7 ASSESSMENT OF KEY ISSUES

7.1 Scoping and prioritisation of issues

Recent reforms to the *Environmental Planning and Assessment Act 1979* and associated planning instruments provide for the consolidated assessment of major projects, including wind farms involving more than $30 million in capital investment. The reforms also provide for improvements to efficiency in the assessment and approval process, by allowing assessments to focus on key 'moderate to high priority' issues. Moderate to high priority issues are those with the potential to produce significant environmental or human impacts.

Lower priority issues are those which can be demonstrated to be manageable using established practices and mitigation measures. Using best practice and adaptive management approaches these issues are not likely to cause unacceptable environmental or human impacts. Where uncertainty or high levels of risk exist, issues are allocated to the moderate to high priority category.

Moderate to high priority issues have been identified by an extensive review of experiences and research at existing wind farms in Australia and overseas, and consultation with landholders, the general public, government agencies and experts. In particular, the issues scoping process drew on the results of an Open House and questionnaire public consultation process held Gunning on 17 November 2005 (refer section 6.2), and a Planning Focus Meeting involving state and local government representatives held at the subject site on 10 November 2005 (refer section 6.3). A Project Application indicating the issues to be addressed in the EA and their priority for assessment was accepted by the Department of Planning on 7 December 2005.

The proposal indicates a range of options regarding turbine size and capacity in order to maintain flexibility in product selection and finescale design. Where this would affect the type or intensity of impacts, the assessment in the EA has been based on the option with greatest potential negative impact. Similarly, the description of positive benefits would be based on the option with least potential benefits.

Table 7.1 summarises the final categorisation of key issues, investigation strategies employed and where they are evaluated within this document. Issues of lesser priority are discussed in Section 8.

Table 7.1 Categorisation of key impact areas related to the proposal

Issue	Strategy	Refer to:
Visual amenity	Investigation via visual assessment involving community consultation.	Section 7.2 (specialist report attached in full, Attachment 3.1)
Noise (operational)	Investigation via noise assessment including modelling and mapping.	Section 7.3 (specialist report attached in full, Attachment 3.2)
Community	Investigation via community consultation and research.	Sections 7.4.1
Economic benefit	Desktop investigation and liaison with local contractors.	Section 7.4.2
Land values	Investigation via land value study and literature review.	Section 7.4.3 (specialist report attached in full, Attachment 3.6)
Aboriginal archaeology	Investigation via archaeological assessment including desktop literature review and onsite field work.	Section 7.5 (specialist report attached in full, Attachment 3.3)
Biodiversity	Investigation via biodiversity assessment including desktop literature review and onsite field work.	Section 7.6 (specialist report attached in full, Attachment 3.4)
Land use	Investigation of agricultural, tourism and lifestyle landuses via literature review.	Section 7.7
Services and infrastructure	Investigation via consultation with the Upper Lachlan Council, the Road and Traffic Authority (RTA), telecom providers, the Civil Aviation Safety Authority (CASA) and Air Services Australia.	Section 7.8
Bushfire	Liaison with the RFS and research.	Section 7.9
Cumulative impacts	Investigation using the results of the specialist reports, assessments of other issues and research.	Section 7.10
Removal of infrastructure	Guided by the Upper Lachlan DCP for wind farms and DoP Statement of commitments database and research.	Section 7.11

7.2 Visual impact

Scenic Landscape Architecture completed the Visual Assessment of the proposed Cullerin Range wind farm. A draft of this report was peer reviewed by Inspiring Places (J. DeGryse) and comments pertaining to the methodology and information sources were included in the final report to increase the rigour of the assessment. The following information was extracted from the final report to summarise the methodology, results and recommendations of the Visual Assessment (full report attached, Attachment 3.1).

Existing environment

The method used to determine the visual impacts has been adapted from the Windfarms and Landscape Values, a report commissioned by Australian Wind Energy Association and the National Trust (Planisphere 2005), and from the Bureau of Land Management in the United States, known as the BLM method. The latter method identifies methodologies for assessing and documenting landscape values, significance and sensitivities.

This visual assessment has been completed by the:

- Review of existing literature;
- Review of topographical maps and aerial photographs;
- Review of photomontage visualisations;
- Review of shadow flicker analysis;
- Review of zone of visual influence map;
- Visiting the site and adjacent areas; and
- Using the community open house workshop (held on November 17, 2005, detailed in Section 6.2 of this EA) to document the community's and stakeholder's values of the landscape setting in the local and regional area.

The visual assessment ultimately identifies the visual impact that the proposed wind farm will have on various viewpoints in the surrounding landscape. This is done by:

- Categorising the landscape into character types and uses, and describing those types;
- Identifying the landscape quality through the assessment of the scenic quality. The scenic quality of the site is described and measured as the visual appeal or value of the landscape as determined by scarcity or uniqueness of landscape, landscape type, natural features, vegetation and water within each landscape character site;
- Identifying important views to the wind turbines and associated infrastructure from surrounding areas including roads, farms, neighbouring residences and towns;
- Identifying the type of user in the surrounding areas, duration of exposure and dominance of exposure. This component determines the visual sensitivity of views to the wind farm;
- Identifying the distance from viewpoints to the site;
- Identifying the degree of change introduced by the project and subsequent contrast to the existing landscape; and
- Determining the ability of the landscape to absorb the proposed changes.

Visual characteristics of the wind farm

The visual characteristics of a wind farm include the physical form of a wind farm and its potential visual effects within a landscape and to surrounding users of the landscape, as outlined in Table 7.2 (drawn from Planisphere 2005 and modified as necessary to be applicable to the Cullerin Range proposal).

Table 7.2 Visual characteristics of the wind farm

Characteristics	Effect	Examples of responses
Scale of development – height and numbers of turbines	Change of landscape character Eye catching High visibility from short to long distances Contrast to the horizon and ridgelines	Majestic or dominant – depending on perceived perception of landscape and user
	Effects to cultural heritage values	Loss of cultural heritage
Form of development	Eye catching Change of landscape character	Majestic or dominant – depending on perceived perception of landscape and user
Movement of turbines	Sun glint and shadow flicker	Distracting
	Eye catching	Relaxing or irritating
Colour of towers and blades	Level of contrast to surrounding landscape	Intrusive or integrated
Location and layout in landscape	Change of landscape character	Majestic or dominant – depending on perceived perception of landscape and user
	Change visual appeal of landscape	Loss, change or gain of visual features
	Layout of towers– cumulative effect of grouping etc	Dramatic, harmonious or dominant
Location of substation	Change in landscape character	Dominant or non intrusive
	Potential change in visual appeal	Loss or change
Location of power lines and easements	Change in landscape character – structures and clearing of trees	Dominant or non intrusive
	Potential change in visual appeal	Loss or change

Public perception of wind farms

When wind farms are proposed, there is a usually some concern by the public over the likely visual impact. By their very nature wind farms are highly visible being usually sited on ridges and hilltops where the wind flow is greatest (Meridian Energy 2005). But visual impact does not necessarily mean a negative impact, as is largely assumed. It is apparent that the beliefs of the individual are the major determinant of whether a wind farm will be viewed favourably or not:

> "The key premise underlying the visual assessment is that visual impacts of the wind farm are largely determined by the perception of viewers to wind farms and wind energy per se." Department's assessment report for the Crookwell wind farm, DIPNR (2004b, p25).

And that:

> "…. even if the facts are not in dispute, a perceptual gulf defined by individual's values and beliefs separates those in favour and those against." (Warren *et al.* 2005).

Most people believe there is broader public benefit from the production of 'green' and sustainable energy. An understanding of the broader benefits of wind farms can result in people being more accepting of the structures and this type of development. However, there is usually opposition from some local residents to wind farms proposed in their locality.

Recent studies show that opposition to wind farms (especially to their visual impact) is not the majority view. Lothian (undated) notes that in the United Kingdom, most people regard them favourably, and that surveys indicate broad support for wind farms. Further:

> "An Irish survey of 1200 people found that only 1 per cent of the general public is opposed to wind farms, that 84 per cent regard them as a good thing, and that most of those with direct experience of wind farms do not consider that they have had any adverse impact on the scenic beauty of the area … "(Warren *et al.* 2005; SEI, 2003).

And that:

> "Prior to construction, locals typically expect the landscape impacts to be negative, whereas, once in operation, many people regard them as an attractive addition (Warren *et al.* 2005)."

Therefore, the visual impact of wind farms is not necessarily negative (and can change over time). Wind turbines can sometimes add a positive visual quality to the landscape.

Landscape character of the locality and region

The region has low variety in character types due to the dominance of agriculture as the predominant land use. Most of the region consists of a modified farming landscape, characterised by pastures with light scattered timber, located on surrounding rolling hills, and sometimes in the paddocks. The landscape is largely a cultural landscape due to the modifications that have been bought around by 180 years of rural practices.

The modified nature of the landscape is further emphasised by the abundance of visible built structures such as homesteads, farm buildings, fences and other infrastructure including highways, roads and transmission lines.

Scenic quality and landscape character types of the region

Scenic quality is a way to describe and measure the visual appeal of the immediate landscape of the proposal and the surrounding area. This is largely determined by reviewing seven key factors: landform, vegetation, water, colour, adjacent scenery, scarcity, and cultural modifications. The scenic quality rating system (based on the United States Bureau of Land Management's visual resource management system) has three levels:

i) Low scenic quality – fairly common scenic quality to the physiographic region;

ii) Moderate scenic quality – a combination of common or outstanding scenic quality to the physiographic region;

iii) High scenic quality – outstanding scenic quality to the physiographic region

Seven landscape character types were identified within a 15 kilometre radius of the site. A summary of the scenic quality rating assigned to these is presented in Table 7.3. Refer to Figure 7.1 for location of the Types. (Detailed description of Areas provided in the attached Visual Assessment report).

Table 7.3 Summary of landscape character types and scenic quality

	Landscape character types	Scenic quality (range derived from Areas assessed)
Type A:		
Gunning, Collector, Breadalbane, Parkesbourne	Country towns and rural residential communities	Low to moderate
Type B:		
Hume Hwy, Sydney- Melb. Railway, Federal Hwy	Transport Corridors	Low to moderate
Type C:		
Wet Lagoon	Nature Reserves/Wetlands	Moderate to high
Type D:		
Mutmutbilli, Collector Creek, Breadalbane Plains	Plains – mostly agricultural land	Low to moderate
Type E:		
West of Cullerin Range, South of Gunning/ Lerida, Wollogorang, North of Breadalbane, Gurrundah	Rolling hills with sparse vegetation cover – generally agricultural land	Low to moderate
Type F:		
Cullerin, Lerida south, North of Mutmutbilli	Hills with light to moderate vegetation coverage – generally agricultural use or rural residential land use	Moderate
Type G:		
Cullerin Range North, Collector Hill, The Mundoonen Range and ranges to the north-east of the site	Ranges/hills with moderate to high vegetation coverage – including state forests or privately owned land, sometimes for agricultural use	Moderate

Visual sensitivities

The visual sensitivity of users to the wind farm was determined from various locations around the site. To account for differences in personal perceptions of landscapes, this section of the report incorporates a generalised perspective of different users and their sensitivity to changes in the landscape. The visual sensitivity of the user has three components:

i) Dominance of exposure to the wind farm;

ii) Duration of exposure to the wind farm; and

iii) Likely relationship of the user to the environment.

There were a number of user types identified that live in or visit the area. These included: primary producers, rural residential landholders, town's people, arterial road users, rail users and recreational users.

