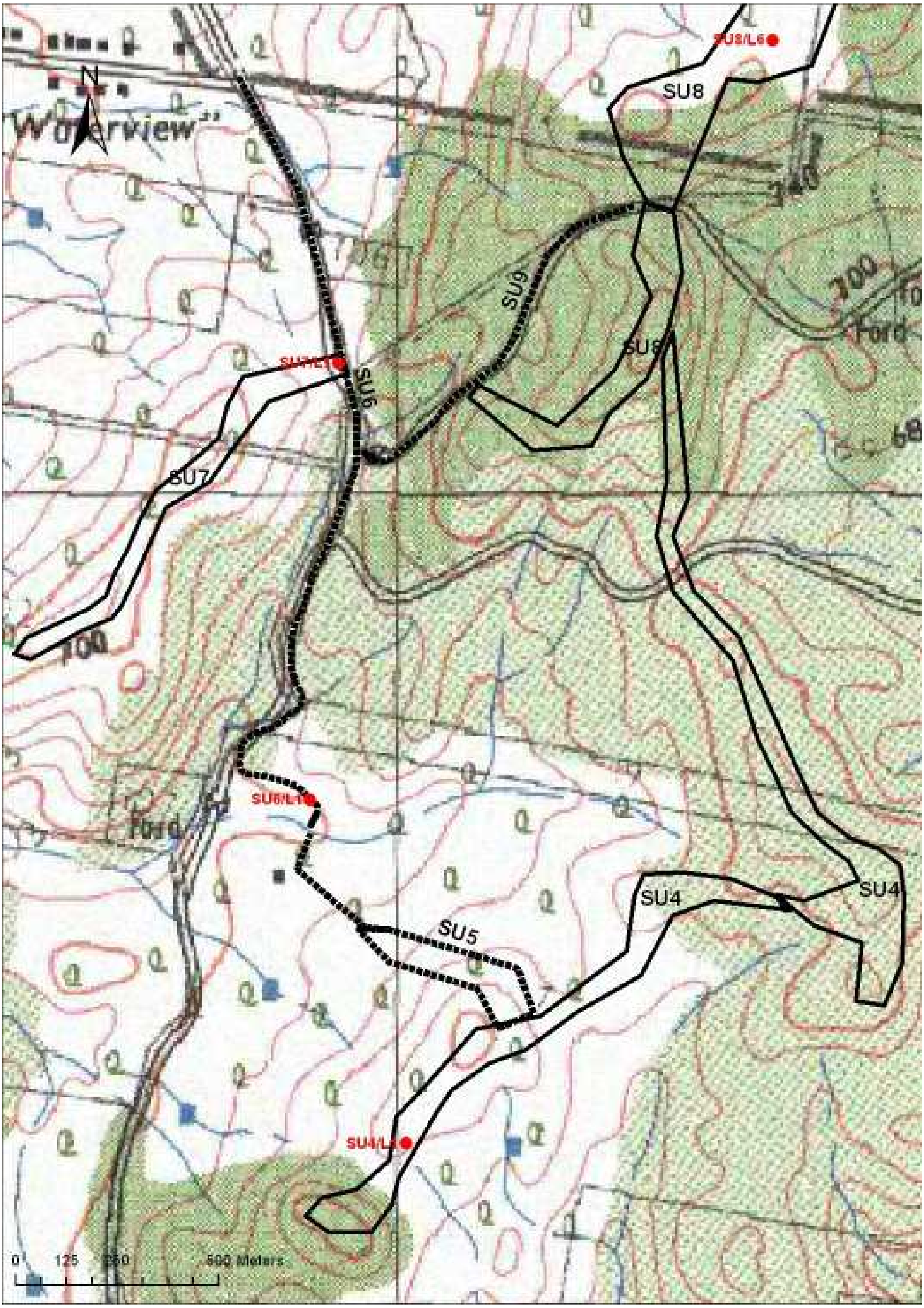


Figure 4. Carrolls Ridge Map 3.

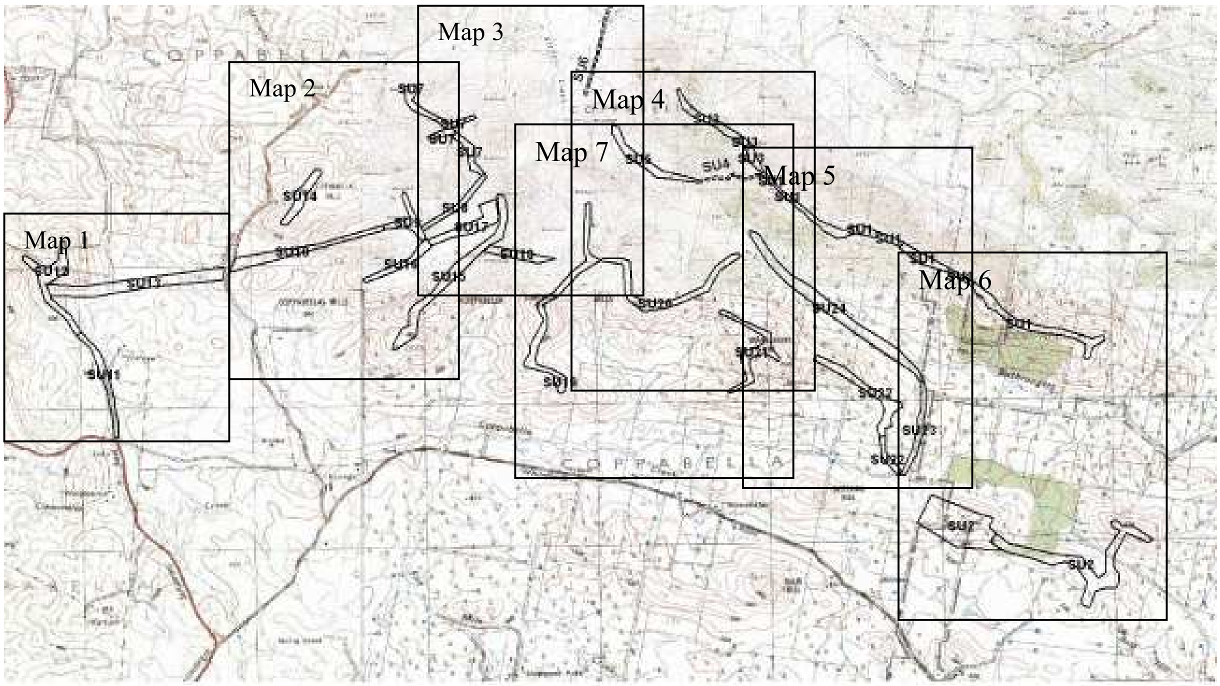


Figure 5. Coppabella Hills Key Map.

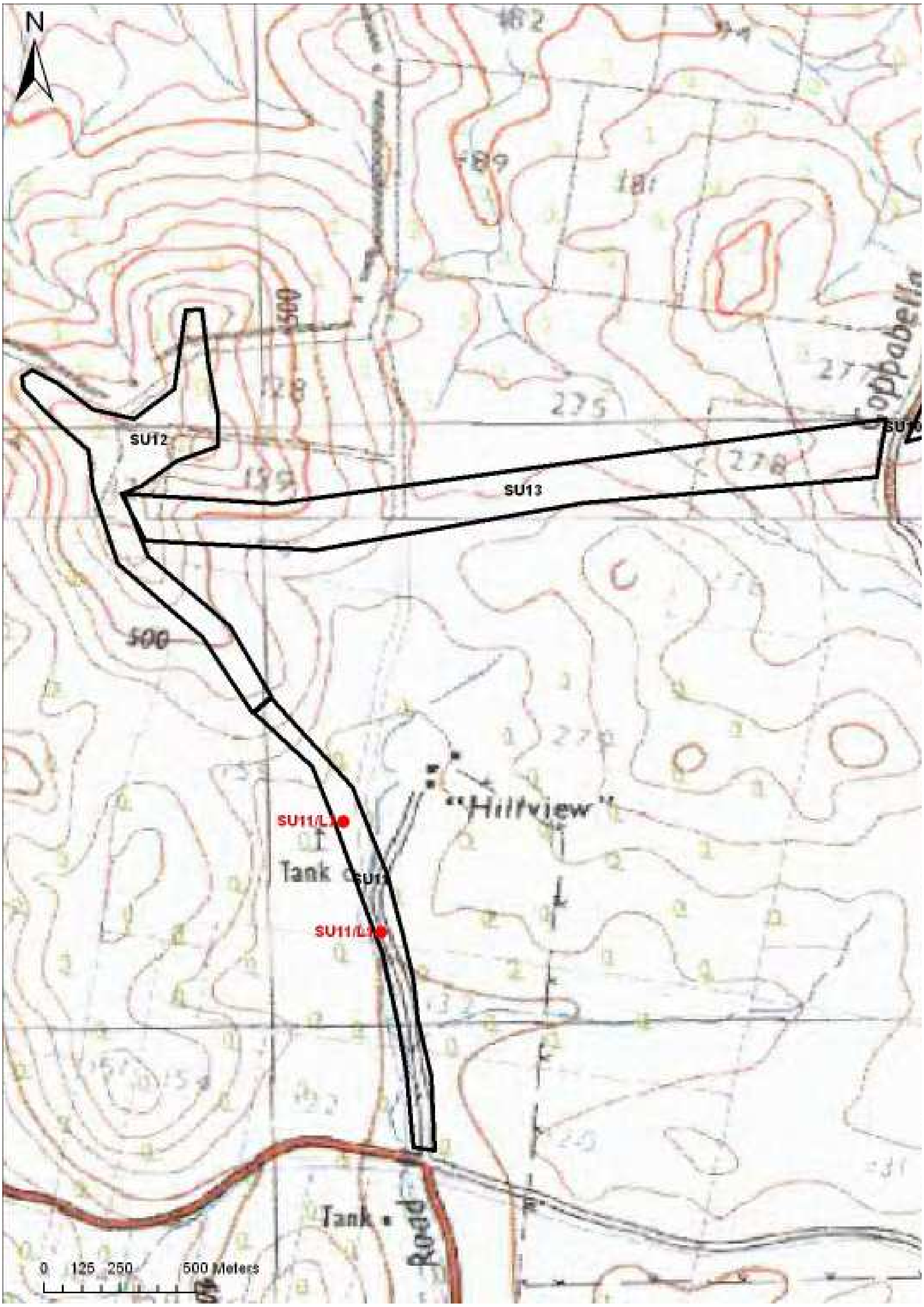


Figure 6. Coppabella Hills Map 1.

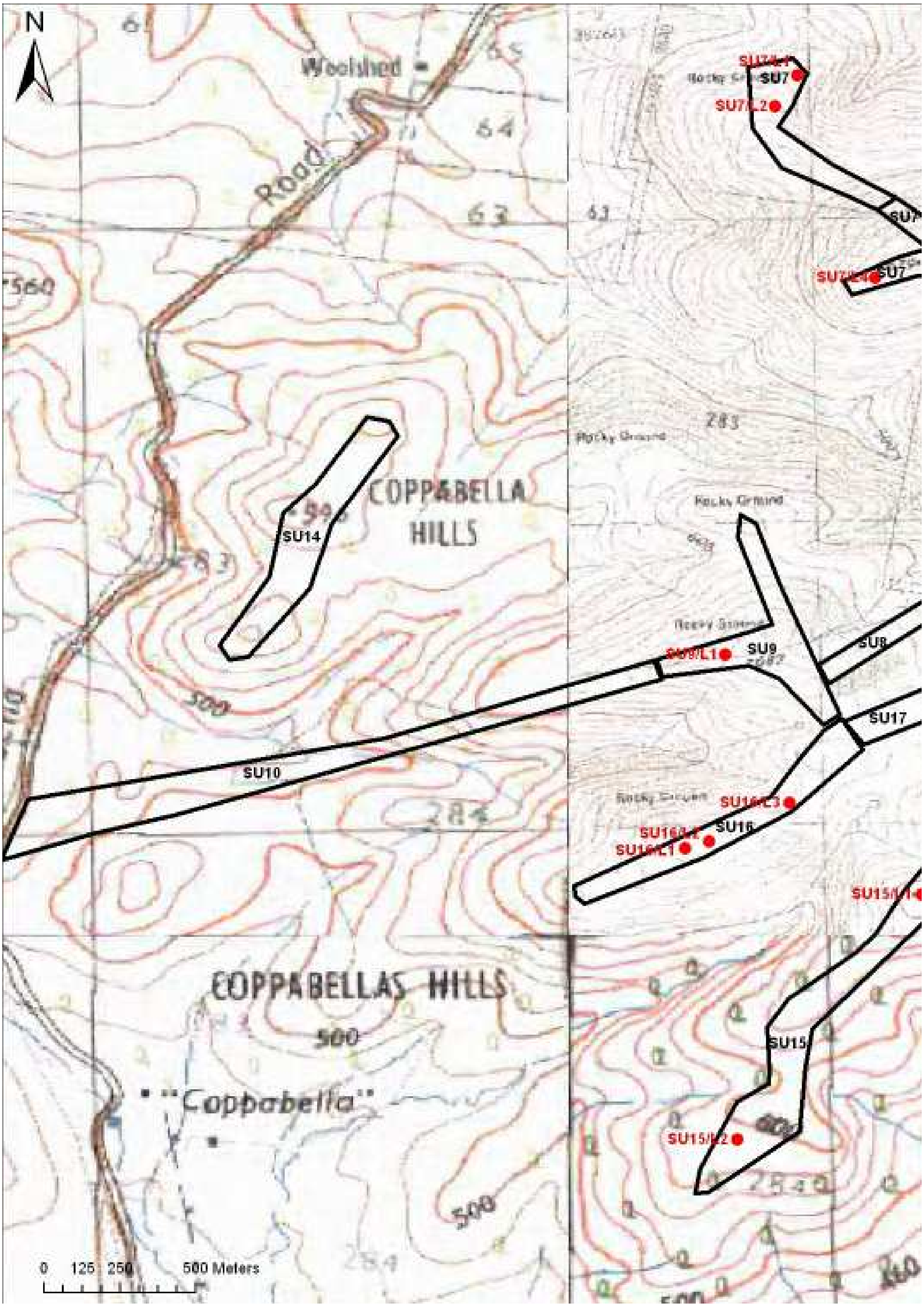


Figure 7. Coppabella Hills Map 2.

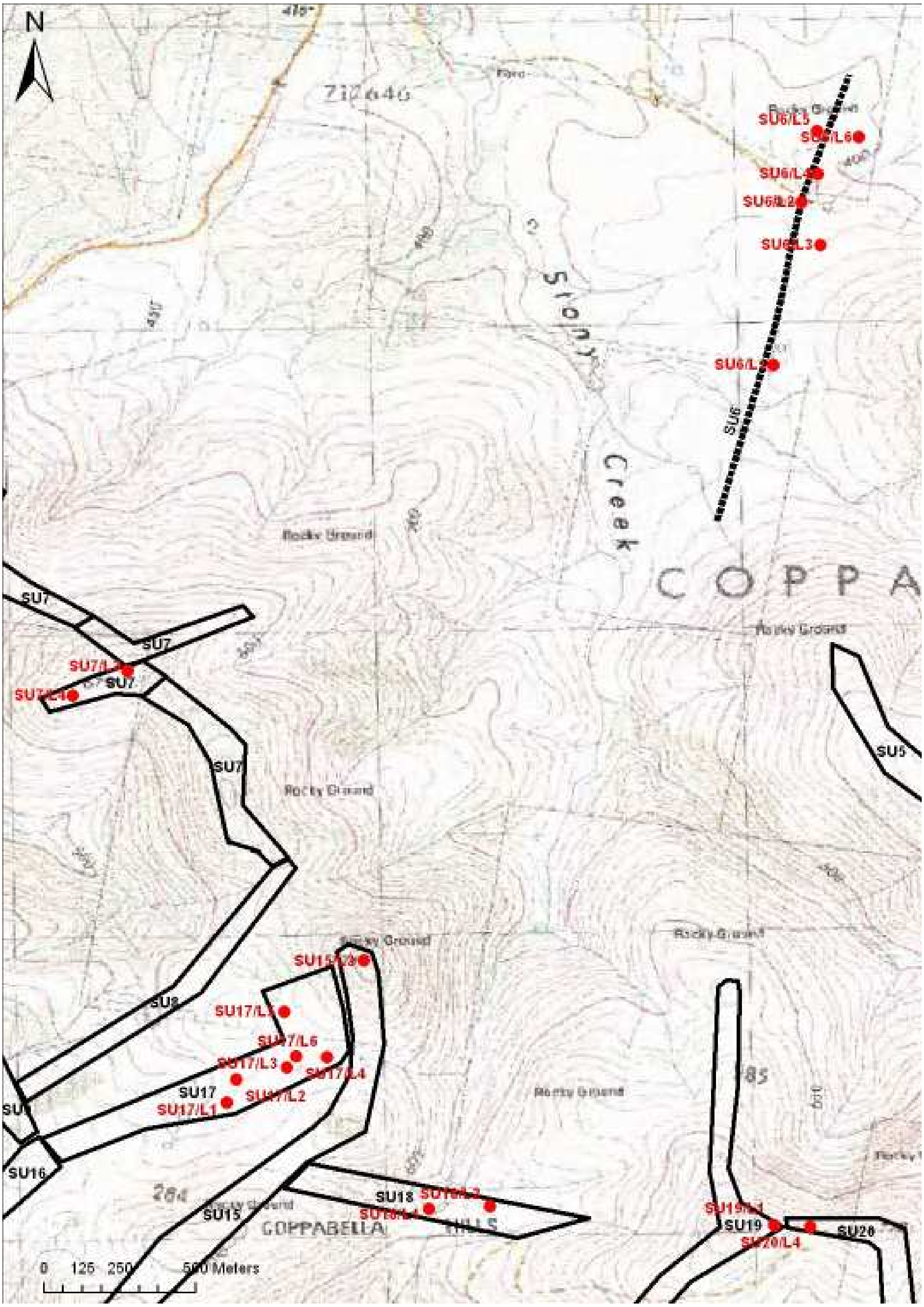


Figure 8. Coppabella Hills Map 3.

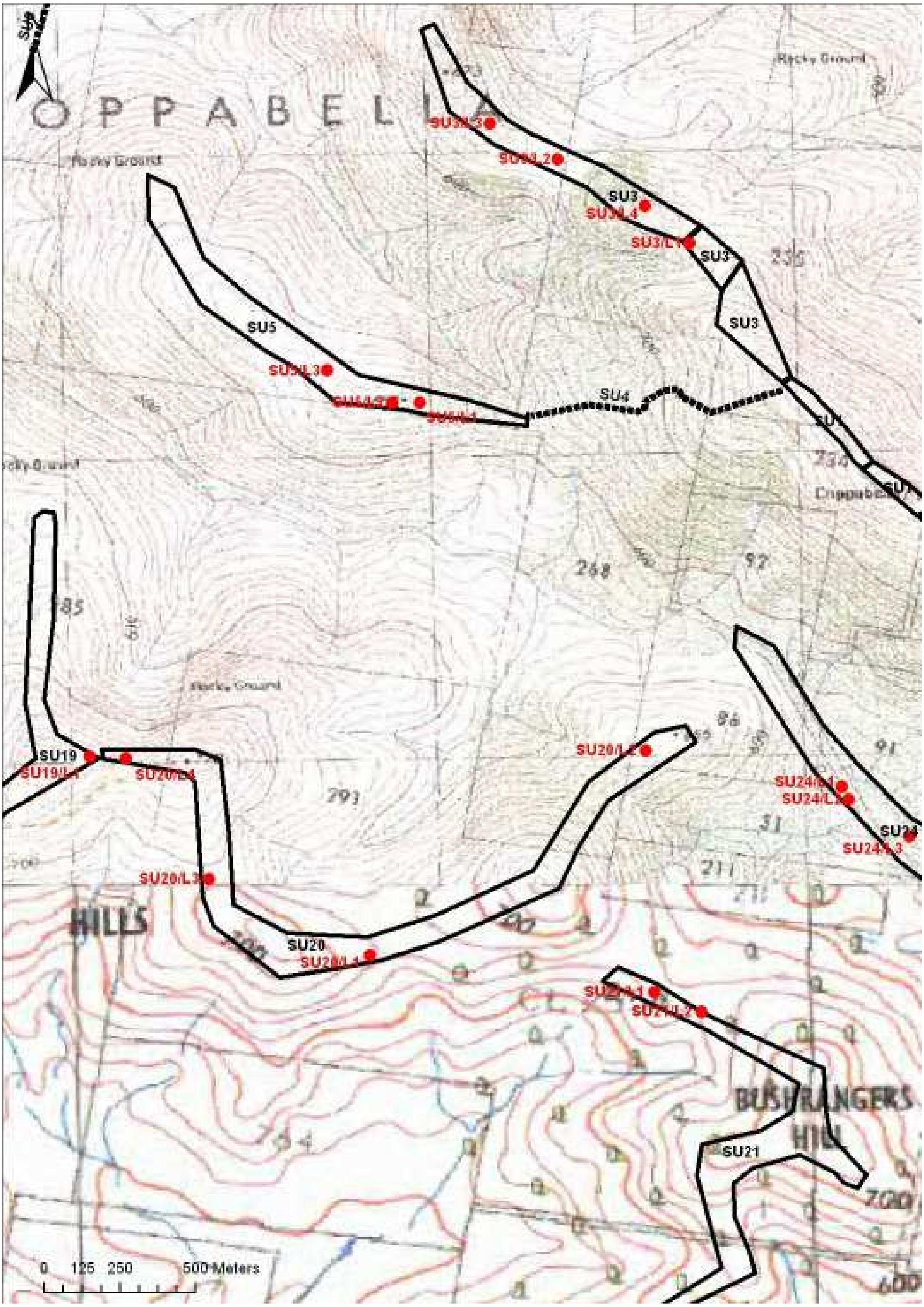


Figure 9. Coppabella Hills Map 4.

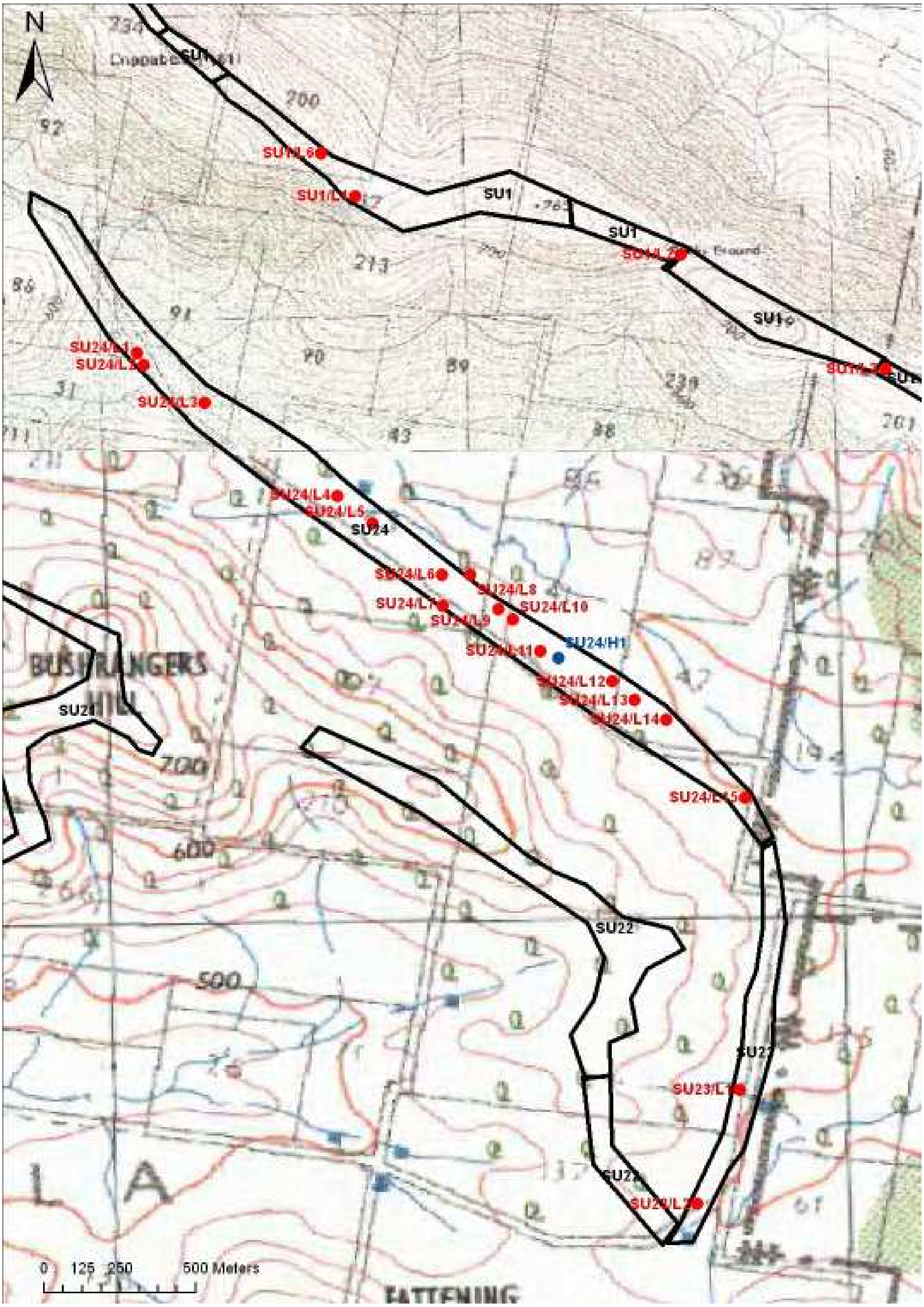


Figure 10. Coppabella Hills Map 5.

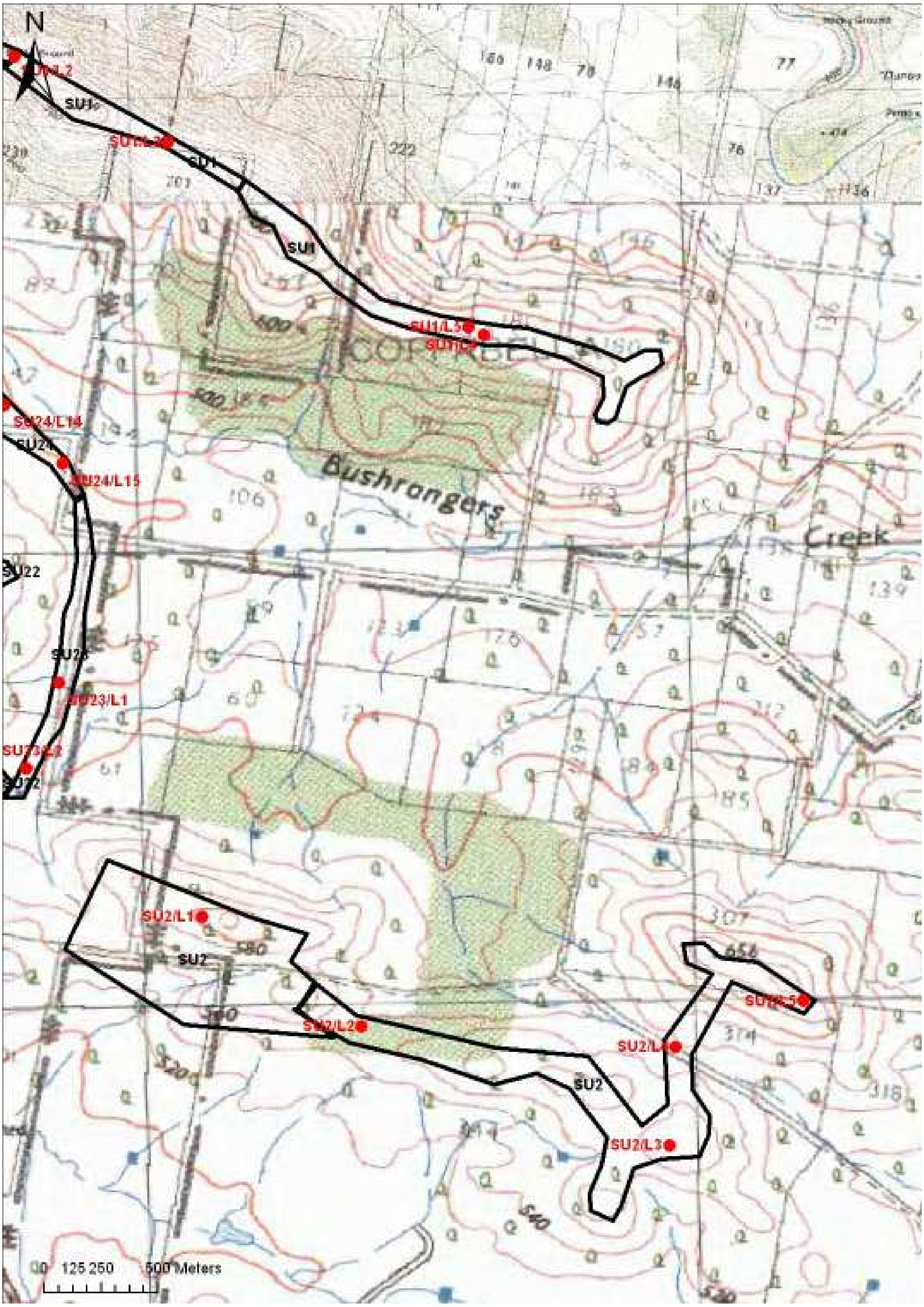


Figure 11. Coppabella Hills Map 6.

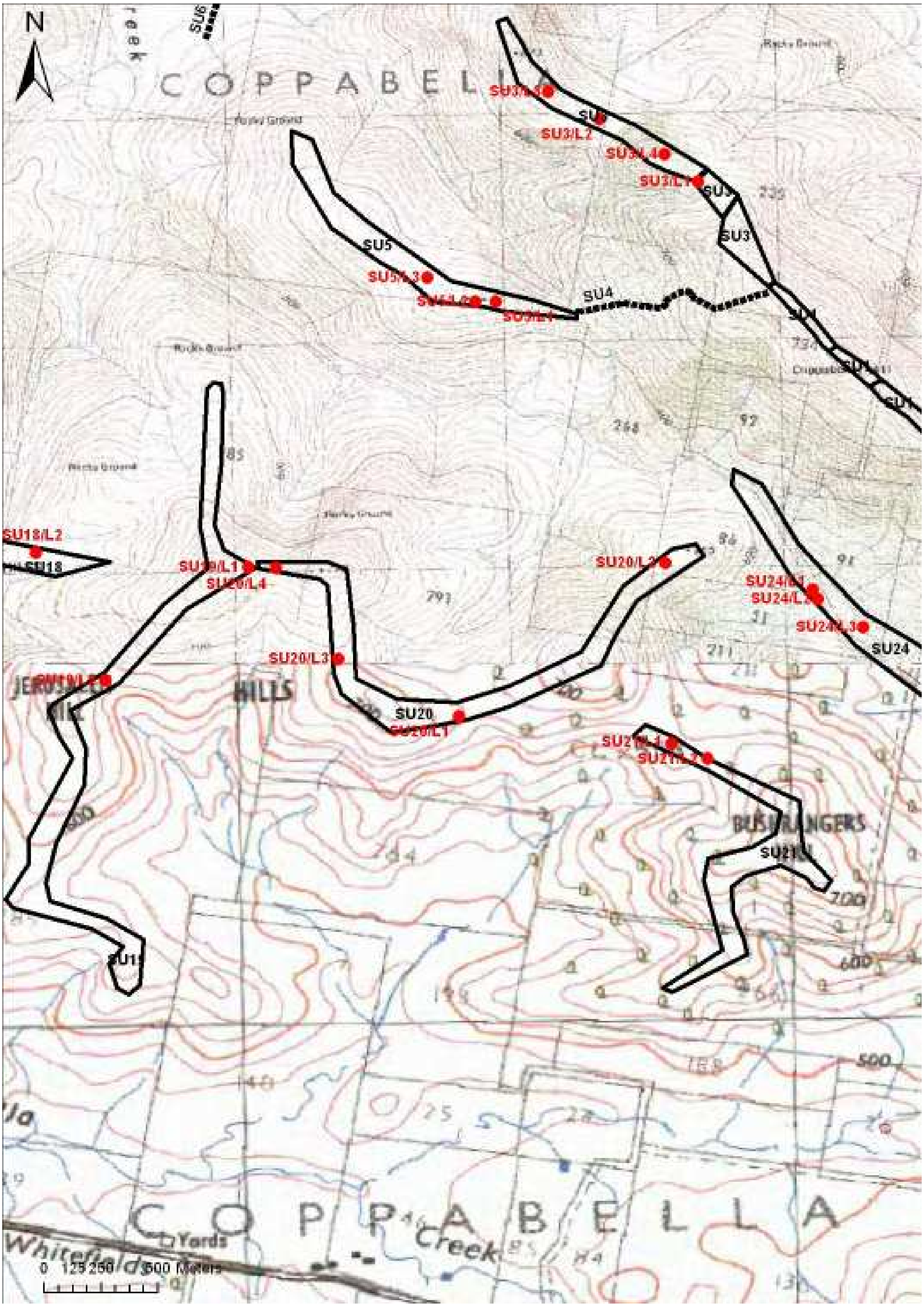


Figure 12. Coppabella Hills Map 7.

Appendix 5 COMMUNICATIONS AND AIRCRAFT ASSESSMENT

Telecommunications and Aviation Navigation Services Assessment

Yass Valley Wind Farm -

Coppabella Hills Precinct

May 2009

1 EXECUTIVE SUMMARY

The objective of this report is to investigate the potential impacts of the Coppabella Hills Precinct, part of the Yass Valley Wind Farm proposal, on existing telecommunications services in the vicinity of the proposal and to propose appropriate mitigation strategies for any impacts identified.

Telecommunication services, including television, radio, mobile phone services and other radio communication services occur in proximity to population centres and often utilise the ridgelines that provide optimum locations for wind turbines. As with any large structure, wind turbines have the potential to cause interference with such signals.

In general, VHF and UHF frequency band radio signals, and digital voice based technologies such as GSM mobile, are essentially unaffected by wind turbines. This includes land mobile repeaters, radio, the audio component of analogue television and mobile phones.[1]

Following a review of the radio communication services near the wind farm site, the nature of potential interference and consultation with the service providers, it is considered that the wind farm would have minimal effect on telecommunications services. Mitigation strategies are proposed to ensure any impacts can be managed and mitigated.

2 GLOSSARY OF TECHNICAL TERMS

VHF	Very High Frequency
UHF	Ultra High Frequency
EMI	Electromagnetic Interference
VHF Channels	TV Channels 0 to 12 (45 - 230 MHz)
UHF Channels	TV Channels 28 - 46 (526 - 820 MHz)
Band 111	VHF TV Channels 5A - 12
Fresnel Clearance	Clearance to obstructions from the ray line on a radio path which does not produce any additional loss above free space loss
FM	Frequency Modulation
MF	Medium Frequency
LF	Low Frequency
GSM	Global Systems Mobiles
CDMA	Code Division Multiple Access cellular mobile system
ITU	International Telecommunications Union
ABA	Australian Broadcasting Authority
ACMA	Australian Communications & Media Authority
CB Radio	Citizens Band Radio

[1] http://www.dungog.nsw.gov.au/files/2142/File/GreenpowerEMIAnalysisIssue.pdf

3 EXISTING ENVIRONMENT

Coppabella Hills Precinct site

A review of telecommunication technologies that are in use within the area surrounding the proposed Coppabella Hills Precinct has identified the following:

- TV and radio broadcasting
- Mobile phone services provided by telecommunication companies
- Radio communication systems, including point to point microwave links, licensed by the Australian Communications and Media Authority (ACMA)
- Other radio links including mobile radio, CB radio; and
- Aircraft navigation systems

Electromagnetic Interference (EMI) has the potential to cause degradation or total loss of signal strength and may cause poor TV reception and/or "ghosting" effects. EMI may also result in a reduction in the coverage of mobile phone, radio and aircraft navigation communications in certain instances. There are three principal mechanisms by which wind turbines may cause EMI: reflection or scattering, diffraction and near field effects.[2]

---

[2] D. F. Bacon, A Proposed Method for Establishing an Exclusion Zone around a Terrestrial Fixed Link outside of which a

Reflection or scattering

When a signal sent between a transmitter and receiver becomes obstructed by an object located within the path of a signal, reflection and/or scattering may occur. If the rotating blade of a wind turbine receives a primary transmitted signal, a scattered time delayed (or out of phase) signal may be produced and transmitted to the receiver. The out of phase signal will be distorted in relation to the primary signal, causing EMI.[3]

Diffraction

In some instances when an object is located in the path of a signal wave front, the object can both reflect and absorb the signal. This phenomenon is commonly referred to as diffraction.[4]

Near field effects

Wind turbines may cause interference to radio signals due to the electromagnetic fields emitted by the generator and the switching components within the turbine nacelle. This is referred to as a near field effect.[5]

Due to advances in technology and compliance with the Electromagnetic Emission Standard, EN 61000-6-4 (AS/NZ 4251.2:1999) *Emission standard for industrial environments*, the wind turbines proposed for the project will not cause active EMI due to near field effects.