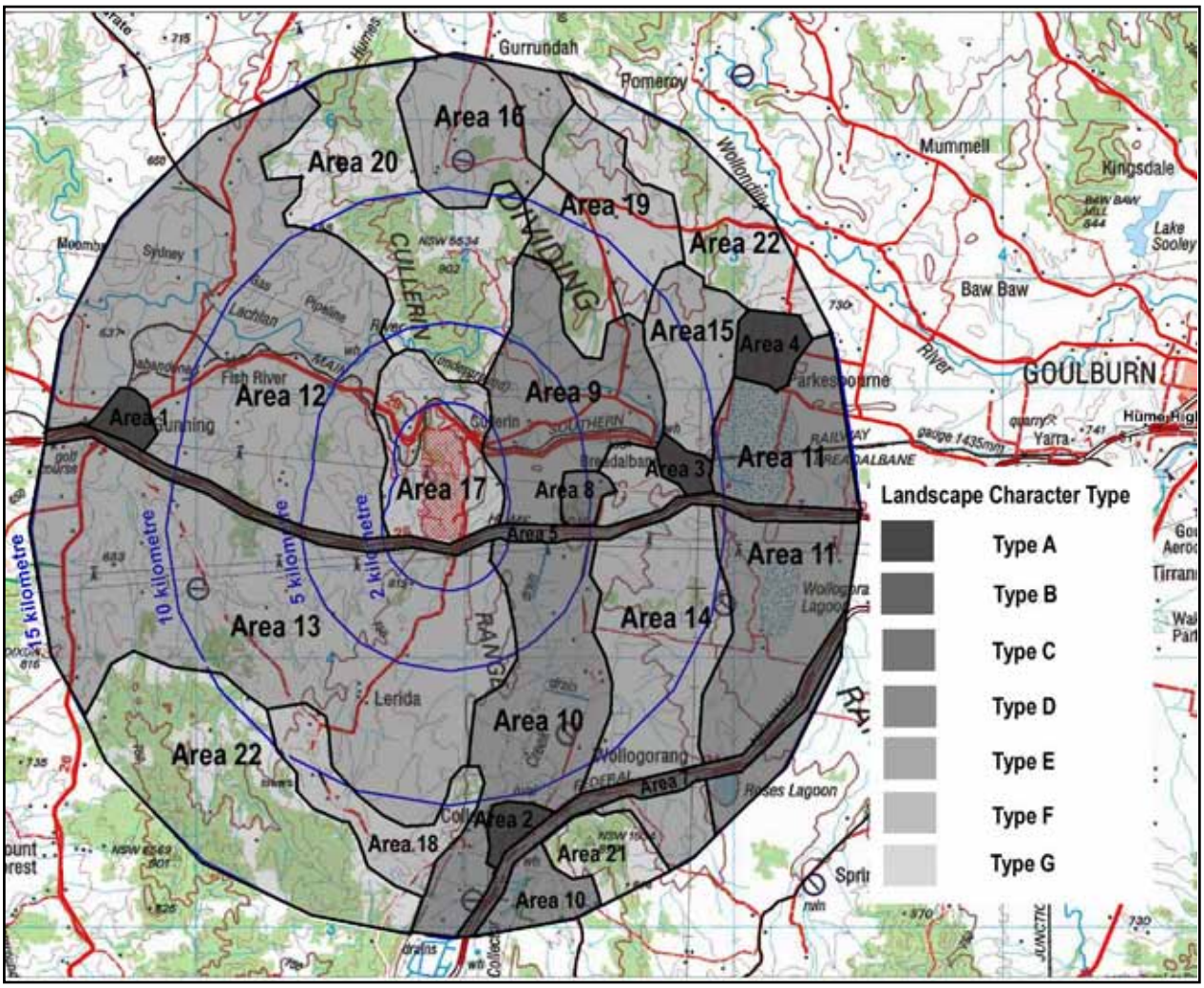

Figure 7.1 Landscape character types

The visual sensitivity analysis incorporated the broad perspectives that each user group is likely to have to the surrounding landscape. Three categories were used to assist in the determination of the level of user sensitivity to the landscape (based on the BLM method):

i) Low – views from low use sites where duration of view are short or not important or maybe partially obscured by landscape features;

ii) Moderate – duration of view is moderate, such as views from roads where many of the viewers are frequent and their visual sensitivity is constrained due to the orientation of the user; and

iii) High – duration of view is high from residential and recreational areas where the perceived degree of concern about scenic quality is evident and the project site is dominant in the visual catchment and views are highly regarded.

A Zone of Visual Influence study, undertaken by Garrad Hassan Pty Ltd and based on turbine Layout B, was also used to verify locations from where the wind farm may be visible.

When the visual sensitivity analysis was combined with the distance of the viewer from the site and the scenic quality of the landscape, a determination could be made as to the visual impact on the viewer within each area around the site.

Impact assessment

Construction and decommissioning impacts

Relatively minor impacts are associated with the construction and decommissioning of the wind farm. These relate to the movement and operation of large machinery both onsite and enroute to the site. These impacts will be temporary and can be managed to minimise impact on surrounding receptors (residents, motorists, tourists, workers). Mitigation required to reduce the visual impact of the development during the construction phase include:

- Minimise the visibility of traffic movement when installing towers, including minimising traffic through Breadalbane and other highly populated areas.

Operational impacts

By far, the majority of the visual impact will occur within the operational phase of the wind farm.

Impact on specific locations

The visual assessment involves an evaluation of two aspects of the visual impact of the wind farm: the contrast that the wind farm will create in the landscape and the visual impact on the user in the landscape.

The contrast to the existing landscape relates to the impact that the wind farm will have on the different landscape character types, and an assessment is made as to whether the contrast of the wind farm to the landscape is acceptable or not. Based on the nature of the modified rural landscape in the area, and the many significant built elements visible in the landscape, it was determined that there were no landscape character types in the area where the contrast between the wind farm and the landscape would be unacceptable.

The second aspect of the visual impact is to consider the impact on the user and the view that they will have to the wind farm. This aspect includes consideration of the visual sensitivity of the user to changes in the landscape and the distance that the viewer is from the wind farm. For example, the wind farm will have a lower visual impact from a road to passing traffic than to a home where the wind farm can be viewed from the lounge room. The scenic quality of the landscape is a consideration in determining the visual impact on the user. That is, the visual impact of a wind farm across a pristine landscape is greater than the visual impact of a wind farm in a modified landscape.

The visual impact on the viewer considers three levels of impact:

i) High – proposal is dominant within the landscape and generally not overlooked by the observer;

ii) Moderate – moderately dominant and is noticed; and

iii) Low – can be seen but does not attract attention.

The visual impact of the wind farm from key locations is summarised in Table 7.4, based on user type, visual sensitivity and visibility. Photomontages were used to assist this process (refer to base map Figure 7.2 and photomontages Figures 7.3 – 7.13).

Table 7.4 Visual impact summary

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Type A Country towns and rural residential communities					
Area 1: Gunning	Low to moderate	12 – 13	Low visibility	Low	Gunning sits low in the landscape so the wind farm will not be a significant visual feature for most in the town The visibility of the turbines will be low The wind farm is unlikely to adversely affect the visual character of the town
Area 2: Collector	Low to moderate	10 – 11	Low visibility	Low	There are only a few vantage points within the town that have views to the site and the wind farm will not be a dominant visual feature from the town The Federal Highway adds an existing strong built form to the character of the town The wind farm is unlikely to significantly impact the visual character of the town
Area 3: Breadalbane	Moderate	8 – 9	Moderate visibility	Moderate	The wind farm will be seen from several vantage points within the town Breadalbane is the closest of the towns to the wind farm at 8 to 9 kilometres The wind farm is unlikely to significantly impact the visual character of the town
Area 4: Parkesbourne	Moderate	11 – 12	Low visibility	Low	Parkesbourne is an attractive area with several rural residential properties. Views are generally contained within Parkesbourne, so the wind farm will not be a major visual feature The view to the wind farm is across a modified farming landscape common in the region

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Type B Transport Corridors					
Area 5: Hume Highway	Low to moderate	1 – 15	Low to high visibility	Low to moderate	The view from the Hume Highway is as close as 500 metres to the turbines. The average traveller will have a low sensitivity to the surrounding landscape The view predominantly from the highway is the highway itself and the modified farming landscape The wind farm is unlikely to significantly impact the landscape character of the highway
Area 6: Sydney to Melbourne Railway	Moderate	1 – 15	Low to high	Low to moderate	Views from the railway are clear and from as close as 1 kilometre Passengers are not likely to have any connection with the landscape and therefore a low to moderate sensitivity The wind farm is unlikely to unduly and significantly impact the surrounding landscape character viewed from the rail line
Area 7: Federal Highway	Low	11 – 15	Low	Low	The highway passes well to the south of the site Views are only intermittent and at 90 degrees to the direction of the road The view predominantly is along the road corridor with intermittent views of the surrounding farming land The wind farm is unlikely to significantly impact the landscape character of the highway

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Type C Nature Reserves/Wetlands					
Area 8: Wet Lagoon	Moderate to high	4 - 6	Moderate to high	Moderate to high	Wet Lagoon is close to the site It is a unique landscape in the area and sensitive to changes in the landscape The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area
Type D Plains – mostly agricultural land					
Area 9: Mutmutbilli	Moderate to high	2 – 12	Low to high	Moderate to high	The landscape is a modified farming landscape and is not overly sensitive to change There are clear views to the site from some houses in the area These prominent views result in a moderate to high visual impact
Area 10: Collector Creek	Moderate to high	3 – 15	Low to high	Moderate to high	The landscape is a modified farming landscape and is not overly sensitive to change There are clear views to the wind farm from some houses in the area The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area
Area 11: Breadalbane Plains	Low	10 – 15	Low	Low	There are limited views to the site from this location

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Type E Rolling hills with sparse vegetation cover					
Area 12: West of Cullerin range	Low to high	3 – 15	Low to high	Moderate to high (residences with views to the site within 5km)	The landscape is a modified farming landscape and is not overly sensitive to change The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area The greatest visual impact will be on properties with clear views to the wind farm from Old Hume Highway
				Low to moderate (other areas)	The wind farm will have little visual impact on views from the west and north
Area 13: South of Gunning/ Lerida	Moderate	1 – 15	Low to high	Moderate	The landscape is a modified farming landscape and is not overly sensitive to change The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area There are clear views to the site from some houses in the area, but these houses tend to be further away from the site Houses closer to the wind farm tend to be screened from the wind farm
Area 14: Wollogorang	Moderate	6-15	Low to moderate	Moderate	Very few houses are located in this area There is one house with direct views from around 11 kilometres The landscape is a modified farming landscape The landscape will be able to absorb the visual impact of the wind farm

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Area 15: North of Breadalbane	Low to moderate	8 – 12	Low to moderate	Low to moderate	There are two properties with partially screened views to the site from 10 kilometres The landscape is a modified farming landscape The landscape will be able to absorb the visual impact of the wind farm
Area 16: Gurrundah	Low	10 – 15	Low	Low	There are limited views to the site from this location
Type F Hills with light to moderate vegetation coverage					
Area 17: Cullerin	High	1 – 5	High	Moderate to high	There are a number of properties close to the site in this area Some have open views to the site with a high visual impact Although quite well treed, it is a production landscape The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area
Area 18: Lerida south	Moderate to high	8 – 15	Low to moderate visibility	Moderate	The landscape is reasonably well treed but shows signs of past and current farming practices The landscape character will be impacted by the wind farm, but the change will not unduly impact on the landscape character of the area There are limited views from houses and the road to the wind farm, with most views screened by vegetation
Area 19: North of Mutmutbilli	Moderate	6 – 13	Low to moderate	Low to moderate	There are limited views to the site from this location One house has direct views from 10 kilometres These views are end on so few turbines will be in view

Location	Visual Sensitivity of the user	Distance from the wind farm (km)	Visibility	Visual impact	Contributing factors
Type G Ranges/hills with moderate to high vegetation coverage					
Area 20: Cullerin Range North	Low	2 – 15	Low to high	Low	There are limited views to the site from this location
Area 21: Collector Hill	Low to moderate	12 – 15	Low	Low	There are limited views to the site from this location
Area 22: Other Areas	Low	10 – 15	Low	Low	There are limited views to the site from this location

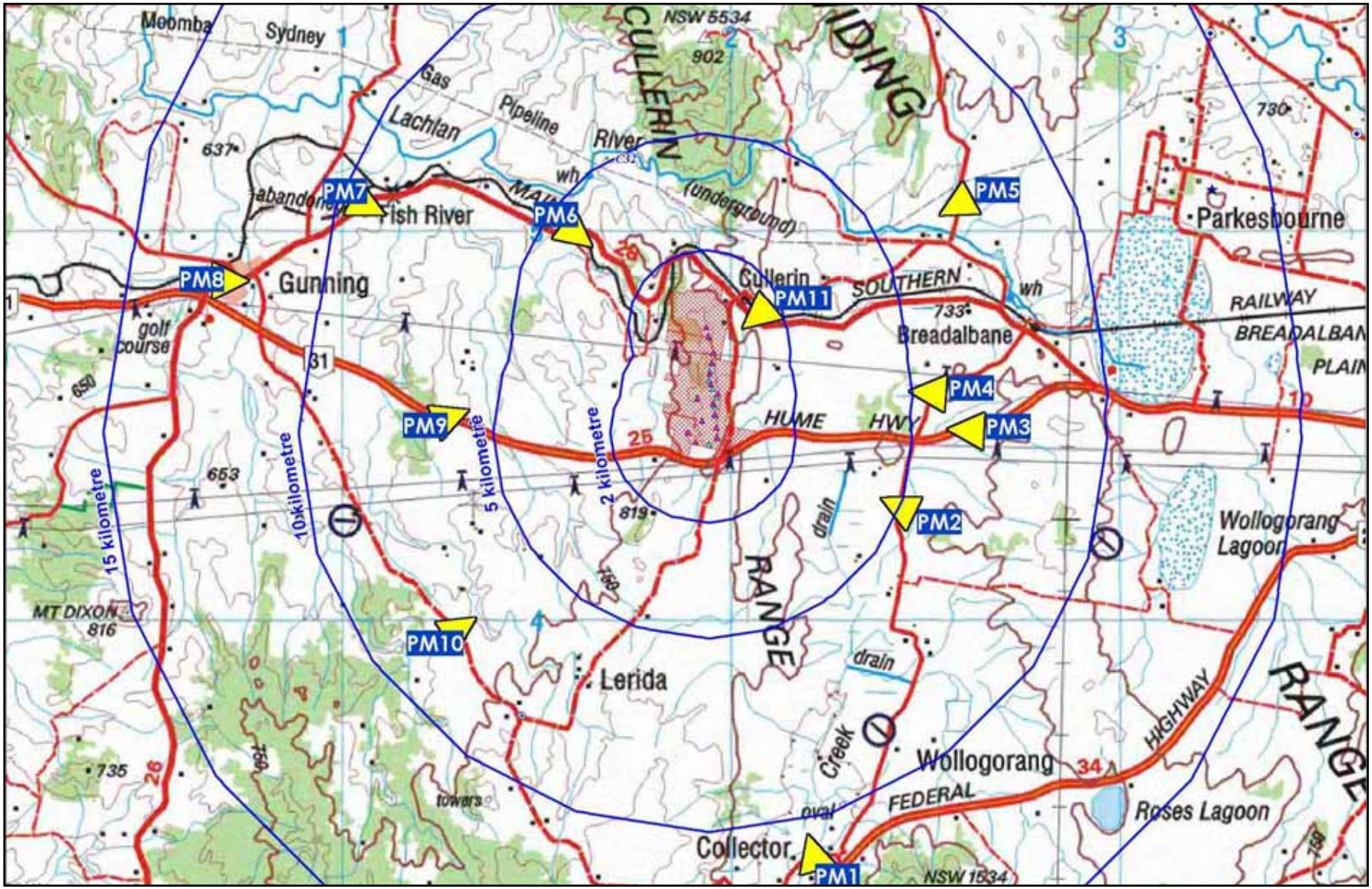

Figure 7.2 Base map of the location of photomontages (PM1 -11)

Figure 7.3 Photomontage from Gunning (PM8)

Figure 7.4 Photomontage from Collector (PM1)

Figure 7.5 Photomontage from the Hume Highway, approximately 8km east of the site (PM3)

Figure 7.6 Photomontage from the Hume Highway, approximately 6km west of the site (PM9)

Figure 7.7 Photomontage from Wet Lagoon, approximately 4km east of the site (PM4)

Figure 7.8 Photomontage from north of 'Sweetwood Lea' (PM5)

Figure 7.9 Photomontage from the road between Collector and Breadalbane (PM2)

Figure 7.10 Photomontage from the Old Hume Highway, approximately 4km west of the site (PM6)

Figure 7.11 Photomontage from the Old Hume Highway, approximately 8km west of the site (PM7)

Figure 7.12 Photomontage from the Old Hume Highway, near 'Illawambra' (PM11)

Figure 7.13 Photomontage from the road between Collector and Gunning (PM10)

Conclusion

The reality of wind farms is that structures of this size cannot be hidden and the requirements of wind production siting mean that they will not function if hidden. Consequently, there will always be visual impacts associated with wind farms. This is not always a negative impact, as some people find the visual aesthetic of wind farms appealing. Balancing the local visual concerns of the community and the broader benefits of clean energy production can be difficult. The more positive aspects of the development of a clean energy source and the positive visual landmark that wind farms can provide should not be overlooked.

The area that will be most impacted is the area directly around the site where there are close range views of the turbines and infrastructure. There is also moderate to high visual impact from Wet Lagoon, the plains around Mutmutbilli, houses close to the site on the west of the Cullerin Range, and three properties adjacent to the Collector River to the south-east of the site.

Due to the nature of the site, little can be done to minimise the visual impact on these areas with regard to turbine siting, as there is limited opportunities to relocate turbines on the relatively small area of land along this section of Cullerin Range. Vegetation around existing properties can be a very effective way to screen views to the site; providing assistance to landholders to do this may be an approach worth undertaking.

The report found that the contrast of the wind farm to the surrounding modified farming landscape was acceptable. Consequently the landscape of the area will be able to absorb the change in the landscape character resulting from the introduction of a wind farm. This report considers that from most locations around the site, the wind farm will not represent a significant visual impact.

There may be a cumulative impact from other wind farms that have been approved in the area, if these are constructed. Most notably, the Gunning wind farm that has been approved is located ten kilometres north of the proposed wind farm site along the Cullerin Range.

There will also be a visual impact from shadow flicker (generated by the moving turbine blades when the sun is low in the sky) and associated infrastructure (substation, control building, overhead transmission lines and access roads). Shadow flicker can have a negative impact within 1000m of a turbine (Degryse 2000); the effect attenuates between 500 and 1000m from the turbine. A shadow flicker analysis determined that within 1000m, only one residence could be affected by flicker; Springvale, an involved property, modelled as experiencing 25-28 hours of shadow flicker per year. Individual turbines can be turned off during offending periods. Temporarily shutting down turbines is a strategy that may be recommended by post construction shadow flicker monitoring. Taurus have committed to shutting down relevant turbines during all periods of shadow flicker at residences within 1km of a turbine.

Measures which have been recommended to minimise the visual impact of the proposed wind farm are as detailed below. These are measures to which the proponent is committed (refer to Section 9.2 Draft Statement of commitments).

- Avoid locating turbines in areas of native vegetation, and minimise the removal of native vegetation for turbine bases and access roads.
- Localised landscape treatment can assist greatly in reducing the visual impact of the wind farms from specific view points, particularly around houses. It is recommended that the proponent make provision for landscaping material to landholders to screen views of the wind farm from houses or outdoor entertaining areas around the site.
- The turbine towers will be predominantly viewed from below as the ridge is significantly higher than the surrounding land. This means that it is relatively easy to select colours that reduce the visual impact of the towers as much as possible. Towers should be coloured light off white/light grey to help reduce visual impact.

- If possible, the substation would be located on the western side of Cullerin Range so as to minimise the visual impact of the substation. Planting should be used to screen the substation from the surrounding landscape (planting should use species of the surrounding vegetation community).
- The substation should be coloured grey to blend into the surrounding landscape.

7.3 Operational noise impacts

Heggies Australia was contracted by Taurus Energy to undertake a Noise Impact Assessment of the proposed Cullerin Wind Farm (full report attached, Attachment 3.2). The Noise Impact Assessment report details the noise criteria, background noise measurements and the predicted noise level at all potentially impacted receivers from the operation of the proposed wind farm. The following information was extracted from the final report to summarise the methodology, results and recommendations of the assessment.

Existing environment

The proposed site incorporates the farming properties Fairview, Springvale and Wandella which include residential dwellings. The owners of these residences will have a direct involvement with the project (through lease agreements for use of their land). Taurus Energy intends to form noise agreements with these landowners which would allow Taurus Energy to exceed SA EPA Guidelines. The agreements would require Taurus Energy to meet WHO guidelines of 45 dB(A) or background plus 5 dB(A) (whichever is higher), and will be finalised prior to construction once final turbines have been selected. Additional mitigation measures (e.g. acoustic insulation) will be provided to these land owners on their request either before or after construction in the event that they are unduly disturbed by noise generated.

An indicative assessment has been carried out against WHO guidelines to ensure no unreasonable impact will occur, and to provide the basis of the agreements between Taurus and the site landowners. The results of this assessment have been provided to the involved landowners.

Residential dwellings surround the proposed site and are generally located along the Old Hume Highway. The assessment locations include all dwellings located within 5 km of a proposed wind turbine.

Road traffic on the Old Hume Highway is intermittent and all residential dwellings surrounding the proposed site have an ambient background noise environment that is determined by predominantly natural sources which are largely wind influenced. The Hume Highway to the south of the site carries continuous traffic, however, few sensitive receivers are located close to it. The prevailing wind is from the West to West-northwest and East and the district receives only marginal rainfall.

Methodology

Two alternative turbines layouts (detailed in Section 3.2.2, Figure 3.8 and Figure 3.9) were assessed in accordance with the South Australian EPA Noise Guidelines for Wind Farms (February 2003), World Health Organisation limits and construction noise guidelines. Noise monitoring was conducted in November 2005 at four residences. The collected data was used to determine baseline conditions and establish indicative criteria for surrounding residential receivers. A detailed computer noise model was used to predict wind turbine generator (WTG) noise levels for both layouts.

In general the assessment procedure contains the following steps:

1. Predict and plot the LAeq 35 dBA noise level contour from the wind farm under reference conditions. Receivers outside the contour are considered to be within acceptable wind farm noise levels.

2. Establish the pre-existing background noise level at each of the relevant assessment receivers within the LAeq 35 dBA noise level contour through background noise monitoring.
3. Predict wind farm noise levels at all relevant assessment receivers for the wind range from cut-in to approximately 10 m/s.
4. Assess the acceptability of wind farm noise at each relevant assessment receiver to the established limits.

Where the assessment of a receiver has shown unacceptable resulting wind farm noise levels, a process of noise mitigation and alternative wind farm layouts is considered. Steps 3 and 4 were repeated until an acceptable arrangement was developed.

A three dimensional computer noise model was used to predict L_{Aeq} noise levels from all wind turbine locations at all surrounding residential dwellings. The estimated accuracy of the prediction model is approximately ±3 dBA.

Impact assessment

This section deals only with the operational noise impacts. Construction noise is considered in Section 8.2.

Results

An assessment of the acceptability of wind farm noise levels at all assessment receivers located within a distance of 5 km of the proposed wind farm was made in accordance with SA EPA Guideline criteria and the pre-existing background noise level regression analysis.

Layout A - Repower MM82

- The predicted curves show that all locations comply to their respective criteria.

Layout B - Suzlon S88

- The predicted curves show that most locations comply to their respective criteria.
- Location C02, Springvale, is predicted to marginally exceed the WHO based limit by up to approximately 1.5 dBA in the wind speed range 6-12 m/s. It is anticipated that façade noise levels at critical locations (outside bedrooms) would likely be less than the predicted free field level.
- Location C37 Faybri is predicted to marginally exceed SA EPA Guideline Criteria by approximately 3 dBA in the wind speed range 3-7 m/s.
- Location C04, Illawambra, is predicted to marginally exceed SA EPA Guideline Criteria by approximately 2 dBA in the wind speed range 3-6 m/s.

An assessment of tonality was carried out in accordance with IEC 61400-11. For the wind speed range analysed (6 – 10 m/s), tonality was not deemed to be audible.