The level of EMI produced by a wind turbine due to reflection or scattering, diffraction and near field effects is dependant on a number of factors, including placement of the wind turbine in relation to the signal path/s; the signal frequency; the characteristics / composition of the wind turbines rotor blades; the receiver characteristics; and the propagation characteristics of the radio wave in the local atmospheric conditions.[6]

While the site proposed for the development of the wind farm is a rural area, a number of communications links and broadcast networks are present in the surrounding region.

As with any large structure, there may be circumstances where wind turbines can cause disruption to the electromagnetic signals used in a variety of commonly used radar, navigation and telecommunications services. The following approach was adopted to identify the impact of the proposal on telecommunications:

- Identify license holders within a 25km radius of the proposed wind farm site, and point-to-point links in the vicinity of the site, using information provided on the ACMA RADCOM database;
- Provide written notification of the proposal and seek comments from each license holder identified via the ACMA RADCOM database within a 25km radius of the site;
- Record and review all responses received to identify any issues raised by license holders;

Wind Turbine will cause Negligible Degradation of the Radio Link, Radiocommunications Agency UK Report Ver 1.1, 28 Oct 2002

[3] URS Woodlawn Wind Farm Environmental Impact Statement 2004
[4] *Ibid.*
[5] *Ibid.*
[6] *Ibid.*

- Discuss issues raised with relevant license holder with the aim to resolve or identify mitigation options;
- Carry out an assessment of the “Fresnel zone” associated with each fixed point-to-point communications link in the vicinity of the site;
- Determine appropriate exclusion zones for proposed turbine layout based on Fresnel zone calculations and advice from license holders;
- Confirm that all turbines (including blades) are located outside the exclusion zone;
- Determine appropriate additional mitigation measures which may be required.

3.1 Impact assessment

The possible impact of the proposed Coppabella Hills Precinct on the four most common communications services has been investigated separately. These services are television and radio broadcast services, mobile phone services, radio communication services and aircraft navigation services.

Any impacts would be confined to the *operational phase* of the wind farm. Various measures are available to help mitigate potential impacts and are discussed below.

4 TELEVISION AND RADIO BROADCAST SERVICES

4.1 Existing services and facilities

The ACMA RadCom database lists the following broadcasters for television and radio, under postcode 2582, Yass.

Television broadcasting:

Southern New South Wales TV1: ABC, CBN, CTC, SBS and WIN.

Radio broadcasting:

Canberra RA1: 1ART, 1CBR, 1CMS, 1WAY, 1XXR, 2ABCFM, 2CA, 2CC, 2CN, 2JJJ, 2PB, 2RN, 2ROC, 2SBSFM

Canberra RA2: 1RPH

Goulburn RA1: 2ABCFM, 2ABCRN, 2ABCRR, 2GN, 2JJJ, 2RN, 2SNO.

Yass RA1: 2YAS

The ACMA RadCom database lists the following broadcasters for television and radio, under postcode 2584, Binalong.

Television broadcasting:

Southern New South Wales TV1: ABC, CBN, CTC, SBS and WIN.

Radio broadcasting:

No radio broadcasters listed.

Canberra (Black Mountain) is the nearest TV transmission source for the locality of the proposed Coppabella wind farm. Black Mountain is approximately 50km South East of the wind farm site. Details of the Canberra television channels are provided in the table below.

Broadcaster	Channel	Band	Frequency (MHz)
Capital (CTC)	6	VHF	177.5
Capital (CTC)	7	VHF	182.258
ABC	9	VHF	196.26
ABC	9A	VHF	205.625
SBS	28	UHF	527.26
SBS	30	UHF	543.5
WIN	11	VHF	219.5
WIN	31	UHF	548.198
Prime (CBN)	12	VHF	226.5
Prime (CBN)	34	UHF	569.198

License holders identified via the ACMA RadCom database within a 25km radius of the wind farm were notified of the proposal in relation to potential impacts and asked to provide comments.

At the time of writing, no concerns had been raised from the license holders contacted regarding possible impacts to television or radio broadcasting services. EPURON will work with organisations to resolve any issues, should any be identified.

4.2 Television broadcasting

4.2.1 Interference and impact analysis

Television Interference (TVI) is dependent on a range of factors including environmental factors (topography, direct signal strength, transmitter type, and receiver type) and wind farm design factors (turbine elevation, rotor size and orientation, speed of rotation, blade material and pitch). TVI caused by the operation of wind turbines is characterised by video distortion, while the audio component of the signal is not affected.[7] Due to the variability of local conditions and the characteristics of antennae used in particular installations, there is a degree of uncertainty regarding predicted levels of interference.

The level of TVI can be influenced by a number of factors including:

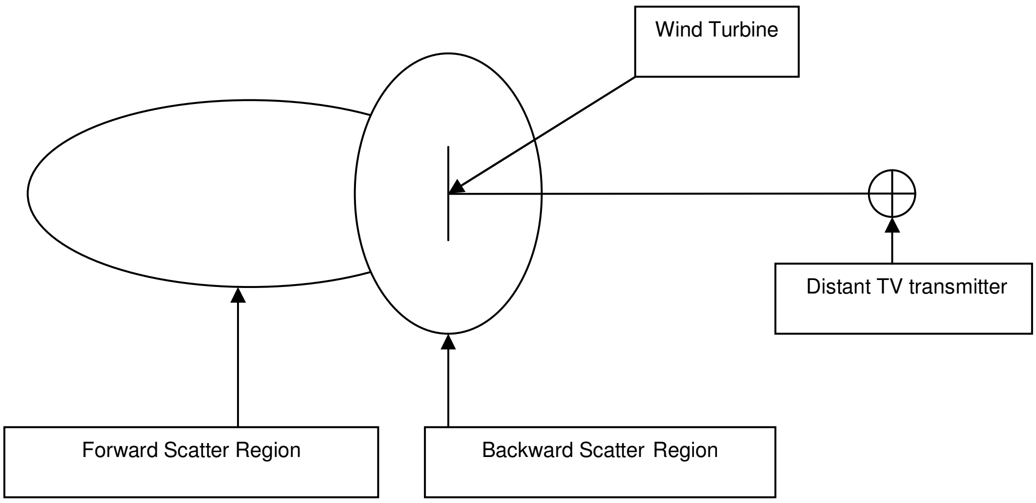
- Where the receiver is located, relative to the TV transmitter and the wind farm;
- The frequency of the transmitted TV signal;
- Whether there are any other tall structures in the vicinity of the receiver;
- The direction of the rotor blades and blade material;

[7] David E Spera, Wind Turbine Technology, Chapter 9 ASME Press 1994

- The nature of the receiving aerial e.g. design, height, directionality, power.

In general, the potential for interference at receiver locations can increase with distance of the receiver from the transmitter, as signal strength decreases with increasing distance from the source. As such, a wind farm in an area of already poor signal strength may potentially have a greater impact on reception than the same wind farm in an area of relatively strong signal strength. In addition, reception in the vicinity of the wind farm can vary with the degree of topographic obstruction of the signal.

A wind turbine has the potential to scatter analogue television waves both forward and back. Forward scatter will only occur if a wind turbine is located approximately between the dwelling and the broadcast site. The forward scatter region is as shown in the figure below, and generally does not extend further than 5 km for the worst combination of factors. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the wind turbines. The effect of the forward scatter is to potentially cause the brightness of the television picture to vary with the rotation of each blade. Modern television sets usually incorporate Automatic Gain Compensators (AGC) which act to lessen or eliminate variations in picture gain or brightness. [8]



Schematic diagram of potential analogue television signal interference zones around a wind turbine[9]

The zone of potential interference for a wind farm is the resultant total of the effects from the individual turbines. The International Telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond 5 kilometres are unlikely.[10]

It also indicates that interference may extend beyond 5km where the receiver location is shielded from the direct signal, but in direct line-of-sight to the turbine. The form of

[8] http://www.dungog.nsw.gov.au/files/2142/File/GreenpowerEMIAnalysisIssue.pdf

[9] Reproduced from the Connell Wagner PPI Gunning Wind Farm Environmental Impact Statement - Chapter 11.

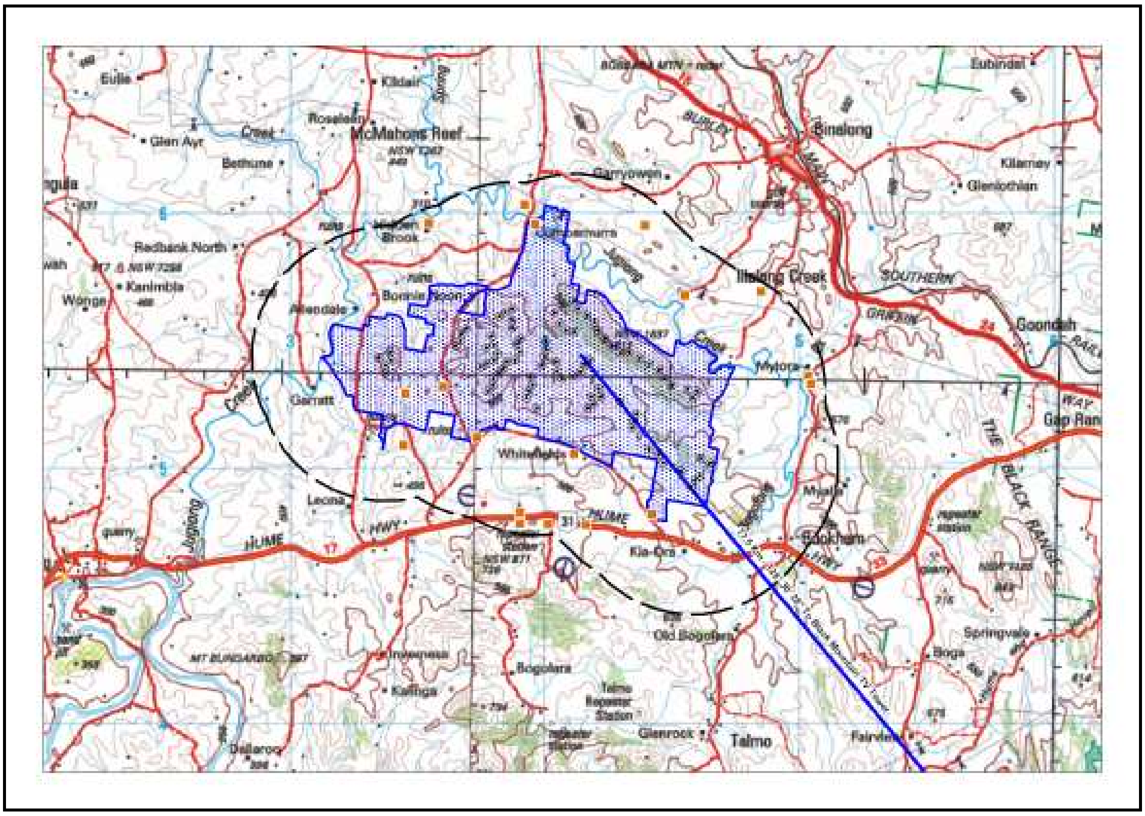
[10] Crookwell II Wind Farm – Environmental Impact Statement - URS

interference, if experienced, will depend on the relative positions of the wind farm, the transmitting station and the receiver.

Television interference can take the form of either a “ghost” image that pulsates horizontally at the “blade pass” frequency or a fluctuation in picture brightness, also at the “blade pass” frequency.[11]

There are approximately 60 houses within a 5km radius of the proposed wind farm site boundary. The location of the wind farm with respect to the Black Mountain communications tower can be seen in the following diagram.

4.2.2 House and television tower locations



It is difficult to assess the likely impact on these specific house locations and once the wind farm is operational it is possible that television reception could be affected at some of these locations unless some form of mitigation is introduced. However, houses further than 5km from the site are unlikely to be affected.

4.3 Mitigation measures

In the design of the project, the proponent will carry out the following mitigation measures to help minimise TVI:

- Use of primarily non-metallic turbine blades;

[11] Connell Wagner Delta Electricity Gunning Environmental Impact Statement 2004

- Use wherever practical of equipment complying with the Electromagnetic Emission Standard, AS/NZS 4251.2:1999;

Once the wind farm is operational, the proponent will offer to undertake a monitoring program of houses within 5km of the wind farm to determine any loss in television signal strength, if requested by the owners. In the event that TVI is experienced by existing receivers in the vicinity of the wind farm, the source and nature of the interference will be investigated by the proponent.

Should investigations determine that the cause of the interference can be reasonably attributable to the wind farm; the proponent will put in place mitigation measures at each of the affected receivers in consultation and agreement with the landowners.

Specific mitigation measures may include:

- Modification to, or replacement of receiving antenna;
- Provision of a land line between the effected receiver and an antenna located in an area of favourable reception;
- Improvement of the existing antenna system;
- Installation of a digital set top box or,
- In the event that interference cannot be overcome by other means, negotiating an arrangement for the installation and maintenance of a satellite receiving antenna at the proponents cost.

4.4 Satellite Pay Television

Some homesteads in the area may have satellite pay TV service antenna installations.

Unless a particular subscriber's antenna reception direction and elevation is aligned with a turbine, no impacts on TV reception are likely.[12]

4.5 Radio broadcasting

The level of radio broadcast interference experienced can be influenced by a variety of variables including:

- Abnormal weather conditions;
- Multi-path distortion (reception of a signal directly from a transmitter and also a reflected signal from hills, structures etc.);
- Overloading (occurs when an FM receiver receives too strong a signal);
- Electrical interference from household appliances etc;

4.6 FM sound broadcasting

Low power national FM stations on 107.7 & 106.9MHz are listed on the Wades Hill TV site at Crookwell. National, community and commercial services on 101.5, 102.3, 105.5,

---

[12] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

104.7, 98.3, 99.1, 92.7, 91.9, 91.1, 106.3 and 103.9MHz are located on Black Mountain.[13][14]

4.7 MF sound broadcasting

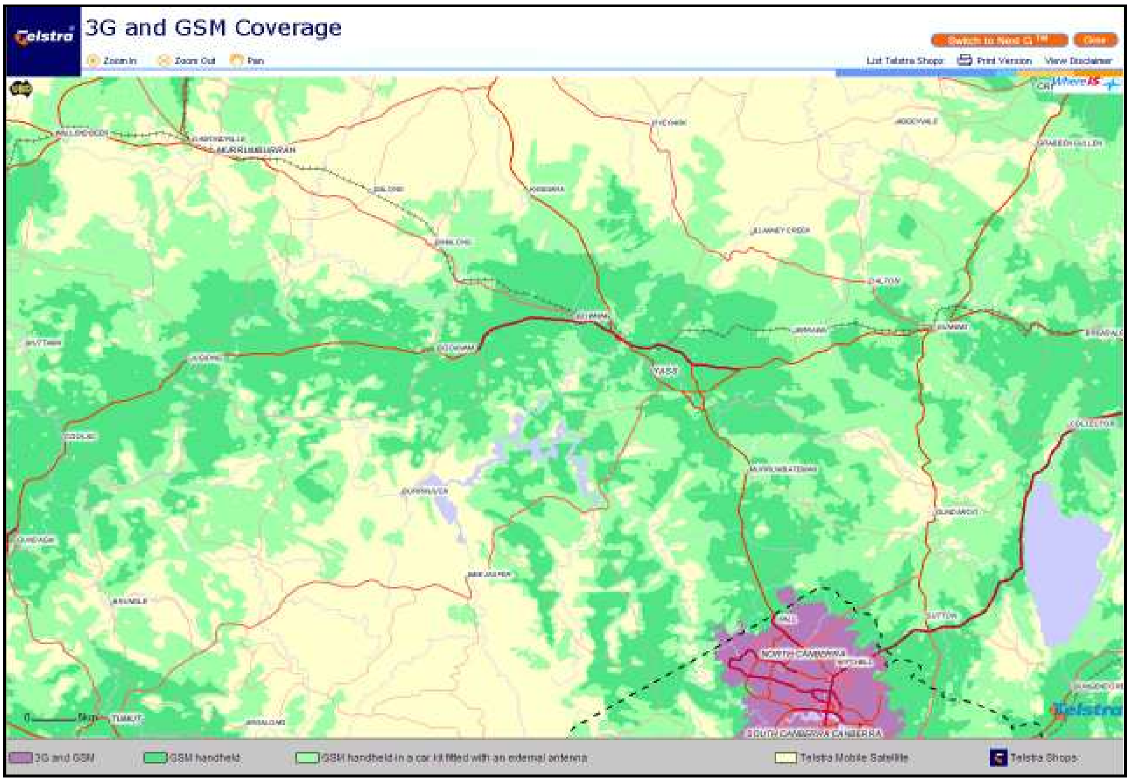
Wind farm effects on MF radio are highly unlikely and therefore the stations serving the area have not been listed.[15]

5 MOBILE PHONE SERVICES

5.1 Existing services and facilities

This section covers GSM (2G) and 3G services (high frequency communications links used for mobile transmission networks are discussed in the next section: Radio Communication Services).

Figures below show the existing local mobile phone coverage from the three providers (Source: company websites)



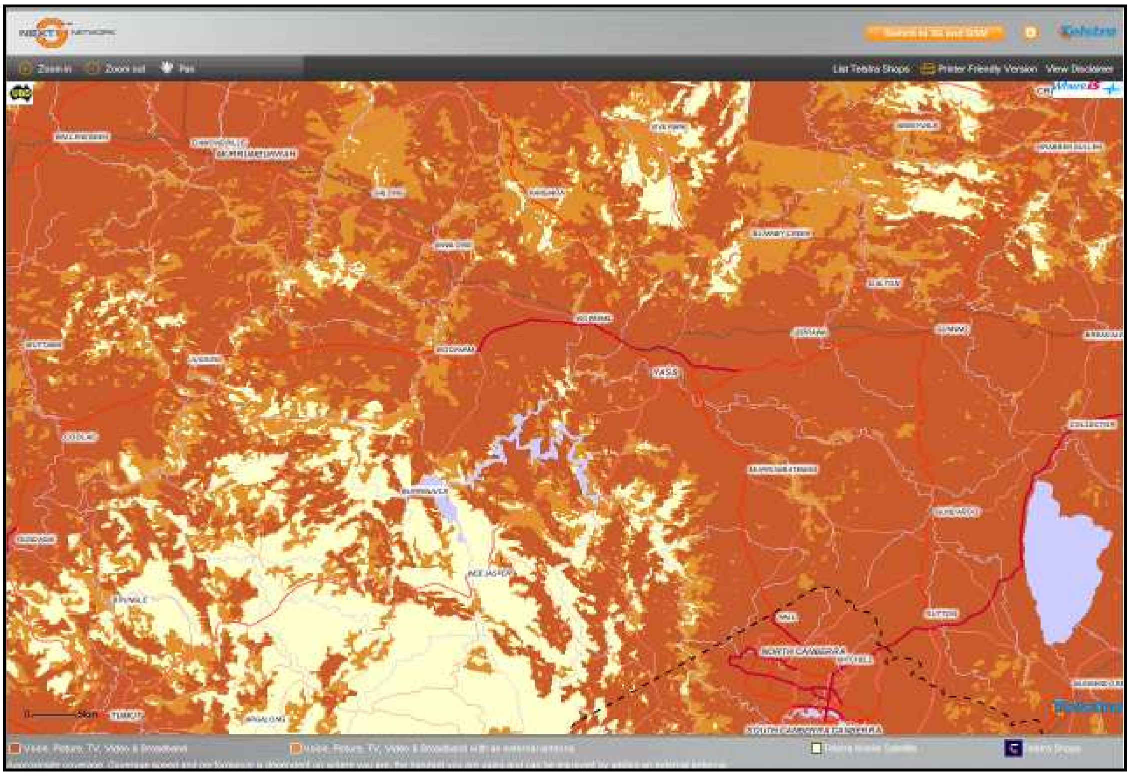
Telstra 3G and GSM (2G) Coverage

---

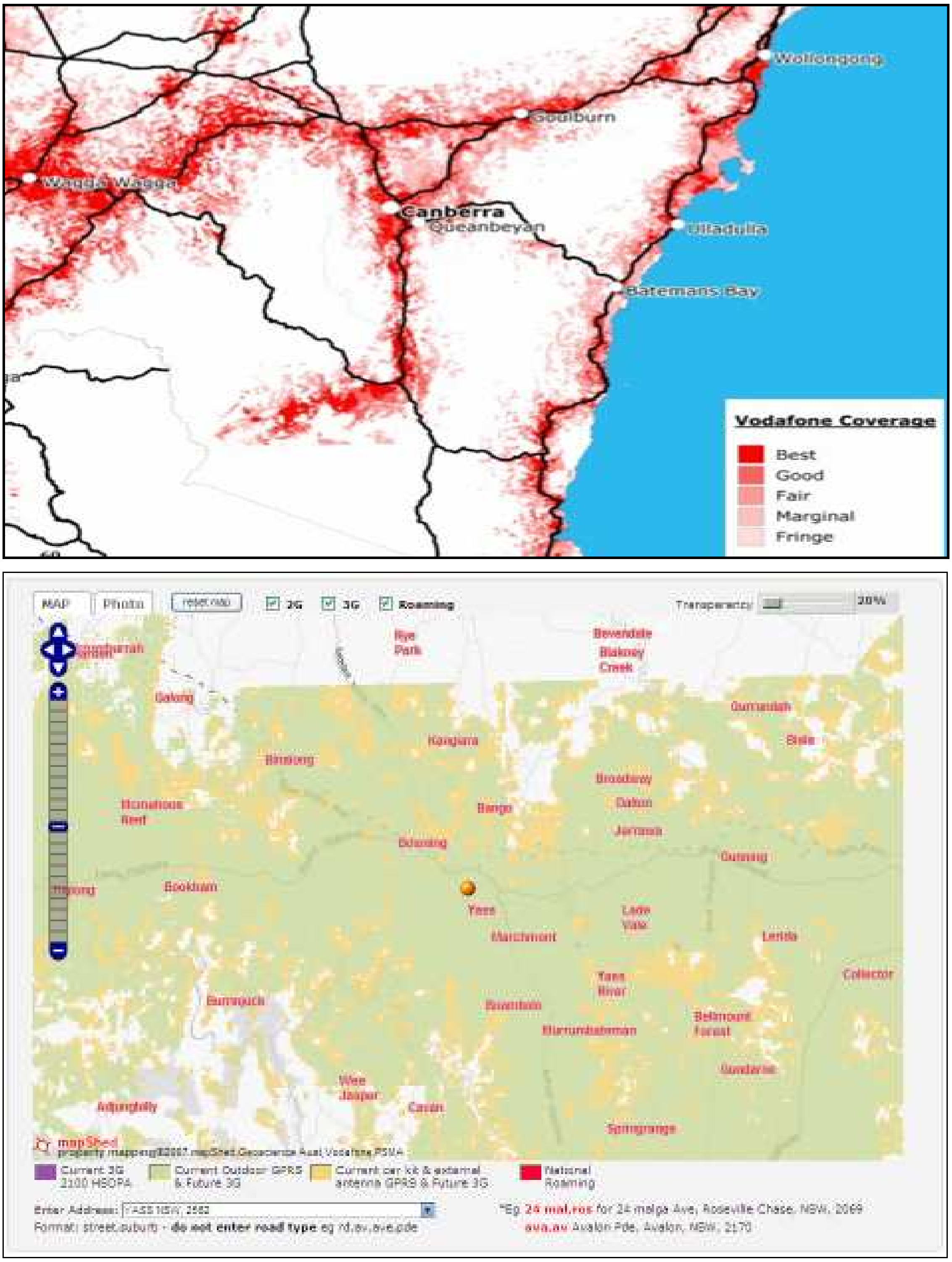
[13] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

[14] http://www.ausradiostations.com/fmact.html and http://www.ausradiostations.com/fmnsw.html

[15] *Ibid*



Telstra Next G



Vodafone GSM Coverage

Optus GSM (2G) Coverage

5.2 Interference and Impact Analysis

A mobile phone network consists of a system of adjoining zones called 'cells', which vary in size with a radius of 2 - 10 km. Each cell has its own base station that sends and receives radio signals throughout its specified zone. Mobile phone antennas need to be mounted clear of surrounding obstructions such as buildings to reduce 'dead spots' and allow the base station to effectively cover its intended cells. [16]

The ACMA RadCom Database identified three mobile phone companies as using base stations within the vicinity of the proposed wind farm. The table below lists the companies and ACMA site ID numbers.

Mobile Phone Companies	ACMA Site ID No.
Optus Mobile Pty Ltd / Singtel Optus Pty Ltd	201821,198028
Telstra Corporation Ltd	130627, 9515, 100784
Vodafone Network Pty Ltd	201821, 198028

[16] URS Crookwell II Wind Farm Environmental Impact Statement ,

All companies were contacted by EPURON regarding potential impacts and asked to provide feedback as to any potential conflicts with their existing networks.

5.3 Mitigation measures

No GSM/CDMA mobile services are registered at sites in the close vicinity of the wind farm. The Telstra mobile service from Wades Hill, Crookwell is too distant to be affected by the wind turbines[17] Telstra no longer operates its CDMA network.

No additional mitigation measures are required.

6 RADIO COMMUNICATION SERVICES

6.1 Existing services and facilities

The Australian Communication and Media Authority (ACMA) issues radio communications licenses in accordance with Part 3.5 of the Commonwealth Radiocommunications Act 1992. The ACMA issues licenses to use specific segments of the radio broadcasting frequency spectrum for different purposes and maintains a register (the ACMA RadCom Database) of all the licenses issued.

The register allows the ACMA to create a 'density' classification of areas across Australia as high, medium or low depending on the number of licenses in operation in a particular area. According to the ACMA RadCom Database, the area in the vicinity of the proposed wind farm is classified as a "Low Density Area".

According to the ACMA RadCom Database, license holders operate a range of radio communications services, primarily fixed link microwave communication and mobile communication systems within a 25km radius of the proposed wind farm. Multiple license holders use some sites, while sole users employ others.

Radio communication license holders within 25km of the Coppabella Hills Precinct

(Latitude -34 46 52.81, Longitude 148 40 57.9)

ACMA Licence Holder	ACMA Site ID No.
Airservices Australia	9001816, 34921
Ambulance Service of New South Wales	34921
Commissioner of Police NSW Police	35851, 34921, 198028
Country Energy	9542, 404037
Department of Environment and Conservation	9519
Goldenfields Water County	198028

[17] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

ACMA Licence Holder	ACMA Site ID No.
Council	
Harden Shire Council	9542
NSW Department of Commerce – Government Chief Information Office	201821
NSW Department of Primary Industries	40307
NSW Rural Fire Service	9519, 34897, 9542
NSW Volunteer Rescue Association	39030,34921
Optus Mobile Pty Ltd	201821,198028
Roads and Traffic Authority of NSW	9519
Singtel Optus Pty Ltd	201821, 198028
Telstra Corporation Ltd	130627, 9515, 100784
The Info Radio Network Pty Ltd	198028
TransGrid	34921
Vodafone Network Pty Ltd	201821, 198028
W. S Gregory & Associates Pty Ltd	9519
Yass Valley Council	9519

6.2 Interference and Impact Analysis

A fixed link radio transmission is a point-to-point transmission path typically between two elevated topographical features. The transmission path may become compromised if a wind farm is located within the direct line-of-sight or what is known as the ‘Fresnel Zone’ around the line of sight between the sending and receiving antennae.

The potential impact zone will vary with the distance between the transmitter and receiver, frequency of transmission and the location of any particular point along its path. Communications are only likely to be affected if a wind farm is in the line-of-sight between two sending and receiving antennae or within a zone of the line-of-sight of these antennae.

Where a potential exists for interference to line-of-sight links, an obstruction analysis can be undertaken to ensure that no part of a wind turbine assembly will enter the Fresnel Zone of the microwave link. The maximum extent of the Fresnel zone occurs at the midpoint along the path of the microwave link.

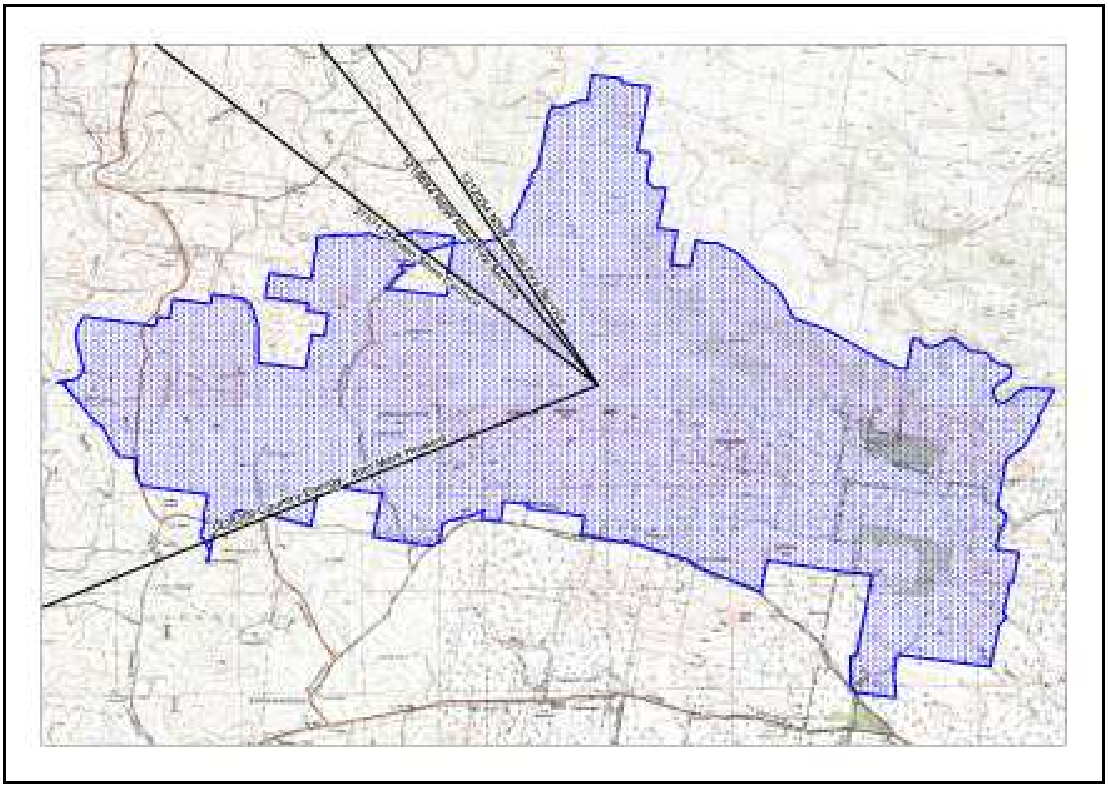
EPURON identified and mapped the point-to-point communication links in the vicinity of the proposed wind farm site to establish the line-of-sight path.

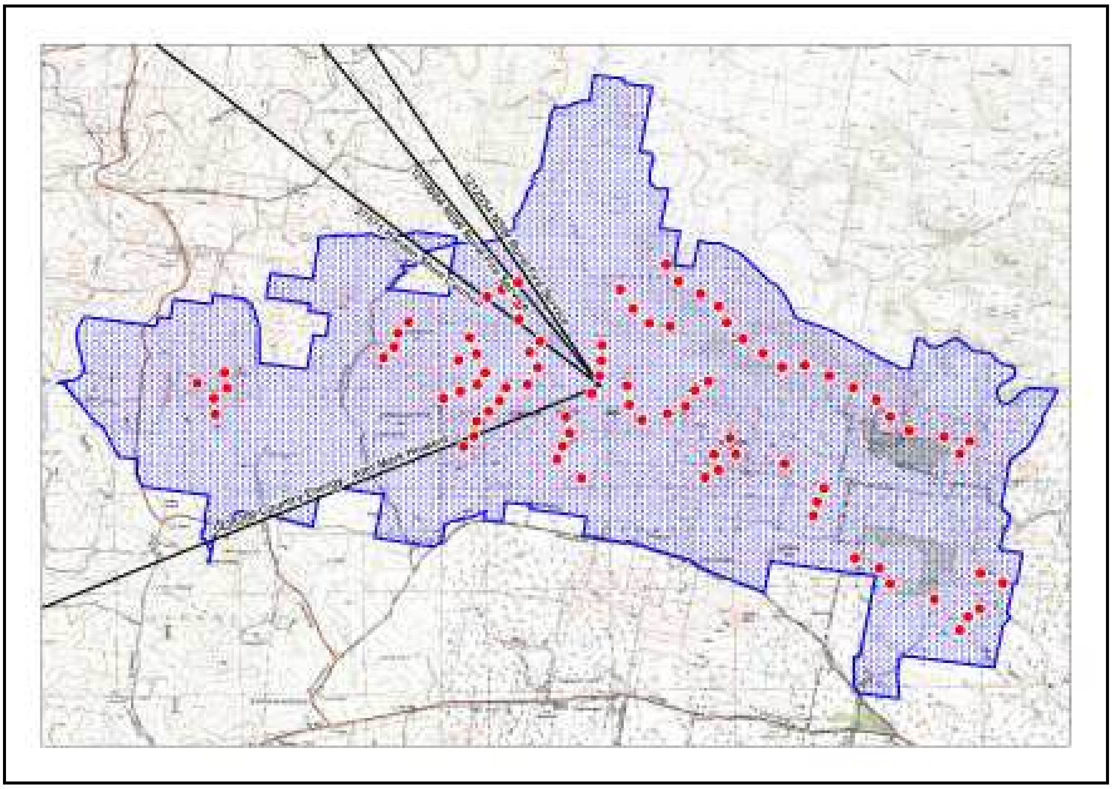
The figure below provides details of the locations of fixed microwave links around the site. (Prepared by EPURON based on data contained in the ACMA RadCom database.)

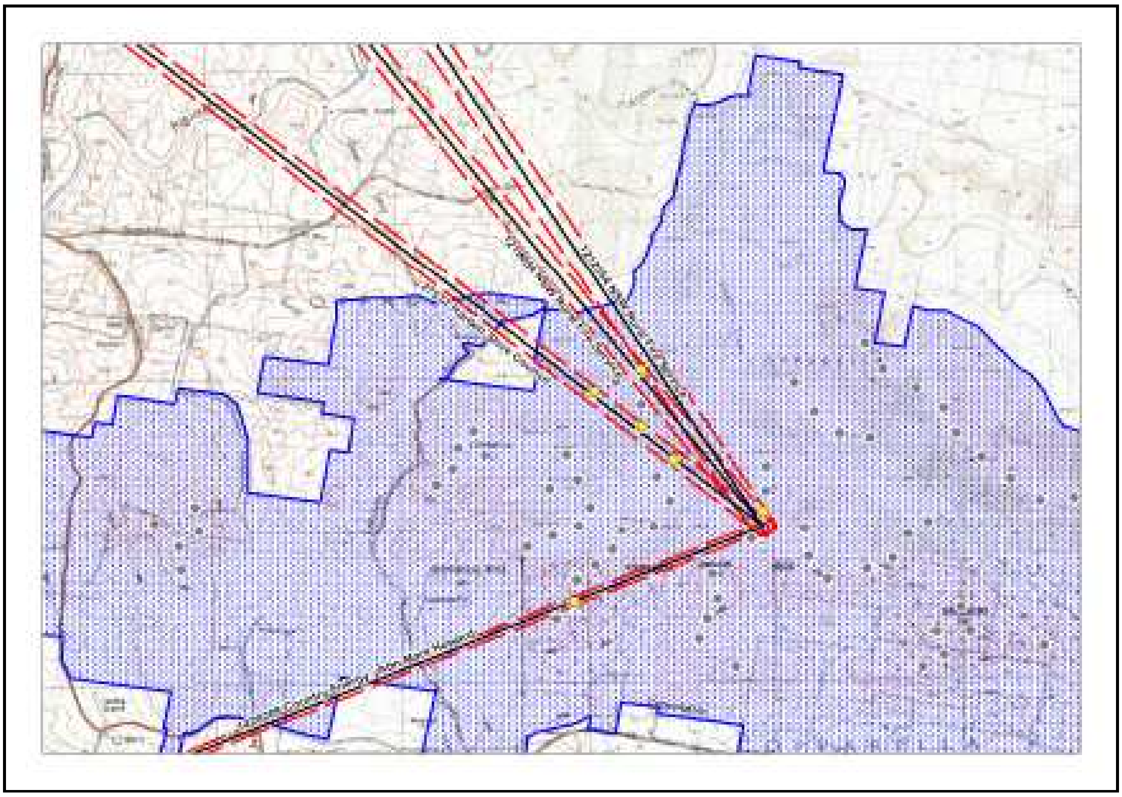
In order to ensure that no obstruction to transmission paths occurs, calculations of the 2nd Fresnel Zone of the point-to-point communications links in proximity to the site were undertaken. It is suggested that beyond the 2nd Fresnel Zone the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver (Bacon 1999).