Infrasound is not tested as an obligatory part of IEC 61400-11. Low frequency or infrasonic noise and vibration has been an impact associated with wind turbines. 'Low frequency noise' describes noise levels below 200Hz; thunder and diesel engines are examples of sounds in this range (British Wind Energy Association 2005). It is noted that in general modern wind turbines

do not exhibit significant infrasound emissions. Improvements to turbine design, particularly the development of upwind blade configurations have reduced this component to a very low level, below the level of human perception (British Wind Energy Association 2005). This has been determined through measurements taken at turbines in the United Kingdom, Denmark, Germany and the USA over the past decade.

Mitigation

Where exceedances of SA EPA Guideline noise criteria or WHO limits are predicted a number of measures are proposed to minimise the impact or reduce noise levels. The proposed mitigation measures vary dependant upon the receiver (project involved or not involved) the magnitude of the exceedance and number of affected receivers.

Layout A

- The layout was shown to fully comply to criteria and goals. No mitigation required

Layout B

- The predicted marginal exceedance for Location C02, Springvale, would be re-evaluated in detail with house orientation and layout taken into consideration.

- The predicted marginal exceedances for Location C37, Faybri, and Location C04, Illawambra, would be re-evaluated once final turbine selection has been made with background noise monitoring to be conducted at the actual property.

- Should any residual impact be predicted for facades that include noise sensitive uses, such as bedrooms, then consideration would be given to providing mechanical ventilation (to remove requirement for open windows), building acoustic treatments (improved glazing) or to remove turbines or switch turbines off under conditions known to produce excess noise.

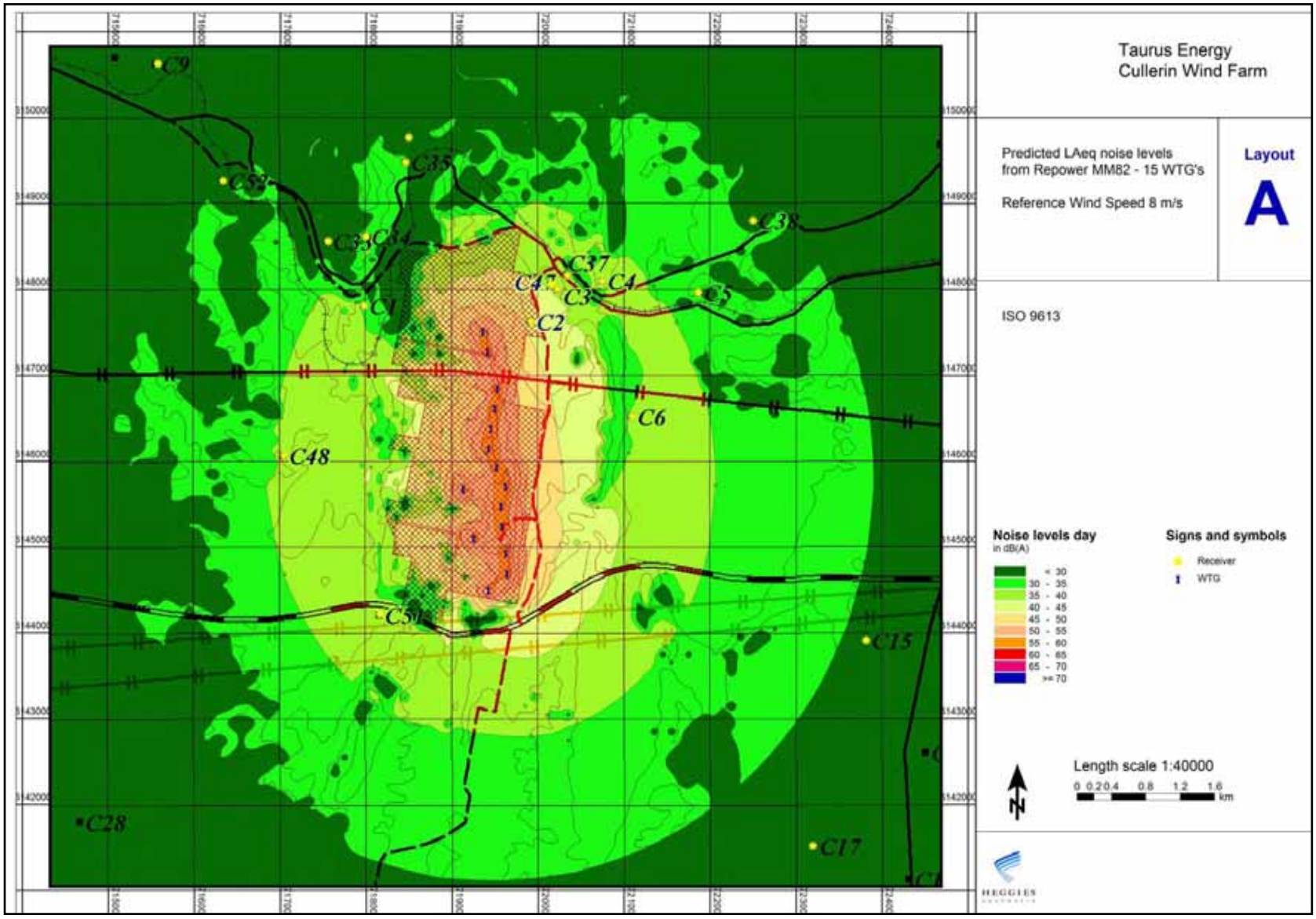

Figure 7.14 Layout A: modelled noise levels (Repower MM82)

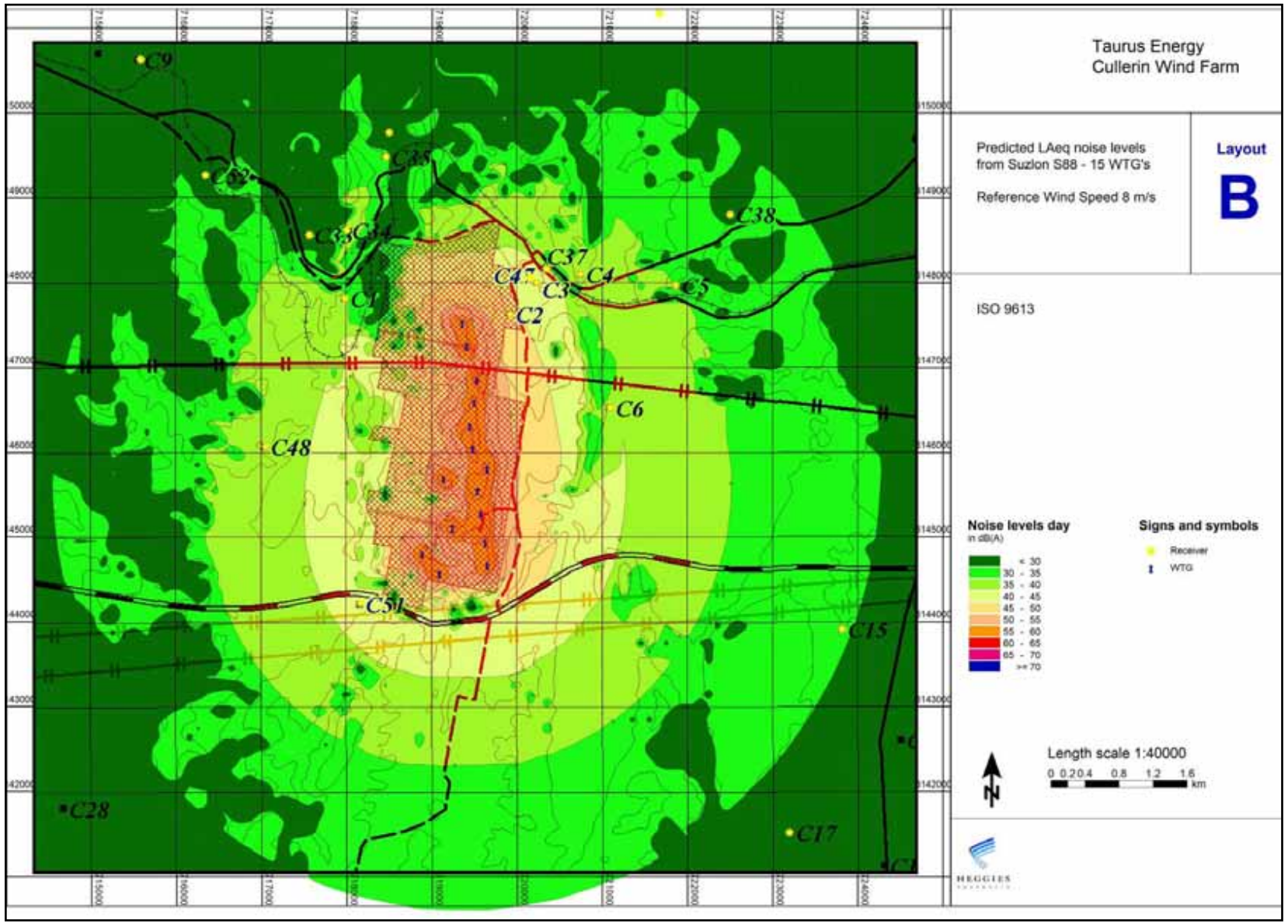

Figure 7.15 Layout B: modelled noise levels (Suzlon S88)

7.4 Social and economic factors

On the Southern Tablelands, it has been recognised that social and cultural issues play an important role in preserving natural ecosystems when planning for the long-term land use future of the region (Fallding 2002). This section considers the anticipated impacts of the proposal on social issues including community wellbeing, economic impacts and potential land value impacts.

7.4.1 Community impacts

Existing environment

The Upper Lachlan Shire Council was formed in February 2004 from the Crookwell shire, the majority of the Gunning Shire and part of the Mulwaree Shire. Gunning is the centre of "The Shire of Small Villages". It has features that make it both strong and vulnerable to adverse community impacts.

The local government area is sparsely populated, as would be expected for a predominantly rural area. Density is recorded as one person per 88.59 hectares, which is half the density of the surrounding 17 LGAs in the region (data sourced from the Upper Lachlan Shire Council Annual Report 2004-2005). The estimated residential population as of June 2004 was 7,621 and demographic trends indicate an aging population. The proportion of indigenous residents is around 1%, less than the national average of 2.2% (data sourced from the Upper Lachlan Shire Council Annual Report 2004-2005). Key statistics pertaining to the Gunning Shire, prior to amalgamation are provided in Table 7.5.

Table 7.5 Key statistics for Gunning Shire

Size of shire: Area of sq km.	2209
Population	
Number (1996)	2,300
% Growth since 1991	5.2
Medium age 1996 (yrs)	35
Value of Industry	**$ Million**
Tourism	4.0
Retail	3.2
Manufacturing	n/a
Agriculture	20.4
Value of Building Approved	2.7
Education	
Number of people with	
- post-school qualifications	586
- trade qualifications	325
- tertiary qualifications	261
Top 5 Industries (number of people employed)	
Retail Trade	69
Agriculture, Forestry & Fishing	326
Property & Business Services	81
Health & Community Services	68
Governments Admin & Defence	109
Number of Business 1996	410

Source: ABS, Tourism NSW

One measure of 'community' in Gunning is the willingness of individuals to be involved in volunteer organisations such as the Bush Fire Brigade, Meals on Wheels, the Country Women's Association and farmers' associations. Local sports and recreation clubs are also well represented in the region. These organisations are based on shared goals and maintained by volunteer efforts. The additional element of people who have long associations with the area strengthens the fabric of the local community.

The make up of the local community can be seen as being comprised of families that have been in the area for several generations and newer residents attracted by work opportunities or by the rural lifestyle. A large number of people pass through the area due to its location between the major cities of Canberra and Sydney. It also suggests the possibility of an increased transient community as well as an increased attractiveness of the area to city dwellers looking for a rural holiday or retirement home or the ability to commute to work in the city from a rural area ('tree-changers'). While the 'tree change' phenomenon can bring skills and diversity to a community, it can also be a source of division by increasing the pace of change and affecting established structures or attitudes in a community. By virtue of the increased transient population alone, the tree-change (or sea change) demographic shift can result in a loss of sense of community (Gurran *et al.* 2005).

The amalgamation of the local government areas in 2004 has been recognised as having had an adverse impact on some aspects of the community. Weakened connections between some people and some groups in the community and fractures due to rivalry or suspicion have been observed (M. Breen pers. comm. 2004). The amalgamation has also increased the proportion of people from ethnic origins within the new shire boundaries, which may, similarly to the tree-change shift, have positive as well as adverse impacts on social cohesion.

The Goulburn region has, over the last several years, had several wind farms proposed and one wind farm developed. Excluding proposals by Taurus Energy, recent proposals have all been for large scale wind farms. The local Council and state government have been the consent authority variously. Criticisms have been levelled at the community consultation processes employed (Upper Lachlan Shire Council pers. comm. 2005) and frustration has been observed in the community related to the developers, type of development and the assessment and consent process for both state and council approved developments (B. Marshall pers. observation from Cullerin community consultation November 2005).

Community consultation

One of the objectives of the community consultation open house session held in Gunning in November 2005 was to gauge what aspects of the proposal most concerned members of the community. Thirty-eight participants registered their attendance at the open house. Half of these provided written feedback on the proposal in its initial form. Although feedback can be skewed (those with higher written skills and stronger opinions are more likely to respond in writing) the results provided an indication of the range and strength of views regarding this proposal and wind farms in general.

Most respondents lived and/or worked nearby and were involved in commercial agricultural activities. Most (eleven) respondents believed they would see the wind farm from their place of residence. The local area's views, cultural landscape, work and recreational opportunities were valued most by respondents. The following issues regarding this wind farm proposal were of concern to respondents: visual, land values, noise, electromagnetic interference and community benefits/impacts. Asked to nominate general issues of concern under the broad headings of 'environmental', 'visual', 'heritage', 'noise', 'recreation', 'health', 'other' the most frequent responses were (in order of the listed headings):

- Flora and fauna (including stock)
- Change of visual landscape

- Historic landscape affected
- Impact on residents within 2km
- Noise impacts
- Lack of short and long-term research on effects of wind farms
- Telecommunication interference
- Misinformation / 'secretive' way the proposal is being put forward

Several participants had very strong feelings about the proposal and there was a level of suspicion about wind farm developers, the assessment process and consent authorities that could be related to past experiences in the community with wind farms assessed by the local Council as well as to the perceived impacts of this proposal and the distribution of its benefits.

Impact assessment

This section discusses only those impacts directly related to community wellbeing. Issues such as visual, economic, traffic and safety impacts are discussed separately elsewhere in this document.

Construction issues

The construction of the wind farm would generate a level of community disruption, not related to actual construction impacts but rather to this phase marking the beginning of a proposal that people have strong views about. Community consultation has highlighted that there are a range of views toward the proposal, including very positive, neutral and very negative and highlighted specific aspects of the proposal that the respondents were concerned about (the majority of which have been investigated in specialist reports and/or discussed in this EA). These issues can be addressed on an individual basis and mitigation measures implemented; for example, a turbine location can be moved in order that modelled noise levels are acceptable at a nearby residence. Several other issues however, relate more to the community than to the individual or a specific physical impact. These are discussed below.

Landscape attachment

Unlike more densely populated areas, in areas with large land holdings, people may feel a greater level of attachment to landscapes beyond their own property boundaries and therefore feel a greater level of concern over developments that would impact these landscapes. This may be attributed to the lack of infrastructure in the area, and therefore the high level of contrast the development would create and may also signify an attachment to the broader landscape values.

This landscape attachment, when shared by members of a local community, can be a binding element; part of the 'sense of community' more often attributed to indigenous communities than non-indigenous occupants in Australia. The landscape surrounding the site is highly modified; slopes and flats are cleared for agricultural production, ridges have scattered trees and fragmented woodlands, electricity easements run parallel to the highway as well as across the site. Nonetheless, the landscape character contains a functional aesthetic to a community involved in agricultural activities and with ties to past generations who have farmed this land. Furthermore, given the proximity to Canberra and Sydney, the potential for subdivision of smaller 'life-style' blocks in the area increases the concern over the impact of the development on land values.

Community involvement

An underlying issue less able to be recorded during the consultation process may be the lack of control that the community feels they have over this and similar large scale developments in their local area. Several people during the consultation process suggested that there was little point in providing feedback, that the development would go ahead regardless. Although visual impact and community views are considered in the assessment process, the resulting decision making process cannot accommodate the views of all people who may feel some attachment to the site. Furthermore the assessment process can be complex and exclusive, as documents are tailored for a professional audience, adding to the suspicion that decisions are out of the community's hands. This can create a lack of empowerment and resentment in a community. Fuelling this resentment and increasing the community disruption may be the knowledge that involved landowners are entering into lease agreements to financially compensate them for the use of the land. This highlights the disparity in economic benefit; although many people will see the infrastructure, only a small proportion will receive direct benefit from it (involved land owners, employed contractors, local residents who may benefit from road upgrades).

Public attitudes are critically influenced by the nature of the planning and development process; the more open and participatory, the greater the level of public support (Birnie *et al.* 1999; Khan 2003, cited in Warren *et al.* 2005). Although the community consultation process was instigated early in the development of the Cullerin Range wind farm proposal and the community was invited to participate, past experience with wind farm developments and the assessment and approvals process in the Goulburn region may have created a history that influences the community's perception of this proposal.

Experiences at other wind farms

Warren *et al.* (2005) observed that the move from centralised power generation to decentralised use of renewable sources raises novel and challenging issues for planning, land use and social engagement. Their study of wind farms in Scotland and Ireland investigated the nature of community views about wind farms.

The study tested and supported three hypotheses:

i) The 'not in my backyard' (NIMBY) syndrome does not adequately explain variations in public attitudes.

ii) Local people become more favourable towards wind farms after construction;

iii) The degree of acceptance increases with proximity to the wind farm;

There was evidence during the consultation process for the Cullerin site of the NIMBY attitude in comments suggesting wind farms were a good idea but should be located at sea or otherwise out of view of the public. The reverse NIMBY attitude was also recorded, with those located closest to the project being most in favour (involved landowners). Opposition was also in the form of a blanket rejection of the concept; they are 'inefficient', 'unreliable', 'an industrialisation of the landscape'. However, surveys of this attitude before and after construction in the Warren *et al.* study (2005) suggested that attitudes changed based on actual experience of the wind farm and therefore that the NIMBY syndrome was not a reliable explanation of peoples' attitudes in the long-term.

The study found that aesthetic perceptions (whether positive or negative) are the strongest single influence on individuals' attitudes towards wind farms. Surveys showed that people with anti-wind farm views perceived turbines as noisier and more intrusive than those in favour of wind turbines, regardless of the actual recorded levels (Krohn and Damborg 1999, cited in Warren *et al.* 2005). The study observed that opposition arises in part from exaggerated perceptions of wind farms that living near a wind farm dispels (Elliott 1994; Redlinger *et al.* 2002; SEDD 2002; Braunholtz 2003; SEI 2003a, cited in Warren *et al.* 2005). More positive

feelings about wind farms were recorded closer to the wind farm site than further away (Warren *et al.* 2005).

Conclusion

Warren *et al.* (2005) state that a consistent picture of public attitudes to wind power is emerging from surveys and case studies in Europe. Large majorities are strongly in favour of wind farms, their opinions formed by personal experience, in contrast to a minority in opposition whose opinions are formed not by experience but by misinformation and prejudice. This does not discount the real issues associated with community impacts, those being landscape aesthetics and the speed, scale and uncoordinated nature of the wind farm developments (Warren *et al.* 2005). The pertinent points, if wind power is to develop and form part of the energy solution in rural areas, are therefore dissemination of accessible and independent information on impacts and the development of a strategic planning framework.

Considering the characteristics of the Gunning community, in many ways the Cullerin site is appropriate for the development of a small to medium scale wind farm. The population density is low, even by comparison to surrounding rural areas, the agricultural land use is compatible with the installation of wind power infrastructure and the supplementary income provided by the lease agreements could be used to manage the land more sustainably. The acknowledgement that opposition to wind farms can be a reflection of exaggerated perceptions and of previous experiences with the development process is particularly relevant to this proposal and others in the Goulburn region. Opposition to the wind farm exists at Cullerin and although it is not the sole cause of division in the community, it is already acting to exacerbate divisions and tension which may have wide-reaching impacts on a local community characterised by long family associations and community organisations.

Several options could address the impacts to community wellbeing generated by this proposal, the most obvious being a 'do nothing' or 'no development' approach. However, there is a clear argument for a shared responsibility in addressing community impacts between both the planning bodies and the developers. That is, to place the onus of amelioration solely on private wind farm developers is to ignore a large component of the problem.

In light of the above discussion and considering the potential for community gains, several strategies may be relevant which may better address the roots of the community impacts as well as allow for the development of wind power as a viable contribution to future energy demands. For example, the New South Wales Government have proposed to undertaking a review of wind farms in key locations across New South Wales to ensure there is a balanced approach to development issues. This review will examine key locations for wind farms and, amongst other issues, consider their cumulative impact, and the the ability to provide wider community benefits (from media release of 7th March 2006, from NSW Planning minister Frank Sartor).

Given the potential for exaggerated perceptions of the impacts of the wind farm and uneven distribution of benefits, it is recommended that:

- Accessible and independent educational material about wind farms should be disseminated to the public.
- Investment in community infrastructure, such as through the establishment of the Community Fund should occur to spread the benefits of the proposal. Volunteer community organisations are a symbol of community cohesion in the locality. The community fund, supported by an ongoing income stream for the life of the project, would assist organisations which provide locally appropriate support at a community level as well spread the benefits of the proposal more equitably throughout the community. Examples of possible assistance may include purchasing materials or equipment for organisations such as the Rural Fire Brigade or local schools or libraries (rather than on an individual basis).

Operational issues

The proposal is not anticipated to impact community wellbeing in ways additional to those issues discussed above, during the operational phase.

Decommissioning issues

The proposal is not anticipated to impact community wellbeing in ways additional to those issues discussed above, during the decommissioning phase.

7.4.2 Economic impacts

Existing environment

Proposal characteristics

Wind farms are an economically viable means to generate electricity and provide several environmental benefits, when compared to currently available alternatives. The project would be privately funded by Taurus Energy. There would be no ongoing financial expenses to the community or to the Upper Lachlan Shire Council. Potential for gains exists in the provision of lease agreements and local employment. The development would be of direct economic benefit to landowners who enter into leasing arrangements with Taurus Energy. Approximately 50 full time jobs would be provided during the construction phase of the development and approximately three during the operational phase, ongoing for maintenance and monitoring activities. Local contractors would be selected where they can demonstrate the capacity to undertake the works effectively. Other economic benefits would result via the provision of services to these workers; such as accommodation, food and fuel from local service centres. Economic benefits will vary depending on final site design, turbine suppliers, timing of works, and other details. It is estimated that up to $10 million could be spent within the region as a result of the wind farm over its life. This would be broadly split with approximately $5 million during the construction phase and $5 million during the operation phase.

Local economy

Gunning is the nearest town to the site, located approximately ten kilometres west. Traditionally, Gunning's economy is reliant on wool production, regarded as one of the major centres of fine wool in Australia. Crookwell is the administrative centre of the Upper Lachlan Shire. The shire is largely agricultural. Whilst built around merino sheep and seed potato production for international markets the area is now diversifying into olive production, alpaca and horse enterprises. Tourism is the third largest industry behind agriculture and retail.

Goulburn, approximately 25km to the east, is the largest regional centre with a population in 2001 of 21,400 (over 75% of the regional population is located in Goulburn). The locality offers visitors an historic rural experience and provides employment in agriculture, several service sectors but few manufacturing opportunities by comparison (refer to Figure 7.16, main employment sectors for Goulburn Mulwaree).