In order to determine whether a radio link could be affected by the wind turbines, EPURON defined an 'exclusion zone' beyond which the level of interference will not disrupt the radio link, based on the concept of the Fresnel Zone, as previously described.

The following point-to-point links were identified in the vicinity of the site.







6.3 Radio communication links

In order to ensure that no obstruction to transmission paths occurs, calculations of the 2nd Fresnel zone of the point-to-point communications links in proximity to the site were undertaken.

It is suggested that beyond the 2nd Fresnel zone, the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver.[18].

At the time of writing, five point-to-point communications links were identified as crossing the site.

A link between “Commsite Coppabella Hill” and “Demondrille Hill via Harden”, (License No. 27571) operated by Harden Shire Council, passes across the site. This link operates at 450.625 MHz.

A link between “Commsite Coppabella Hill” and “Shire Council Site Boundary Rd 7km SSE of Young”, (License No. 1212554) operated by the NSW Rural Fire Service, passes across the site. This link operates at 404.875 MHz.

A link between “Commsite Coppabella Hill” and “Rocky Hill via Harden”, (License No. 1219084) operated by NSW Rural Fire Service, passes across the site. This link operates at 450.8725MHz.

A link between “Country Energy Substation JUGIONG” and “Commsite Coppabella Hill”, (License No. 1428209) operated by Country Energy, passes across the site. This link operates at 852.6125 MHz.

A link between “Shire Council Site Boundary Rd 7km SSE of Young” and “Commsite Coppabella Hill”, (License No. 1428213) operated by Country Energy, passes across the site. This link operates at 852.3875 MHz. [19]

In order to determine whether a radio link could be affected by the wind turbines, EPURON defined an ‘exclusion zone’ beyond which the level of interference will not disrupt the radio link, based on the concept of the Fresnel zone, as previously described.

EPURON previously contacted all organisations identified as operating radio communication licences (including fixed link communications) within 25km of the nearby Cullerin wind farm proposal.

Each license holder was asked to provide independent comments / advice on the possibility of the wind farm development interfering with their communications links. At that time, no organisation within the 25km radius raised concerns. Optus, Vodafone and Telstra provided general guidelines to assist in the planning of wind farms.

In response to these enquiries,

Harden Shire Council responded with:

---

[18] D. F. Bacon, A Proposed Method for Establishing an Exclusion Zone around a Terrestrial Fixed Link outside of which a Wind Turbine will cause Negligible Degradation of the Radio Link, Radiocommunications Agency UK Report Ver 1.1, 28 Oct 2002

[19] Not shown on the diagram as it shares the same corridor as licence number 1212554

Council has no comments to make at this stage of the proposal, however, wishes to be informed on possible impacts to the communications network. Council also added that they would be happy to work with the proponent to resolve any potential impacts.

Optus Mobile noted:

> "Provided wind turbines are located well outside the 2nd Fresnel zone of the point to point microwave links, no interference to communications is expected" (pers. comm. Mr. Trong Ho, Optus Mobile)[20]

Vodafone noted:

> "Clearance criteria is the same for all carriers. Please use the same criteria as proposed by Optus"
> (pers. comm. Mr. Ganesh Ganeswaran, Senior Engineer / Transmission, AAP Communications Services 22/11/05)[21]

Telstra noted:

> "Provided wind turbines are greater than 100m away from Mobile tower (or in the case of directional panel antennae) not in direct line of sight for panel antennas, wind turbines will have minimal effect on existing coverage." (pers. comm. Mr. Ivan D'Amico, Area Team Manager (Country) - NSW&ACT, Telstra Services, Wireless Access Solutions, Mobile Coverage Delivery)[22]

These suggestions have been incorporated into the planning of the Yass Valley Wind Farm proposal.

6.4 Other radio communication

6.4.1 Two-way mobile

A small number of mobile bases exist in the area surrounding the wind farm site. These bases potentially provide cover to mobiles in a 360 degree arc from their bases. No significant impact from the wind farm on base coverage beyond normal mobile operational performance is predicted in view of the geographic separation between the base antennas and the turbine structures. Of course a mobile unit communicating with a base station when the mobile is located within metres of the wind turbine structures (or indeed near any large building, silo, tower etc) may experience some very local performance change, however moving a short distance would restore performance to normal.[23]

6.4.2 CB radio

CB radios are not individually licensed, the equipment being subject to class licensing only. Therefore, no records of location or operators of CB radios exist, and the channels are shared without any right of protection from interference. No impact from the wind farm is predicted except perhaps for very local effects to portable or mobile units in the

---

[20] Taurus Energy - Cullerin Range Wind Farm Environmental Assessment Report 2006

[21] *Ibid.*

[22] *Ibid.*

[23] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

immediate vicinity of the turbines which could be avoided by a small location change of the unit.[24]

6.4.3 Wireless Broadband

From studies in other areas such as Mahinerangi, NZ[25] it is concluded that the minimum separation required between wind turbines and mobile broadband transmitters is approximately 240m. Turbines will be located outside this distance to avoid any impacts on mobile broadband services.

6.5 Mitigation measures

As a result of the exclusion zones established in planning the wind farm, there is the possibility that impacts could occur to existing point-to-point links, in particular link 27571 operated by Harden Shire Council. The proponent has engaged with council to discuss these impacts and possible mitigation strategies. Both council and the proponent are confident that any potential impacts will be able to be mitigated using the following techniques:

- Modifications to or relocation of the existing antennae;
- Installation of a directional antennae to reroute the existing signal;
- Installation of an amplifier to boost the signal; and/or
- Utilisation of onsite optical cable to reroute the original signal.

7 AIRCRAFT NAVIGATION SYSTEMS

7.1 Existing services and facilities

The closest airports to the proposed wind farm site are Canberra and Goulburn. There is one radar installation in the vicinity of Canberra airport, namely Mt Majura. A secondary radar installation is located at Mt Bobbara.

7.2 Interference and impact analysis

EPURON has consulted with the Civil Aviation Safety Authority (CASA), Airservices Australia and the Department of Defence in relation to the proposal.

Due to the height of the turbines (>110m), the Civil Aviation Safety Authority previously recommended that obstacle lighting be provided as per section 5.5 of Advisory Circular 139-18(0) - *Obstacle Marking and Lighting of Wind Farms.* The Advisory Circular was withdrawn in September 2008 and at the time of writing a recommendation was not available from CASA in relation to Obstacle Marking and Lighting of Wind Farms.

EPURON wrote to Airservices Australia (AA) in relation to the wind farm proposal on 15-7-08. In their response dated 16-12-08, AA suggested that there may be potential for navigational aid issues. Specific details regarding installations affected were not provided in the initial response.

---

[24] *Ibid.*

[25] Mahinerangi Wind Farm Compatibility with radio services April 2007 - Kordia

At a meeting at Airservices Australia Brisbane office on 1-4-09 attended by David Cook – Manager Navigation & Surveillance, Matt Kelly – Engineering Specialist, Long Nguygen – Senior Engineering Specialist (video link) and Mitch Sloan – Airport Relations (video link), David Cook suggested that there may be potential impacts to the navigational aids at Mt Bobbara (SSR) and possibly although to a lesser extent Mt Majura (PSR) and (SSR). In his opinion, mitigation measures should be available to overcome or reduce these impacts.

Airservices Australia indicated at the meeting that they would not be able to conduct an internal assessment of the impacts to their navigational aids due to resourcing constraints. Accordingly, it was proposed that EPURON agree on a scope of work acceptable to Airservices Australia so that EPURON could engage a suitable consultant to investigate and prepare a report to assist Airservices Australia in their assessment of the proposal.

EPURON will continue to work closely with AA to mitigate issues discovered with the Mt Bobbara (SSR) and Mt Majura (PSR / SSR) that can be reasonably attributable to the proposed wind farm.

A review of the proposal was undertaken by the Department of Defence. No objection to the proposal was made.

Mitigation measures

Obstacle lighting will be provided if required by CASA. Further investigation into Airservices Australia claim that navigational aids may be affected will be required. At the time of writing insufficient information from Airservices Australia was available to enable more work to proceed. No other mitigation measures are required.

8 CONCLUSION

Interference to MF and FM sound broadcasting is not expected.

Conflicts between point to point radio systems and the wind turbines are expected to be avoided with appropriate clearances being established. Also, mobile radio and other radio communication services in the area are not expected to be impacted by the wind farm or its operation.

VHF TV reception at dwellings within about 1 km of the wind farm turbines and with antennas having turbines located with +/- 25 degrees angle of their reception direction will have some probability of noticeable “ghosting” at times. For UHF TV time variant ghosting may be evident out to about 2 km for turbines located +/- 20 degrees from the reception direction.

Digital TV is not susceptible to visible “ghosting” degradation. Any impact of reflections from the turbines would be a minor reduction of coverage at the limit of the service area.

For any confirmed wind farm interference problems where TV antenna system improvements are unsuccessful, the use of the digital TV services in the area may be the best solution, requiring the provision of a digital set top converter.

Overseas experience indicates that electrical interference from wind farm generators and controls is not a problem with established and reputable wind turbine manufacturers and therefore no electrical noise measurements are warranted.

9 CORRESPONDENCE:

From: Sloan, Mitchell [mailto:Mitchell.Sloan@AirservicesAustralia.com]
Sent: Tuesday, 16 December 2008 1:46 PM
To: Anthony Micallef
Cc: Rogers, Carly
Subject: RE: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Dear Anthony

I regret to advise that at this stage we are unable to approve your proposed windfarm due Navigational Aid issues.

We require a more detailed study to be conducted on this proposal and it's potential impact on radar. This may require us to engage a consultant for this type of assessment, which would have to be at the proponents expense.

I will get back to you shortly with a more detailed response.

Regards

Mitch

Senior Adviser
Airport Relations
Phone: (02) 62684410
Mobile: 0408 994410

Harden Shire Council

Contact: Sharon Langman
Quote Reference:

PO Box 110
3 East Street
HARDEN NSW 2587
Tel 02 6386 2305
Fax 02 6386 2083
Email council@harden.nsw.gov.au
Web www.harden.nsw.gov.au

9 September 2008

Mr Anthony Micallef
Epuron Pty Ltd
Sent by email to A.Micallef@epuron.com.au

Dear Mr Micallef

Re: COPPABELLA AND MARILBA WIND FARM

Council acknowledges the receipt of your letter dated 15 July 2008 and at this stage has no comment to make with regard to the proposal. However Council requests that should the project go ahead that information be provided as to the likely impacts upon the communications network operating in the immediate area.

Should the proposal go ahead Council would be willing to work with you to find solutions to any likely impacts.

Yours sincerely

Sharon Langman
DIRECTOR ENVIRONMENTAL SERVICES

G:\Enviro Services\DEVELOPMENT APPLICATIONS\Correspondence - DAs - General\wind farm proposal.doc

From: Cremer Rachel [mailto:Rachel.Cremer@BroadcastAustralia.com.au]
Sent: Thursday, 4 September 2008 5:00 PM
To: Anthony Micallef
Cc: Langridge Emmajane; Freer Peter; Pizzato Bob
Subject: RE: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Hi Anthony

Thanks for your letter regarding the Coppabella & Marilba wind farms and apologies for the delay in replying.

Broadcast Australia (BA) does not operate any broadcast facilities within 50 kilometres of your proposed wind farms and it is therefore unlikely to impact on our services. However we do recommend that Epuron engages an engineering consultancy firm to undertake a detailed study of potential impact on television and radio transmissions in the region as part of your Environmental Impact Study investigations. The Mt Carroll site you mentioned in your letter is not utilised by BA and I suggest you contact WIN Television and Australian Capital Television if you haven't done so already.

Thanks for notifying us of this proposal and please keep us informed of future developments. Please forward any further requests or notifications to Emmajane Langridge who will be BA's wind farm contact in future. Emmajane can be contacted on 02 8113 4718 or emmajane.langridge@broadcastaustralia.com.au.

Please contact me if you need any further information in relation to the above.
With regards
Rachel

Rachel Cremer
Property Co-ordinator
Broadcast Australia Pty Ltd
t: 02 6256 8020
f: 02 6256 8041
e: rachel.cremer@broadcastaustralia.com.au
w: www.broadcastaustralia.com.au

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

02/06111
OUT08/10594

1 September 2008

Epuron Pty Ltd
Level 11, 75 Miller Street
NORTH SYDNEY NSW 2060

Attn: Anthony Micallef

Dear Mr Micallef,

Re: "Coppabella" & "Marilba" Wind Farms

I refer to your letter dated 16 July 2008. Thank you for referring this proposal to the Department for comment.

I note that you wish to seek advice on the impact of the proposed wind farms on NSW DPI's radio communications services within the vicinity of the site. Advice from Chris Clarke at NSW DPI's Bathurst Office has confirmed that there will be no anticipated impact of the wind farm on the radio facilities.

Yours faithfully

Wendy Goodburn
Resource Management Officer (land use)
Goulburn

Aquatic Habitat Protection, Fisheries Conservation and Aquaculture Branch
NSW Department of Primary Industries
PO Box 17 Batemans Bay NSW 2536
1st Floor, Cnr Beach Road and Orient Street

ABN 51 734 124 190
www.dpi.nsw.gov.au
Tel: 02 4478 9103
Fax: 02 4472 7542

From: Curtis, Russell J [mailto:Russell.J.Curtis@team.telstra.com]
Sent: Tuesday, 2 September 2008 11:52 AM

To: Anthony Micallef
Cc: Turner, Martin V; D'Amico, Ivan D; Souksamlane, Kham; Yaghobzadeh, Sima
Subject: RE: EPURON: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

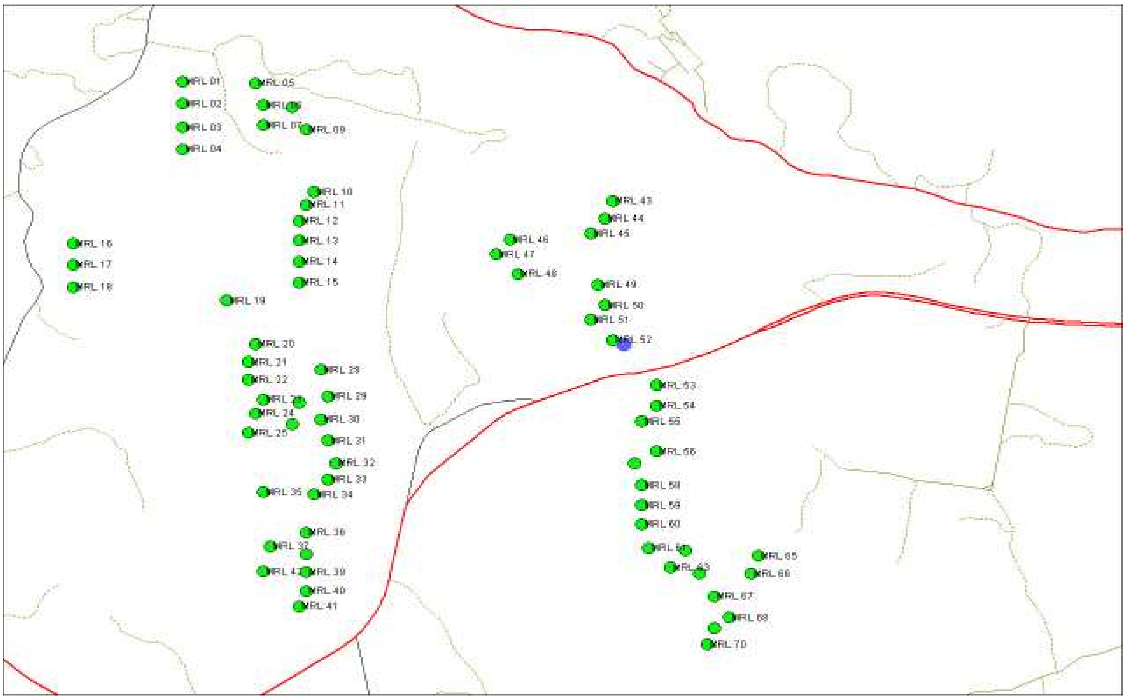
Anthony,
Further to your proposal - Information from our Mobiles department, they have a base station very close to MRL 52. This is "Conroy's Gap BTS". (refer to attachment)

Co-ords are: CGAP Conroy's Gap Latitude_GDA94: -34.77278 Longitude_GDA94: 148.72565

You will need to keep a distance greater than 100m away, the further away that you can place the turbines the better so as not to obstruct the BTS.

Yours Sincerely,

Russell Curtis
Technology Specialist
Telstra - Radio - Core & Access Technology
15/242 Exhibition St MELBOURNE 3000
Phone (03) 9634 7092 / Mobile 0418 387 971



From: Patrick Clague [mailto:Patrick@ses.nsw.gov.au]
Sent: Saturday, 23 August 2008 11:25 AM
To: Anthony Micallef
Cc: Kevin Anderson; Abby Mayers; Barrie Miller - SHR
Subject: FW: Epuron Wind farms near Bookham, NSW

Dear Anthony.
The below email fro Mark Pilkington provides the SES response to your letter dated 15 July

Regards
Patrick Clague
Manager Communications
NSW State Emergency Service
Ph.02 42516555

Fax 02 42516620
Mobile 0419 242250
Email patrick.clague@ses.nsw.gov.au

-----Original Message-----
From: Mark Pilkington [mailto:mark.pilkington@tait.com.au]
Sent: Tuesday, 5 August 2008 1:06 PM
To: Patrick Clague
Cc: Nicola Holden; Neil.johnson@tait.com.au
Subject: Epuron Wind farms near Bookham, NSW

Pat
In relation to the proposed wind farms near Bookham in the NSW SES Southern Highlands region.
The location of the 2 proposed wind farms "Coppabella Windfarm" and "Marilba Windfarm" does not fall with-in the link paths of the 2 closest NSW SES PMR sites, which are Boundary Road and Mundoonen. The 2 proposed wind farm therefore do not pose an interference issue to linking of these 2 sites.
As for users of NSW SES mobile or portable radios, with any large metallic structures there may be the possibility of local radio interference to users within the boundaries or in the immediate vicinity of those wind farms.

Regards
Mark

P.S - The attached kmz file is used for Google Earth. If you have Google earth installed then when you click on the NSW SES.kmz file it will open Google earth and display the location of all the NSW SES PMR sites

Mark Pilkington - Project Manager
Tait Electronics (Aust) Pty Ltd
186 Granite Street Geebung QLD 4017
Ph (+61) 07 3865 7799 [Ext. 19]
Fax (+61) 07 3856 7990
Email mark.pilkington@tait.com.au
Web www.taitworld.com

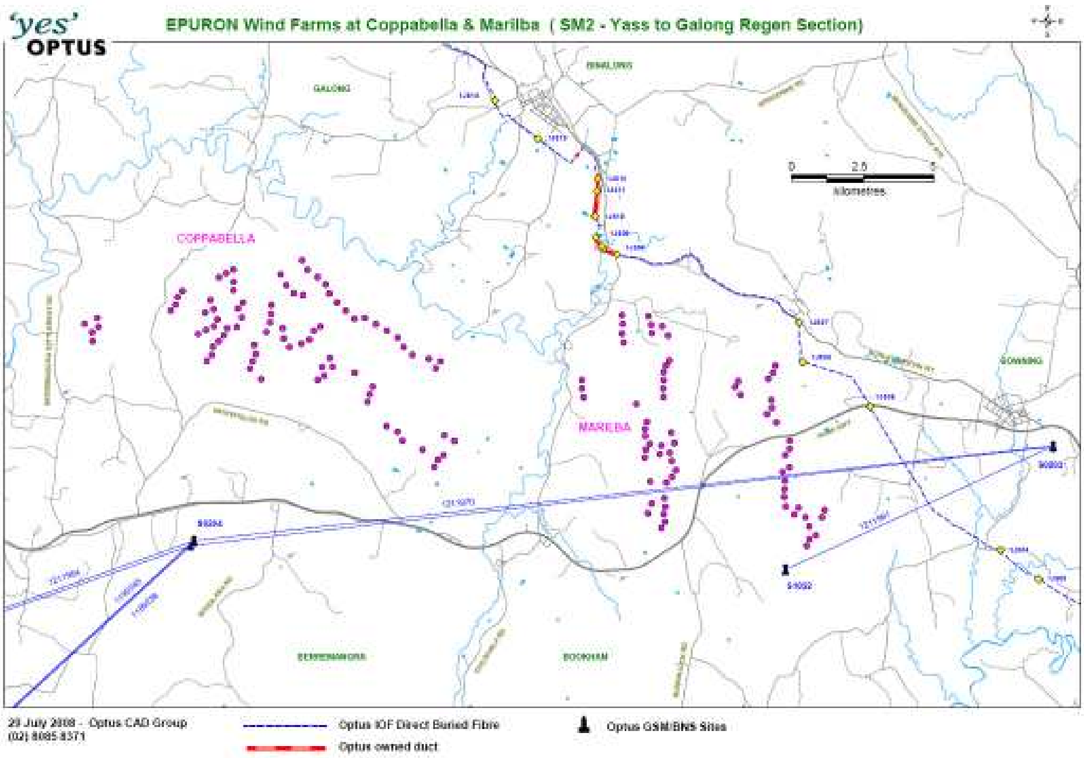
From: Jayantha Wickramasinghe
Sent: Tuesday, 12 August 2008 12:12 PM
To: 'Anthony Micallef'
Cc: Guna Kalugalage
Subject: RE: Notification of Coppabella & Marilbaa Wind Farm proposals - Telecommunications

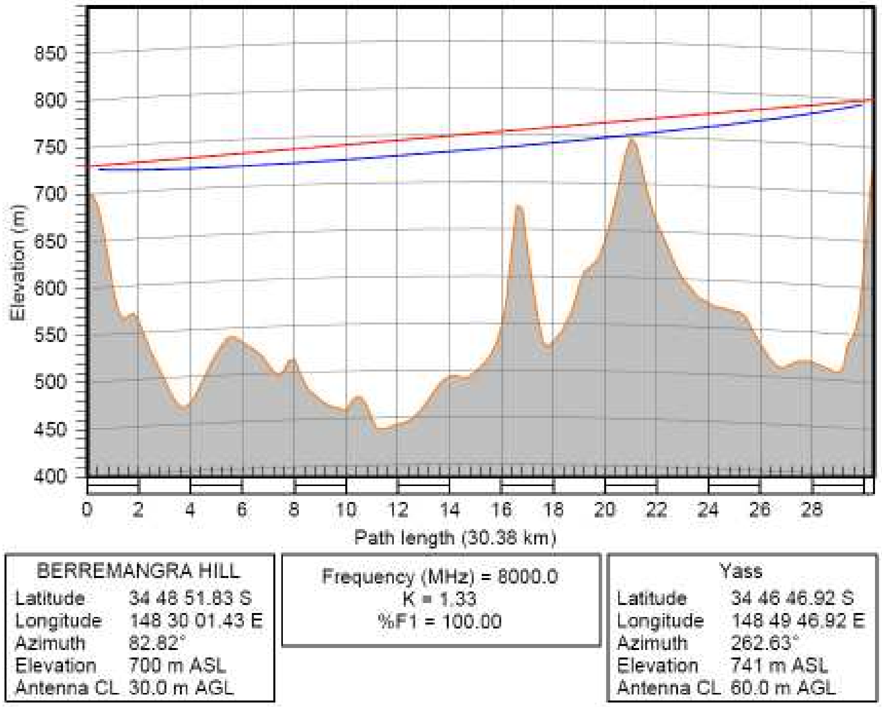
Dear Anthony
The microwave radio link between Optus Mobile sites namely Yass and Berremangra Hill pass through the Marilba wind farm, refer to attached GIS plot, the Mobile deployment advised that Optus doesn't have any options to relocate the radio link or to connect the sites to fibre network and hence the wind turbines must not be obstruct the line of sight path.

Regards
Jayantha

Jayantha Wickramasinghe | Radio Transmission Planning | SingTel Optus Pty Limited | Fixed Networks Engineering | t: +61 2 8082 0353 | m: +61 411 526 668 | f: +61 2 8085 5189 | 1 Lyonpark Road, Macquarie Park NSW 2113 | www.optus.com.au

scanned, stored, or disclosed to others by Optus at Optus' discretion. Optus has exercised care to avoid errors in the information contained in this e-mail but does not warrant that the information is error or omission free.




850
800
750
700
650
600
550
500
450
400
Elevation (m)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
Path length (30.38 km)
BERREMANGRA HILL
Latitude 34 48 51.83 S
Longitude 148 30 01.43 E
Azimuth 82.82°
Elevation 700 m ASL
Antenna CL 30.0 m AGL
Frequency (MHz) = 8000.0
K = 1.33
%F1 = 100.00
Yass
Latitude 34 46 46.92 S
Longitude 148 49 46.92 E
Azimuth 262.63°
Elevation 741 m ASL
Antenna CL 60.0 m AGL

Australian Government
Department of Defence
Defence Support Group

2004/1044160/3
LPSI/OUT/2008/110

Mr Anthony Micallef
Eupuron Pty Ltd
Level 11, 75 Miller St
North Sydney, NSW, 2060

Dear Mr Micallef

RE: PROPOSED 'COPPABELLA' AND 'MARILBA' WIND FARMS WEST OF YASS, NSW

Thank you for referring the abovementioned wind energy projects to the Department of Defence (Defence) for comment. Defence understands that these projects will be located at two sites known as 'Coppabella' and 'Marilba' located approximately 20-30km west of the town of Yass, NSW. Defence further understands that the wind farm projects will consist of a total of 90 wind turbines at Coppabella Wind Farm and 80 wind turbines at Marilba Wind Farm.

As per your letter, Defence has performed its assessment based upon the wind turbines being situated atop 80m towers and using 105m diameter blades. The maximum height at the blade tip zenith will be up to 135m above ground level. As discussed in a phone call on 22 July 2008, Defence has also allowed for 1 wind monitoring mast at each site and associated works (including an electrical substation and overhead wiring to connect with the National Electricity Grid).

Defence has assessed the proposal with respect to any impact on the safety of military flying operations and possible interference to Defence communications and radars.

The proposed development will be outside any areas affected by the Defence (Areas Control) Regulations (DACR). The DACR control the height of objects (both man-made structures and vegetation) and the purpose for which they may be used within approximately 15km radius of Defence airfields. In addition, the proposal has been assessed as unlikely to affect existing Defence communications and radars in the region.

However, it should be noted that tall structures present a hazard to flight safety for low level flying operations. Consequently, there is an ongoing need to obtain and maintain accurate information about tall structures so that risks associated with inadvertent collision by low flying aircraft can be reduced. RAAF Aeronautical Information Service (RAAF AIS) in Melbourne is responsible for recording the location and height of tall structures. The information is held in a central database managed by RAAF AIS and relates to the erection, extension or dismantling of tall structures the top measurement of which is:

a. 30 metres or more above ground level - within 30 kilometres of an aerodrome; or

b. 45 metres or more above ground level elsewhere.

The proposed wind farm development will meet the above definition of tall structure. RAAF AIS has requested that the developer supply them with final design documentation before construction commences. After construction is complete, the Department of Defence requests that the developer provide RAAF AIS with "as constructed" details.

RAAF AIS has a web site with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm which can be used to enter the location and height details of tall structures. Any queries in regard to information about tall structures or the database should be directed to RAAF AIS.

The Civil Aviation Safety Authority (CASA) has produced an Advisory Circular, AC 139-18(0) *Obstacle Marking and Lighting of Wind Farms* dated July 2007, which provides amongst other things, guidance to proponents of wind farms. Wind turbines are tall structures which can be hazardous objects to aviation and AC 139-18(0) outlines measures on how to reduce the hazard including the use of obstacle marking and lighting. In accordance with the AC 139-18(0) CASA will need to be consulted on this proposal determination.

Overall, the Department of Defence has no concerns with the Coppabella Wind Farm and the Marilba Wind Farm at this time. Should you wish to discuss the content of this advice further, please contact Brenin Presswell, Executive Officer, Land Planning on (02) 6266 8128 or by email at brenin.presswell@defence.gov.au.

Yours sincerely

John Kerwan
Director Land Planning & Spatial Information
Department of Defence
BP3-1-A052
Brindabella Park
Canberra ACT 2600

5 August 2008

Cc. DSG - ACT/NSW
RAAF AIS
CASA

Goldenfields WATER County Council

84 Parkes Street (P.O. Box 220)
TEMORA NSW 2666
ABN 54 357 453 921
Telephone (02) 6977 3200
Facsimile (02) 6977 3299
E-mail office@gwcc.nsw.gov.au
ALL HOURS EMERGENCY
1800 800 917

Our Reference: G25406005:PMW

Your Reference:

25 July 2008

Mr Anthony Michallef
Project Manager
Epuron Pty Ltd
Level 11, 75 Miller St
NORTH SYDNEY NSW 2060

Dear Anthony,

Re: Proposed Wind Farm at "Coppabella" and "Marilba"

I refer to your correspondence of 16 July 2008 regarding the above matter. After investigation I can confirm that Council does not believe that the proposed development will have a detrimental impact on its radio communications installation at Beremangera Hill, Beremangera.

I trust the above meets your requirements however should you require any further information please contact Council's Electrical Services Support Officer, Alan Moston on 0427 232 629.

Yours faithfully,

Paul Wearne
General Manager

From: Souksamlane, Kham [mailto:Kham.Souksamlane@team.telstra.com]
Sent: Monday, 28 July 2008 10:29 AM
To: Anthony Micallef
Cc: Kouroushis, Pol; Curtis, Russell J
Subject: RE: EPURON: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Anthony,

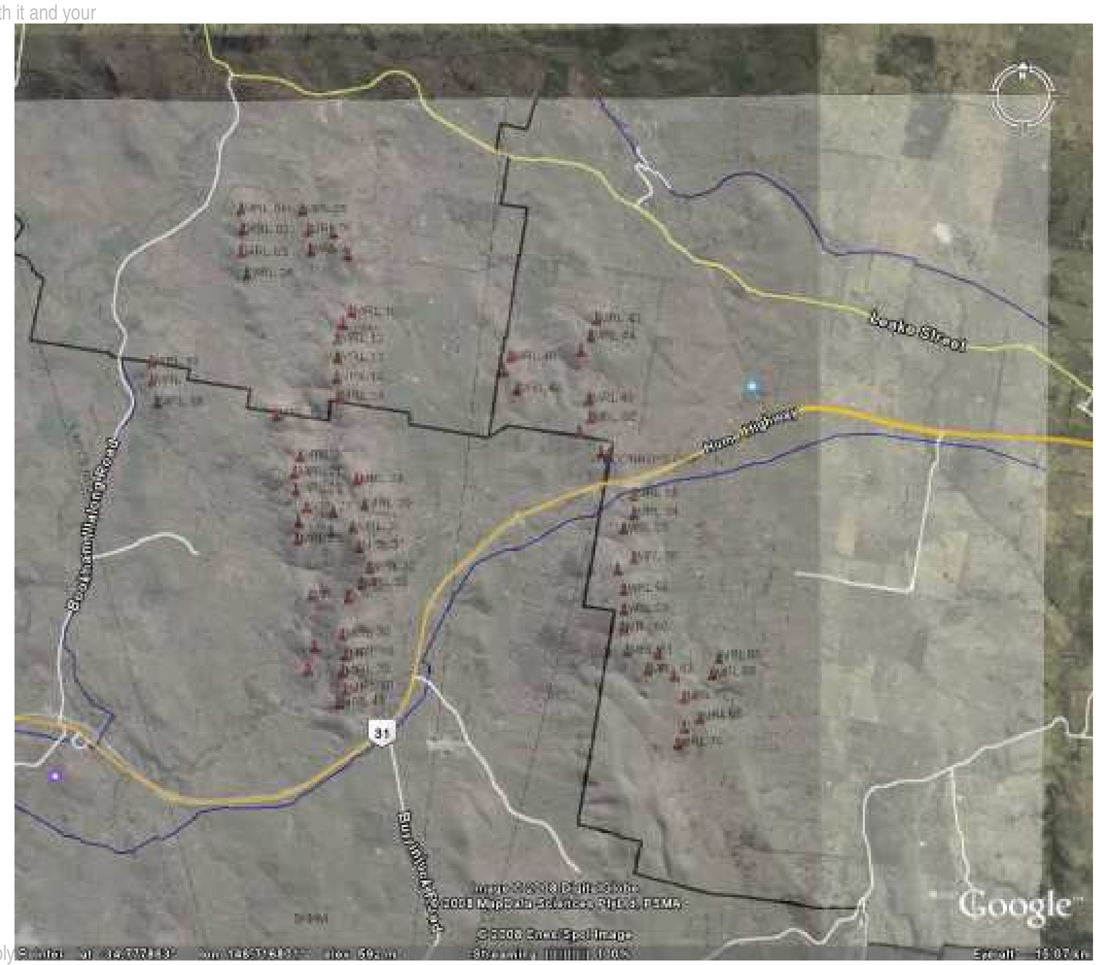
Some of the Marilba wind farm turbines (as supplied) seem to fall outside the indicated Zones (18 Turbines are in the Southern side of the Hume Hwy).
Is this correct ?
If the indicative locations as per the attached map is correct, then there will be no impact on Telstra network.

Regards

Kham Souksamlane
Capacity Planner
Forecasting & Area Planning - NSW
Fundamental Planning
Network & Technology
Telstra Operations
Phone:☎(02) 9397 2068
Fax: (02) 9397 2030
E-mail : Kham.Souksamlane@team.telstra.com

Fundamental Planning -
"Supporting Telstra's Business Success through wise Planning and Investment in the Access Network"

both it and your



reply

From: Jensen, Tim I [mailto:Tim.Jensen@team.telstra.com]
Sent: Wednesday, 30 July 2008 4:09 PM
To: Anthony Micallef
Cc: Barton, Paul L
Subject: NSW GRN & "Coppabella" and "Marilba" proposed wind farm sites.

Dear Anthony

I received your letter dated 15th July 2008, regarding "Coppabella" and "Marilba" proposed wind farm sites.

I work for Telstra, and am engaged in the management and operation of the NSW Government Radio Network (GRN) under contract to the NSW Department of Commerce.

I have reviewed your letter, and determined that the operation of the proposed wind farms at "Coppabella" and "Marilba" will not cause the NSW GRN site at Black Trig (Linbrook Property) any detrimental effects.

I have now forwarded your letter to the NSW Department of Commerce as they may wish to comment on any effects that these proposed wind farms may have on a future microwave network that may be installed to link into this NSW GRN site at Black Trig.

Thank you very much for providing the opportunity to comment on your proposal.

Best regards

Tim Jensen

NSW GRN

Managed Radio & Wireless Solutions
Telstra Enterprise and Government

Phone: (02) 9396 6115
Fax: (02) 9396 6446
Mob: 0418 360 355
L14/320 Pitt St, Sydney 2000 NSW
Locked Bag 6716, Sydney 2001 NSW

From: ALLEN, RICHARD [mailto:RICHARD.ALLEN@casa.gov.au]
Sent: Tuesday, 22 July 2008 9:03 AM
To: Anthony Micallef
Subject: FW: Notification of Coppabella & Marilba Wind Farm proposals - CASA [SEC=UNCLASSIFIED]

Anthony

The advice I have been given by CASA Central Office is as follows:.

" - CASA's interest in tall structures relates to the possible hazard to aircraft that the structures could pose.

- Under existing legislation, a person who proposes to construct a building or structure, the top of which will be 110 metres or more above ground level, is required to notify CASA of such development. Civil Aviation Safety Regulations 1998 (CASR) Part 139, **Subpart 139E Obstacles and hazards**, is available on our Web Site at http://www.casa.gov.au/rules/1998casr/139/139casr.pdf .

- CASA has published an Advisory Circular **AC 139-18(0)** titled **Obstacle Marking And Lighting of Wind Farms**. The purpose of the advisory circular is to provide general information and advice to proponents of wind farms and planning authorities with jurisdiction over the approval of such developments. It explains the possible hazardous nature of wind farms to aviation activity, indicates the regulations that are applicable, and provides advice on how the hazard to aviation can be reduced. The usual expectation of wind farms with turbines exceeding 110 metres in height, is that the wind farm should be equipped with obstacle lights in accordance with the Advisory Circular, to reduce the hazard to aviation. AC 139-18(0) is available on our Web Site at: http://www.casa.gov.au/rules/1998casr/139/139c18.pdf .