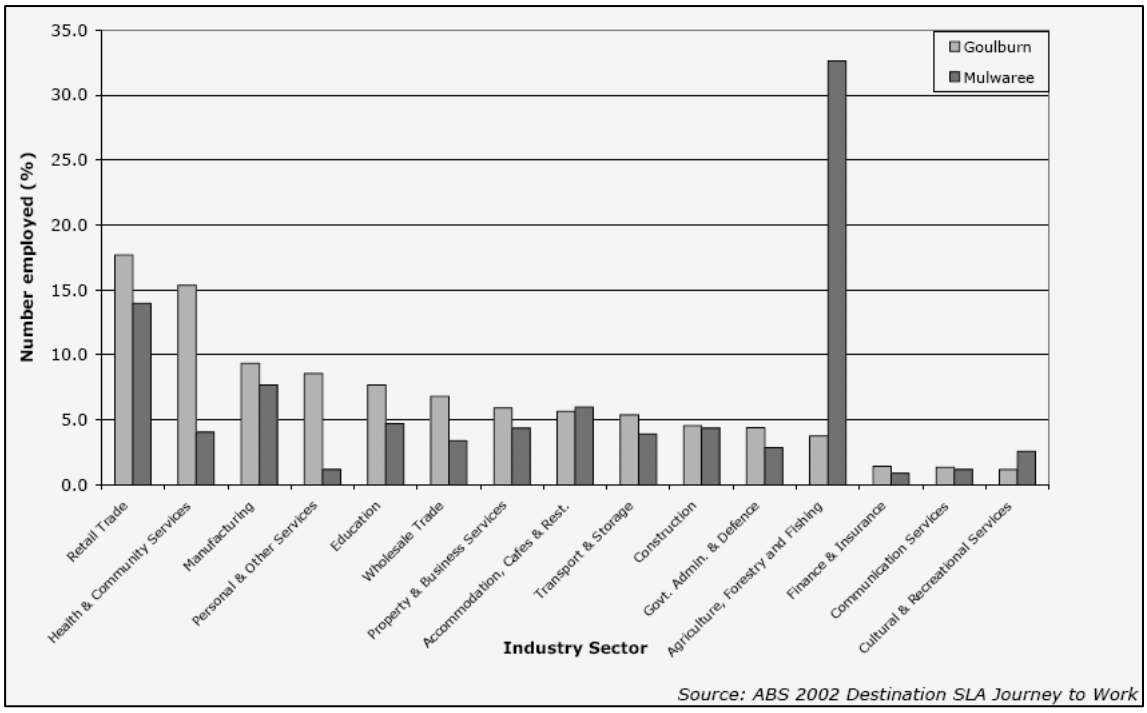

Figure 7.16 Employment break down for the Goulburn-Mulwaree region

Impact assessment

Construction and decommissioning impacts

The construction and decommissioning phases of the wind farm would generate the largest economic gain for the largest number of people. The local area appears suited to benefit from the temporary provision of 50 additional contracting jobs as well as other service related employment (provision of food, fuel, accommodation to contractors). Adverse economic impacts are not anticipated.

To maximise the economic benefit of the proposal, it is recommended that:

- The proponent should liaise with local industry representatives to maximise the use of local contractors and manufacturing facilities in the construction phase of the project.

Operational impacts

The operational wind farm is compatible with the current agricultural use of the Cullerin site and would be similarly unlikely to impact on the profitability of agricultural activities of adjacent land parcels (discussed in more detail in Section 7.7: Land use impacts).

A feature of wind farm developments is that the distribution of benefits can be limited to a small number of people, while the impacts (such as visual impact) can have a much larger sphere of influence. This economic disparity is most relevant to the operational phase of the wind farm. Adverse economic impacts are not anticipated during this phase however, the potential to affect community wellbeing through this inequitable distribution of benefits is discussed in Section 7.4.1. The proponents are currently considering several options to provide additional benefits to the larger community (refer to Section 9.2 Draft Statement of commitments).

7.4.3 Land value impacts

Existing environment

The Cullerin Range wind farm has potential to affect land values in the immediate area of the wind farm as well as the general locality. While public perception of wind farms is highly variable and subjective (SRSC 2005), there is the potential for a section of the market to be negatively affected by perceived visual or noise impacts, or by changes to compatible land uses (perceived community impacts have been addressed in Section 7.4.1 Community well-being).

Land values are influenced by prevailing and permitted land uses, economic conditions, access and proximity to markets and workplaces, demand for lifestyle as well as a range of other factors. While the development of wind turbines does not preclude agricultural use, it is unclear what impact such developments have on land values. Prediction and quantification of land value impacts is problematic as there are few studies examining the effects of wind farms on land values in Australia.

There are examples of successful residential estates being developed near existing wind farms, in Australia. An informal study of the Salmon Beach estate near the Esperance wind farm in Western Australia showed a strong trend of increasing house prices (AusWEA 2004a). As well, there are concerns about properties being devalued (Cullerin wind farm, community consultation process, November 17, 2005). Impact on land values is an important impact that is of particular interest to residents of local communities where wind farms are proposed, being listed along with visual and noise impacts during the Cullerin community consultation process as issues of major concern to local residents.

The Cullerin site is located near three major transport corridors; the Hume Highway, the Old Hume Highway and the Great Southern Railway. The wind farm would be highly visible from the Hume Highway at the south of the site and may therefore have a greater impact on people's perception of the area than if it was less visibly located. The development may be interpreted as symbolizing industry or power generation over the rural lifestyle values. This may impact on the sector of the population looking for these latter values in the immediate area. Conversely, it may encourage development orientated buyers. At greater distances from the wind farm, the impact on landscape quality is debatable. For some, the whole region may be perceived as impacted by the sight of the development in transit. For others, the impact will be more localized or may even present a point of interest. At distances greater than 15km, the structures are not anticipated to attract the eye and, in general, at distances greater than 2km from the turbines, no operational noise impact is anticipated (detailed in Sections 7.2 and 7.3).

The land surrounding the proposal site is zoned 1(a) Rural Zone, used for extensive sheep and cattle grazing. In addition to traditional farmers, 'hobby farm' or 'lifestyle' residents are present in the local area. Given the proximity to the upgraded Hume Highway, there is the opportunity to commute to work in Canberra, Goulburn and Yass. Gunning is the local service centre and with its access to the Hume Highway, provides the opportunity to a number of people to commute to work in Canberra while living in a smaller rural village. Lots within this zone, for the purpose of erecting a dwelling, can be no less than 80ha (Gunning LEP 1997).

Hobby farm or lifestyle residents around the study area may have purchased property for aesthetic qualities. The consistency of the visual environment with the 'bush' or 'farm' ideal is important for this group; land holders involved in traditional farming may have a more pragmatic approach to the landscape (Scenic Landscape Architecture 2005), being more likely to view land and property primarily in terms of production. In general, the former group would be most sensitive to the visual or noise impact of wind farms, while the latter would be more likely to interpret wind farms as simply another element in a production landscape (Scenic Landscape Architecture 2005).

Land value study

Due to the concerns raised during community consultation, Henderson and Horning Property Consultants were contracted by Taurus Energy to assess the likely impact of the Cullerin wind farm on local land values, by recourse to the impacts resulting from overseas wind farms and the Crookwell wind farm, developed in 1998. The existing Crookwell wind farm is the nearest wind farm to the Cullerin site, has similar land uses (agricultural and rural residential) and several sales have taken place since the development of the wind farm.

The land value assessment examined what effect wind farm development has on 'market value'. Market value, as defined by the Australian Property Institute, has adopted the International Assets Valuation Standards Committee definition:

> "... the estimated amount for which an asset should exchange on the date of valuation between a willing buyer and a willing seller in an arms' length transaction after proper marketing wherein the parties had each acted knowledgeably, prudently, and without compulsion".

The study included a literature review of Australian and overseas studies and investigated the nature of wind farm development, valuation methodology and the effect of wind farm installations on the surrounding properties.

The full report is attached to this EA, Attachment 3.6. Extracts from the report are reproduced below.

Literature review

To date no valuation research has been completed in Australia on the effect wind farm developments have on subject or surrounding land values. A review of overseas research provides a single statistical analysis in the United States and a perceptual study has been undertaken in the United Kingdom.

The most extensive survey to examine the effect of wind farms on property values was undertaken in the United States and presented as Analytical Report by the Renewable Energy Policy Project (Sterzinger *et al.* 2003). The study did not model the changes in property values, rather it was an empirical review where data from 10 wind farm sites was collected and subjected to a statistical regression analysis to determine price changes in three ways:

- How property values changed over the entire period of the study for the view shed and comparable region;
- How prices changed in the view shed before and after the projects came on-line; and
- How property values changed for both the view shed and comparable community but only for the period after the project came on-line.

The results identified that in thirty separate analyses (i.e. 10 wind farm sites subjected to three assessments), twenty-six property values in the affected view shed performed better than the comparable properties. This study concluded that "there is no support for the claim that wind development will harm property values" was qualified with a statement that more data will need to be analysed as it becomes available.

The Royal Institute of Chartered Surveyors (RICS) carried out a study of its members to gauge professional property opinion about the impact wind farm development had on both residential and agricultural land values. It received 405 responses of which 81 indicated they had dealt with residential transactions affected by wind farm development. The study did not attempt to make a quantitative assessment of the impact merely gauge the perception of its members. The report concluded the main negative impact on property values are visual impact, fear of blight and the proximity of a property to a wind farm.

The report found that 72% of the sample believed wind farm development had no impact or a positive impact on agricultural land values. Where as 60% believed wind farms decreased the value of residential properties where the wind farm was in view. The perceived negative impact continues but becomes less severe after two years post completion.

Lastly, the Bald Hills Wind Farm Panel Inquiry in Victoria examined the issues of property devaluation for neighbouring properties in a more qualitative manner. A number of property valuers and real estate agents provided submissions and appeared before the Panel Inquiry as expert witnesses. From a review of this evidence the Panel Inquiry report concluded that:

> "All that appears to emerge from the range of submissions and evidence on valuation issues is the view that the effect of wind energy facilities on surrounding property values is inconclusive, beyond the position that the agricultural land component of value would remain unchanged. On this there appeared to be general agreement."

Crookwell case study

The principle object of the land values report was to determine the wind farm installations effect on land values, subject to the development and the surrounding properties. Sale transactions in the Crookwell area over a 15 year period were searched (1990 to 2006). Traditional valuation considerations used in rural valuation such as climate, topography, soils, improvements etc have not been measured as the wind farm development has no negative impact on the productive capacity of commercial agricultural enterprises.

Properties investigated were those that surround the development and have some direct impact from a valuation perspective; principally aesthetic influences including, visual, noise and shadow effects. These sales are deemed 'effected' sales, the hypotheses being these sales had been influenced by the development of the wind farm. A control group of sales in the same location with little or no physical and visual link to the Wind Farm formed the 'not effected' sales. The 'effected' and 'non effected' sales were compared over time to determine whether a correlation existed between the Wind farm development and land value movements.

A general trend of larger properties being sold and broken up into smaller lots commencing in the late 1990's, with very few sales occurring in the period prior to the development of the Wind Farm, was the background to the study. This trend is an example of the changing nature of land use in the area from commercially operating grazing land to a more passive rural residential use; market forces appear to value the rural residential amenity above that of the agricultural productive capacity of the land.

Discussions with Local Agents generally indicated that although topical, the existing wind farm had little or no effect on land values in Crookwell. However, the perception of the proposed wind farm (Crookwell II) planned close to the existing farm could have an effect. The Lake Birubi resale best demonstrates this. The original sale occurred prior to the wind farm being installed although the approval had been granted. The most recent sale of the Birubi property is in line with sales of similar property that are deemed not effected.

A review of the sales evidence of the deemed 'effected sales' when compared to the sales that did not have a view of the Crookwell wind farm indicated that no detectable discount exists. That is, the market evidences suggests that having a view of the wind turbines did not have an effect on land value.

It is clear that the underling agricultural productive capacity of the land subject to the wind farm and the surrounding property is not in any measured way affected by the development of the Crookwell wind farm, meaning there has been no reduction in values. This would support the findings of the RICS perception survey of UK valuers, 72% of which believe that wind farm development has either no effect or had a positive impact on agricultural land values. Indeed the property subject to the development enjoys additional revenue and has some added

benefits from improved roads, erosion control and passive wind protection for stock from the sub stations and turbine tower structures.