- You indicate that the total height above ground of your turbines, tower plus blade, will be approximately 135 m. As your turbines will exceed 110 m above ground level, CASA considers that they will likely be hazardous to aviation. You can reduce the hazard by providing obstacle marking and lighting in accordance with our Advisory Circular. If your turbines are located such that they penetrate the Obstacle Limitation Surface of an aerodrome, you should also advise that aerodrome of your proposal. See subsection 5.3 of the Advisory Circular.

- In due course, you should forward to CASA a scale drawing showing the layout of turbines, clearly indicating which turbines you propose to equip with obstacle lights complying with the Advisory Circular. The scale should be sufficient for CASA to be able to determine longitudinal separation of turbines. You should also include data on turbine height and ground level, so that the turbines that extend furthest into the airspace above your wind farm are identified.

- Airservices Australia also has an aviation interest in proposed wind farms, including possible adverse effects on defined air traffic routes, lowest safe altitude, and Radar interference. You should advise Airservices Australia of this proposal, if you have not already done so, by the following contact:

Mr. Joe Doherty
Manager, Airport Relations
Airservices Australia
GPO Box 367
CANBERRA ACT 2601
joseph.doherty@airservicesaustralia.com "

Please let me know if you have any further questions
Regards

Richard Allen

Aerodromes Coordinator
Phone 131 757 Ext. 3129
Fax 02 9669 6151
GPO Box 2005 Canberra 2601

NSW **National Parks and Wildlife Service**

Our reference: DOC08/33228
Enquiries: Andrew Grant (02) 6947 7006

Epuron Pty Ltd
Attn: Mr A Micallef
Level 11, 75 Miller St
North Sydney
NSW **2060**

Dear Anthony,

Re: 'Coppabella' & 'Marilba' Wind Farms

I am writing in response to your letter dated 15 July 2008 regarding the proposed development of wind farms at 'Coppabella' & 'Marilba' near Yass, NSW, and the Department of Environment and Climate Change (DECC) communications site on Black Range Trig (Site ID 9519).

DECC has radio base equipment located in the NSW Roads and Traffic Authority facility located at Black Range Trig. Following a review of the proposed wind farm location DECC do not believe there will be any impact on our radio service.

Please feel free to contact me on (02) 6947 7006 or mobile 0427 469 383 should you need any further information. Alternatively my e-mail is: andrew.grant@environment.nsw.gov.au

Yours sincerely,

Andrew Grant
Senior Ranger Fire
For: Steve Horsley
South West Slopes Regional Manager
Parks Wildlife Division

The Department of Environment and Conservation NSW is now known as the Department of Environment and Climate Change NSW

PO Box 472, TUMUT NSW 2720
7A Adelong Road, TUMUT NSW 2720
Tel: (02) 6947 7000 Fax: (02) 6947 4170
ABN30 841 387 271
www.environment.nsw.gov.au

Department of **Environment and Climate Change** NSW

Telecommunications and Aviation Navigation Services Assessment

Yass Valley Wind Farm –

Marilba Hills Precinct

May 2009

1 EXECUTIVE SUMMARY

The objective of this report is to investigate the potential impacts of the Marilba Hills Precinct, part of the Yass Valley Wind Farm, on existing telecommunications services in the vicinity of the proposal and to propose appropriate mitigation strategies for any impacts identified.

Telecommunication services, including television, radio, mobile phone services and other radio communication services occur in proximity to population centres and often utilise the ridgelines that provide optimum locations for wind turbines. As with any large structure, wind turbines have the potential to cause interference with such signals.

In general, VHF and UHF frequency band radio signals, and digital voice based technologies such as GSM mobile, are essentially unaffected by wind turbines. This includes land mobile repeaters, radio, the audio component of analogue television and mobile phones.[1]

Following a review of the radio communication services near the wind farm site, the nature of potential interference and consultation with the service providers, it is considered that the wind farm would have minimal effect on telecommunications services. Mitigation strategies are proposed to ensure any impacts can be managed and mitigated.

2 GLOSSARY OF TECHNICAL TERMS

VHF	Very High Frequency
UHF	Ultra High Frequency
EMI	Electromagnetic Interference
VHF Channels	TV Channels 0 to 12 (45 - 230 MHz)
UHF Channels	TV Channels 28 - 46 (526 - 820 MHz)
Band 111	VHF TV Channels 5A - 12
Fresnel Clearance	Clearance to obstructions from the ray line on a radio path which does not produce any additional loss above free space loss
FM	Frequency Modulation
MF	Medium Frequency
LF	Low Frequency
GSM	Global Systems Mobiles
CDMA	Code Division Multiple Access cellular mobile system
ITU	International Telecommunications Union
ABA	Australian Broadcasting Authority
ACMA	Australian Communications & Media Authority
CB Radio	Citizens Band Radio

[1] http://www.dungog.nsw.gov.au/files/2142/File/GreenpowerEMIAnalysisIssue.pdf

3 EXISTING ENVIRONMENT

Marilba Hills Precinct site

A review of telecommunication technologies that are in use within the area surrounding the proposed Marilba Hills Precinct has identified the following:

- TV and radio broadcasting
- Mobile phone services provided by telecommunication companies
- Radio communication systems, including point to point microwave links, licensed by the Australian Communications and Media Authority (ACMA)
- Other radio links including mobile radio, CB radio; and
- Aircraft navigation systems

Electromagnetic Interference (EMI) has the potential to cause degradation or total loss of signal strength and may cause poor TV reception and/or “ghosting” effects. EMI may also result in a reduction in the coverage of mobile phone, radio and aircraft navigation communications in certain instances. There are three principal mechanisms by which wind turbines may cause EMI: reflection or scattering, diffraction and near field effects.[2]

---

[2] D. F. Bacon, A Proposed Method for Establishing an Exclusion Zone around a Terrestrial Fixed Link outside of which a Wind Turbine will cause Negligible Degradation of the Radio Link, Radiocommunications Agency UK Report Ver 1.1, 28 Oct 2002

Reflection or scattering

When a signal sent between a transmitter and receiver becomes obstructed by an object located within the path of a signal, reflection and/or scattering may occur. If the rotating blade of a wind turbine receives a primary transmitted signal, a scattered time delayed (or out of phase) signal may be produced and transmitted to the receiver. The out of phase signal will be distorted in relation to the primary signal, causing EMI.[3]

Diffraction

In some instances when an object is located in the path of a signal wave front, the object can both reflect and absorb the signal. This phenomenon is commonly referred to as diffraction.[4]

Near field effects

Wind turbines may cause interference to radio signals due to the electromagnetic fields emitted by the generator and the switching components within the turbine nacelle. This is referred to as a near field effect.[5]

Due to advances in technology and compliance with the Electromagnetic Emission Standard, EN 61000-6-4 (AS/NZ 4251.2:1999) *Emission standard for industrial environments*, the wind turbines proposed for the project will not cause active EMI due to near field effects.

The level of EMI produced by a wind turbine due to reflection or scattering, diffraction and near field effects is dependant on a number of factors, including placement of the wind turbine in relation to the signal path/s; the signal frequency; the characteristics / composition of the wind turbines rotor blades; the receiver characteristics; and the propagation characteristics of the radio wave in the local atmospheric conditions.[6]

While the site proposed for the development of the wind farm is a rural area, a number of communications links and broadcast networks are present in the surrounding region.

As with any large structure, there may be circumstances where wind turbines can cause disruption to the electromagnetic signals used in a variety of commonly used radar, navigation and telecommunications services. The following approach was adopted to identify the impact of the proposal on telecommunications:

- Identify license holders within a 25km radius of the proposed wind farm site, and point-to-point links in the vicinity of the site, using information provided on the ACMA RADCOM database;
- Provide written notification of the proposal and seek comments from each license holder identified via the ACMA RADCOM database within a 25km radius of the site;
- Record and review all responses received to identify any issues raised by license holders;
- Discuss issues raised with relevant license holder with the aim to resolve or identify mitigation options;

[3] URS Woodlawn Wind Farm Environmental Impact Statement 2004
[4] *Ibid.*
[5] *Ibid.*
[6] *Ibid.*

- Carry out an assessment of the “Fresnel zone” associated with each fixed point-to-point communications link in the vicinity of the site;
- Determine appropriate exclusion zones for proposed turbine layout based on Fresnel zone calculations and advice from license holders;
- Confirm that all turbines (including blades) are located outside the exclusion zone;
- Determine appropriate additional mitigation measures which may be required.

3.1 Impact assessment

The possible impact of the proposed Yass Valley Wind Farm on the four most common communications services has been investigated separately. These services are television and radio broadcast services, mobile phone services, radio communication services and aircraft navigation services.

Any impacts would be confined to the *operational phase* of the wind farm. Various measures are available to help mitigate potential impacts and are discussed below.

4 TELEVISION AND RADIO BROADCAST SERVICES

4.1 Existing services and facilities

The ACMA RadCom database lists the following broadcasters for television and radio, under postcode 2582, Yass.

Television broadcasting:

Southern New South Wales TV1: ABC, CBN, CTC, SBS and WIN.

Radio broadcasting:

Canberra RA1: 1ART, 1CBR, 1CMS, 1WAY, 1XXR, 2ABCFM, 2CA, 2CC, 2CN, 2JJJ, 2PB, 2RN, 2ROC, 2SBSFM

Canberra RA2: 1RPH

Goulburn RA1: 2ABCFM, 2ABCRN, 2ABCRR, 2GN, 2JJJ, 2RN, 2SNO.

Yass RA1: 2YAS

The ACMA RadCom database lists the following broadcasters for television and radio, under postcode 2584, Binalong.

Television broadcasting:

Southern New South Wales TV1: ABC, CBN, CTC, SBS and WIN.

Radio broadcasting:

No radio broadcasters listed.

Canberra (Black Mountain) is the nearest TV transmission source for the locality of the proposed Marilba Hills Precinct. Black Mountain is approximately 50km South East of the wind farm site. Details of the Canberra television channels are provided in the table below.

Broadcaster	Channel	Band	Frequency (MHz)
Capital (CTC)	6	VHF	177.5
Capital (CTC)	7	VHF	182.258
ABC	9	VHF	196.26
ABC	9A	VHF	205.625
SBS	28	UHF	527.26
SBS	30	UHF	543.5
WIN	11	VHF	219.5
WIN	31	UHF	548.198
Prime (CBN)	12	VHF	226.5
Prime (CBN)	34	UHF	569.198

License holders identified via the ACMA RadCom database within a 25km radius of the wind farm were notified of the proposal in relation to potential impacts and asked to provide comments.

At the time of writing, no concerns had been raised from the license holders contacted regarding possible impacts to television or radio broadcasting services. EPURON will work with organisations to resolve any issues, should any be identified.

4.2 Television broadcasting

4.2.1 Interference and impact analysis

Television Interference (TVI) is dependent on a range of factors including environmental factors (topography, direct signal strength, transmitter type, and receiver type) and wind farm design factors (turbine elevation, rotor size and orientation, speed of rotation, blade material and pitch). TVI caused by the operation of wind turbines is characterised by video distortion, while the audio component of the signal is not affected.[7] Due to the variability of local conditions and the characteristics of antennae used in particular installations, there is a degree of uncertainty regarding predicted levels of interference.

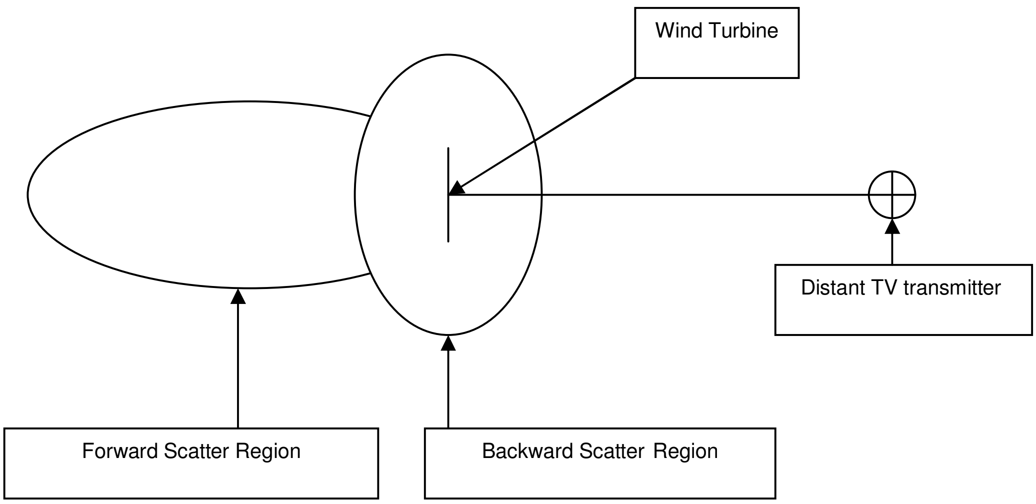
The level of TVI can be influenced by a number of factors including:

- Where the receiver is located, relative to the TV transmitter and the wind farm;
- The frequency of the transmitted TV signal;
- Whether there are any other tall structures in the vicinity of the receiver;
- The direction of the rotor blades and blade material;
- The nature of the receiving aerial e.g. design, height, directionality, power.

[7] David E Spera, Wind Turbine Technology, Chapter 9 ASME Press 1994

In general, the potential for interference at receiver locations can increase with distance of the receiver from the transmitter, as signal strength decreases with increasing distance from the source. As such, a wind farm in an area of already poor signal strength may potentially have a greater impact on reception than the same wind farm in an area of relatively strong signal strength. In addition, reception in the vicinity of the wind farm can vary with the degree of topographic obstruction of the signal.

A wind turbine has the potential to scatter analogue television waves both forward and back. Forward scatter will only occur if a wind turbine is located approximately between the dwelling and the broadcast site. The forward scatter region is as shown in the figure below, and generally does not extend further than 5 km for the worst combination of factors. Interference may extend beyond 5 km if the dwellings are screened from the broadcast tower, but do have line-of-sight to the wind turbines. The effect of the forward scatter is to potentially cause the brightness of the television picture to vary with the rotation of each blade. Modern television sets usually incorporate Automatic Gain Compensators (AGC) which act to lessen or eliminate variations in picture gain or brightness. [8]



Schematic diagram of potential analogue television signal interference zones around a wind turbine[9]

The zone of potential interference for a wind farm is the resultant total of the effects from the individual turbines. The International Telecommunications Union Recommendation ITU-R BT.805 states that impacts beyond 5 kilometres are unlikely.[10]

It also indicates that interference may extend beyond 5km where the receiver location is shielded from the direct signal, but in direct line-of-sight to the turbine. The form of interference, if experienced, will depend on the relative positions of the wind farm, the transmitting station and the receiver.

---

[8] http://www.dungog.nsw.gov.au/files/2142/File/GreenpowerEMIAnalysisIssue.pdf

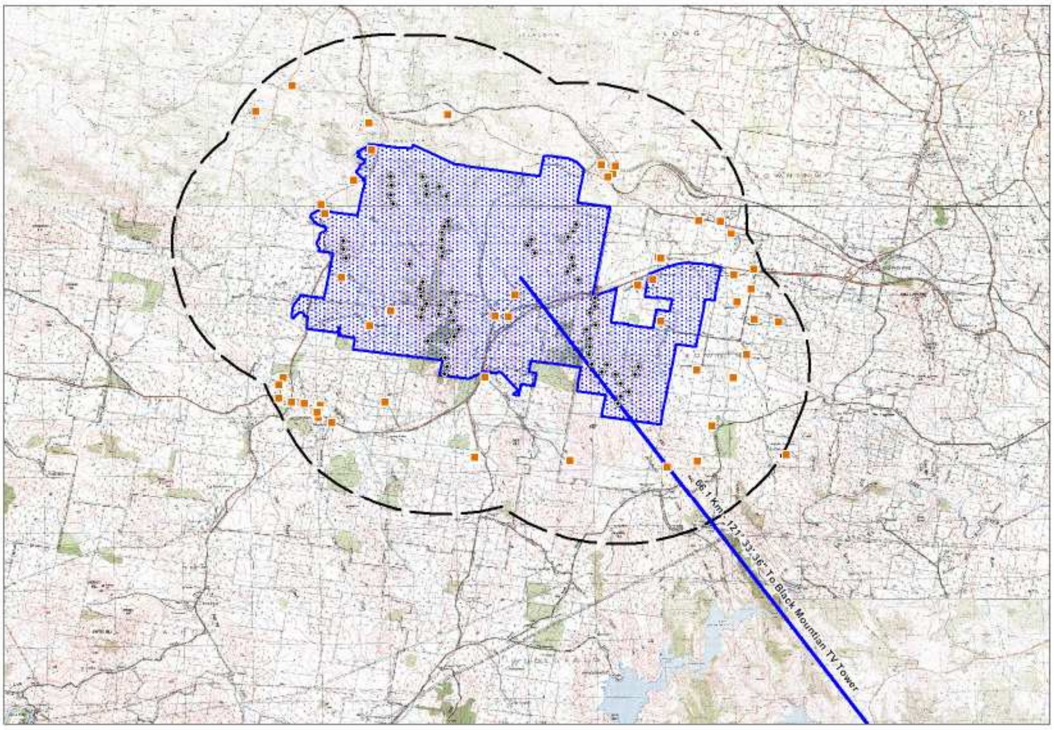
[9] Reproduced from the Connell Wagner PPI Gunning Wind Farm Environmental Impact Statement - Chapter 11.

[10] Crookwell II Wind Farm – Environmental Impact Statement - URS

Television interference can take the form of either a “ghost” image that pulsates horizontally at the “blade pass” frequency or a fluctuation in picture brightness, also at the “blade pass” frequency.[11]

Approximately 80 houses were identified within a 5km radius of the proposed wind farm site boundary. The location of the wind farm with respect to the Black Mountain communications tower can be seen in the following diagram.

4.2.2 House and television tower locations



It is difficult to assess the likely impact on these specific house locations and once the wind farm is operational it is possible that television reception could be affected at some of these locations unless some form of mitigation is introduced. However, houses further than 5km from the site are unlikely to be affected.

4.3 Mitigation measures

In the design of the project, the proponent will carry out the following mitigation measures to help minimise TVI:

- Use of primarily non-metallic turbine blades;
- Use wherever practical of equipment complying with the Electromagnetic Emission Standard, AS/NZS 4251.2:1999;

[11] Connell Wagner Delta Electricity Gunning Environmental Impact Statement 2004

Once the wind farm is operational, the proponent will offer to undertake a monitoring program of houses within 5km of the wind farm to determine any loss in television signal strength if requested by the owners. In the event that TVI is experienced by existing receivers in the vicinity of the wind farm, the source and nature of the interference will be investigated by the proponent.

Should investigations determine that the cause of the interference can be reasonably attributable to the wind farm; the proponent will put in place mitigation measures at each of the affected receivers in consultation and agreement with the landowners.

Specific mitigation measures may include:

- Modification to, or replacement of receiving antenna;
- Provision of a land line between the effected receiver and an antenna located in an area of favourable reception;
- Improvement of the existing antenna system;
- Installation of a digital set top box or,
- In the event that interference cannot be overcome by other means, negotiating an arrangement for the installation and maintenance of a satellite receiving antenna at the proponents cost.

4.4 Satellite pay television

Some homesteads in the area may have satellite pay TV service antenna installations.

Unless a particular subscriber's antenna reception direction and elevation is aligned with a turbine, no impacts on TV reception are likely.[12]

4.5 Radio broadcasting

The level of radio broadcast interference experienced can be influenced by a variety of variables including:

- Abnormal weather conditions;
- Multi-path distortion (reception of a signal directly from a transmitter and also a reflected signal from hills, structures etc.);
- Overloading (occurs when an FM receiver receives too strong a signal);
- Electrical interference from household appliances etc;

4.6 FM sound broadcasting

Low power national FM stations on 107.7 & 106.9MHz are listed on the Wades Hill TV site at Crookwell. National, community and commercial services on 101.5, 102.3, 105.5, 104.7, 98.3, 99.1, 92.7, 91.9, 91.1, 106.3 and 103.9MHz are located on Black Mountain.[13][14]

---

[12] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

[13] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

4.7 MF sound broadcasting

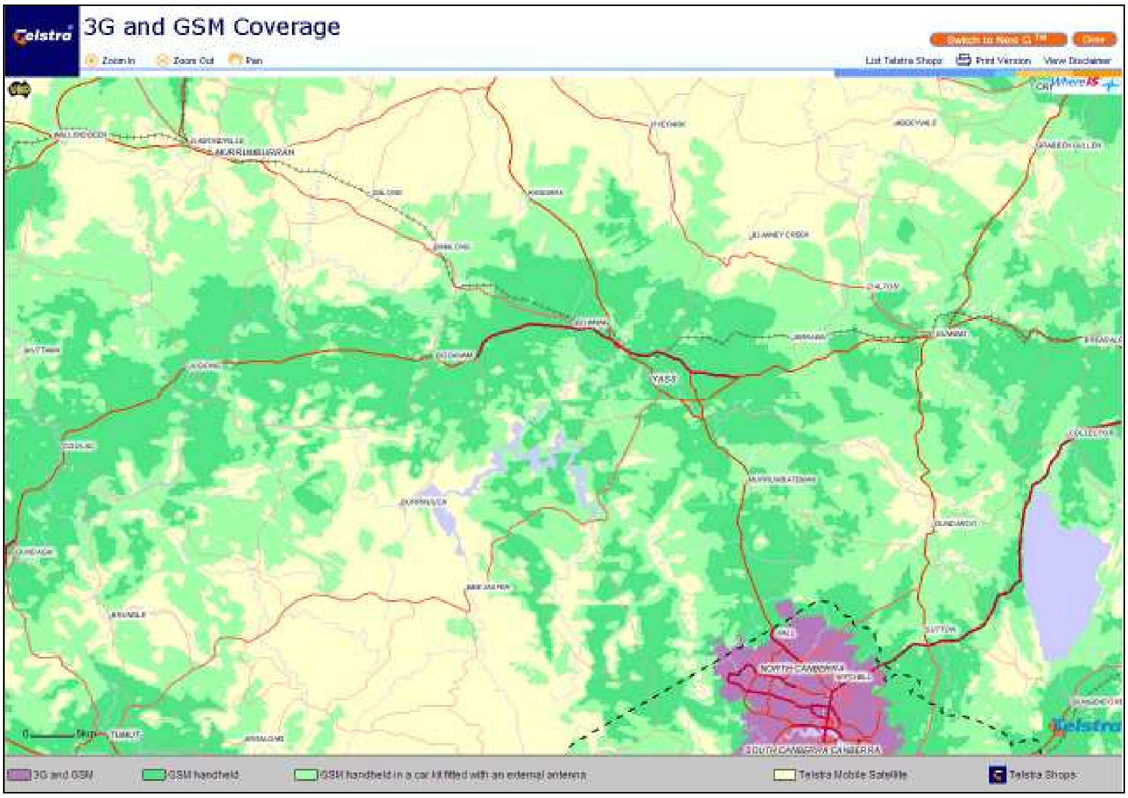
Wind farm effects on MF radio are highly unlikely and therefore the stations serving the area have not been listed.[15]

5 MOBILE PHONE SERVICES

5.1 Existing services and facilities

This section covers GSM (2G) and 3G services (high frequency communications links used for mobile transmission networks are discussed in the next section: Radio Communication Services).

Figures below show the existing local mobile phone coverage from the three providers (Source: company websites)

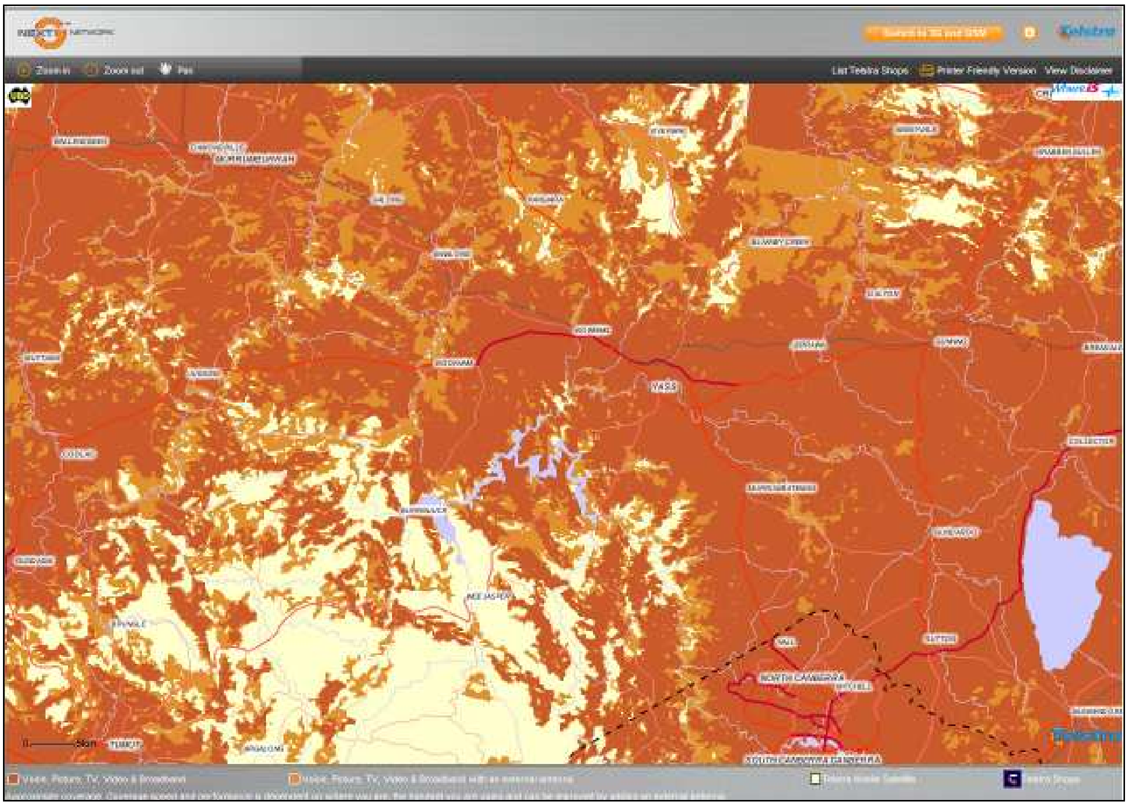


Telstra 3G and GSM (2G) Coverage

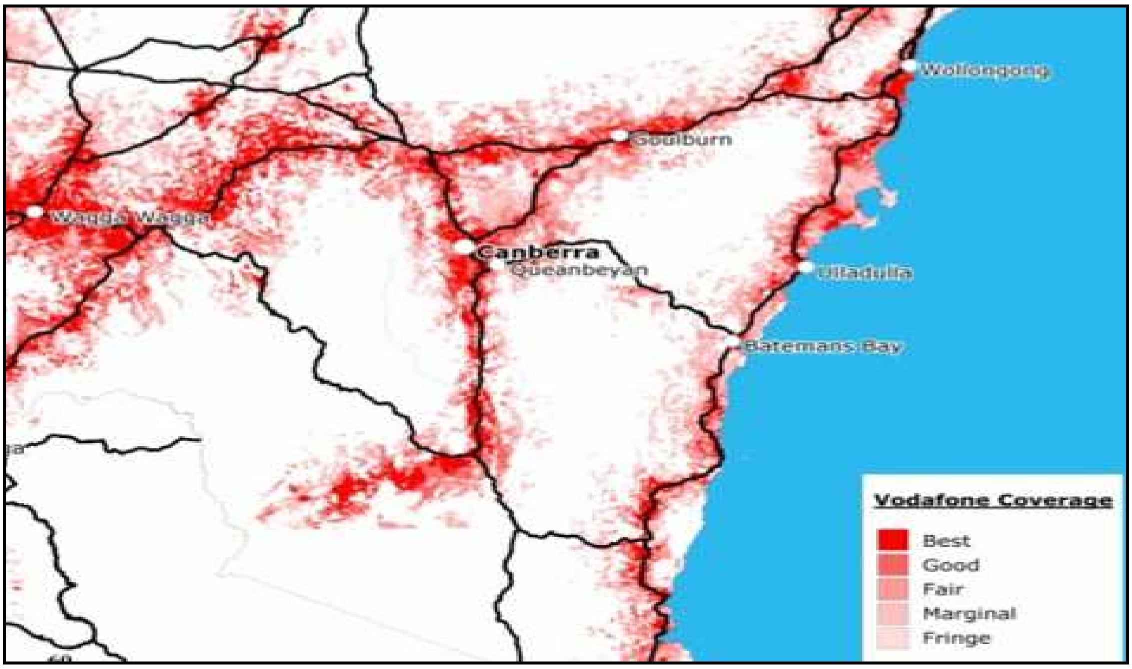
---

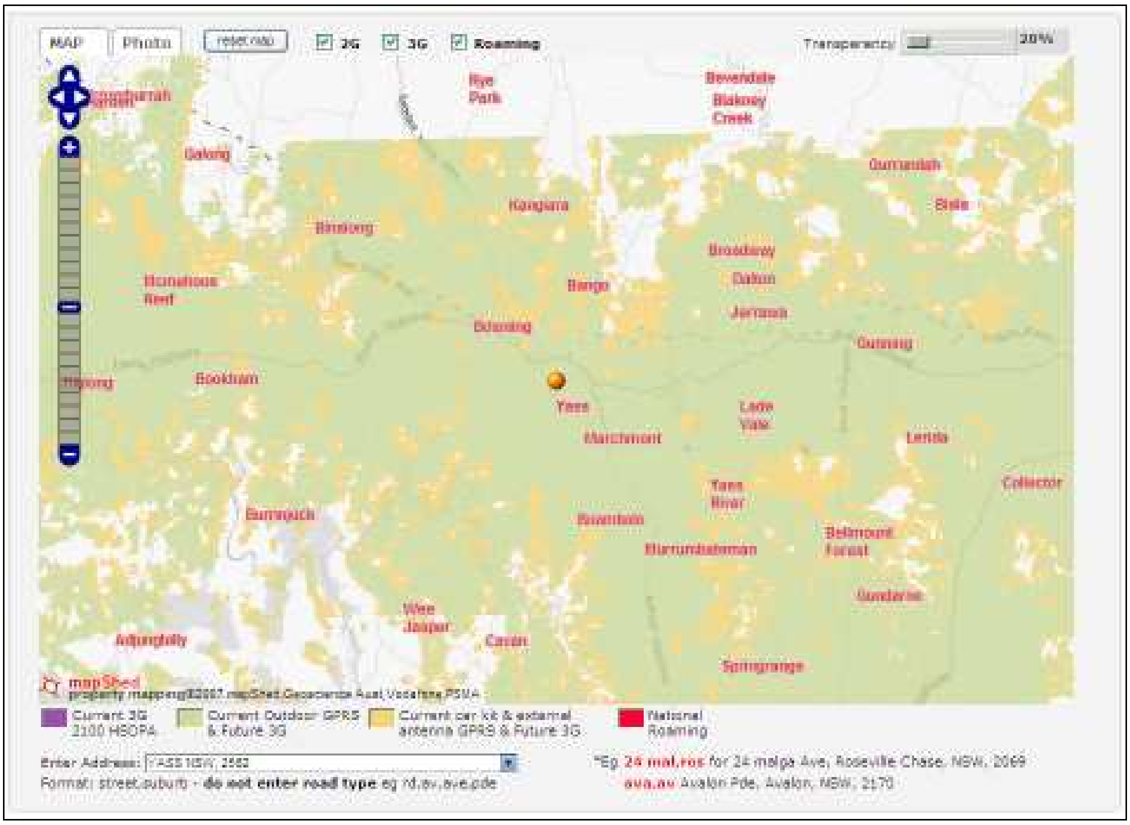
[14] http://www.ausradiostations.com/fmact.html and http://www.ausradiostations.com/fmnsw.html

[15] *Ibid*



Telstra Next G Coverage





Vodafone GSM Coverage

Optus GSM (2G) Coverage

5.2 Interference and Impact Analysis

A mobile phone network consists of a system of adjoining zones called ‘cells’, which vary in size with a radius of 2 - 10 km. Each cell has its own base station that sends and receives radio signals throughout its specified zone. Mobile phone antennas need to be mounted clear of surrounding obstructions such as buildings to reduce ‘dead spots’ and allow the base station to effectively cover its intended cells. [16]

The ACMA RadCom Database identified three mobile phone companies as using base stations within the vicinity of the proposed wind farm. The table below lists the companies and ACMA site ID numbers.

Mobile Phone Companies	ACMA Site ID No.
Optus Mobile Pty Ltd / Singtel Optus Pty Ltd	201821, 55601, 198028
Telstra Corporation Ltd	130627, 9515, 55601, 9518, 131404, 131407, 101537,38513, 100784
Vodafone Network Pty Ltd	201821, 198028

[16] URS Crookwell II Wind Farm Environmental Impact Statement ,

All companies were contacted by EPURON regarding potential impacts and asked to provide feedback as to any potential conflicts with their existing networks.

5.3 Mitigation measures

No GSM/CDMA mobile services are registered at sites in the close vicinity of the wind farm. The Telstra mobile service from Wades Hill, Crookwell is too distant to be affected by the wind turbines[17] Telstra no longer operates its CDMA network.

No additional mitigation measures are required.

6 RADIO COMMUNICATION SERVICES

6.1 Existing services and facilities

The Australian Communication and Media Authority (ACMA) issues radio communications licenses in accordance with Part 3.5 of the Commonwealth Radiocommunications Act 1992. The ACMA issues licenses to use specific segments of the radio broadcasting frequency spectrum for different purposes and maintains a register (the ACMA RadCom Database) of all the licenses issued.

The register allows the ACMA to create a 'density' classification of areas across Australia as high, medium or low depending on the number of licenses in operation in a particular area. According to the ACMA RadCom Database, the area in the vicinity of the proposed wind farm is classified as a "Low Density Area".

According to the ACMA RadCom Database, license holders operate a range of radio communications services, primarily fixed link microwave communication and mobile communication systems within a 25km radius of the proposed wind farm. Multiple license holders use some sites, while sole users employ others.

Radio communication license holders within 25km of the Marilba Hills Precinct

(Latitude -34 46 52.81, Longitude 148 40 57.9)

ACMA Licence Holder	ACMA Site ID No.
Airservices Australia	9001816, 34921
Ambulance Service of New South Wales	34921
Australian Capital Television Pty Ltd	9514
Commissioner of Police NSW Police	55601,35851, 34921, 198028
Country Energy	36149, 9542, 34921
Department of Environment and Conservation	9519

[17] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

ACMA Licence Holder	ACMA Site ID No.
Goldenfields Water County Council	198028
Harden Shire Council	9542
NSW Department of Commerce – Government Chief Information Office	201821
NSW Department of Primary Industries	40307
NSW Rural Fire Service	9519, 34897, 9542
NSW State Emergency Service	201458
NSW Volunteer Rescue Association	39030,34921
Optus Mobile Pty Ltd	201821, 55601, 198028,
Prime Television Southern Pty Ltd.	9514
Roads and Traffic Authority of NSW	9519
Robinvale District Health Services	304511
Singtel Optus Pty Ltd	201821, 55601, 198028
Telstra Corporation Ltd	130627, 9515, 55601, 9518, 131404, 131407, 101537,38513, 100784
The Info Radio Network Pty Ltd	55601, 198028
TransGrid	34921
Vodafone Network Pty Ltd	201821, 198028
W. S Gregory & Associates Pty Ltd	9519
Yass Valley Council	9519

6.2 Interference and Impact Analysis

A fixed link radio transmission is a point-to-point transmission path typically between two elevated topographical features. The transmission path may become compromised if a wind farm is located within the direct line-of-sight or what is known as the 'Fresnel Zone' around the line of sight between the sending and receiving antennae.

The potential impact zone will vary with the distance between the transmitter and receiver, frequency of transmission and the location of any particular point along its path. Communications are only likely to be affected if a wind farm is in the line-of-sight between two sending and receiving antennae or within a zone of the line-of-sight of these antennae.

Where a potential exists for interference to line-of-sight links, an obstruction analysis can be undertaken to ensure that no part of a wind turbine assembly will enter the Fresnel Zone of the microwave link. The maximum extent of the Fresnel zone occurs at the midpoint along the path of the microwave link.

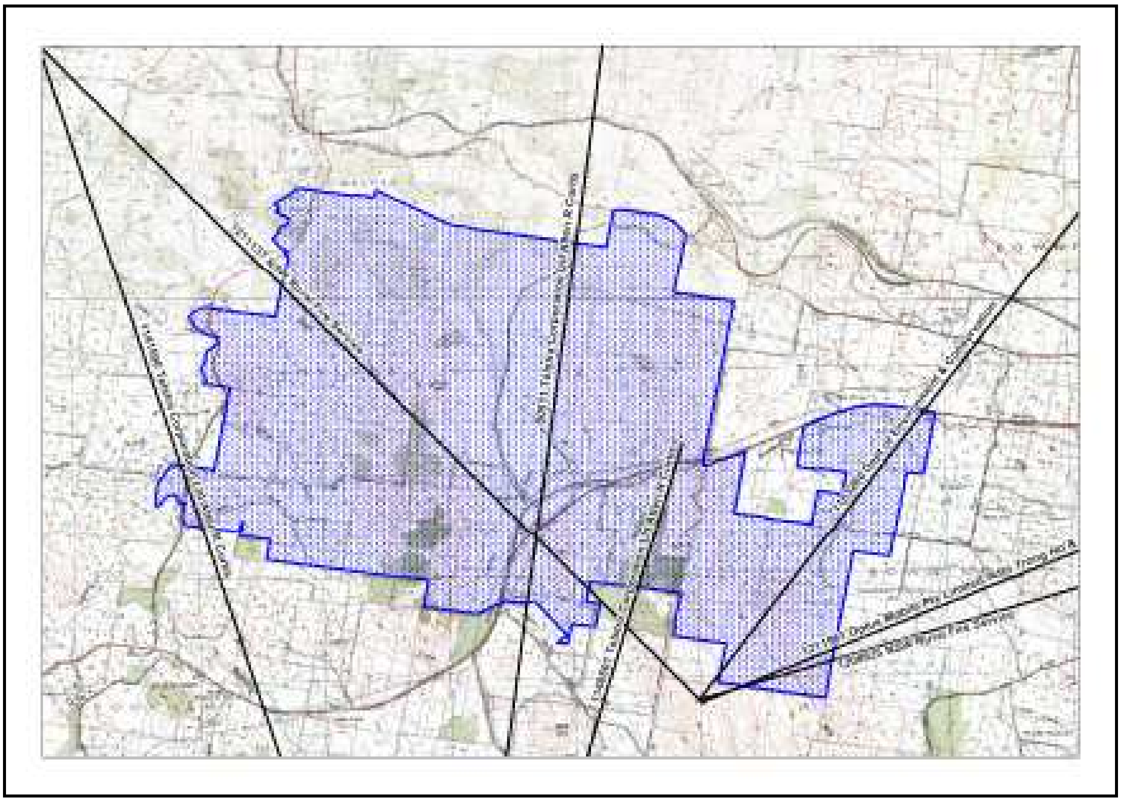
EPURON identified and mapped the point-to-point communication links in the vicinity of the proposed wind farm site to establish the line-of-sight path.

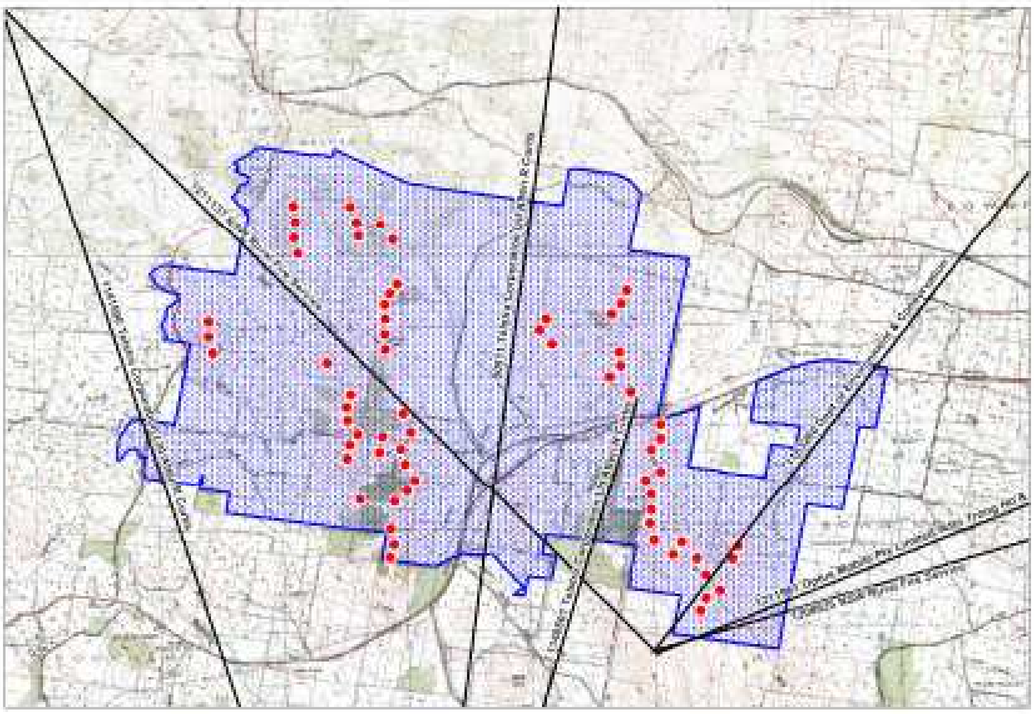
The figure below provides details of the locations of fixed microwave links around the site. (Prepared by EPURON based on data contained in the ACMA RadCom database.)

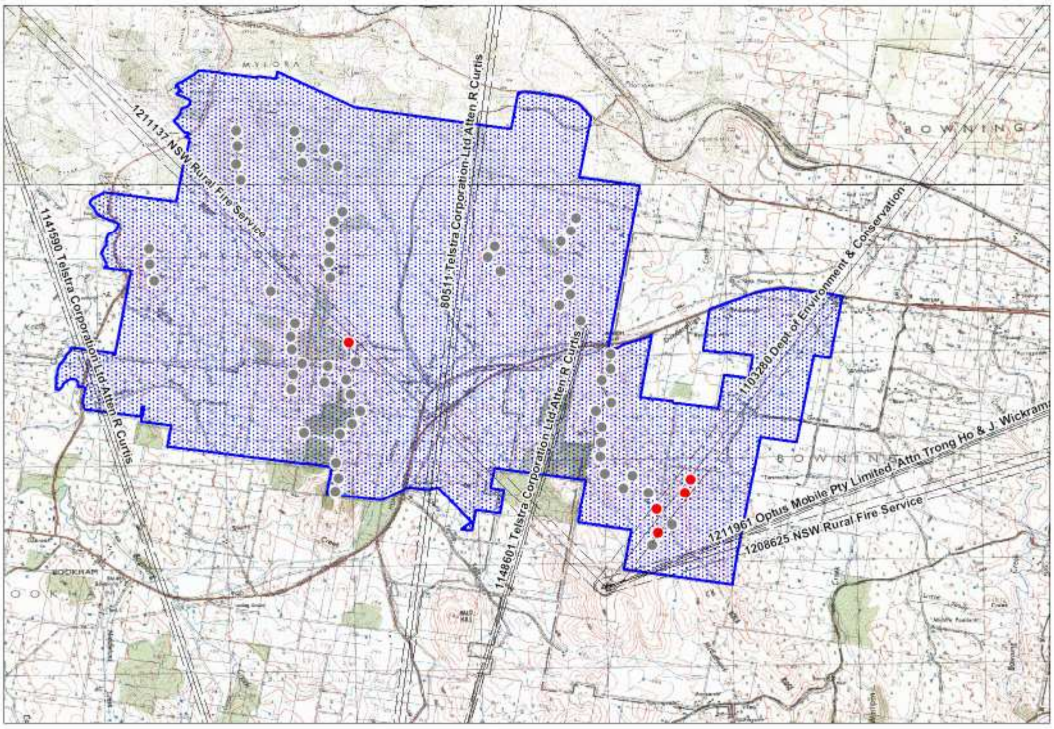
In order to ensure that no obstruction to transmission paths occurs, calculations of the 2nd Fresnel Zone of the point-to-point communications links in proximity to the site were undertaken. It is suggested that beyond the 2nd Fresnel Zone the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver (Bacon 1999).

In order to determine whether a radio link could be affected by the wind turbines, EPURON defined an ‘exclusion zone’ beyond which the level of interference will not disrupt the radio link, based on the concept of the Fresnel Zone, as previously described.

The following point-to-point links were identified in the vicinity of the site.






1211137 NSW Rural Fire Service
1141590 Telstra Corporation Ltd Attn R Curtis
80511 Telstra Corporation Ltd Attn R Curtis
1148601 Telstra Corporation Ltd Attn R Curtis
1211961 Optus Mobile Pty Limited, Attn Trong Ho & J. Wickrama
1208625 NSW Rural Fire Service

6.3 Radio communication links

In order to ensure that no obstruction to transmission paths occurs, calculations of the 2nd Fresnel zone of the point-to-point communications links in proximity to the site were undertaken.

It is suggested that beyond the 2nd Fresnel zone, the power of a scattered signal from a structure such as a wind turbine would be small enough such that it would not result in significant interference at the receiver.[18].

At the time of writing, seven point-to-point communications links were identified as crossing the site.

A link between "Australian Space Office Site Mt Canemumbola Boorowa" and "Telstra Site Mt Carroll", (License No 80511) operated by Telstra Corporation, passes across the site. This link operates at 1.0 GHz. (54.73km)

A link between "Commsite Black Trig" and "Comm Site 12km SE of Bigga Snowy Mountain", (License No. 1103280) operated by the Department of Environment and Conservation, is shown as passing across the site. This link operates at 404.25 MHz. (86.68 km)

A link between "Commsite Black Trig" and "Commsite Mt Mary", (License No. 1208625) operated by the NSW Rural Fire Service, is shown as passing across the site. This link operates at 404.35 MHz. (60.36 km)

A link between "Vodafone Linbrook Property Black Trig" and "Bowning Hill Trig Yass", (License No. 1211961) operated by Optus Mobile Pty Ltd, is shown as passing across the site. This link operates at 1 GHz. (10.37 km)

A link between "Commsite Black Trig" and "Shire Council Site Boundary Rd 7km SSE", (License No. 1211137) operated by the NSW Rural Fire Service, is shown as passing across the site. This link operates at 404.875 MHz. (64.41 km)

A link between "Telstra Site Mt Carroll" and "Commsite Mt Bobbara", (License No. 1141590) operated by Telstra Corp, is shown as passing across the site. This link operates at 1.0GHz. (31.56 km)

A link between "Telstra Site Mt Carroll" and "Telstra Site Conroys Gap", (License No.1148601) operated by Telstra Corp, is shown as passing across the site. This link operates at 1.0GHz. (15.85 km)

In order to determine whether a radio link could be affected by the wind turbines, EPURON defined an 'exclusion zone' beyond which the level of interference will not disrupt the radio link, based on the concept of the Fresnel zone, as previously described.

EPURON previously contacted all organisations identified as operating radio communication licences (including fixed link communications) within 25km of the nearby Cullerin wind farm proposal.

Each license holder was asked to provide independent comments / advice on the possibility of the wind farm development interfering with their communications links. At

---

[18] D. F. Bacon, A Proposed Method for Establishing an Exclusion Zone around a Terrestrial Fixed Link outside of which a Wind Turbine will cause Negligible Degradation of the Radio Link, Radiocommunications Agency UK Report Ver 1.1, 28 Oct 2002

that time, no organisation within the 25km radius raised concerns. Optus, Vodafone and Telstra provided general guidelines to assist in the planning of wind farms.

In response to these enquiries,

Optus Mobile noted:

> "Provided wind turbines are located well outside the 2nd Fresnel zone of the point to point microwave links, no interference to communications is expected"
> (pers. comm. Mr. Trong Ho, Optus Mobile)[19]

Vodafone noted:

> "Clearance criteria is the same for all carriers. Please use the same criteria as proposed by Optus"
> (pers. comm. Mr. Ganesh Ganeswaran, Senior Engineer / Transmission, AAP Communications Services 22/11/05)[20]

Telstra noted:

> "Provided wind turbines are greater than 100m away from Mobile tower (or in the case of directional panel antennae) not in direct line of sight for panel antennas, wind turbines will have minimal effect on existing coverage."
> (pers. comm. Mr. Ivan D'Amico, Area Team Manager (Country) - NSW&ACT, Telstra Services, Wireless Access Solutions, Mobile Coverage Delivery)[21]

These suggestions have been incorporated into the planning of the Yass Valley Wind Farm proposal.

6.4 Other radio communication

6.4.1 Two-way mobile

A small number of mobile bases exist in the area surrounding the wind farm site. These bases potentially provide cover to mobiles in a 360 degree arc from their bases. No significant impact from the wind farm on base coverage beyond normal mobile operational performance is predicted in view of the geographic separation between the base antennas and the turbine structures. Of course a mobile unit communicating with a base station when the mobile is located within metres of the wind turbine structures (or indeed near any large building, silo, tower etc) may experience some very local performance change, however moving a short distance would restore performance to normal.[22]

6.4.2 CB radio

CB radios are not individually licensed, the equipment being subject to class licensing only. Therefore, no records of location or operators of CB radios exist, and the channels are shared without any right of protection from interference. No impact from the wind farm is predicted except perhaps for very local effects to portable or mobile units in the

[19] Taurus Energy - Cullerin Range Wind Farm Environmental Assessment Report 2006

[20] *Ibid.*

[21] *Ibid.*

[22] Lawrence Derrick & Associates Bannister Wind Farm – Investigation of possible impacts on broadcasting and Radio communication Services September 2003

immediate vicinity of the turbines which could be avoided by a small location change of the unit.[23]

6.4.3 Wireless Broadband

From studies in other areas such as Mahinerangi, NZ[24] it is concluded that the minimum separation required between wind turbines and mobile broadband transmitters is approximately 240m. Turbines will be located outside this distance to avoid any impacts on mobile broadband services.

6.5 Mitigation measures

As a result of the exclusion zones established in planning the wind farm, no significant impacts will occur to existing point-to-point links and therefore no mitigation will be required. In the event that any issues with additional license links are identified as a result of the wind farm, whether prior to or post construction, EPURON will consult with the operator and undertake appropriate remedial measures, which may include:

- Modifications to or relocation of the existing antennae;
- Installation of a directional antennae; and/or
- Installation of an amplifier to boost the signal.

7 AIRCRAFT NAVIGATION SYSTEMS

7.1 Existing services and facilities

The closest airports to the proposed wind farm site are Canberra and Goulburn. There is one radar installation in the vicinity of Canberra airport, namely Mt Majura. A secondary radar installation is located at Mt Bobbara.

7.2 Interference and impact analysis

EPURON has consulted with the Civil Aviation Safety Authority (CASA), Airservices Australia and the Department of Defence in relation to the proposal.

Due to the height of the turbines (>110m), the Civil Aviation Safety Authority previously recommended that obstacle lighting be provided as per section 5.5 of Advisory Circular 139-18(0) - *Obstacle Marking and Lighting of Wind Farms.* The Advisory Circular was withdrawn in September 2008 and at the time of writing a recommendation was not available from CASA in relation to Obstacle Marking and Lighting of Wind Farms.

EPURON wrote to Airservices Australia (AA) in relation to the wind farm proposal on 15-7-08. In their response dated 16-12-08, AA suggested that there may be potential for navigational aid issues. Specific details regarding installations affected were not provided in the initial response.

At a meeting at Airservices Australia Brisbane office on 1-4-09 attended by David Cook – Manager Navigation & Surveillance, Matt Kelly – Engineering Specialist, Long

[23] *Ibid.*

[24] Mahinerangi Wind Farm Compatibility with radio services April 2007 - Kordia

Nguygen – Senior Engineering Specialist (video link) and Mitch Sloan – Airport Relations (video link), David Cook suggested that there may be potential impacts to the navigational aids at Mt Bobbara (SSR) and possibly although to a lesser extent Mt Majura (PSR) and (SSR). In his opinion, mitigation measures should be available to overcome or reduce these impacts.

Airservices Australia indicated at the meeting that they would not be able to conduct an internal assessment of the impacts to their navigational aids due to resourcing constraints. Accordingly, it was proposed that EPURON agree on a scope of work acceptable to Airservices Australia so that EPURON could engage a suitable consultant to investigate and prepare a report to assist Airservices Australia in their assessment of the proposal.

EPURON will continue to work closely with AA to mitigate issues discovered with the Mt Bobbara (SSR) and Mt Majura (PSR / SSR) that can be reasonably attributable to the proposed wind farm.

A review of the proposal was undertaken by the Department of Defence no objection to the proposal was made.

7.3 Mitigation measures

Obstacle lighting will be provided if required by CASA. No other mitigation measures are required.

8 CONCLUSION

Interference to MF and FM sound broadcasting is not expected.

Conflicts between point to point radio systems and the wind turbines are expected to be avoided with appropriate clearances being established. Also, mobile radio and other radio communication services in the area are not expected to be impacted by the wind farm or its operation.

VHF TV reception at dwellings within about 1 km of the wind farm turbines and with antennas having turbines located with +/- 25 degrees angle of their reception direction will have some probability of noticeable "ghosting" at times. For UHF TV time variant ghosting may be evident out to about 2 km for turbines located +/- 20 degrees from the reception direction.

Digital TV is not susceptible to visible "ghosting" degradation. Any impact of reflections from the turbines would be a minor reduction of coverage at the limit of the service area.

For any confirmed wind farm interference problems where TV antenna system improvements are unsuccessful, the use of the digital TV services in the area may be the best solution, requiring the provision of a digital set top converter.

Overseas experience indicates that electrical interference from wind farm generators and controls is not a problem with established and reputable wind turbine manufacturers and therefore no electrical noise measurements are warranted.

9 CORRESPONDENCE

From: Sloan, Mitchell [mailto:Mitchell.Sloan@AirservicesAustralia.com]
Sent: Tuesday, 16 December 2008 1:46 PM
To: Anthony Micallef
Cc: Rogers, Carly
Subject: RE: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Dear Anthony

I regret to advise that at this stage we are unable to approve your proposed windfarm due Navigational Aid issues.

We require a more detailed study to be conducted on this proposal and it's potential impact on radar. This may require us to engage a consultant for this type of assessment, which would have to be at the proponents expense.

I will get back to you shortly with a more detailed response.

Regards

Mitch

Senior Adviser
Airport Relations
Phone: (02) 62684410
Mobile: 0408 994410

Harden Shire Council

Contact: Sharon Langman
Quote Reference:

PO Box 110
3 East Street
HARDEN NSW 2587
Tel 02 6386 2305
Fax 02 6386 2083
Email council@harden.nsw.gov.au
Web www.harden.nsw.gov.au

9 September 2008

Mr Anthony Micallef
Epuron Pty Ltd
Sent by email to A.Micallef@epuron.com.au

Dear Mr Micallef

Re: COPPABELLA AND MARILBA WIND FARM

Council acknowledges the receipt of your letter dated 15 July 2008 and at this stage has no comment to make with regard to the proposal. However Council requests that should the project go ahead that information be provided as to the likely impacts upon the communications network operating in the immediate area.

Should the proposal go ahead Council would be willing to work with you to find solutions to any likely impacts.

Yours sincerely

Sharon Langman
DIRECTOR ENVIRONMENTAL SERVICES

G:\Enviro Services\DEVELOPMENT APPLICATIONS\Correspondence - DAs - General\wind farm proposal.doc

From: Cremer Rachel [mailto:Rachel.Cremer@BroadcastAustralia.com.au]
Sent: Thursday, 4 September 2008 5:00 PM
To: Anthony Micallef
Cc: Langridge Emmajane; Freer Peter; Pizzato Bob
Subject: RE: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Hi Anthony

Thanks for your letter regarding the Coppabella & Marilba wind farms and apologies for the delay in replying.

Broadcast Australia (BA) does not operate any broadcast facilities within 50 kilometres of your proposed wind farms and it is therefore unlikely to impact on our services. However we do recommend that Epuron engages an engineering consultancy firm to undertake a detailed study of potential impact on television and radio transmissions in the region as part of your Environmental Impact Study investigations. The Mt Carroll site you mentioned in your letter is not utilised by BA and I suggest you contact WIN Television and Australian Capital Television if you haven't done so already.

Thanks for notifying us of this proposal and please keep us informed of future developments. Please forward any further requests or notifications to Emmajane Langridge who will be BA's wind farm contact in future. Emmajane can be contacted on 02 8113 4718 or emmajane.langridge@broadcastaustralia.com.au.

Please contact me if you need any further information in relation to the above.
With regards
Rachel

Rachel Cremer
Property Co-ordinator
Broadcast Australia Pty Ltd
t: 02 6256 8020
f: 02 6256 8041
e: rachel.cremer@broadcastaustralia.com.au
w: www.broadcastaustralia.com.au

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

02/06111
OUT08/10594

1 September 2008

Epuron Pty Ltd
Level 11, 75 Miller Street
NORTH SYDNEY NSW 2060

Attn: Anthony Micallef

Dear Mr Micallef,

Re: "Coppabella" & "Marilba" Wind Farms

I refer to your letter dated 16 July 2008. Thank you for referring this proposal to the Department for comment.

I note that you wish to seek advice on the impact of the proposed wind farms on NSW DPI's radio communications services within the vicinity of the site. Advice from Chris Clarke at NSW DPI's Bathurst Office has confirmed that there will be no anticipated impact of the wind farm on the radio facilities.

Yours faithfully

Wendy Goodburn
Resource Management Officer (land use)
Goulburn

Aquatic Habitat Protection, Fisheries Conservation and Aquaculture Branch
NSW Department of Primary Industries
PO Box 17 Batemans Bay NSW 2536
1st Floor, Cnr Beach Road and Orient Street

ABN 51 734 124 190
www.dpi.nsw.gov.au
Tel: 02 4478 9103
Fax: 02 4472 7542

From: Curtis, Russell J [mailto:Russell.J.Curtis@team.telstra.com]
Sent: Tuesday, 2 September 2008 11:52 AM

To: Anthony Micallef
Cc: Turner, Martin V; D'Amico, Ivan D; Souksamlane, Kham; Yaghobzadeh, Sima
Subject: RE: EPURON: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

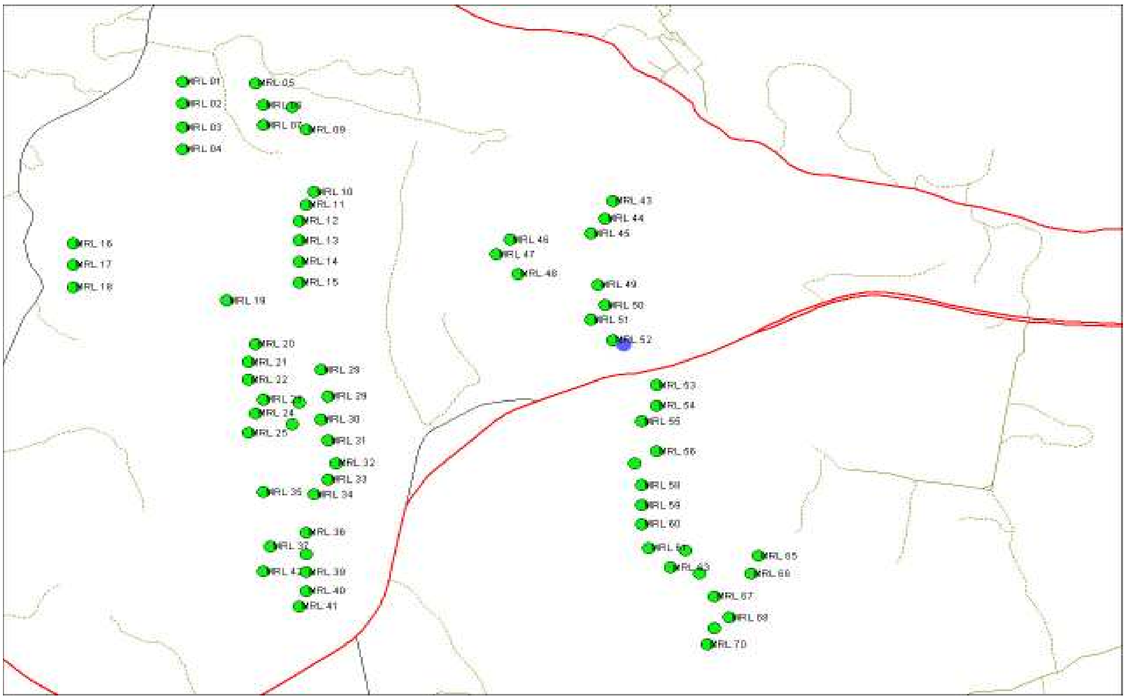
Anthony,
Further to your proposal - Information from our Mobiles department, they have a base station very close to MRL 52. This is "Conroy's Gap BTS". (refer to attachment)

Co-ords are: CGAP Conroy's Gap Latitude_GDA94: -34.77278 Longitude_GDA94: 148.72565

You will need to keep a distance greater than 100m away, the further away that you can place the turbines the better so as not to obstruct the BTS.

Yours Sincerely,

Russell Curtis
Technology Specialist
Telstra - Radio - Core & Access Technology
15/242 Exhibition St MELBOURNE 3000
Phone (03) 9634 7092 / Mobile 0418 387 971



From: Patrick Clague [mailto:Patrick@ses.nsw.gov.au]
Sent: Saturday, 23 August 2008 11:25 AM
To: Anthony Micallef
Cc: Kevin Anderson; Abby Mayers; Barrie Miller - SHR
Subject: FW: Epuron Wind farms near Bookham, NSW

Dear Anthony.
The below email fro Mark Pilkington provides the SES response to your letter dated 15 July

Regards
Patrick Clague
Manager Communications
NSW State Emergency Service
Ph.02 42516555

Fax 02 42516620
Mobile 0419 242250
Email patrick.clague@ses.nsw.gov.au
This message is intended for the addressee named and may contain confidential information. If you are not the intended recipient, please delete it and notify the sender. Views expressed in this message are those of the individual sender, and are not necessarily the views of the NSW State Emergency Service.

-----Original Message-----
From: Mark Pilkington [mailto:mark.pilkington@tait.com.au]
Sent: Tuesday, 5 August 2008 1:06 PM
To: Patrick Clague
Cc: Nicola Holden; Neil.johnson@tait.com.au
Subject: Epuron Wind farms near Bookham, NSW

Pat
In relation to the proposed wind farms near Bookham in the NSW SES Southern Highlands region.
The location of the 2 proposed wind farms "Coppabella Windfarm" and "Marilba Windfarm" does not fall with-in the link paths of the 2 closest NSW SES PMR sites, which are Boundary Road and Mundoonen. The 2 proposed wind farm therefore do not pose an interference issue to linking of these 2 sites.
As for users of NSW SES mobile or portable radios, with any large metallic structures there may be the possibility of local radio interference to users within the boundaries or in the immediate vicinity of those wind farms.

Regards
Mark

P.S - The attached kmz file is used for Google Earth. If you have Google earth installed then when you click on the NSW SES.kmz file it will open Google earth and display the location of all the NSW SES PMR sites

---

Mark Pilkington - Project Manager
Tait Electronics (Aust) Pty Ltd
186 Granite Street Geebung QLD 4017
Ph (+61) 07 3865 7799 [Ext. 19]
Fax (+61) 07 3856 7990
Email mark.pilkington@tait.com.au
Web www.taitworld.com

From: Jayantha Wickramasinghe
Sent: Tuesday, 12 August 2008 12:12 PM
To: 'Anthony Micallef'
Cc: Guna Kalugalage
Subject: RE: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Dear Anthony
The microwave radio link between Optus Mobile sites namely Yass and Berremangra Hill pass through the Marilba wind farm, refer to attached GIS plot, the Mobile deployment advised that Optus doesn't have any options to relocate the radio link or to connect the sites to fibre network and hence the wind turbines must not be obstruct the line of sight path.

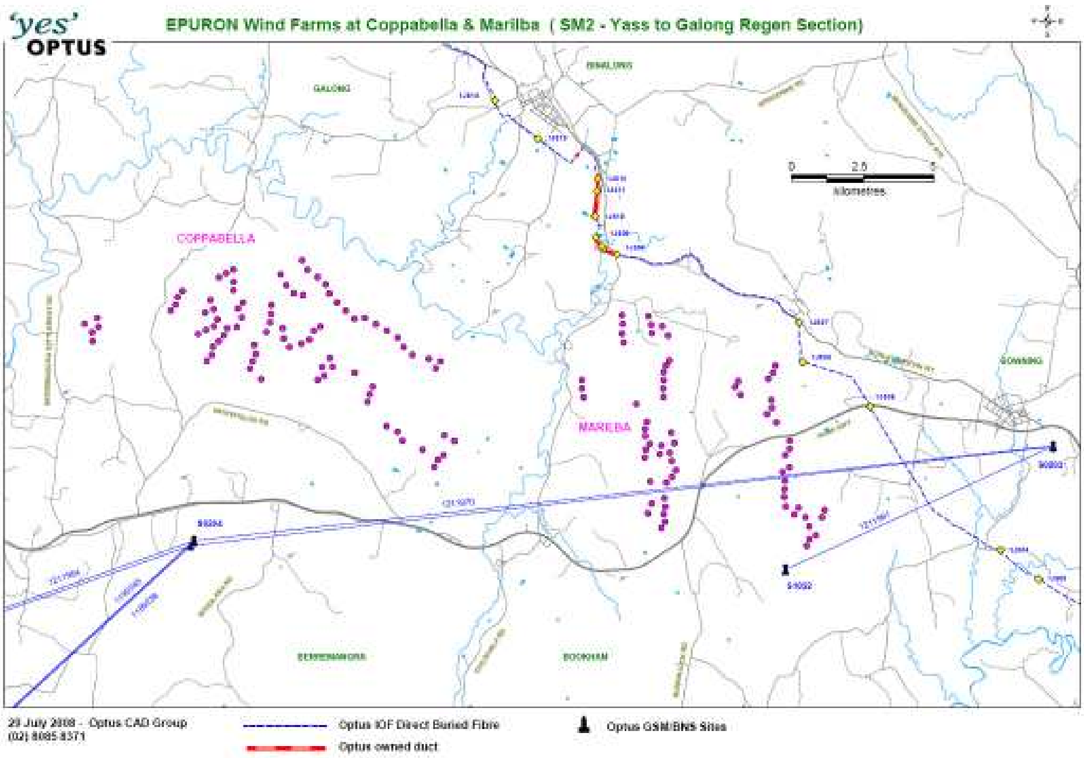
Regards
Jayantha

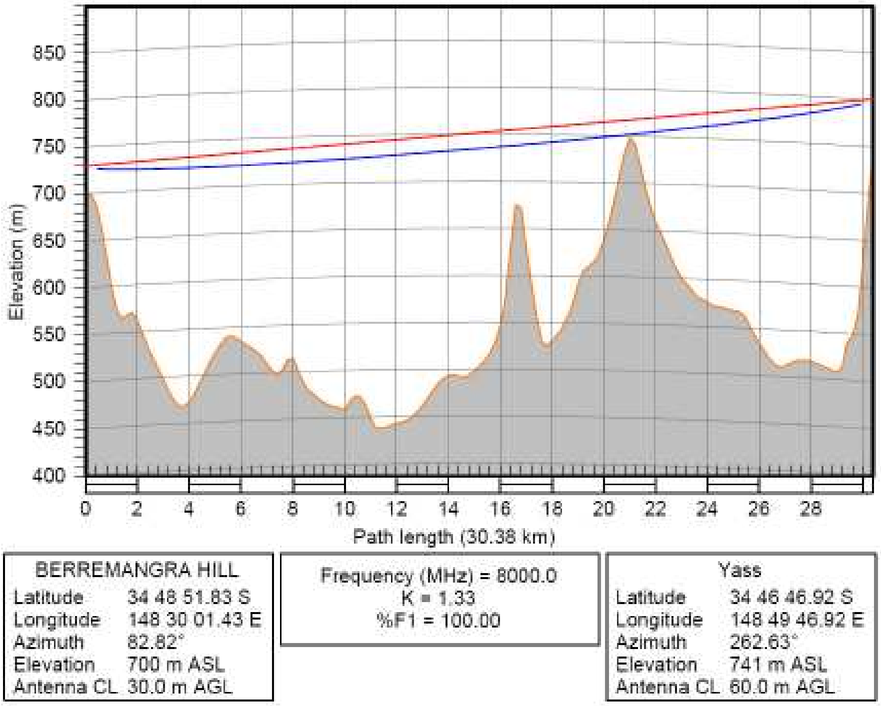
Jayantha Wickramasinghe | Radio Transmission Planning | SingTel Optus Pty Limited | Fixed Networks Engineering | t: +61 2 8082 0353 | m: +61 411 526 668 | f: +61 2 8085 5189 | 1 Lyonpark Road, Macquarie Park NSW 2113 | www.optus.com.au

Please think of the environment before printing this email

*****Disclaimer******

This e-mail may contain confidential information. If you are not the intended recipient, please notify the sender immediately and delete this e-mail from your system. You must not disclose this email to anyone without express permission from the sender. The contents of all emails sent to, and received from, Optus may be *scanned, stored, or disclosed to others by Optus at Optus' discretion. Optus has exercised care to avoid errors in the information contained in this e-mail but does not warrant that the information is error or omission free.*





850
800
750
700
650
600
550
500
450
400
Elevation (m)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
Path length (30.38 km)
BERREMANGRA HILL
Latitude 34 48 51.83 S
Longitude 148 30 01.43 E
Azimuth 82.82°
Elevation 700 m ASL
Antenna CL 30.0 m AGL
Frequency (MHz) = 8000.0
K = 1.33
%F1 = 100.00
Yass
Latitude 34 46 46.92 S
Longitude 148 49 46.92 E
Azimuth 262.63°
Elevation 741 m ASL
Antenna CL 60.0 m AGL

Australian Government
Department of Defence
Defence Support Group

2004/1044160/3
LPSI/OUT/2008/110

Mr Anthony Micallef
Eupuron Pty Ltd
Level 11, 75 Miller St
North Sydney, NSW, 2060

Dear Mr Micallef

RE: PROPOSED 'COPPABELLA' AND 'MARILBA' WIND FARMS WEST OF YASS, NSW

Thank you for referring the abovementioned wind energy projects to the Department of Defence (Defence) for comment. Defence understands that these projects will be located at two sites known as 'Coppabella' and 'Marilba' located approximately 20-30km west of the town of Yass, NSW. Defence further understands that the wind farm projects will consist of a total of 90 wind turbines at Coppabella Wind Farm and 80 wind turbines at Marilba Wind Farm.

As per your letter, Defence has performed its assessment based upon the wind turbines being situated atop 80m towers and using 105m diameter blades. The maximum height at the blade tip zenith will be up to 135m above ground level. As discussed in a phone call on 22 July 2008, Defence has also allowed for 1 wind monitoring mast at each site and associated works (including an electrical substation and overhead wiring to connect with the National Electricity Grid).

Defence has assessed the proposal with respect to any impact on the safety of military flying operations and possible interference to Defence communications and radars.

The proposed development will be outside any areas affected by the Defence (Areas Control) Regulations (DACR). The DACR control the height of objects (both man-made structures and vegetation) and the purpose for which they may be used within approximately 15km radius of Defence airfields. In addition, the proposal has been assessed as unlikely to affect existing Defence communications and radars in the region.

However, it should be noted that tall structures present a hazard to flight safety for low level flying operations. Consequently, there is an ongoing need to obtain and maintain accurate information about tall structures so that risks associated with inadvertent collision by low flying aircraft can be reduced. RAAF Aeronautical Information Service (RAAF AIS) in Melbourne is responsible for recording the location and height of tall structures. The information is held in a central database managed by RAAF AIS and relates to the erection, extension or dismantling of tall structures the top measurement of which is:

a. 30 metres or more above ground level - within 30 kilometres of an aerodrome; or
b. 45 metres or more above ground level elsewhere.

The proposed wind farm development will meet the above definition of tall structure. RAAF AIS has requested that the developer supply them with final design documentation before construction commences. After construction is complete, the Department of Defence requests that the developer provide RAAF AIS with "as constructed" details.

RAAF AIS has a web site with a Vertical Obstruction Report Form at www.raafais.gov.au/obstr_form.htm which can be used to enter the location and height details of tall structures. Any queries in regard to information about tall structures or the database should be directed to RAAF AIS.

The Civil Aviation Safety Authority (CASA) has produced an Advisory Circular, AC 139-18(0) *Obstacle Marking and Lighting of Wind Farms* dated July 2007, which provides amongst other things, guidance to proponents of wind farms. Wind turbines are tall structures which can be hazardous objects to aviation and AC 139-18(0) outlines measures on how to reduce the hazard including the use of obstacle marking and lighting. In accordance with the AC 139-18(0) CASA will need to be consulted on this proposal determination.

Overall, the Department of Defence has no concerns with the Coppabella Wind Farm and the Marilba Wind Farm at this time. Should you wish to discuss the content of this advice further, please contact Brenin Presswell, Executive Officer, Land Planning on (02) 6266 8128 or by email at brenin.presswell@defence.gov.au.