Over that last fifteen years land use in the Crookwell area has changed from larger grazing properties to more rural residential holdings where amenity is valued more highly then the productive capacity. The future development potential of the subject land under the existing planning controls if applied would continue as grazing land. Moreover the property has potential for more intensive agriculture in part and this potential is not lost as a result of the wind farm although, some tillage would clearly be affected by underground services. As with the adjoining Lake Birubi property the subject has potential for further subdivision and given that market demand would appear to be for rural residential, the author can foresee the pattern of development continuing to change in this direction. Having said this, the revenue stream from the wind farm plus the underlying agricultural production from the land may well outbid the subdivision potential for the site. This is premised on the rental income from the turbines being at market value.

Further research will be required to determine what value the market will place on the wind farm revenue streams however, it is suggested that the capitalisation rates will be similar to other infrastructure improvements like mobile communication towers and signage investments. Therefore the wind farm development has the potential to slow down the process of productive agricultural land changing to rural residential uses in the short to medium term with the shift caused by the additional income generated from the wind farm revenue making the agricultural use of (involved properties) viable.

Impact assessment

Construction and decommissioning impacts

The construction of the wind farm, and decommissioning phases would generate a temporary increase in traffic loads (with resultant safety issues), as well as producing increased noise and visual impacts. Increases in dust generation on dirt roads would occur. These impacts would be temporary and are not anticipated to impact land values in the area.

When the site is decommissioned, it could continue to be used for extensive agricultural activities. All disturbed soil, excluding access trails which the landowners may wish to retain, would be stabilised and rehabilitated. Concrete footings used to anchor turbines and buildings during the development would remain onsite (estimated area 4.5ha spread over up to 17 locations; 15 turbines, control room, substation). These may have a minor impact on land valuation of the site however, the lease agreements entered into with the proponent are considered to compensate the landowner for this.

Operational impacts

Operational impacts of the development have the greatest bearing on land value. The development may potentially affect land values in the immediate area where the development is sited as well as in the locality. The reasons may be related to the visual or noise impact of the development, anticipated changes to compatible land uses and impacts to local infrastructure, as investigated by the Henderson and Horning report. The investigation of the existing Crookwell wind farm found that the sales evidence of the deemed ‘effected sales’ when compared to ‘non effected sales’ indicated that no detectable discount existed. That is, the market evidence suggests that having a view of the wind turbines did not have an effect on land value.

This is considered to be a comparable situation to the proposed Cullerin site. The Cullerin site, is located in the same region (approximately 35km from the site, as the crow flies), on a recently upgraded transport corridor, is used for extensive agricultural production and has increasing interest in smaller rural residential holdings. Therefore, it is also considered that the conclusions of the report may equally apply to the Cullerin site. That is,

- The underling agricultural productive capacity of the land subject to the wind farm and the surrounding property is not anticipated to be affected by the development of the wind farm;
- The revenue stream from the wind farm plus the underlying agricultural production from the land may well outbid the subdivision potential for the site, slowing down the process of productive agricultural land changing to rural residential uses in the short to medium term;
- The evidence suggests that having a view of the wind turbines would not have an effect on land value on surrounding properties.

It appears likely that, although the presence of the wind farm may dampen a sensitive section of the property buying market, this effect is balanced by other influences such as demand for land and housing within a commutable distance from a larger centre and the creation of a development-oriented or green energy aesthetic. The proposal would also result in some economic gains for the locality, in the form of lease agreements with landowners, employment opportunities and provision of services to workers (the majority during construction). Furthermore, the proposal is highly reversible; the site would be returned to its current appearance at the end of the project's life, with only minor impacts to vegetation and soils.

7.5 Aboriginal archaeology

Existing environment

The Goulburn/Gunning area was occupied and used by Aboriginal people from the late Pleistocene onwards. The proposal area would have been covered with woodland tree species and is situated away from a confluence of resource zones. Accordingly the area would have been used by Aboriginal people for a limited range of activities which may have included hunting and gathering and travel through the country (NSW Archaeology 2005). Sources provide fragmentary and incomplete accounts of the traditional culture of those Aboriginal groups; Tindale (1974) determined that Goulburn was situated at the boundary of two tribes – the Gandangara to the north and the Ngun(n)awal to the south; Smith (1992) suggests that the current location of Goulburn fell within the territory of the Gandangara and was an intersection of boundaries and a 'cross roads' for at least six Gandangara 'bands', including the Burra Burra, Tarlo, Wollondilly, Cookmai, Parramarrago and Pajong (Smith 1992: 45). The paucity of reliable ethno-historic sources also means that an estimate of the pre-European Aboriginal population of the district cannot confidently be established (NSW Archaeology 2005).

New South Wales Archaeology Pty Ltd undertook an Aboriginal Archaeological Assessment of the site proposed for the Cullerin Range wind farm in November 2005 – January 2006. The assessment concerned areas of direct impact related to the proposal including the location of wind turbines, on-site electrical connections, communications cabling, two alternative substation sites and road access. Given the nature of the proposed works the project has the potential to cause impacts to any Aboriginal objects or deposits which may be present within the zones of direct impact. However it is noted that impacts will be discrete and generally small in area.

The study has sought to identify and record any Aboriginal objects which may be present in the proposal area, to assess the archaeological potential of the landform elements present and to formulate management recommendations based on the results of background research, a field survey and site significance assessment. The investigation has included both a literature search and field survey and has been undertaken in partnership with Pejar Local Aboriginal Land Council, Onerwal Local Aboriginal Land Council and Buru Ngunawal Aboriginal Corporation.

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 used archaeologically in order to analyse archaeological variability across the landscape. Accordingly in this study while the artefact is the elementary unit recorded it is the Survey Unit which is used as a framework of recording and analysis.

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 each of which has been defined on the basis of a combination of environmental variables. These areas are termed archaeological terrain units which in this study have been defined according to landform element, gradient and aspect.

The rationale for employing this definition relates to its utility in regard to predicting the archaeological potential of landforms; archaeological terrain units are "…discrete, recurring areas of land for which it is assumed that the Aboriginal land use and resultant heritage evidence in one location may be extrapolated to other similar locations" (Kuskie 2000: 67); the archaeological evidence observed within individual Survey Units is assumed to be generally representative of the archaeological resource located within the entire Survey Unit.

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 Interim Guidelines for Aboriginal Community Consultation - Requirements for Applicants (NSW DEC 2004).

Results

A search of the New South Wales DEC Aboriginal Heritage Information Management System (AHIMS) has indicated that there are no previously recorded sites located within the proposal area. However a number of sites have been recorded to the south of the proposal area (AHIMS: 20th December 2005).

Field work was undertaken in November 2005. The field survey was focused on investigating zones of proposed impact and these were subject to a comprehensive survey. Four locales containing stone artefacts were recorded (Figure 7.17). 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.

Given the absence of a reliable fresh water source and the limited resources that would have been present in the proposal area when the region was occupied by Aboriginal people, it is predicted that the area was not likely to have been subject to sustained Aboriginal habitation. Aboriginal habitation sites are expected to be present elsewhere in areas close to permanent watercourses and near to a confluence of resource zones.

The proposal area is likely to have been used for hunting and gathering forays conducted away from base camps. Such short term events are unlikely to result in the formation of large, high density or complex archaeological sites. It is predicted that such land usage would result in low to very low levels of artefactual discard.

Effective survey coverage achieved during the survey is assessed to have been adequate for the purposes of providing a reasonably reliable indication of the archaeological status of the proposal area.

The Survey Units present in the study area are each assessed to be of low or very low archaeological potential based on various environmental factors including steep gradients, the distance from reliable water and the shallow or skeletal soils which are present across the proposal area. The proposal area is assessed to be of low archaeological potential and sensitivity. The survey results are assessed to be in accordance with the predictive model of site location relevant to the proposal area.

Impact assessment

Construction impacts

Impacts on aboriginal heritage items and sites would be confined to the initial construction phases, as operational and decommissioning phases are not anticipated to disturb additional areas of land. Earthworks required to install the wind farm could disturb or destroy artefacts onsite.

The proposal area is assessed to be of low archaeological potential and sensitivity. Accordingly, no further archaeological assessment is considered necessary in relation to the proposed Taurus Energy wind farm at Cullerin.

Recommendations to minimise the impacts of the proposal, with regard to Aboriginal heritage, are listed below (see Attachment 3.3, Section 12 for a full listing of recommendations). The proposal includes these measures (see also Section 9.2 Draft statement of commitments).

- The proponent should give due consideration to the discussion in regard to management and mitigation of Aboriginal artefact locales and Survey Units as outlined in the attached Aboriginal Archaeological Assessment, Section 11.
- The four locales containing Aboriginal stone artefacts recorded in the proposal area do not surpass any scientific significance thresholds which would act to preclude impacts which may ensue as a result of the construction of the proposed wind farm. Accordingly, if impacts to any of the four stone artefact locales recorded in the proposal area are proposed, unmitigated impacts are justified.
- The proponent should consult with the Aboriginal communities who have participated in the assessment in regard to impacts to the Aboriginal objects found in the proposal area.

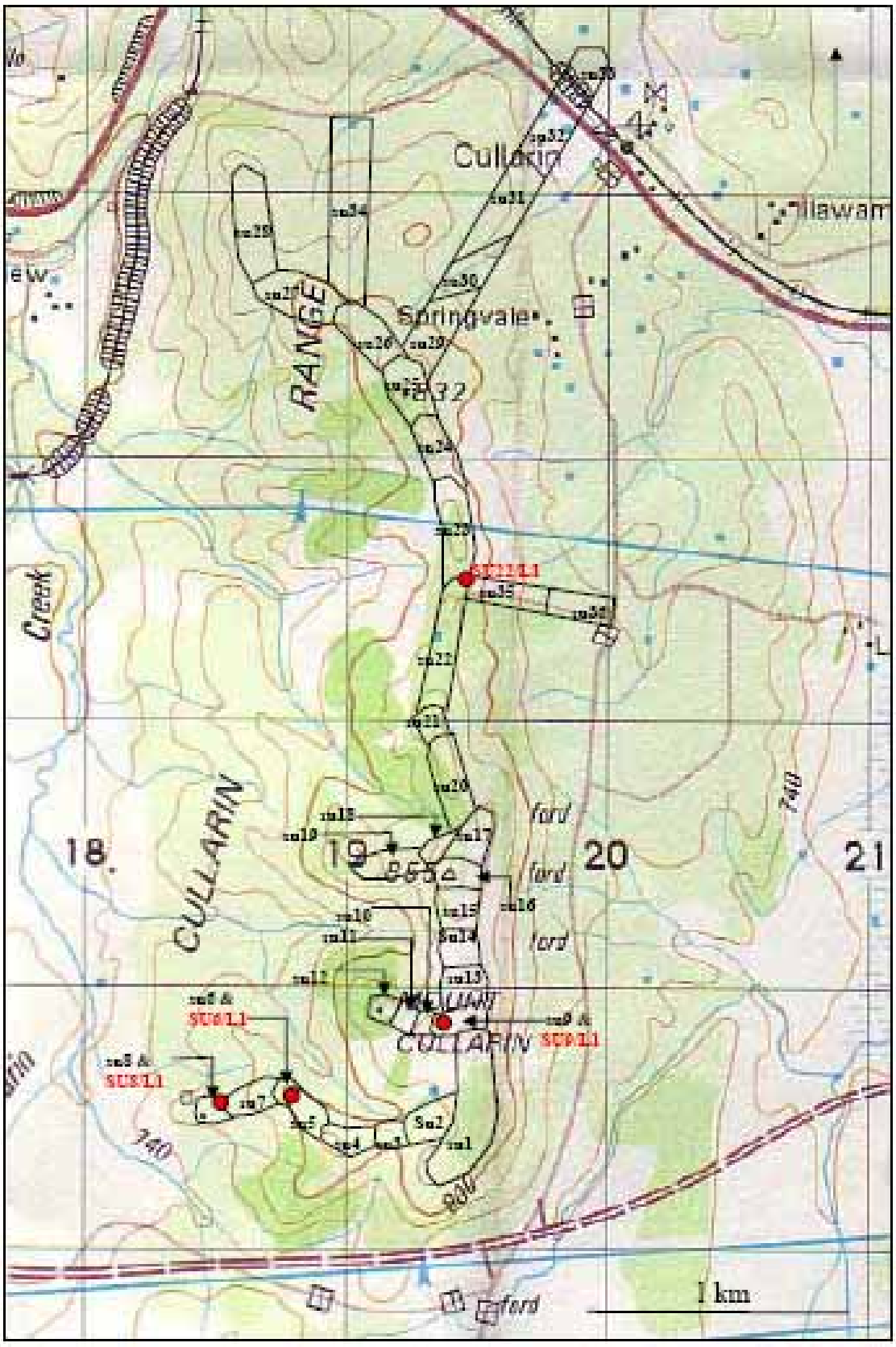

Figure 7.17 Location of survey units and the four artefact locales (in red)

7.6 Biodiversity

A Biodiversity Assessment was prepared by **ngh**environmental, February 2006. The report characterises the biodiversity attributes of the site and determines the likelihood and level of impact to flora and fauna that may arise during and following site development, pursuant to the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* and the NSW *Threatened Species Conservation Act 1995*. The methods and outputs of the assessment are intended to meet the requirements contained in the Draft Assessment Guidelines for Threatened Species Assessment prepared by the Department of Environment and Conservation (DEC 2005a). Key guidance documents used in the assessment included:

- Studying wind energy/bird interactions: a guidance document (Anderson et al. 1999);
- Wind Farms and Birds: Interim standards for risk assessment (Lane and Associates 2005); and
- Wind farms and birds: An analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues (Langston and Pullen 2002).