Yours sincerely

John Kerwan
Director Land Planning & Spatial Information
Department of Defence
BP3-1-A052
Brindabella Park
Canberra ACT 2600

5 August 2008

Cc. DSG - ACT/NSW
RAAF AIS
CASA

Goldenfields WATER County Council

84 Parkes Street (P.O. Box 220)
TEMORA NSW 2666
ABN 54 357 453 921
Telephone (02) 6977 3200
Facsimile (02) 6977 3299
E-mail office@gwcc.nsw.gov.au
ALL HOURS EMERGENCY
1800 800 917

Our Reference: G25406005:PMW

Your Reference:

25 July 2008

Mr Anthony Michallef
Project Manager
Epuron Pty Ltd
Level 11, 75 Miller St
NORTH SYDNEY NSW 2060

Dear Anthony,

Re: Proposed Wind Farm at "Coppabella" and "Marilba"

I refer to your correspondence of 16 July 2008 regarding the above matter. After investigation I can confirm that Council does not believe that the proposed development will have a detrimental impact on its radio communications installation at Beremangera Hill, Beremangera.

I trust the above meets your requirements however should you require any further information please contact Council's Electrical Services Support Officer, Alan Moston on 0427 232 629.

Yours faithfully,

Paul Wearne
General Manager

From: Souksamlane, Kham [mailto:Kham.Souksamlane@team.telstra.com]
Sent: Monday, 28 July 2008 10:29 AM
To: Anthony Micallef
Cc: Kouroushis, Pol; Curtis, Russell J
Subject: RE: EPURON: Notification of Coppabella & Marilba Wind Farm proposals - Telecommunications

Anthony,

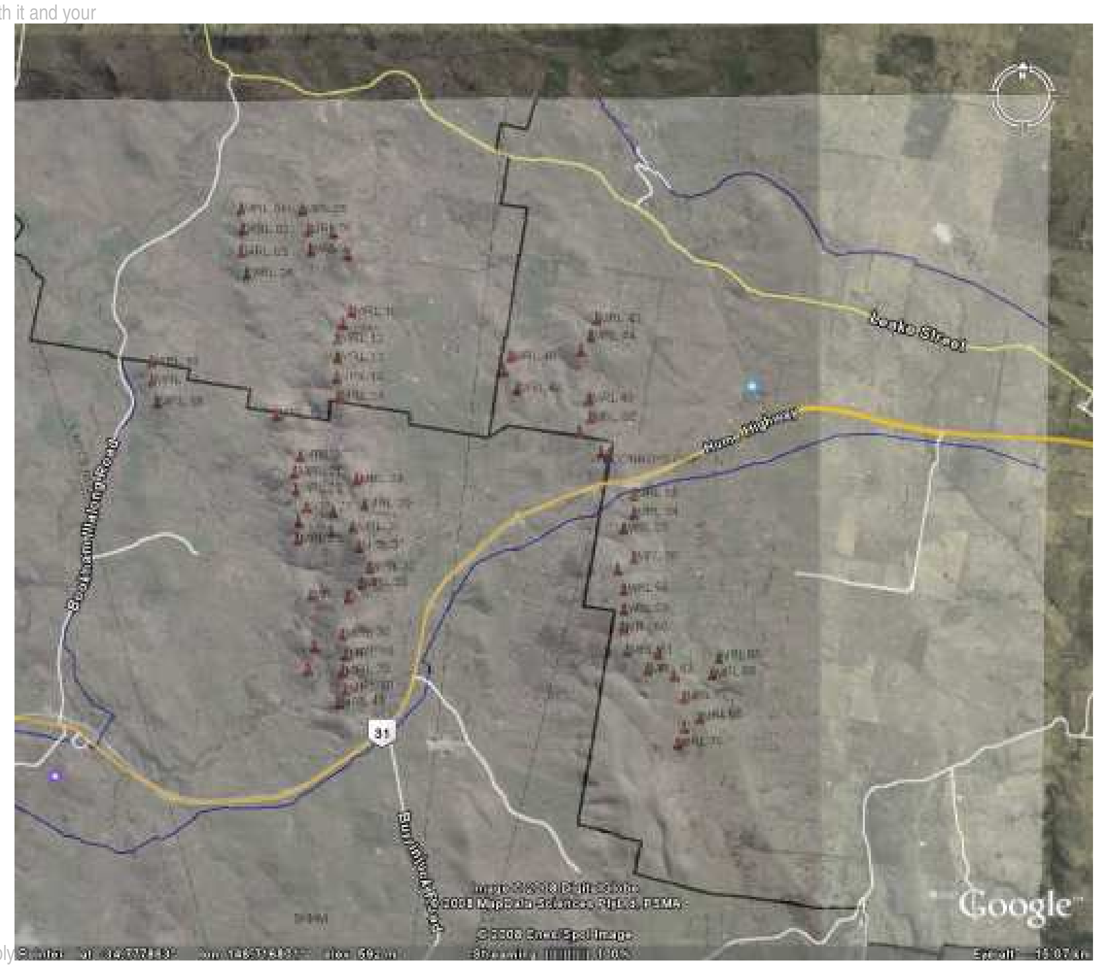
Some of the Marilba wind farm turbines (as supplied) seem to fall outside the indicated Zones (18 Turbines are in the Southern side of the Hume Hwy).
Is this correct ?
If the indicative locations as per the attached map is correct, then there will be no impact on Telstra network.

Regards

Kham Souksamlane
Capacity Planner
Forecasting & Area Planning - NSW
Fundamental Planning
Network & Technology
Telstra Operations
Phone:☎(02) 9397 2068
Fax: (02) 9397 2030
E-mail : Kham.Souksamlane@team.telstra.com

Fundamental Planning -
"Supporting Telstra's Business Success through wise Planning and Investment in the Access Network"

both it and your



reply

From: Jensen, Tim I [mailto:Tim.Jensen@team.telstra.com]
Sent: Wednesday, 30 July 2008 4:09 PM
To: Anthony Micallef
Cc: Barton, Paul L
Subject: NSW GRN & "Coppabella" and "Marilba" proposed wind farm sites.

Dear Anthony

I received your letter dated 15th July 2008, regarding "Coppabella" and "Marilba" proposed wind farm sites.

I work for Telstra, and am engaged in the management and operation of the NSW Government Radio Network (GRN) under contract to the NSW Department of Commerce.

I have reviewed your letter, and determined that the operation of the proposed wind farms at "Coppabella" and "Marilba" will not cause the NSW GRN site at Black Trig (Linbrook Property) any detrimental effects.

I have now forwarded your letter to the NSW Department of Commerce as they may wish to comment on any effects that these proposed wind farms may have on a future microwave network that may be installed to link into this NSW GRN site at Black Trig.

Thank you very much for providing the opportunity to comment on your proposal.

Best regards

Tim Jensen

NSW GRN

Managed Radio & Wireless Solutions
Telstra Enterprise and Government

Phone: (02) 9396 6115
Fax: (02) 9396 6446
Mob: 0418 360 355
L14/320 Pitt St, Sydney 2000 NSW
Locked Bag 6716, Sydney 2001 NSW

From: ALLEN, RICHARD [mailto:RICHARD.ALLEN@casa.gov.au]
Sent: Tuesday, 22 July 2008 9:03 AM
To: Anthony Micallef
Subject: FW: Notification of Coppabella & Marilba Wind Farm proposals - CASA [SEC=UNCLASSIFIED]

Anthony

The advice I have been given by CASA Central Office is as follows:.

" - CASA's interest in tall structures relates to the possible hazard to aircraft that the structures could pose.

- Under existing legislation, a person who proposes to construct a building or structure, the top of which will be 110 metres or more above ground level, is required to notify CASA of such development. Civil Aviation Safety Regulations 1998 (CASR) Part 139, **Subpart 139E Obstacles and hazards**, is available on our Web Site at http://www.casa.gov.au/rules/1998casr/139/139casr.pdf .

- CASA has published an Advisory Circular **AC 139-18(0)** titled **Obstacle Marking And Lighting of Wind Farms**. The purpose of the advisory circular is to provide general information and advice to proponents of wind farms and planning authorities with jurisdiction over the approval of such developments. It explains the possible hazardous nature of wind farms to aviation activity, indicates the regulations that are applicable, and provides advice on how the hazard to aviation can be reduced. The usual expectation of wind farms with turbines exceeding 110 metres in height, is that the wind farm should be equipped with obstacle lights in accordance with the Advisory Circular, to reduce the hazard to aviation. AC 139-18(0) is available on our Web Site at: http://www.casa.gov.au/rules/1998casr/139/139c18.pdf .

- You indicate that the total height above ground of your turbines, tower plus blade, will be approximately 135 m. As your turbines will exceed 110 m above ground level, CASA considers that they will likely be hazardous to aviation. You can reduce the hazard by providing obstacle marking and lighting in accordance with our Advisory Circular. If your turbines are located such that they penetrate the Obstacle Limitation Surface of an aerodrome, you should also advise that aerodrome of your proposal. See subsection 5.3 of the Advisory Circular.

- In due course, you should forward to CASA a scale drawing showing the layout of turbines, clearly indicating which turbines you propose to equip with obstacle lights complying with the Advisory Circular. The scale should be sufficient for CASA to be able to determine longitudinal separation of turbines. You should also include data on turbine height and ground level, so that the turbines that extend furthest into the airspace above your wind farm are identified.

- Airservices Australia also has an aviation interest in proposed wind farms, including possible adverse effects on defined air traffic routes, lowest safe altitude, and Radar interference. You should advise Airservices Australia of this proposal, if you have not already done so, by the following contact:

Mr. Joe Doherty
Manager, Airport Relations
Airservices Australia
GPO Box 367
CANBERRA ACT 2601
joseph.doherty@airservicesaustralia.com "

Please let me know if you have any further questions
Regards

Richard Allen

Aerodromes Coordinator
Phone 131 757 Ext. 3129
Fax 02 9669 6151
GPO Box 2005 Canberra 2601

NSW **National Parks and Wildlife Service**

Our reference: DOC08/33228
Enquiries: Andrew Grant (02) 6947 7006

Epuron Pty Ltd
Attn: Mr A Micallef
Level 11, 75 Miller St
North Sydney
NSW **2060**

Dear Anthony,

Re: 'Coppabella' & 'Marilba' Wind Farms

I am writing in response to your letter dated 15 July 2008 regarding the proposed development of wind farms at 'Coppabella' & 'Marilba' near Yass, NSW, and the Department of Environment and Climate Change (DECC) communications site on Black Range Trig (Site ID 9519).

DECC has radio base equipment located in the NSW Roads and Traffic Authority facility located at Black Range Trig. Following a review of the proposed wind farm location DECC do not believe there will be any impact on our radio service.

Please feel free to contact me on (02) 6947 7006 or mobile 0427 469 383 should you need any further information. Alternatively my e-mail is: andrew.grant@environment.nsw.gov.au

Yours sincerely,

Andrew Grant
Senior Ranger Fire
For: Steve Horsley
South West Slopes Regional Manager
Parks Wildlife Division

The Department of Environment and Conservation NSW is now known as
the Department of Environment and Climate Change NSW

PO Box 472, TUMUT NSW 2720
7A Adelong Road, TUMUT NSW 2720
Tel: (02) 6947 7000 Fax: (02) 6947 4179
ABN 30 841 387 271
www.environment.nsw.gov.au

Department of **Environment and Climate Change** NSW

Appendix 6 TRAFFIC IMPACT ASSESSMENT

TRAFFIC IMPACT STUDY

PROPOSED YASS WIND FARM

Coppabella Hills, Marilba Hills & Carrolls Ridge Precincts

Prepared for Epuron Pty Ltd

December 2008

By Rodger Ubrihien

Bega Duo Designs

TABLE OF CONTENTS

APPENDICES

Appendix A: Location of the proposal and relevant access roads

Appendix B: Photographic Plates

Appendix C: Hume Highway Junction Layout

Appendix D: Shadow Flicker Diagram

1 INTRODUCTION

1.1 Scope of this Assessment

Bega Duo Designs was commissioned by **ngh**environmental to complete the Traffic Impact Study for inclusion in the Environmental Assessment of the proposed Yass Wind Farm.

This report conforms to the *Guide to Traffic Generating Developments* as recommended by the NSW Roads and Traffic Authority and provides a technical appraisal of the traffic and safety implications arising from the proposal. The report also develops measures and makes recommendations for the minimisation of traffic impacts during the construction and operation of the wind farm. This report focuses primarily on the construction phase of the project which would generate the maximum traffic impact.

This report considers the general impact of the heavy and oversized vehicles on the public road network and immediate surrounds. It does not include a detailed route assessment for the transportation of the over-mass and over-dimension turbine and transformer components along the routes from the major manufacturing centres and ports to Yass. This assessment would be required to be produced by the haulage contractor and approved by the relevant roads authorities prior to the commencement of the construction phase.

An assessment prepared by URS for the Crookwell 2 wind farm details the available routes from Port Kembla to the Hume Highway in Goulburn, information which is not repeated in this assessment. The assessment also discussed types of vehicles which may be used. The URS assessment concluded that feasible routes exist from Port Kembla to the Hume Highway. The Hume Highway is within 10 kilometres of all precincts and is currently in use by heavy vehicles transporting wind farm components to wind farms under construction near Canberra and Goulburn. This report examines routes along the Hume Highway in the vicinity of the proposed wind farm as well as routes along local roads to access the precincts under consideration.

The proposal outlines a three year period for the construction phase of the wind farm. Planning has commenced for the preparation of an Environmental Assessment for submission to the NSW Department of Planning, in March 2009.

This assessment examines the projected traffic impacts for the construction of up to 185 wind turbines within three precincts, referred to as Coppabella Hills, Marilba Hills & Carrolls Ridge. The combined three precincts will generally be referred to as the ‘Yass Wind farm’ in this report.

The final location of internal access roads has not been determined at this stage of the planning and therefore assumptions have been made about the most likely access points based on terrain, existing road condition, and cooperation with the relevant property managers. Changes to the locations of the access points should not significantly affect the conclusions of this report.

This report does not include details of the operational maintenance or hand over requirements of onsite access roads or alterations to existing local roads. These details would require the involvement of the local roads authorities and land holders, in the detailed design planning stage.

1.2 Proposal Overview

The three precincts are located between 20 and 50 kilometres west and southwest of Yass. The Coppabella and Marilba precincts are generally north of the Hume highway, whilst the Carrolls Ridge Precinct is 10 kilometres to the south of Hume Highway, near Burrinjuck Dam (refer to Appendix A).

The estimated generation of the Yass Wind Farm (all three precincts) is over 1.5 million Megawatt Hours of energy, sufficient for the average consumption of up to 210,000 homes (pers. comm. S. Davey, Epuron, Yass Wind Farm Planning Focus Meeting 14-15 October 2008).

The proposed Coppabella Hills Precinct is located within both the Harden and Yass Valley Shires. The Marilba Hills and Carrolls Ridge precincts are located entirely within the Yass Valley Shire. Most construction would be located in open grazing land with the exception of Carrolls Ridge where some bushland may be affected.

Construction at all precincts would involve roads, substations and electrical connections (overhead and underground electrical cables).

The Coppabella Precinct would contain up to 86 turbines located on the high ridges extending approximately 13 kilometres in a generally east to west direction. Electrical connection would be to the Transgrid 132KV Transmission line between Harden and Yass, pending further investigation, which is located to the north of the precinct. Vehicular access from the Hume Highway would be via minor local roads.

The Marilba Precinct would contain up to 66 turbines located on two sets of ridges running generally in a north to south direction approximately 20 kilometres west of Yass with the majority of turbines located north of the Hume Highway. The eastern section of the Marilba Precinct on Black Range has approximately 18 proposed turbine locations south of the Hume Highway. Electrical connection would be to the Transgrid 132KV Transmission line between Harden and Yass. The major access points proposed are from the Hume Highway at Conroys Gap and Marilba Station. Secondary access may be provided from Illalong Road and Burley Griffin Way at the northern end of the precinct.

The Carrolls Ridge Precinct would contain up to 33 turbines and is located on a ridge parallel and east of the Burrinjuck Road from 9 to 15 kilometres south of the Hume Highway. The precinct generally overlooks Burrinjuck Dam. Electrical connection would be to the 132kV Tumut to Yass transmission line. Access would be via Burrinjuck Road from the Hume Highway. Access to the southern section of the precinct may be from Waterview Road.

1.3 Key Issues and Objectives

The issues outlined in Table 2.1 of the Roads and Traffic Authority's *Guide to Traffic Generating Developments* are considered in this study. Additional issues have been included because of the unique nature of the development. These include the structural condition of the existing road surfaces as observed during precinct inspections.

Key Issues

- Existing road hierarchy and proposals for improvement
- Impact on road safety
- Impact of traffic noise
- Traffic volumes and trends
- Traffic generation
- Safety and efficiency of internal roads
- Impact on intersections and surrounding developments
- Safety and efficiency of access routes (including capacity) between the precinct and adjacent road networks

1.4 Methodology

- Base project information was obtained from **ngh**environmental and Epuron
- Further information and feedback was received from key stakeholders at the Yass Wind Farm Planning Focus Meeting, held on site on the 14th & 15th of October, 2008
- Existing mapping was used to identify features during the precinct inspection
- Planning documentation for other wind farm proposals was reviewed
- All roads were inspected, inventories prepared and photographs taken. Road junction and intersections were inspected and photographed
- Approximate traffic count information was obtained from observations at all precincts during November 2008. Roads & Traffic Authority data was used to establish the existing traffic volumes (vehicles per day) on the main roads.
- Discussions were held with representatives from **ngh**environmental, Epuron, Roads & Traffic Authority, Harden and Yass Valley Councils.
- Information on road conditions was obtained from property owners and interested residents at the Open House Community Consultation Day on 10th of December 2008.
- Methods of wind turbine construction and programming of the works were investigated to estimate the proposed vehicle trips.

Note

In accordance with the *Guide to Traffic Generating Developments,* a ‘trip’ is defined as a one-way vehicle movement from one point to another, excluding the return journey.

The general method of measuring traffic volume is ‘vehicles per day’. This is the total of all trips made in either direction per day.

2 PROPOSED DEVELOPMENT

2.1 Precinct Descriptions

The largest precinct, Coppabella Hills, has steep rocky ridges which rise to 800 metres above sea level and up to 300 metres above the surrounding landform. Access tracks are very steep and travel for 6 to 8 kilometres from an existing road may be necessary to access the turbine locations. The primary land use is sheep grazing.

The Marilba Hills Precinct is generally lower, less rocky, less steep and the main land use is sheep and cattle grazing. Most of this precinct is within 4 kilometres of an existing road.

Carrolls Ridge Precinct rises to 850 metres and is steep and wooded on the side slopes. The access tracks into Carrolls Ridge at each end of the ridge are of lesser gradient than most tracks on the other precincts and access to the turbine locations is generally within one kilometre of Burrinjuck Road. The cleared land on the ridge contains communications towers and is mainly used for grazing.

2.2 Precinct Access

Existing access roads are shown on the Plan, Appendix 1.

The roads are generally classified as follows:

- National Highways - Hume Highway which is owned and maintained by the Roads & Traffic Authority
- State Roads – Burley Griffin Way which is maintained by Yass Valley Council under contract to the Roads & Traffic Authority
- Regional Roads – Burrinjuck Road which is part funded by a grant agreement administered by the Roads & Traffic Authority
- Local Roads – All other roads which are owned by the Council (either Harden or Yass Valley). Council may choose to maintain or not maintain any of these roads under its control

All three wind farm precincts are between 20 and 50 kilometres west of Yass, a major country town and service centre. The Hume Highway provides a safe road connection with up to 110km/h travel speed. The village of Binalong provides some services and is within 10 kilometres of the northern extremity of the Marilba Hills and Coppabella Hills Precincts.

Access to the wind farm infrastructure (turbines, substation etc) would be via a road network, most likely constructed along existing tracks within the leased properties. Access points for this road network are shown on the Plan, Appendix 1. The concept planning of the proposed access roads within the precinct has not been completed at this stage and therefore access on established roads up to the most likely access track locations is evaluated in this study.

The currently favoured access points are shown on the Plan, Appendix 1.

The Bogo Quarry on Paynes Road is currently preparing an environmental assessment for the expansion of the Quarry which would include a mobile concrete batch plant and a mobile asphalt plant (Department of Planning 2008). Access to this batch plant for the supply of concrete to all precincts has been considered as a desirable planning option. This quarry could also provide road construction materials.

Access requirements for the wind farm can be separated into the following categories:

- Standard road vehicles from 2 wheel drive cars to B-Double trucks. These vehicles are required to access the precinct usually as far as the depot or storage compound precinct. They represent the largest proportion of vehicles.
- 4 wheel drive vehicles which may be required for most transport to the turbine locations and would provide ongoing maintenance.
- Specialist vehicles may include off-road construction vehicles, for example with nonstandard axle combinations. These may include tracked vehicles and reconfigured trailers used to tow components into position onsite. These would not generally be able to be used on sealed local roads.
- Over-dimensional vehicles transporting turbine components and oversize construction machinery. These vehicles would generally be wider and longer but weights of loads would not be excessive (generally up to 70 tonnes carried over 7 axles) and they would be able to cross most drainage structures without damage.
- Over-mass and over-dimensional vehicles transporting electrical transformers of up to 200 tonnes. These vehicles would possibly require the strengthening of bridges and drainage structures because of the close spacing of axles. There would be only a small number of these vehicles and the delivery location would be at a substation.

Many of the access roads under consideration could be described as farm access tracks and would not be suitable for a large number of vehicles without complete reconstruction. Considering the differing vehicle requirements, it may be necessary to adopt some access points along these tracks for over-mass deliveries only, or for future maintenance tracks.

Coppabella Precinct

The major access points being considered for the Coppabella Precinct are from Whitefields Road to the south of the precinct. Whitefields Road connects with the Hume Highway, 38 kilometres from Yass. The western end of Whitefields Road connects with the Hume Highway via Coppabella and Berramangra Road. Additional access points may be available from Coppabella for low volumes of 4 wheel drive or specialist vehicles. The five turbines at the western end of the precinct would be accessed from Berramangra Road which junctions with the Hume Highway, 47.3 kilometres from Yass.

Marilba Precinct

Access points under consideration for the eastern section of the Marilba Precinct are from the Hume Highway, via the truck rest areas on each side of Conroys Gap, 20.9 kilometres from Yass. Access to the majority of turbines would be from the Marilba Station access road, 23.0 and 25.2 kilometres from Yass. An access to the northern section from Illalong Road at 1.6 kilometres from Burley Griffin Way is being considered. An access off Burley Griffin Way at 3.5 kilometres from the Hume Highway could provide access to the eastern section of the precinct and the proposed connection to the 132kV transmission line.

Carrolls Ridge Precinct

Access to Carrolls Ridge Precinct is likely to be via an existing access track at 10.0 kilometres from the Hume Highway on Burrinjuck Road. The southern section of the precinct may obtain access from Waterview Road.

2.3 Future Road Proposals

The Roads and Traffic Authority, Harden and Yass Valley Councils have ongoing maintenance and improvement programmes for the roads and bridges under their control.

There are no current proposals for major road improvements on the access roads under consideration.

The Director of Operations at Yass Valley Council has advised that plans are being prepared for the replacement of the timber bridge on Illalong Road. No funding is presently available for the construction.

3 EXISTING TRAFFIC CONDITIONS

3.1 General

Traffic safety is dependant on many variables such as driver behaviour and weather conditions. This section of the report examines the physical constraints which could have an impact on traffic safety, as observed on an inspection of the roads carried out in November 2008. This work included observations of traffic volumes.

3.2 Specific Routes

Hume Highway

The Hume Highway provides access to Melbourne and Adelaide to the south and south west and Sydney and Port Kembla to the east. Locally, it provides access between the precincts as well as Yass, Burley Griffin Way and Paynes Road (Bogo Quarry).

The Hume Highway is a high speed four lane dual carriageway road with a high standard of access at all of the major junctions (Plate 1, Appendix B).

An examination of the Roads and Traffic Authority Accident Data Base was made for the section of Hume Highway within Yass Valley and Harden Shire Councils. There were four fatal accidents in the three years from December 2005 and available information suggests that none of these accidents were related to road deficiencies.

The major junctions are similar to the layout shown in Appendix C with full length deceleration lanes for traffic turning right from the high speed lane. The minor junctions are constructed to a slightly lower standard, with a reduced length deceleration lane and a reduced width on the side road. The minor junctions do not have advance signposting and therefore, prior knowledge of their location is required to undertake a safe approach. The junctions with the Hume Highway are described in the comments below, for each particular access road.

Burley Griffin Way

The Burley Griffin Way (Main Road 84) is a sealed high standard two lane road with marked centreline and edge lines (Plate 2 shows Burley Griffin Way 6.5 kilometres from the Hume Highway). This is a regional route connecting south east New South Wales with Griffith and the Riverina. It departs from the Hume Highway 18.3 kilometres west of Yass. This major junction has been recently reconstructed to a high standard with separate turn lanes to and from the Hume Highway.

A road on the left at 3.5 kilometres from the Hume Highway could provide access to the north eastern end of the Marilba Precinct and the 132 kV transmission line. The junction has a gravel surface and the turning radii may restrict long loads. The sight distance along Burley Griffin Way is slightly restricted towards the west (refer to Plates 3 & 4).

Illalong Road departs the Burley Griffin Way at 11.19 kilometres from the Hume Highway. Binalong is located on the Burley Griffin Way, 16.6 kilometres from the Hume Highway. Garry Owen Road departs westward from Burley Griffin Way on the northern side if Binalong.

Access from Hume Highway at Conroy's Gap Truck Rest Areas

Conroy's Gap at 21.5 kilometers from Yass has two large truck rest areas for travel in both directions. Deceleration and acceleration lanes provide safe entry and exit. The Hume Highway is a controlled access road and access to adjacent properties would be via licensed access points. Plates 39 & 40 show the eastbound rest area and Plates 41 & 42 show the westbound rest area.

The existing access to the ridge from the northern rest area (eastbound traffic) is on the deceleration lane at a point where entering traffic are still traveling at speed.

The truck rest areas are designed for traffic entry and exist in one direction only; there is no provision for eastbound vehicles to rejoin the highway, travelling westbound, or vice versa, for their return journey.

Illalong Road

This road provides an important link to and from Binalong. It is the major route for local traffic accessing western localities along the Hume Highway (refer to the Plan, Appendix 1). The surface is sealed to approximately 5.5m wide and the section up to 3.1 kilometres from Burley Griffin Way appears to have been recently re-surfaced. The route is posted with a 10 tonne load limit. The Director of Engineering Services for Yass Valley Council indicated that the load limit was in place to protect the pavement from deterioration caused by large numbers of heavy vehicles.

The junction with Burley Griffin Way has good sight distance and turning radii (Plate 5). A possible access point on the left at Weilora Woolshed is at 1.60 kilometres (Plate 6) from the Burley Griffin Way. This access has good sight distance in both directions. The following distances are measured from the junction with Burley Griffin Way.

The timber bridge at 3.13 kilometres (Plate 7) has a 4.8 metre width between kerbs. A concrete bridge at 6.09 kilometres (Plate 8) has a width of 7.0 metres between kerbs.

Campbells Road is at 8.5 kilometres on the left (Plate 9). Sight distance at Campbells Road along Illalong Road is good in both directions however use by long vehicles would require improvements to turning radii. The gravel surface would be expected to deteriorate rapidly with increased traffic. A concrete bridge at 10.27 kilometres has a width of 7.0 metres between kerbs (Plate 10).

The junction with the Hume Highway is at 11.01 kilometres. This intersection also provides access to Childowa Road and the village of Bookham on the southern side of the highway. The intersection is of a high standard with raised islands to control turning movements (Plate 11).

Marilba Access Roads

The access roads to Marilba Station are located off the Hume Highway at 23.0 and 25.2 kilometres from Yass. These minor junctions are generally constructed in accordance with the layout shown in Appendix C (Hume Highway Junction Layout), except for the provision of a short deceleration distance for traffic from the east. Turning radii and the width in the 'throat' of the junction are also reduced. Plates 29 to 33 show the southern junction and Plates 34 to 37 show the northern junction. The distances referred to below are measured from the southern junction toward the north.

The 'Marilba' Road is part of the old highway and has a bitumen seal. Large 6.0 metre wide cattle grids are provided at 0.19 kilometres and 2.52 kilometres. Plate 38 shows the grid at 0.19 looking north. A smaller grid is at 1.29 kilometres. Sheep utilise the shade of the roadside trees and graze on the roadside for the full length between the large grids. Access to the turbine precincts from Marilba Road is likely to be located close to each end of the link road.

Paynes Road

Paynes Road provides access to the Bogo Quarry which may be utilised for concrete batching as well as a supplier of road base material and asphalt.

The junction with the Hume Highway at 26.3 kilometres from Yass (Plate 12) is 0.8 kilometres north of Burrinjuck Road. The junction is of a high standard, designed for the use of heavy vehicles to and from the Quarry.

Paynes Road has a bitumen surface 6.0 metres wide (Plate 13) as far as the Quarry entrance, located 1.34 kilometres from the Hume Highway (Plate 14).

Burrinjuck Road

Burrinjuck Road commences at the Hume Highway 27.21 kilometres from Yass. The junction is of a high standard two stage crossing (Plate 15) as shown in Appendix C. The sight distance to the north for right turn traffic from the south is obscured by vegetation in the central median area (Plate 16).Distances shown for this road are in kilometres from Hume Highway. Burrinjuck Road forms part of the Hume and Hovel recreational trail.

The bitumen surface of Burrinjuck Road is approximately 6.0 metres wide with painted centreline marking. The road pavement appears to be failing in some areas as indicated by the deformation of the surface (Plate 17). Large trees overhang the road in many locations and there is insufficient width to maintain the road shoulder (Plate 18). Shoulder widening has been provided at some locations which could provide safer pull over areas. The existing alignment, width and grading is generally not suitable for high travel speeds and a speed restriction of 80 kilometres per hour is in place.

Sutton Grange Road is on the left at 4.35 kilometres and a large drainage culvert is located at 4.37 kilometres. Woolgarlo Road is on the left at 9.1 kilometres.

A proposed access road to Carrolls Ridge is on the left at 10.0 kilometres. The sight distance in both directions is partially restricted by the presence of trees close to the road (Plates 19 and 20). Turning movements by long vehicles would be restricted by the narrow road formation combined with the narrow gate and grid. The gate has insufficient setback from Burrinjuck Road (Plate 21).

Waterview Road

Access to the southern section of Carrolls Ridge would be via Waterview Road (not signposted) at 14.25 kilometres along the Burrinjuck Road from the Hume Highway (the distances are measured from the junction of the Hume Highway and Burrinjuck Road). The road is unsealed. The first 1.73 kilometres is maintained by Yass Valley Shire Council.

The junction with Burrinjuck Road is at an acute angle and whilst sight distance to the north is good, the sight distance to the south is restricted by the combination of curved alignment and roadside trees (Plates 22 &23).

Plate 24 shows the first section of Waterview Road looking back towards the Junction. Plate 25 shows an access on the left at 14.6 and the road narrowing to approximately 4.0 metres wide. Trees close to the road commence at 15.2 kilometres and the standard of alignment reduces. (Plate 26) The road crosses a stock grid at 15.8 kilometres (Plate 27).

The track divides at 16.1 kilometres and inspection of the left fork of the track continued to the top of the ridge at 17.0 kilometres. The track narrows to approximately 3.0 metres and is poorly drained which has resulted in severe erosion of the road edges (Plate 28).

Whitefields Road

Whitefields Road departs from the Hume Highway at 38 kilometres from Yass. The signposting incorrectly indicates 'Whitfields' Road. Advance signposting is not present for this junction. The distances referred to are in kilometres from the eastern junction with the Hume Highway.

The junction with Hume Highway is of the type shown in Appendix C with a short deceleration for traffic turning from the east. The left turn into Whitefields Road from the west is restricted by the width and the alignment of the 'throat' of the junction (Plates 43 to 46).

The gravel road commences at the stock grid which is located at 0.03 kilometres. Plate 47 shows the gravel road at 0.13 kilometres. A property access is on the right at 1.16 kilometres (Plate 48). The gravel road reduces in alignment and width at 1.4 kilometres with large trees close to the road (Plate 49). The trees remain close to the road as far as the gate at 2.65 kilometres.

The road towards the west has been provided with culverts and the gravel surface has had some maintenance. The road is basically a farm access track with gates between the properties. The gradients are undulating and road access towards the proposed wind farm in the north would be possible from several locations along the route.

An access track toward the north departs at 2.75 kilometres. Plate 50 shows the gate at 2.65 kilometres. Plate 51 shows the causeway at 2.87 kilometres and some erosion is evident. Roadside erosion at 3.33 kilometres is shown in Plate 52 (some erosion control measures are in place).

Plate 53 shows the gate at 3.57 kilometres. A sign at this gate indicates the shire boundary between Yass Valley & Harden Shire Councils. The road up to this point is maintained by Yass Valley Council. (The location of this boundary would appear to contradict the boundary location shown on some of the available mapping data).

A track on the left at 4.92 kilometres provides access to a residence which is several hundred metres from the road. An access to the ranges in the north appears to be available near the buildings at 5.95 kilometres (see Plate 54). The road and gate at 8.41 kilometres is shown in Plate 55 and a causeway at 8.69 kilometres is shown in Plate 56. Plate 57 shows the gates at 9.36 kilometres. An access on the right at 9.37 kilometres is to a residence.

The road widens to 4 to 5 metres wide between 9.37 kilometres and the junction with Coppabella Road at 9.78 kilometres. Plate 58 taken from 9.64 kilometres and shows the junction with Coppabella Road ahead. The section of road between Whitefields Road and Berramangra Roads is signposted as Coppabella Road which turns at the junction with Whitefields Road.

Coppabella Road from Cumbamurra Road South to Berramangra Road

Most of this section of Coppabella Road (refer to the Plan, Appendix A) can be considered as a farm access road with gates, grids and few drainage structures and it is unlikely that it would become a major access route. As indicated in Section 2.2 of this report, parts of the route may be utilised for the access of small numbers of specialist equipment. Distances on this part of the report are in kilometres from the junction with Cumbamurra Road. Plate 59 is taken from the junction towards the gates at 0.02 kilometres.

Plates 60 to 63 show the road 0.30.1.76, 2.47 & 3.34 kilometres. Plate 64 shows a stream crossing at 3.6 kilometres. Plate 65 shows the road ahead from 4.0 kilometres. A concrete stream crossing approximately 5m wide is located at 5.93 kilometres (shown in Plate 66).

Plate 67 shows the gate at 6.23 kilometres. The road condition improves from 6.5 kilometres and the width of pavement at 7.3 kilometres is 4.0 metres (Plate 68). A residence is on the right at 7.72 kilometres and the road appears to be used regularly. There are cattle grids at 7.82, 8.78 & 9.97 kilometres. Plate 69 shows the road at 7.83 kilometres. Plate 70 shows the low level bridge (approximately 5m wide) ahead at 10.01 kilometres.

The junction with Whitefields Road and the next section of Coppabella Road is shown in Plate 71. The road is in good condition and approximately 5.0 metres wide with a causeway crossing of the same width at 12.50 kilometres (Plate 72). The road is not fenced and stock grids are crossed at 11.24, 12.29 & 12.90 kilometres.

The junction with Berramangra Road is at 12.91 kilometres (Plates 73 & 74). The junction is at an acute angle and the sight distance to the north is restricted by a crest in Berramangra Road.

Berramangra Road

Berramangra Road commences at the Hume Highway 47.33 kilometres from Yass. The junction is a high standard two stage crossing, as shown in Appendix C and Plates 75 to 77. Distances shown for this road are in kilometres from the Hume Highway. Berramangra is a sealed road approximately 5.5 metres wide. Safe travel speeds are estimated to be 60 to 70 kilometres per hour, due to sharp crests and curves.

Plate 78 shows the road at 1.1 kilometres. The junction with Coppabella Road is at 1.5 kilometres. The concrete bridge at 3.59 kilometres is shown in Plate 79. The width between kerbs is 5.5 metres.

Plate 80 shows the road at 4.32 kilometres. Lack of shoulder maintenance and low traffic volumes have resulted in grass growing onto the pavement.

A gate on the right at 4.52 kilometres gives access to Hillview Road. Plates 81 & 82 show the available sight distance to south and north respectively. The sight distance is adequate for the travel speeds expected on Berramangra Road, however the turning radius from the north could be improved.

Westbourne Road is on the left at 6.31 kilometres. Plate 83 shows the junction looking north along Berramangra Road. The sight distance is adequate for safe travel speeds. The turning radii should be larger to accommodate large vehicles.

There is a possibility of an access point to the five most western turbine precincts at approximately 8.5 kilometres. The standard of road alignment reduces to approximately 40 to 50 kilometres per hour at 9.3 kilometres due to sharp crests and curves. A sharp crest on straight alignment at 11.8 kilometres is considered to be dangerous.

A stock grid at 13.44 kilometres marks the end of the fenced road reserve. The junction with Cumbarmurra Road is at 13.60 kilometres (Plates 84 & 85). This junction is at an acute angle as shown in Plate 83 (looking back south along Berramangra Road).

Westbourne Road

Westbourne Road provides a link between Hume Highway at 50.19 kilometres west of Yass to Berramangra Road, approximately 5 kilometres to the north. The distances referred to are in kilometres south from Berramangra Road.

The road has a gravel surface approximately 4 to 5 metres wide with steep gradients and relatively straight alignment. Plate 102 shows Westbourne Road from 0.05 kilometres. There are two concrete causeways on the route. Plate 103 shows the causeway at 0.42 kilometres.

The junction with Hume Highway is of a high standard and is shown in Plates 104 & 105.

Coppa Creek Road

Coppa Creek Road is 2.3 kilometres long and connects Coppabella and Berramangra Road at the Hillview Road Junction. This road was constructed to provide a flood free connection during flooding of the causeway on Coppabella Road. The route is not currently in use except for property access between the four properties along the route. There are six gates on the route.

Cumbamurra Road

Cumbamurra Road provides a 7.5 kilometre link between Berramangra Road and Coppabella Road. The pavement is gravel, approximately 4.0 m wide, and the road is unfenced with three gates and two stock grids. The travel speed is often restricted by stock on the road, however the alignment in several of the gullies reduces travel speed to approximately 30 kilometres per hour. Distances quoted are in kilometres from Berramangra Road.

There is a 5 m wide concrete causeway crossing at 3.64 kilometres which is in poor condition (Plate 86) and an open crossing at 6.04 kilometres. There are large trees overhanging the road at several locations. Plate 87 shows the road at 4.57 kilometres.

The junction with Coppabella Road is at 7.5 kilometres. At this junction, the Cumbamurra Road leg proceeds to become Coppabella Road to the north and Coppabella Road joins on the right at an acute angle to the south. Plates 88 to 90 show this junction.

Coppabella Road from Cumbamurra North to Garry Owen Road

This section of Coppabella Road 3.12 kilometres long and provides a part of the link to and from Binalong for properties in the vicinity and would be unlikely to operate as a through road because of faster links via Illalong Road and the Hume Highway. This section has a 4.0m wide gravel surface is unfenced and has a large concrete causeway of the same width at 1.0 kilometre (Plates 91 & 92).

Garry Owen Road joins on the right at 3.12 kilometres from Cumbamurra Road (Plate 93). This junction is 9.66 kilometres from Binalong.

Garry Owen Road

Garry Owen Road is 9.66 kilometres long and provides access to properties west of Binalong. The surface is mostly gravel, 4 to 5 metres in width and the boundaries are fenced. The initial 4.84 kilometres are in Yass Valley Shire, the remainder being in Harden Shire.

The alignment allows safe travel speeds of up to 70 kilometres per hour reducing to 50 kilometres per hour in areas of poor alignment and grading. There no guideposts, bridge width markers or regulatory speed signs in place. Distances shown are in kilometres from Burley Griffin Way in Binalong.

Plates 94 & 95 show the junction with Burley Griffin Way. This junction has adequate sight distance and turning radii.

The 5.5 metre wide pavement is bitumen sealed up to 0.81 kilometres. A timber bridge at 0.69 kilometres is 3.9 metres between kerbs (Plates 96 & 97). There is a causeway at 3.54 kilometres (Plate 98) and a concrete box culvert with wearing surface at 8.28 kilometres (Plate 99).

Low branches overhang the road at 2.0, 4.4, 6.4 & 7.3 kilometres. Plate 100 shows the trees at 7.3 kilometres. The alignment approaching Coppabella Road is shown in Plate 101.

3.3 Existing Traffic Volumes

Traffic observations were made during mornings and afternoons on 3rd and 4th of November 2008.

Volumes obtained from RTA counts (Roads and Traffic Authority) are average, annual, daily traffic counts and have been adjusted to represent numbers of vehicles. The volumes were based on counts collected in 2006. The figures include vehicle numbers in both directions and can be adjusted if required, assuming that the peak hour represents 10% of the annual average daily traffic volumes (AADT). The volumes on the main are lower generally than shown in RTA published data for other years. Precise volumes are not considered to be critical in the examination of traffic Impacts and therefore the 2006 volumes have been adopted.

Observations on most of the minor roads revealed hourly counts approaching zero. The traffic on these roads is generated primarily by the occupied properties. The numbers adopted below have been adjusted based on the number of properties multiplied by traffic generation rates for dwellings given in the RTA Guide to Traffic Generating Developments.

The traffic volumes on Paynes Road at Bogo Quarry are dependant on the production rate on that particular day and can reach up to 20 vehicles per hour. For the purposes of this report, this maximum rate is assumed over a 7 hour day (as per Bega Duo Designs 2006).

The accuracy of the adopted traffic counts on the minor roads is not significant in the assessment of traffic impacts whilst the volumes remain low. Impacts on these roads are considered based on observed defects in each road.

Table 3-1 Traffic Volumes (AADTs) for Roads in the Study Area.

Road	AADT (vehicles per day)	Information source
Hume Highway at Bowning	7223	Obtained from RTA records
Burley Griffin Way Stn 94.085	1661	Obtained from RTA records
Burrinjuck Road	114	Obtained from RTA records
Illalong Road	70	Adjusted from counts taken
Berramangra Road	Less than 50	Adjusted from counts taken
Garry Owen Road	Less than 50	Adjusted from counts taken
Paynes Road to Bogo Quarry	Less than 200	Adjusted from quarry production rates
Cumbamurra, Coppabella, Coppa Ck, Waterview & Whitefields Road	Less than 30	Adjusted from counts taken and discussions with landholders

** AADTs represent the total traffic volume in both directions (they also equate to the number of trips)*

4 FACTORS RELATING TO TRAFFIC GENERATION AND TRAFFIC IMPACT

4.1 Traffic Generation

Construction phase of the project

The maximum traffic volume is expected to occur during the civil construction phase of the wind farm which includes the pouring of concrete for the foundations. Each footing may contain up to 310 cubic metres of concrete to be poured over an eight hour period. This results in a rate of up to 12 mixer truck trips per hour. It is likely that a concrete batching plant would be located at a central location (possibly at Bogo Quarry on Paynes Road). Location of the batching plant on site may reduce the maximum traffic generation rate on the major roads. For the purpose of predicting maximum probable traffic generation, the concrete trucks would be included in the number of vehicles generated on all of the major routes.

Operation phase of the project

The location of the three precincts in the current development (see Plan of Access Roads in Appendix 1) would result in major access links being along the Hume Highway, Burrinjuck Road, Paynes Road and Burley Griffin Way.

Major routes along existing low traffic roads which are being considered include Illalong Road, Berramangra Road, Whitefields Road, Coppabella Road and Waterview Road. These routes are indentified as routes which would be required to carry relatively large volumes of traffic during the construction phase and would continue to carry traffic for the ongoing maintenance of the wind farm.

Once operational, the wind farm would be managed and operated by several crews of technicians, based at Yass. The precincts would be accessed regularly for operational and maintenance activities. It is estimated that the operational phase would generate up to 8 trips per day into the Coppabella Precinct from Whitefields Road. It is assumed that there would be at least four permanent access points into the Marilba Precinct, generating approximately 4 trips per day from the access points at Conroys Gap and Marilba Station. The Carrolls Ridge Precinct would most likely have two access points which would generate 4 trips per day.

4.2 Construction Program

The project would be constructed over a 3 year period. The following major activities are expected to take place at all three precincts.

- Civil works for upgrading of access roads and establishment of precinct offices
- Civil works for construction of internal tracks, excavation for footings and trenching for cables
- Pouring of concrete in turbine footings
- Transportation to precinct, erection and commissioning of wind turbines
- Construction of substation and associated power lines

4.3 Working Hours

Normal construction industry working hours are assumed for the purposes of this report, as specified in the EPA Environmental Noise Control Manual (7am-6pm Mon-Fri, 7am or 8am – 1pm Sat). EPA Guidelines would apply for noise emissions from construction works.

4.4 Assumed Design Traffic Volumes

The traffic volumes contained within this section would be used to design traffic management devices, such as junctions, required for the proposal. They are also used to quantify the traffic impact, for example, on residents living adjacent to the haulage routes, and possible damage to the road pavements.

The daily rate of traffic movements, rather than total number of movements, is the critical factor in determining the level of impact. The daily rate is derived from Table 4.1, which estimates the predicted maximum number of one way traffic movements (trips) per day for the various construction activities.

Table 4-1 Predicted Daily Rates of Traffic (trips) for one precinct.

For the purposes of predicting traffic on major route the following table is based on the construction of 86 wind turbines at one location (the maximum number of turbines that would be installed at any precinct). This represents the maximum traffic load which could occur at any one point on the major access routes shown on the Plan, Appendix 1. The table is based on the Coppabella Precinct which may require access for the construction of up to 86 turbines from Whitefields Road.

Information in the table is generally based around continuous pouring one footing in a day and installation of approximately 2.5 towers per week to complete the whole project (all locations) within 3 years.

Activities	Approximate duration (months)	Maximum number of trips per day	Comments
Construction and management staff	20	**54**	Assuming approx. 3 employees per vehicle.
Precinct set up	1	10	
Road construction	6	30	
Foundation construction	12	**102**	Includes reinforcing steel delivery
Dust suppression	20	**4**	
Substation & Powerline construction	6	**26**	Includes overmass vehicle deliveries of transformers.
Internal Cabling	6	6	
Turbines erection	9	**58**	Includes up to 550 oversize and overmass vehicle deliveries.

The trips shown in **bold** could be concurrent, resulting in a maximum 240 trips per day.

This table indicates that the maximum daily rate of traffic at any point on the major access route may increase by 250 vehicles per day during the peak construction period.

The peak volumes may apply for periods of up to 12 to 18 months at the major access point for the Coppabella Precinct whilst the peak period for the access from Berramangra Road may apply for several months only. The period of high traffic volumes would vary at each precinct depending on the number of turbines, substations, depots, and administrative facilities at each precinct.

The estimated hourly rate during the peak hour (based on 15% of the daily volume) is approximately 40 vehicles per hour. This figure would be used in the design of new junctions and is applicable when estimating the impacts on residents adjacent to the proposed routes.

4.5 Design for Heavy Vehicles

The standard design vehicle for the construction of intersections and the design of parking and turning areas as a minimum would be the 'Austroads' Single Unit Truck/Bus 12.2m long. However, provision would be made wherever possible to allow for a 'B-Double' template, which requires a wider path. This wider path would allow for the turning of semi trailers and oversize vehicles.

There is a requirement to transport turbine blades to the precinct, which could be up to 50 metres long. These would be transported on purpose designed steerable trailers making approximately 300 deliveries in total (all precincts). These vehicles would be capable of negotiating small radius curves provided that areas free of obstructions are available on the inside of curves. The transport of tower sections up to 25 metres long and weighing up to 50 tonnes would require a total of 1200 oversize vehicle deliveries. The nacelles would require 300 over-mass (up to 75 tonnes) vehicle deliveries.

The design of access roads and junctions would need to allow for widths of up to 4.2 metres and weights complying with Roads and Traffic Authority maximum loading.

4.6 Traffic Circulation

Hardstand areas would be required around each turbine for the safe operation of large cranes. These areas would also provide turning opportunities for delivery vehicles.

No vehicles would reverse onto the public road network.

4.7 Road Capacity (Level of Service)

Road capacity is normally described as 'Level of Service' and based on Austroads '*Guide to Traffic Engineering Practice, Part 2 Roadway Capacity*'. Capacity is expressed in total vehicles per day. The level of service descriptions are as follows:

Table 4-2 Level of Service (LOS) Descriptions.

LOS A :	Free flow condition, high degree of freedom for drivers to select desired speed and manoeuvre within traffic stream.
LOS B :	Zone of stable flow, reasonable freedom for drivers to select desired speed and manoeuvre within traffic stream.
LOS C :	Zone of stable flow, restricted freedom for drivers to select desired speed and manoeuvre within traffic stream.
LOS D :	Approaching unstable flow condition, severely restricted freedom for drivers to select desired speed and manoeuvre within traffic stream.
LOS E :	Condition close to capacity, virtually no freedom for drivers to select desired speed and manoeuvre within traffic stream. Small increases in flow would generally cause operational problems.

Tables contained in Austroads '*Guide to Traffic Engineering Practice*', Sec. 3.4 & Sec 4 Roadway Capacity, have been used for the following determinations based on the traffic volumes shown in Section 3.1:

- Hume Highway at approximately 7,200 vehicles per day (vpd) operates at LOS A and would not reach LOS B until the volume reaches approximately 20,000 vpd. The estimated maximum design volume (see Section 4.4 of this report) is 7,450 vpd.
- Burley Griffin Way with approximately 1660 vehicles is operating at LOS B and the level of service would no drop to LOS C until volumes reach 2800 vehicles per day.
- Burrinjuck Road, Illalong Road, and Berramangra Road operate at LOS A and the level of service would not drop to LOS B until volumes reach at least 500 vehicles per day.

The determinations above show that the increase in traffic volumes of 250 vehicles per day would have a negligible effect on the capacity of the major routes shown above.

The single lane gravel roads which comprise the remainder of the roads under consideration perform their function as property access roads however **would not** perform satisfactorily with an increase in traffic of 250 vehicles per day. Upgrades would be required on any of these sections carrying increased traffic loads.

The Roads & Traffic Authority design guidelines suggest that roads with volumes between 150 and 500 vehicles per day should be provided with two lanes of 3.0 metres minimum width each (6.0m pavement).This is generally the minimum standard adopted by councils for smaller rural subdivisions.

4.8 Safety Considerations

Traffic generation calculations indicate that the maximum hourly increase in traffic at any location would be approximately 40 vehicles per hour (equivalent to 250 vpd) during the construction phase of the project.

The following safety issues have been considered:

- Risk of vehicle collisions
- Collisions with stock
- Traffic noise
- Dust from unsealed roads
- Driver distraction
- Obstruction by long loads
- Wet weather
- Road surface deterioration
- Structural failure of road structures
- Shadow Flicker
- Protection of walkers and horse riders

The impacts of these issues are discussed in Section 5.

5 IMPACT ASSESSMENT AND ASSOCIATED SAFEGUARDS

5.1 Traffic Impacts on Over-mass and Over-dimensional Haulage Routes

This section of the report considers all route options, including some alternative routes for the over-mass and over-dimensional vehicles. Decisions on the final routes for these vehicles would be the subject of negotiations between the haulage contractor and the road authorities.

Because of the potentially large increase in the number of vehicles using these routes there are many impacts to be considered. The larger vehicles would occupy most of the width of the roadway at many locations increasing the chance of ‘head on’ collisions. For nearby property owners, there would be an increase in traffic noise and dust nuisance and a need to control stock from straying on the roads which are not fenced. Dust would be generated on the unsealed roads affecting visibility and resulting in the loss of pavement materials. The gravel road surfaces would deteriorate and potholes would form under the increased traffic loads, particularly during wet weather when water ponds or floods across the road. Structural damage may occur to some of the culverts, concrete causeway crossings, stock grids and traffic islands. The location of trees and other roadside objects have the potential of obstructing the passage of long wide loads and high loads. Lack of roadside delineation in some locations may impact traffic safety during periods of poor visibility. Some intersections have inadequate pavement width to safely accommodate the turning man oeuvres of the over-size vehicles.

These impacts would be temporary, as the equipment haulage is not a continuous program. Most of the heavy haulage would be in the form of convoys and would be managed through a number of specific mitigation measures developed and implemented in conjunction with both RTA and local Councils. These measures usually include escort vehicles.

Safeguards

- Use of a licensed haulage contractor with experience in transporting similar loads, to be responsible for obtaining all required approvals and permits from the RTA and Councils and for complying with conditions specified in the approvals.
- Development of a Traffic Management Plan in conjunction with the haulage contractor to include but not be limited to the following:
    - Scheduling of deliveries,
    - Managing timing of transport,
    - Limiting the number of trips per day,
    - Undertaking community consultation before and during all haulage activities,
    - Designing and implementing temporary modifications to intersections and roadside furniture,
    - Managing the haulage process, including the erection of warning signs and/or advisory speed posting prior to isolated curves, crests, narrow bridges and changes of road conditions,
    - A speed limit would be placed on all of the roads that would be used primarily by construction traffic to reduce the severity of any accidents and reduce maintenance costs,
    - A Transport Code Of Conduct should be prepared and made available to all contractors and staff detailing traffic routes, behavioural requirements and speed limits.

  - A procedure should be established to monitor the traffic impacts during construction, such as noise, dust nuisance and travel times and work methods modified to reduce the impacts.
  - Providing a dedicated telephone contacts list to enable any issues or concerns to be rapidly identified and addressed,
  - Reinstating pre-existing conditions after temporary modifications to the roads and pavement along the route.
- Implementation of all aspects of the Traffic Management Plan in coordination with the Council and RTA.
- Reconstruction of gravel pavements. The decision to provide a seal needs to be balanced against the cost of maintenance on the gravel surface. Sealing would help address dust suppression and sediment control as well as road deterioration. The environmental impacts of this work should also be considered in the decision.
- The Proponent would prepare road dilapidation reports covering pavement and drainage structures in consultation with the RTA and Council for the route prior to the commencement of construction and after construction is complete. Any damage resulting from the construction traffic, except that resulting from normal wear and tear, would be repaired at the Proponent's cost. Alternatively, the Proponent may negotiate an alternative for road damage with the relevant roads authority.

5.2 Traffic Impacts at Specific Locations

Hume Highway

Additional traffic would be turning to and from the Hume Highway at seven locations between Burley Griffin Way and Westbourne Road (18.3 to 50.2 kilometres West of Yass).

The junctions at Burley Griffin Way, Paynes Road, Burrinjuck Road, Illalong Road and Berramangra Road are of a high standard and the relatively small increase in traffic volumes would not have any significant impacts on safety for turning traffic.

The junctions with Burley Griffin Way and Burrinjuck Road have advance signposting allowing traffic departing from the Highway to select the appropriate lane and decelerate smoothly in preparation for the turn. This facility is not available on the other junctions and drivers who are unfamiliar with the locality are often required to make sudden manoeuvres at high speed when they approach their departure point at a minor junction.

The effects of shadow flicker have been examined for the proposed turbine precincts adjacent to the highway at Conroys Gap (refer to Appendix D). Information from the Danish Wind Industry Association (2003) suggests that the shadow flicker effect diminishes beyond 500metres from the wind tower precinct and is not noticed beyond 1000 metres. The effect is only present when the sun is directly behind the turbine blades within the driver's cone of vision. The final location of the turbines has not been determined and Appendix D is based on the closest turbine being approximately 200 metres south of the highway formation. The diagram in Appendix D indicates that the sun position would not be intersected by the turbine precincts within the driver's cone of vision.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- Traffic Management Plan should include measures along Hume Highway for providing advance warning of the proposed access points.

- The Transport Code of Conduct should detail the location of all access points and rest areas and should be prepared in consultation with the Roads and Traffic Authority.
- The distance from the closest tower to the Hume Highway should be sufficient so that in the event of a collapse of a tower or crane no part would fall within the 'clear zone' of the Highway. In the case of the large cut batter on south side of Conroys Gap, it may be preferable to ensure that any potential collapse would be clear of the cutting slope.

Hume Highway Rest areas at Conroys Gap

The existing access track from the rest area on the northern side departs from the deceleration lane at a point where travel speeds have not sufficiently reduced to permit safe access. The existing access on the southern side does not have sufficient setback from the rest area formation and turning radii are insufficient for large vehicles.

The rest areas do not permit safe turning for return travel.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- The Transport Code of Conduct should contain methods for reducing noise and other disturbance to the users of the rest areas.
- The Traffic Management Plan and Transport Code of Conduct should contain information on the location of safe turning locations for return travel along the Hume Highway.
- As part of the Traffic Management Plan Road, rest area users should be made aware of the construction programme for the turbines to be accessed from the rest areas.
- Designs need to be prepared in consultation with the Roads and Traffic Authority for the construction of safe access roads from both rest areas.

Illalong Road

Increased vehicle movements particularly by heavy vehicles would increase the potential of vehicle conflicts.

Yass Valley Council has imposed a weight restriction of ten tonnes on the full length of Illalong road as the pavement is considered to be of insufficient strength to withstand large volumes of heavy traffic.

An old timber bridge at 3.3 kilometres from Burley Griffin Way is currently under repair. The width between kerbs is 4.8 metres. The bridge and the concrete bridges at 6.09 and 10.27 kilometres may be of insufficient strength and width for use by heavy vehicles.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- Implementation of speeds limits along Illalong Road should be considered to reduce the accident potential.
- Yass Valley Council should be consulted about use of the northern section of Illalong Road as a major access route from Burley Griffin Way to the first potential access point at approximately 1.6 kilometres. Access along Illalong Road from the Hume Highway to Campbells Road should also be considered. The improvements required to the pavement should be investigated and discussed with Council and appropriate construction planned.
- The strength of the bridges should be checked and appropriate repairs or weight restrictions implemented for the timber bridge at 3.32 kilometres and the concrete bridges at 6.09 & 10.27 kilometres from Burley Griffin Way.

- Junctions at the proposed access points at Weilora and Campbells Road should be upgraded to provide safe turning movements, if they are required for access.

Marilba Access Roads

The increased volumes of traffic at these junctions may result in vehicle conflicts in the 'throat' of the junction, between vehicles departing and entering at peak periods.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- The layout of the junctions should be checked and plans prepared for upgrading to provide sufficient area for departing vehicles to stand clear of entering vehicles.
- Speed limits and warning signs should be installed, and should indicate potential hazards along the route.

Burrinjuck Road

The junction with the Hume Highway has restricted sight distance due to vegetation in the central median area.

The significant increase in traffic on Burrinjuck Road would increase the potential for traffic conflicts, particularly during summer holiday periods when recreational activities are at a peak for the year.

Tree branches which overhang the road could conflict with high loads.

Deformation of the road surface at some locations indicates that the surface may fail when subject to an increase in heavy traffic.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- The Roads & Traffic Authority should be contacted in regard to the clearing of sight lines at the Hume Highway Junction.
- Proposed peak construction periods on Burrinjuck should be programmed where possible to avoid the summer holiday periods. Recreational groups which organise horse riding and walking activities should be informed about the timing of construction works, as part of the community consultation required by the Traffic Management Plan.
- The need to lop overhanging branches along Burrinjuck Road should be investigated as part of the Traffic Management Plan.
- The condition of the road pavement should be assessed and measures for repair and or monitoring discussed with Yass Valley Council.
- The road junction at the proposed access at 10 kilometres from Hume Highway requires reconstruction including setback from the existing road formation.

Waterview Road

The junction with Burrinjuck Road has insufficient sight distance to the south.

Waterview Road has insufficient width and sight distance for most of its length to operate as a two lane access road carrying increased traffic.

The gradients towards the main crest would be difficult for vehicles in wet weather due to the combination of steep grades and inadequate roadside drainage.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- The junction with Burrinjuck Road should be realigned to improve sight distance.
- The road requires reconstruction and widening to provide a minimum of 6.0 metres width. A bitumen seal is required on the steep grades. Erosion protection of the roadside drains will be required.

Whitefields Road.

The increased volumes of traffic at the junction with Hume Highways may result in vehicle conflicts in the 'throat' of the junction between vehicles departing and entering at peak periods.

Whitefields Road has insufficient width for most of its length to operate as a two lane access road carrying construction traffic. Trees overhang the road at many locations which would restrict high loads. The proximity of many trees to the roadside could restrict the passage of long wide loads.

The road reserve is not fenced for stock control and properties are separated by gates at six locations along the 10 kilometre length.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- The layout of the junction with Hume Highway should be checked and plans prepared for upgrading to provide sufficient area for departing vehicles to stand clear of entering vehicles.
- The road requires reconstruction and widening to provide a minimum of 6.0 metres width. A bitumen seal should be considered in order to reduce the dust nuisance.
- The road reserve should be fenced or other arrangements made with the property owners for stock control.
- The gates should be replaced with stock grids of sufficient width and strength for heavy vehicles.
- Erosion protection of the roadside drains at some locations is required.
- The Traffic Management Plan should favour access to Whitefields Road from the West via Berramangra and Coppabella Roads as the junction with Hume Highway at Berramangra is of a higher standard than the Whitefields Road Junction.

Coppabella Road (Southern section from Whitefields Road to Berramangra Road).

The 2.6 kilometer section of Coppabella Road from Whitefields Road to Berramangra Road is of insufficient width for part of a major access route and is not fenced.

The relatively straight alignment could result in excessive speed on this section.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.

- The road requires widening to provide a minimum of 6.0 metres width. A bitumen seal should be considered in order to reduce the dust nuisance and increase safety at junctions. Guide posts should be erected.
- Establish speed limits and erect warning signs for potential hazards along the route.
- The road reserve should be fenced or other arrangements made with the property owners for stock control.
- Stock grids of sufficient width and strength for heavy vehicles should be provided.

Berramangra Road

Berramangra Road has inadequate delineation of the alignment and insufficient warning of the poorly aligned sections and roadside hazards. The available width of bitumen is reduced at some locations by roadside vegetation.

The junction with Coppabella Road has insufficient sight distance to the north along Berramangra Road.

A old concrete bridge at 3.6 kilometers has an available width of 5.5 meters between kerbs.

The junction with Hillview Road has inadequate turning radius to the north. The Westbourne Road Junction requires larger turning radii for safe turning by larger vehicles.

Berramangra Road beyond 9.3 kilometers from Hume Highway has a low standard of alignment which reduces safe travel speed on some sections to 40 to 50 kilometers per hour.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- Increase available width of formation by clearing and widening road shoulders.
- Install guideposts and bridge width markers.
- Speed limits and warning signs should be installed, and should indicate potential hazards along the route.
- Investigate the load limits for the bridge at 3.59 kilometres and establish alternative routes if applicable. Other routes may be established via Coppa Ck Road or Westbourne Road.

5.3 Impacts on Minor Roads

There are potential impacts on Westbourne Road, Coppa Creek Road, Cumbarmurra Road, Garry Owen Road and Coppabella Road (Northern Section). These routes are not covered specifically in Section 5.2. Although it is not anticipated that the minor roads identified in this section would become primary access routes, it is probable that some of these routes would experience a small increase in traffic volumes. A relatively small increase in traffic volumes would require improvements to ensure the safety of road users particularly in relation to conflicts between vehicles and stock.

The road reserves are fenced on Westbourne Road and Garry Owen Road and therefore can support small increases in traffic without the level of improvement required on the other minor roads.

Isolated curves and crests on looser gravel surfaces could result in drivers losing control. Many drainage structures may need upgrading to ensure continued access in wet weather.

Safeguards

- Safeguards identified in Section 5.1 are also applicable.
- A programme should be prepared in conjunction with Council to allow for the installation of guideposts bridge width markers, warning signs and speed restriction signs on Garry Owen and Westbourne Roads.
- Closely monitor the traffic volumes on all minor routes in close cooperation with property owners and establish a procedure for the identification and implementation of required improvements. This programme should be capable of a short response period and be prepared in consultation with the relevant councils.
- Investigate the load limits for the bridge at 0.69 kilometres on Garry Owen Road and signpost if required.

5.4 Summary of Key Safeguards

Table 5-1 Summary of the type and extent of key safeguards required to reduce traffic impacts

Shading indicates the action is applicable. This table indicates key areas only and is not considered to be a comprehensive list of all safeguards recommended. Refer to text in Sections 5.1, 5.2, 5.3 and 5.5 for a full discussion of all recommended safeguards.

Key safeguards	Hume Highway	Burley Griffin Way	Illalong Road	Marilba access road	Paynes Road	Burrinjuck Road	Waterview Road	Whitefield's Road	Coppabella Road	Berramangra Road	Westbourne Road	Coppa Creek Road	Cumbamurra Road	Garry Owen Road
Reconstruction and/or realignment to provide 6m wide pavement & consider bitumen seal	-	-	-	-	-	-	1.55 km of reconstruction	9.8 km of reconstruction	2.6 km of reconstruction on the southern section only	-	-	-	-	-
Improve turning radii and advance signposting on junctions [1]	5 junctions	1 junction	2 junctions	(see Hume Highway)	-	2 junctions	(see Burrinjuck Road)	(see Hume Highway)	-	2 junctions	(see Berramangra Road)	-	-	-
Check bridges and pavement condition on sealed roads in consultation with road authorities	-	-	3 bridges & 11 km of pavement	-	-	14 km of pavement	-	-	-	1 bridge & 8.5 km of pavement	-	-	-	1 bridge
Repair and maintain road shoulders on sealed roads	-	-	-	-	-	14 km of sealed pavement	-	-	-	13.8 km of sealed pavement	-	-	-	0.81km of sealed pavement
Provide warning signs and guideposts	-	-	-	-	-	-	1.55 km length of council road	9.8 km length	3.12 km length in the northern section	13.8 km length	5.0 km length	-	-	9.7km length
Discuss with roads authority and land holders level of usage and improvements required	2 junctions at Conroys Gap Rest Areas	-	11 km length	2.2 km length	1.34 km length	-	-	9.8 km length	10.33 km length	13.8 km length	5.0 km length	2.3 km length	7.5 km length	9.7km length

[1] The road indicated is the more major road of the junction

5.5 General Safeguards

Additional to the specific safeguards outlined above, it is recommended that a transport carpool be organised for construction workers. This would minimise the number of vehicles travelling to and from the precincts, with resultant safety and environmental benefits.

The safeguards listed in Sections 5.1 to 5.3 of this report have not been discussed in any detail with road authorities or property owners and are presented for further discussion and assessment. The decision on the extent and standard of road improvements to be provided would be subjective and related to the economies of construction for short term use.

6 CONCLUSION

The Yass Wind Farm Project stretches westward for approximately 30 kilometres north of the Hume Highway, requiring access from this major interstate route for the Marilba Hills and Coppabella Hills precincts which contain 152 potential turbine locations. Burrinjuck Road junctions with the Hume Highway and provides access to the southern portion of the Marilba Precinct and all of the Carrolls Ridge Precinct.

The area proposed for the Yass Wind Farm is sparsely populated and the introduction of an additional 250 vehicles per day during the construction period could have a significant impact on the existing road users on the minor and unsealed roads.

Safeguards considered necessary to address the traffic impacts of the proposal are outlined in this report. These safeguards should be implemented in consultation with the Harden and Yass Valley Councils. Safeguards on the Hume Highway should be discussed with the Roads and Traffic Authority.

Adoption of all the safeguards for minimising traffic impacts outlined in this study should reduce community disruption and the risk of traffic accidents to an acceptable level and minimise structural and environmental damage. Key issues are summarised, as follows:

Hume Highway and Junctions

The Hume Highway alignment has been designed for travel speeds of 110 kilometres per hour. A high level of road safety is maintained by ensuring that sufficient sight distance is available between all vehicles especially at junctions and intersections. The vehicle conflict points resulting from speed differences at junctions are minimised by providing deceleration lanes. Vehicle conflicts between approaching vehicles are minimised by the separation of the opposing carriageways. Conflicts for turning manoeuvres are reduced by the provision of large turning radii and wide sealed shoulders. Rest areas are provided at regular intervals to reduce accidents due to driver fatigue. Advance signposting is provided prior to the major junctions to minimise late vehicle manoeuvres.

Experienced drivers of standard vehicles would negotiate the Hume Highway including all of the junctions with a high degree of safety. The addition of up to 250 vehicles per day would have a negligible impact on this level of safety. Drivers unaware of the location of junctions have potential to produce conflicts with sudden lane changes and deceleration on the approach to junctions.

The safeguards included in this report aim to review the widths for entry into the minor junctions and carry out improvements where required.

Education of drivers using the Hume Highway and its various junctions and side roads with the assistance of signposting and codes of driver conduct are seen as being the major initiatives which would reduce the traffic impacts for this project.

Burrinjuck Road

The potential impacts on Burrinjuck Road are much greater in comparison to the Hume Highway, as the traffic volumes could increase by as much as three times during the peak construction period. As Burrinjuck Road is a tourist route, the traffic is seasonally affected. Every attempt should be made to carry out the construction works outside school holidays.

Adoption of the safeguards contained in this study should reduce the impacts on Burrinjuck to an acceptable level.

Burley Griffin Way, Illalong Road and Berramangra Road

Access from these roads may only be required for access to a small number of turbines. Traffic impacts should not be significant, provided that the general safeguards listed in Section 5 of this report are implemented.

Whitefields Road and southern portion of Coppabella Road

These roads require reconstruction and provision of a two lane road with a minimum width of 6.0 metres. The roads should be bitumen sealed to increase safety and reduce erosion.

Other Minor Roads

As the traffic impacts on these roads could be substantial if utilised, their use should be carefully monitored and measures adopted for prompt improvements to be carried out as required prior to and during the construction period, as detailed in Section 5.3 of this study.

7 REFERENCES

Austroads 1999 ‘Guide to Traffic Engineering Practice, Part 2 Roadway Capacity’.

Bega Duo Designs (2006). Traffic Impact Study for Conroys Gap Windfarm. Report prepared for nghenvironmental.

Danish Wind Energy Association 2003, Shadow variations from wind turbines. Accessed 22/11/2008, www.windpower.org/en/tour/env/shadow/shadow2.htm

Department of Planning (2008) Bogo Quarry - Bookham web page http://majorprojects.planning.nsw.gov.au/page/project-sectors/mining--petroleum---extractive-industries/extractive-industries/?action=view_job&job_id=2711

Renewable Energy Research Laboratory, www.masstech.org/Project%

Roads and Traffic Authority 1999, *Road Design Guide*, Issue 1 May 1999.

Roads and Traffic Authority 2002, *Guide to Traffic Generating Developments*, October 2002.

Roads and Traffic Authority, www.rta.nsw.gov.au

URS 2004, Assessment of Transport Feasibility and Traffic Impact Crookwell 2 Wind Farm, prepared for Wind Farm Joint Venture, 30 April 2004.

The assistance of the following in obtaining information for this study is recognised :

Yass Valley Council Director of Operations*, Simon Cassidy.*

Harden Shire Council Director of Technical Services, *Simon Miller.*

Roads and Traffic Authority Development Assessment Officer*, Maurice Morgan*

Roads and Traffic Authority A/ Road Safety & Traffic Officer*, Suzie Lyons*

8 AUTHOR

Rodger John Ubrihien

Road Design Consultant,

Cert. Engineering Surveying

Member of the Institute of Engineering and Mining Surveyors NSW.

Rodger has been involved in the survey, planning and design of road projects since commencing work with the Department of Main Roads NSW in 1966. Rodger gained knowledge in Traffic Engineering with the Roads and Traffic Authority Traffic Section in Sydney. Since opening his own business ‘Bega Duo Designs’ in 1993, Rodger has completed the planning of a wide variety of civil engineering and related projects throughout NSW and ACT including wind farms at Crookwell and Silverton.

Contact: Bega Duo Designs

Office 1 Main Street

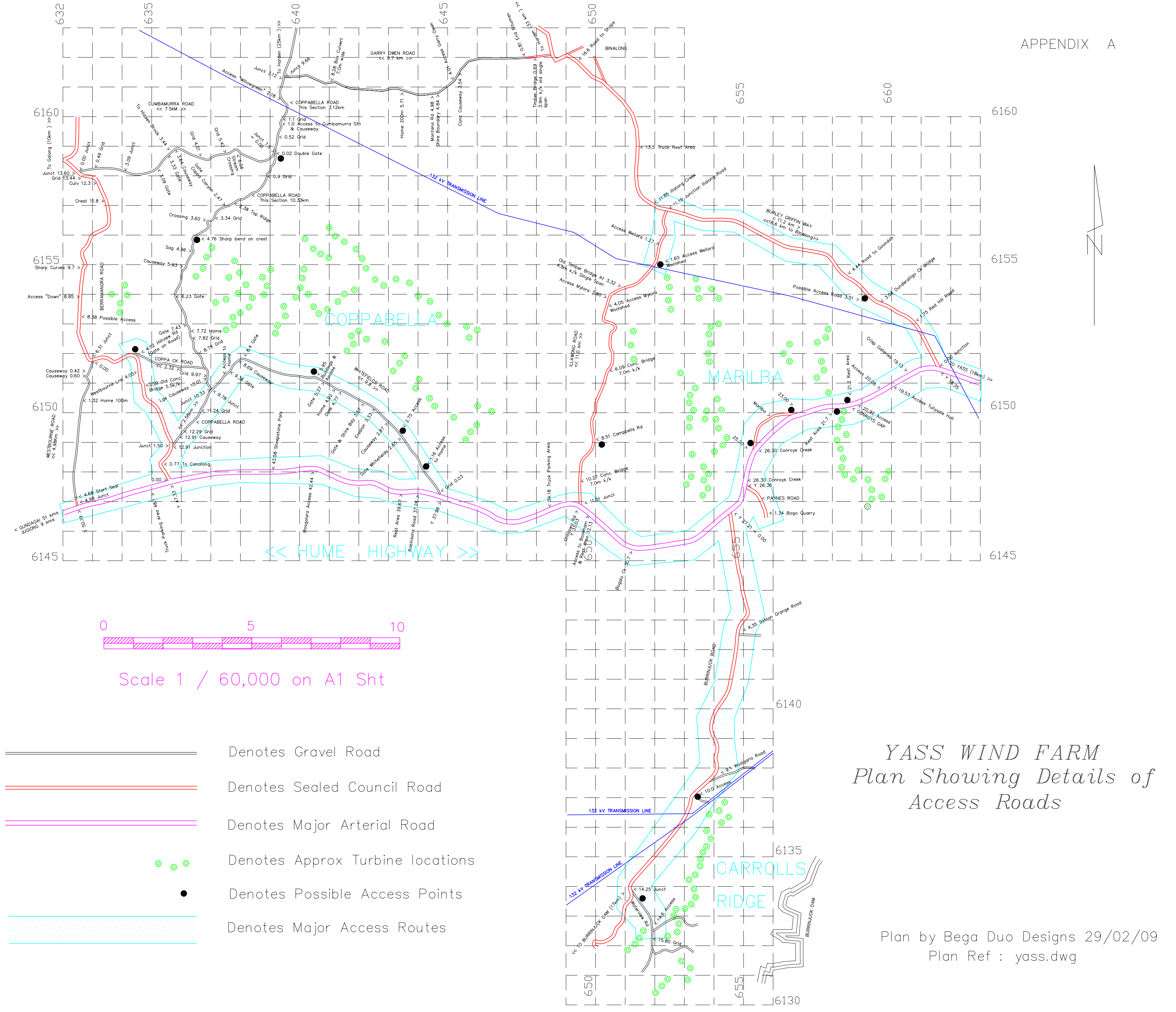
Merimbula NSW 2548

Ph Fax 02 64945456

Mobile 0417292170

Appendix A: Location of the proposal and relevant access roads

APPENDIX A



YASS WIND FARM
Plan Showing Details of Access Roads

Plan by Bega Duo Designs 29/02/09
Plan Ref : yass.dwg

Appendix B: Photographic Plates

PLATE 1

Hume Highway at Conroy's Gap.

PLATE 2

Burley Griffin Way at 6.5km.

PLATE 3

Burley Griffin Way Junction at 3.5km.

PLATE 4

Burley Griffin Way Junction at 3.5km.

PLATE 5

Illalong Rd/Burley Griffin Way Junction

PLATE 6

Illalong Rd/Burley Griffin Way Junction

PLATE 7

Illalong Road Bridge at 3.13km.

PLATE 8

Illalong Road Bridge at 6.09 km

PLATE 9

Illalong Rd/ Cambbells Road at 8.5km.

PLATE 10

Illalong Road Conc. Bridge at 10.27.

PLATE 11

Illalong Road /Hume Hwy Junct.

PLATE 12

Paynes Rd/Hume Hwy Junct.

PLATE 13

Paynes Rd.

PLATE 14

Paynes Rd/Quarry Entrance.

PLATE 15

Burrinjuck Road/Hume Highway Junction.

PLATE 16

Burrinjuck Road/Hume Highway Junction Sight Obscured.

PLATE 17

Burrinjuck Road failing pavement

PLATE 18

Burrinjuck Road Trees over road.

PLATE 19

Burrinjuck Road access at 10.0km.

PLATE 20

Burrinjuck Road/ access at 10.0km.

PLATE 21

Burrinjuck Road/ access at 10.0km.

PLATE 22

Burrinjuck Road Junction with Waterview Rd.

PLATE 23

Burrinjuck Road Junction with Waterview Road

PLATE 24

Waterview Road looking south.

PLATE 25

Waterview Road access on left at 14.6km.

PLATE 26

Waterview Road at 15.2km.

PLATE 27

Waterview Road at 15.8 km.

PLATE 28

Waterview Road at 15.8 km..

PLATE 29

Marilba Access/Hume highway at 23.0km.

PLATE 30

Marilba Access/Hume highway at 23.0km..

PLATE 31

Marilba Access/Hume highway at 23.0km.

PLATE 32

Marilba Access/Hume highway at 23.0km.

PLATE 33

Marilba Access/Hume highway at 23.0km.

PLATE 34

Marilba Access/Hume highway at 25.2km.

PLATE 35

Marilba Access/Hume highway at 25.2km.

PLATE 36

Marilba Access/Hume highway at 25.2km.

PLATE 37

Marilba Access/Hume highway at 25.2km.

PLATE 38

Marilba Access/Grid at 0.19km looking Nth.

PLATE 39

Eastbound rest area Conroy's Gap.

PLATE 40

Eastbound rest area Conroy's Gap.

PLATE 41

Westbound rest area Conroy's Gap.

PLATE 42

Westbound rest area Conroy's Gap.

PLATE 43

Whitefields Road/Hume highway junction.

PLATE 44

Whitefields Road/Hume highway junction.

PLATE 45

Whitefields Road/Hume highway junction.

PLATE 46

Whitefields Road/Hume highway junction.

PLATE 47

Whitefields Road at 0.13km.

PLATE 48

Whitefields Road property access at 1.16km.

PLATE 49

Whitefields Road large trees close to road at 1.4km

PLATE 50

Whitefields Road gate at 2.65km.

PLATE 51

Whitefields Road causeway at 2.87km.

PLATE 52

Whitefields Road erosion at 3.33km.

PLATE 53

Whitefields Road gate at 3.57km.

PLATE 54

Whitefields Road access at 5.95km.

PLATE 55

Whitefields Road and gate at 8.41km

PLATE 56

Whitefields Road causeway at 8.69km.

PLATE 57

Whitefields Road gates at9.36km.

PLATE 58

Whitefields Road Coppabella Road ahead.

PLATE 59

Coppabella Road gate at 0.02km.

PLATE 60

Coppabella Road at 0.30km.

PLATE 61

Coppabella Road at 1.76km.

PLATE 62

Coppabella Road at 2.47km.

PLATE 63

Coppabella Road at 3.34km.

PLATE 64

Coppabella Road at 3.60km.

PLATE 65

Coppabella Road at 4.00km.

PLATE 66

Coppabella Road stream crossing 5.93km.

PLATE 67

Coppabella Road Gate at 6.23km.

PLATE 68

Coppabella Road at 7.3km.

PLATE 69

Coppabella Road at 7.83km.

PLATE 70

Coppabella Road low level bridge ahead.

PLATE 71

Coppabella Road Junct with Whitefields Road ahead

PLATE 72

Coppabella Road causeway at 12.50km.

PLATE 73

Coppabella Road junct with Berramangra Rd.

PLATE 74

Coppabella Road junct with Berramangra Rd.

PLATE 75

Berramangra Rd/Hume Hwy junct.

PLATE 76

Berramangra Rd/Hume Hwy junct.

PLATE 77

Berramangra Rd/Hume Hwy junct.

PLATE 78

Berramangra Road at 1.1 km.

PLATE 79

Berramangra Road Bridge at 3.59km.

PLATE 80

Berramangra Road at 4.32km.

PLATE 81

Berramangra Rd/Hillview Road junct.

PLATE 82

Berramangra Rd/Hillview Road junct.

PLATE 83

Berramangra Rd/Westbourne Road junct.

PLATE 84

Berramangra Rd/Cumbamurra Road junct.

PLATE 85

Berramangra Rd/Cumbamurra Road junct.

PLATE 86

Cumbamurra Road causeway at 3.64km.

PLATE 87

Cumbamurra Road trees over road at 4.57km.

PLATE 88

Cumbamurra/Garry Owen Road junct.

PLATE 89

Cumbamurra/Garry Owen Road junct.

PLATE 90

Cumbamurra/Garry Owen Road junct.

PLATE 91

Coppabella Road Nth at 1.00km.

PLATE 92

Coppabella Road Nth causeway at 1.0km.

PLATE 93

Coppabella Road/Garry Owen Road junct.

PLATE 94

Garry Owen Rd/Burley Griffin Way junct.

PLATE 95

Garry Owen Rd/Burley Griffin Way junct.

PLATE 96

Garry Owen Road Bridge at 0.69km.

PLATE 97

Garry Owen Road Bridge at 0.69km.

PLATE 98

Garry Owen Road causeway at 3.54km.

PLATE 99

Garry Owen Road culvert at 8.28km.

PLATE 100

Garry Owen Road trees at 7.30km.

PLATE 101

Garry Owen Road approaching Coppabella Rd.

PLATE 102

Westbourne Road at 0.05km

PLATE 103

Westbourne Road at 0.05km.

PLATE 104

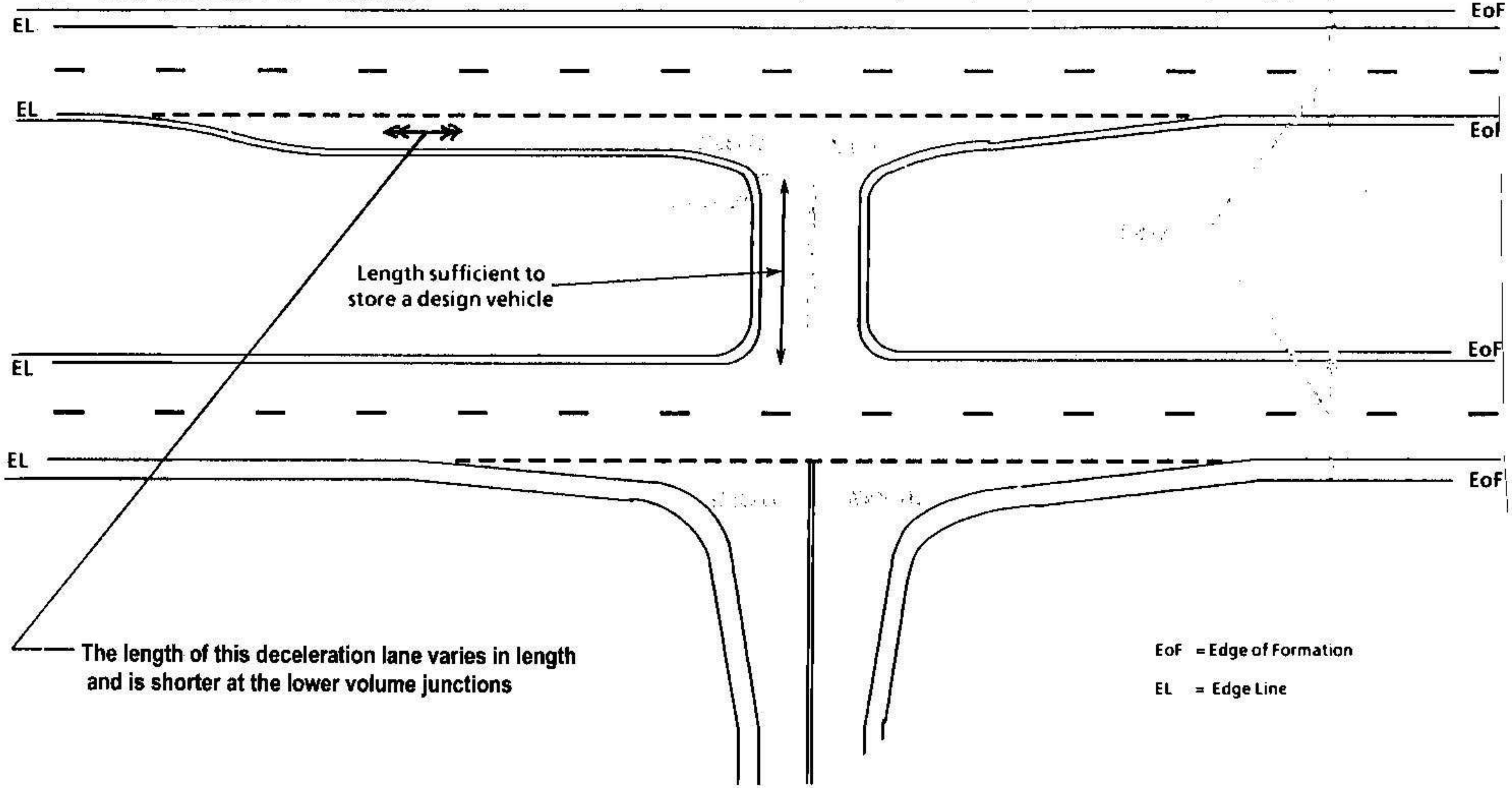
Westbourne Rd/Hume Highway junct.

PLATE 105

Westbourne Rd/Hume Highway junct.

Appendix C – Hume Highway Junction Layout

This layout allows right turning traffic to undertake the manoeuvre in two stages, which has benefits when volumes on the through route are high and the turning movement small. The lanes used for storage on the through road are preferred, but not essential.



Appendix D – Shadow Flicker Diagram

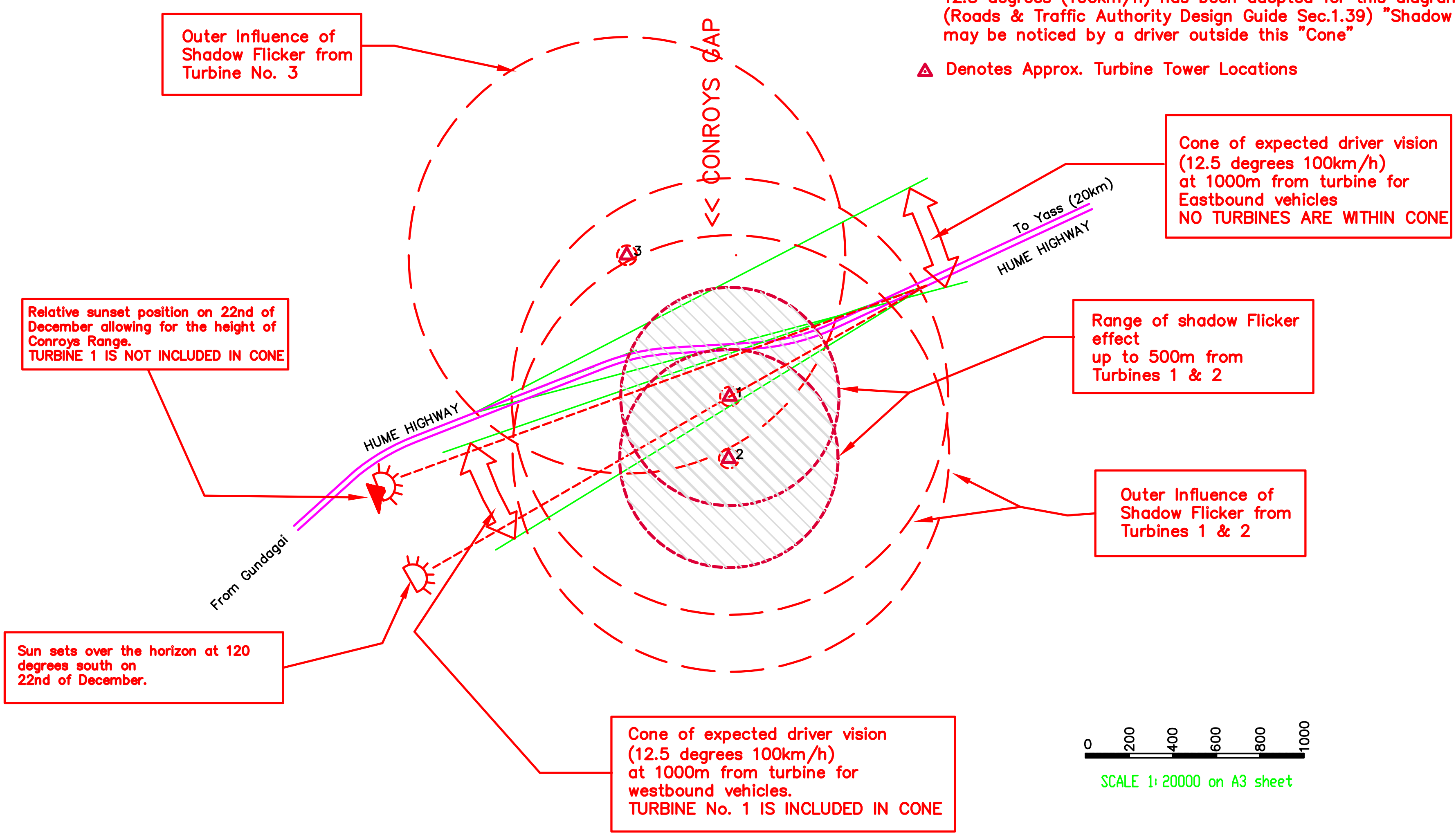
Appendix D

** NOTES **

1/ The "Flicker Effect" attenuates with distance and is not considered to be noticed beyond 500 – 100 metres from a Turbine. (Ref. Danish Wind Energy Association.)

2/ The "Cone of Visual Perception" widens at slower speeds and 12.5 degrees (100km/h) has been adopted for this diagram. (Roads & Traffic Authority Design Guide Sec.1.39) "Shadow Flicker" may be noticed by a driver outside this "Cone"

△ Denotes Approx. Turbine Tower Locations



0 200 400 600 800 1000

SCALE 1: 20000 on A3 sheet

Conroys_shadow.dwg

Appendix 7 SHADOW FLICKER ASSESSMENT

Shadow Flicker Assessment

Yass Valley Wind Farm
Coppabella Hills and Marilba Hills Precincts
May 2009

Table of Contents

Introduction

Shadow flicker is the name given to describe the effect caused by the shadow created as the sun passes directly through the rotating blades of a turbine at a stationary viewpoint. Due to their height, wind turbines can cast shadows on the areas around them. Coupled with this, the moving blades create moving shadows. When viewed from a stationary position the moving shadows appear as a flicker giving rise to the phenomenon of 'shadow flicker'. For a particular position, shadow flicker will only occur during periods when the suns rays pass directly through the swept area of the turbine blades to the viewpoint. The extent of the shadow flicker is dependent on the time of day, geographical location, meteorological conditions of the site and local vegetation.

The purpose of this assessment is to determine the impact that the proposal will have regarding the following questions:

- Is there a potential health risk to the public?
- Will any residence within the vicinity of the project be unacceptably affected by shadow flicker?
- What measures will be taken to ensure that shadow flicker is not a significant issue?

Background

There are a number of factors influencing the effect and duration of shadow flicker, including:

- Position of the sun in relation to the turbine
- Time of year (season) and time of day
- Turbine height and rotor diameter
- Viewer's distance from turbine
- Topography of the area
- Vegetation cover
- Weather patterns, number of cloudy days per year, and
- Airborne particles, haze

In NSW there are no guidelines on which to assess shadow flicker generated by wind turbines. To carry out the shadow flicker assessment we have drawn on the Victorian Planning Guidelines [1] that limit the duration of shadow flicker to 30 hours a year. The South Australian Planning Bulletin [5] suggests that shadow flicker is insignificant once a separation of 500m between the turbine and house is exceeded. However, a conservative distance of 1 km has been used for this assessment.

Assessment

Modelling of the shadow flicker was conducted for each precinct using specialist industry software, assessing the largest turbine (maximum tip height) proposed for the project to represent the worst case impact scenario. This is a GE 2.5xl with 100m diameter blades on a 100m tower with a maximum tip height of 150m.

The number of annual hours of shadow flicker at a given location can be calculated using simple geometrical models incorporating data such as the sun path, the topographic variation and wind turbine details such as rotor diameter and hub height. In such models, the wind turbine rotor is modelled as a disc and assumed to be in the worst case (i.e. perpendicular) to sun-turbine vector. Furthermore, the sun is assumed to be a point light source.

Shadow flicker calculated in this manner overestimates the number of annual hours of shadow flicker experienced at a specified location [2, 3] due to several reasons.

1. The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker.

2. The probability of wind turbines consistently yawing to the 'worst case' scenario where the wind turbine is facing into or away from the sun- wind turbine vector is less than 1 (i.e. less than 100% of the time).

3. The amount of aerosols in the atmosphere has the ability to influence shadows cast due to the following reasons.

   Firstly, the distance from a wind turbine that a shadow can be cast is dependent on the degree to which direct sunlight is diffused, which is in turn dependent on the amount of dispersants (humidity, smoke and other aerosols) in the path between the light source (sun) and the receiver [2].

   Secondly, the quantity of aerosols in the air is known to vary with time and it has the potential to vary the air density, thereby affecting the refraction of light. This in turn affects the intensity of direct light to cause shadows.

4. The modelling of the wind turbine blades as discs to determine shadow path overestimates the shadow flicker effect.

   The blades are of non-uniform width with the thickest viewable blade width (maximum chord) occurring closer to the hub and the thinnest being located at the tip of the blade. As outlined in point 3 above, the direct sunlight is diffused resulting in a maximum distance from the wind turbine that a shadow can be cast. This maximum distance is dependent on the human threshold which variation in light intensity can be perceived [2]. When the blade tip causes shadow, the diffusion of direct sunlight means that the light variation threshold occurs closer to the wind turbine than when a shadow is caused by the maximum chord. That is, the maximum shadow length cast by the blade tip is less than by the maximum chord.

5. Modelling the sun as a point light source rather than a disc has an effect similar to that of point 4 above.

   Firstly, situations arise where the light rays from different portions of the sun disc superimpose around a shadow resulting in light intensity variations less than human perception.

   Secondly, when the sun is positioned directly behind the wind turbine hub, there is no variation in light intensity at the receiver location and therefore no shadow flicker. However, when the sun is modelled as a point source, shadow flicker still arises.

6. The presence of vegetation shields incidences of shadow flicker.

7. Periods where the wind turbine is not in operation due to low winds, high winds or operational and maintenance reasons.

Taking the above issues into account, the modelling of shadow flicker has been conducted using simple geometric analyses. The wind turbine has been modelled assuming all wind turbines are disc objects positioned in the worst case with respect to shadow flicker. The sun has been assumed to be a point light source.

Due to points 3 and 4 above, an approximation for the maximum length of shadow flicker cast has been used. Guidance from the South Australian Government indicates that this distance is 500 m [5]. We have adopted a more conservative approach and have limited the length that a shadow can be cast to 1 km [4].

Therefore, the modelling conducted here represents a very conservative scenario and is believed to overestimate the actual annual hours of shadow flicker experienced at a location.

Actual Conditions

When the actual conditions of the region are taken into consideration, the number of hours of shadow flicker should be reduced. The major consideration in this respect is the weather patterns and particularly the number of cloudy days experienced that result in no shadow flicker.

Based on 43 years (1965 – 2008) of daily weather observations in Yass (Yass, Linton Hostel, Bureau of Meteorology [6]), the nearest source of data, the average number of cloudy days experienced is 109/year. The average number of clear days experienced is 92.3/year. These are based on observations at 9am and 3pm each day.

Table 1: Average daily conditions in Yass (1965-2008)

	Mean Clear Days	Mean Cloudy Days
Jan	10.2	7.5
Feb	8	6.5
Mar	9.4	7.2
Apr	8.8	7.2
May	6.6	10.3
Jun	4.3	12.2
Jul	5.1	12.5
Aug	6.7	11.3
Sep	7.3	9.3
Oct	8	8.9
Nov	7.5	9
Dec	10.4	7.1
Total	**92.3**	**109**

Cloudy days are defined Bureau of Meteorology as:

Average number of cloudy days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A cloudy day is recorded when the mean of the 9 am and 3 pm cloud observations is greater than or equal to 6 oktas. This definition has changed slightly over time. Prior to this, a cloudy day was defined as having greater than or equal to 5.5 oktas averaged over the 9 am and 3 pm observations.

Clear days are defined by the Bureau of Meteorology as:

Average number of clear days in a calendar month or year, calculated over the period of record. This statistic is derived from cloud cover observations, which are measured in oktas (eighths). The sky is visually inspected to produce an estimate of the number of eighths of the dome of the sky covered by cloud. A completely clear sky is recorded as zero okta, while a totally overcast sky is 8 oktas. The presence of any trace of cloud in an otherwise blue sky is recorded as 1 okta, and similarly any trace of blue on an otherwise cloudy sky is recorded as 7 oktas. A clear day is recorded when the mean of the 9 am and 3 pm cloud observations is less than or equal to 2 oktas. This definition has changed slightly over time. Prior to this, a clear day was defined as having less than or equal to 2.5 oktas averaged over the 9 am and 3 pm observations.

Accordingly based on 109 days/year of cloud the number of shadow flicker hours should be reduced by 29.86%. Further reductions for vegetation screening should be considered and applied where appropriate on a case by case basis.

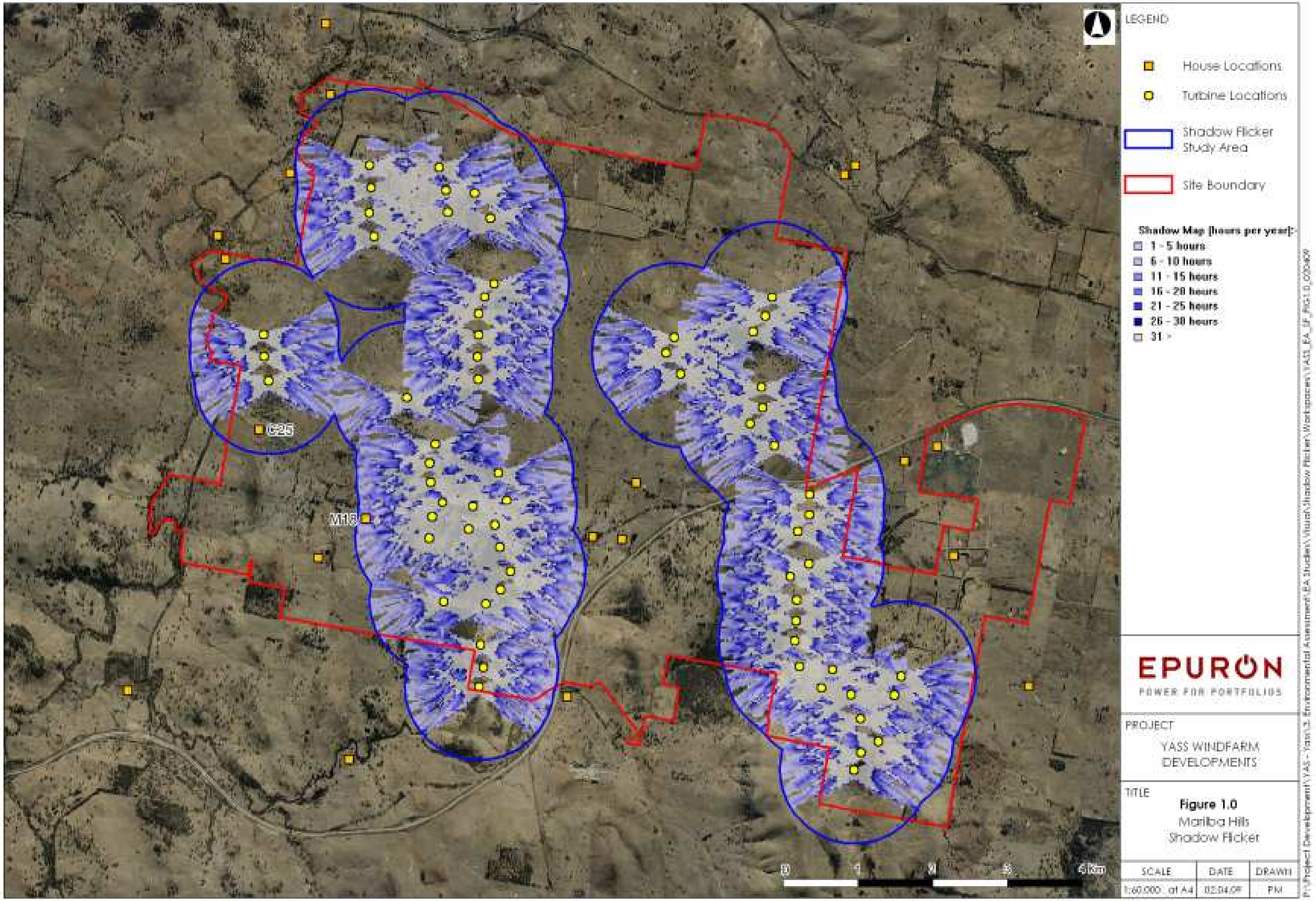
Results

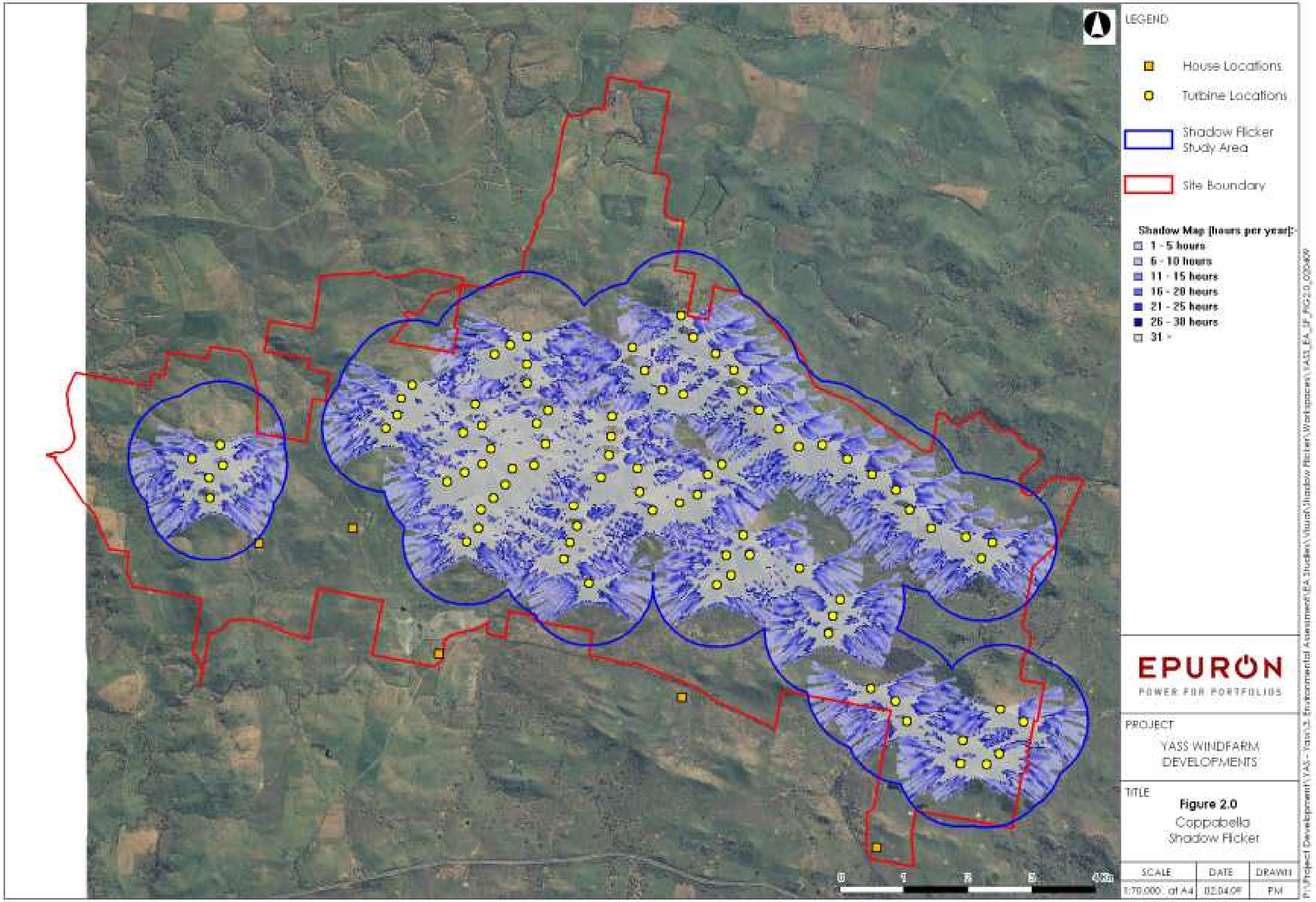
The modelling has calculated the number of annual hours at each of the nearby houses and the results are presented below. A reduction of the theoretical maximum number of hours can be assumed based on the long term observation of cloudy days.

Residence No.	Precinct	Theoretical maximum shadow flicker (hrs/year)	Actual (reduced) shadow flicker (hrs/year)	Maximum shadow flicker (mins/day)	Compliance with Victorian Planning Guidelines
M18	MRL	7	2.1	21	Yes
C25	MRL	0	N/A	0	Yes

MRL = Marilba Hills

The results show compliance with the Victorian Guidelines of a maximum of 30hrs/year and no more than 30 minutes per day at all nearby residences.


LEGEND
House Locations
Turbine Locations
Shadow Flicker Study Area
Site Boundary
Shadow Map [hours per year]:
1 - 5 hours
6 - 10 hours
11 - 15 hours
16 - 20 hours
21 - 25 hours
26 - 30 hours
31 >
C25
M16
0
1
2
3
4 Km
EPURON
POWER FOR PORTFOLIOS
PROJECT
YASS WINDFARM DEVELOPMENTS
TITLE
Figure 1.0
Mariba Hills
Shadow Flicker
SCALE
1:60,000 at A4
DATE
02.04.09
DRAWN
PM


LEGEND
House Locations
Turbine Locations
Shadow Flicker Study Area
Site Boundary
Shadow Map [hours per year]:
1 - 5 hours
6 - 10 hours
11 - 15 hours
16 - 20 hours
21 - 25 hours
26 - 30 hours
31 -
EPURON
POWER FOR PORTFOLIOS
PROJECT
YASS WINDFARM DEVELOPMENTS
TITLE
Figure 2.0
Coppabella Shadow Flicker
SCALE
1:70,000 at A4
DATE
DRAWN
PM

Health effects from shadow flicker

Flicker vertigo is an imbalance in brain cell activity caused by exposure to low frequency flickering or flashing of a light or sunlight seen through a rotating propeller (Rash 2004). It can result in nausea, dizziness, headache, panic, confusion and – in rare cases – loss of consciousness. Flicker vertigo is usually associated with a light flashing sequence, or flicker frequency, of between approximately 4 hertz (cycles per second) and 20 hertz [7,8].

Shadow flicker frequencies of between 8-30 hertz can trigger epileptic seizures for photosensitive epileptics. Less than 5% of cases involve photosensitive epilepsia, and only a portion of these photosensitive cases have experienced a seizure triggered by flickering light (Epilepsy Association of Australia).

Flicker frequency of rotating propellers, including wind farm rotors, is derived by multiplying the hub rotation frequency by the number of blades. Based on the rotation speed of the 3 bladed wind turbines proposed for the project, the maximum shadow flicker frequency would be 1 cycle per second (1 hertz), well outside the frequency range associated with flicker vertigo or photosensitive epilepsy.

The proposal is therefore unlikely to represent a health risk to local residents in relation to flicker vertigo or photosensitive epilepsy.

Blade Glint

Blade glint occurs when sunlight is reflected off turbines blades and is visible to a person. The concern is that this may, under rare circumstances, affect some motorists or cause annoyance at dwellings.

In reality, turbine manufactures around the world have acknowledged the possibility of blade glint and use a low reflectivity gel finish to reduce any reflectivity. The turbines proposed for this project will be finished in a matte, non-reflective finish to ensure blade glint impacts do not occur.

Conclusion

A detailed analysis of the potential for shadow flicker and blade glint to affect dwellings has been carried out.

All residences comply with the Victorian Planning Guidelines of a maximum shadow flicker of 30 hours/year with no more than 30 mins/day.

Blade glint will be avoided by the use of non-reflective coatings on the turbine blades.

References

1. “Policy and planning guidelines for development of wind energy facilities in Victoria”, Sustainable Energy Authority Victoria, 2003.
2. Freund H-D., Kiel F.H., “Influences of the opaqueness of the atmosphere, the extension of the sun and the rotor blade profile on the shadow impact of wind turbines”, DEWI Magazin 20, Feb 2002.
3. Osten, T. & Pahlke T., “Shadow Impact on the surrounding of Wind Turbines”, DEWI Magazin 13., Aug 1998.
4. http://www.windpower.org/en/tour/env/shadow/shadow2.htm
5. Planning SA, Planning Bulletin "Wind Farms, Draft for Consultation”, South Australian Government, 2002.
6. Bureau of Meteorology, Climate statistics for Australian locations, http://www.bom.gov.au/climate/averages/tables/cw_070091.shtml
7. Rash, C.E. (2004) Awareness of causes and symptoms of flicker vertigo can limit ill effects Human Factors and Aviation Medicine March-April 2004, Flight Safety Foundation, Alexandria VA, USA
8. NASA (2001) ASRS Launches Aviation Security Study, Callback Issue No. 268 December 2001, Office of the NASA Aviation Reporting System, Moffet Field, CA, USA