The biodiversity attributes of the site and potential impacts are summarised below for flora and ecological communities (Section 7.6.1) and fauna (Section 7.6.2). The full Biodiversity Assessment report, which includes detailed discussion of risk and impact, is attached (Attachment 3.4). Recommendations to minimise identified impacts are restated below.

The Biodiversity Assessment assessed the development envelope including road access and used the 'highest impact scenario' in terms of the dimensions of turbines and infrastructure being considered for the development.

In compiling the assessment, research and field work was carried out. The DEC NPWS Wildlife Atlas was consulted for records of threatened species and other species of conservation significance included on but not limited to the Gunning, Goulburn, Canberra, Yass, Crookwell and Taralga 1:100,000 map sheets. The national EPBC database search tool was also used to identify known fauna species distributions using a 30 kilometre buffer around the subject site.

Faunal surveying was carried out onsite for nocturnal and diurnal terrestrial vertebrates between November 19 and November 22, 2005. This included an assessment of habitat availability in the local area and totalled approximately 65 person hours. Flora surveying was conducted on November 22, 2005 with a follow up assessment on January 25, 2006, totalling approximately 14 hours in the field (detailed methodology is provided in the attached report).

7.6.1 Flora and ecological communities impacts

Existing environment

Most of the site is highly disturbed, by clearing, sowing of introduced pasture grasses and legumes, grazing and weed invasion. A few areas are less affected, some within the site and some around the edges of the site. The only weed species declared noxious in Goulburn-Mulwaree Local Government Area detected on the site was Scotch thistle, which is present in small numbers in a few locations.

A total of 116 vascular plant species was recorded during the flora survey, including 39 exotic species. A full list of species recorded in the survey zones, and their cover/abundance, is provided in the attached Biodiversity Assessment (Attachment 3.4, Appendix A: Flora list). This list is not exhaustive due to the extensive nature of the survey area, and the omission of some species which flower outside the survey period.

Parts of the site with a more exposed aspect tend to be dominated by brittle gum (Widespread Tablelands Dry Shrub/ Tussock Grass Forest) and more sheltered areas by yellow box and Blakely's red gum, although there are exceptions to this generalisation. The lower slopes surrounding the site still carry less disturbed patches of woodland which are in sufficiently good

condition to be regarded as being examples of the White Box, Yellow Box, Blakely's Red Gum Woodland Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act 1995*. Such areas are scattered along Lerida Road North (shown dotted on Figure 7.18).

The community dominated by brittle gum gum, Widespread Tablelands Dry Shrub/ Tussock Grass Forest, has been substantially degraded by grazing (as has the White Box, Yellow Box, Blakely's Red Gum Woodland onsite). Off-site, there are two remnants in good condition in close proximity to the site. One occurs on the top of a cutting above the railway line immediately south of the proposed substation site, and one on the verge of the unsealed road near the junction with Old Sydney Road at the northern end of the site. Although small, both these remnant patches are in good condition, which appears unusual in the vicinity of Cullerin.

The onsite area surveyed was divided into five survey zones; ridge, northern slope, eastern slope, western slope and southern slope. These areas are mapped, Figure 7.18. Detailed descriptions of the composition and structure of these areas are provided in the attached Biodiversity Assessment (Attachment 3.4).

Vegetation communities of conservation significance

White Box, Yellow Box, Blakely's Red Gum Woodland is listed as an Endangered Ecological Community in NSW under the *Threatened Species Conservation Act 1995* and is covered by the national listing of Grassy White Box Woodland under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. It is also listed, as Yellow Box Red Gum Grassy Woodland in the ACT under the *Nature Conservation Act 1980*, reflecting a high degree of destruction or modification by grazing, and in the ACT, loss of substantial areas to housing. This community probably formerly occupied much of the flats and lower slopes in the Goulburn district, from which it has mostly been completely cleared. Some remnants remain in a few areas, particularly on road verges, and remnant paddock trees indicate some areas where the community previously occurred.

The Final Determination of the NSW Scientific Committee states that:

> "Some remnants of the community may consist only of an intact overstorey or an intact understorey, but may still have high conservation value due to the flora and fauna they support…..Disturbed remnants are still considered to form part of the community including remnants where the vegetation, either understorey, overstorey or both, would, under appropriate management, respond to assisted natural regeneration, such as where the natural soils and associated seed bank are still at least partially intact".

This is quite a liberal interpretation of the community, suggesting that even substantially degraded remnants should be considered as belonging to the EEC. The identification guidelines for the Yellow Box, Blakely's Red Gum Woodland EEC (NSW NPWS undated) take this even further, indicating that size or age of the remnant are not determining factors in whether it is or is not the EEC. If the remnant in question occurs within the geographical area (tablelands and slopes) defined as the habitat of the community, carries, or is likely to have formerly carried, white box, yellow box or Blakely's red gum, is mainly grassy rather than shrubby and includes any of the indicator species listed in the determination (either as plants or in the soil seedbank), and if degraded, is considered to have potential for natural regeneration of the overstorey or understorey, then it is regarded as being part of the EEC.

The only area on the Cullerin site which is unequivocally part of the EEC is the steep slope at the northern end of the site (NS), where Yellow Box, Blakely's Red Gum Woodland occurs with a grassy understorey which still includes a substantial number of native grasses and forbs, although it is somewhat degraded by grazing and weed invasion. This area is of moderate conservation significance, as it has only a low native species diversity, with many native forbs and grasses present as only a small number of plants.

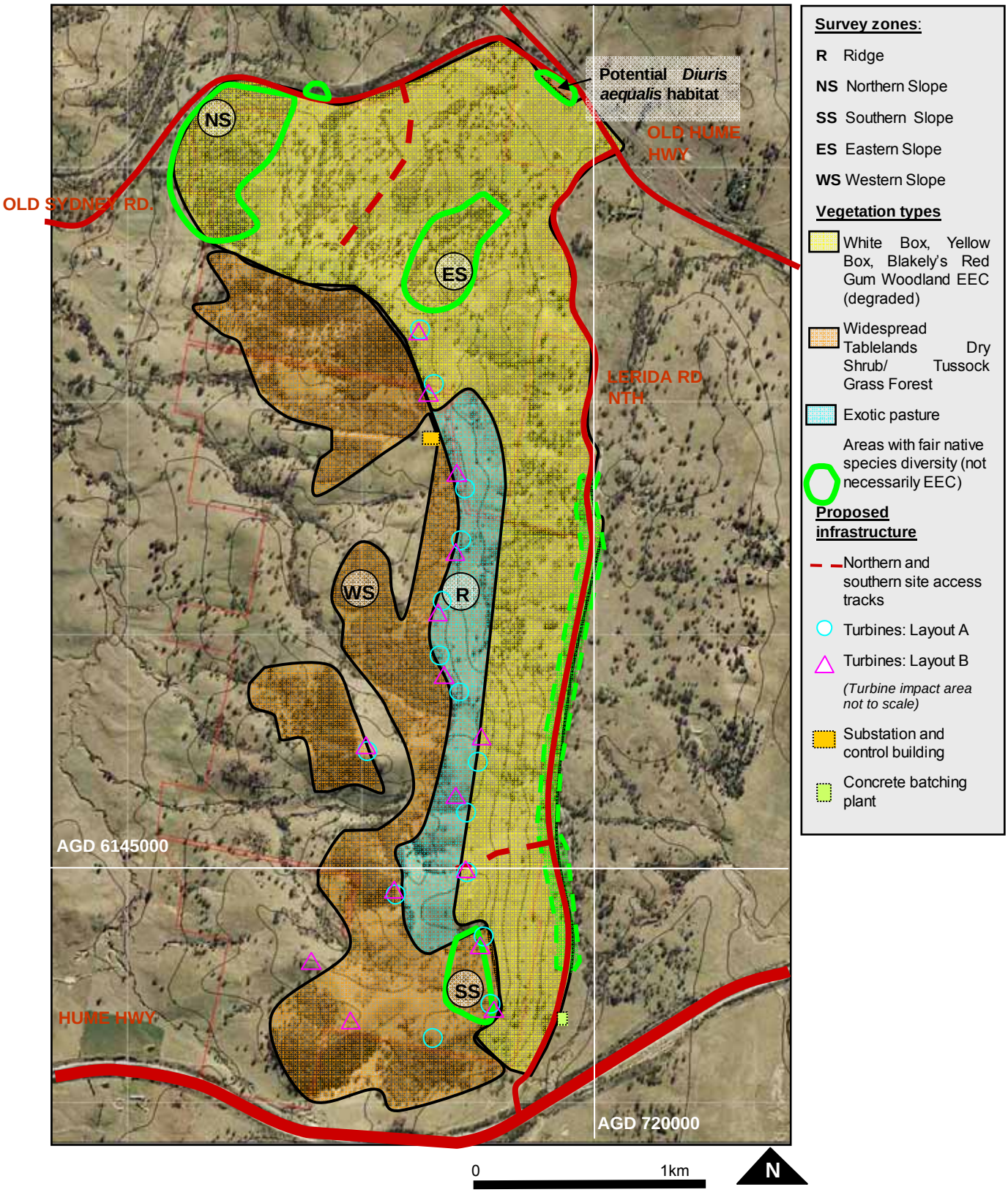

Figure 7.18 Distribution of survey zones and areas which retain fair native species diversity.

The EEC White Box, Yellow Box, Blakely's Red Gum Woodland is technically present though degraded on the eastern and northern slopes while the Widespread Tablelands Dry Shrub/ Tussock Grass Forest is present on the western slopes and substation site. (More accurate scaling and positioning of project infrastructure is given in Figure 3.8 and Figure 3.9).

Under the interpretation of the EEC provided by NSW NPWS however, any area carrying either yellow box or Blakely's red gum, regardless of the nature of the understorey, and any area with a substantially native groundcover which appears likely to have formerly carried these trees, must be included within the EEC, including where the groundcover is substantially altered, if it might be considered that the soil seedbank still includes many native species. The Yellow Box, Blakely's Red Gum Woodland Fact Sheet (NSW NPWS, undated) further states that the three characteristic tree species may occur either as pure stands or in mixtures with other trees including apple box (*E. bridgesiana*), brittle gum (*E. mannifera*), candlebark (*E. rubida*) and red stringybark (*E. macrorhyncha*). Broad-leaved peppermint is not mentioned, but might be assumed, since it is a common associate of brittle gum and red stringybark. These three species occur on the Cullerin site, including in association with yellow box and/or Blakely's red gum.

The decision as to whether the EEC is present hinges on the state of the soil seedbank and, if the groundcover is substantially exotic, whether it has any potential to regenerate to a more native species composition. The breaking of the 2002-05 drought in the Goulburn area in the spring during which the survey was conducted provided ample opportunity to assess the state of the seedbank, since prior to the botanical assessment the site had been observed to be largely bare. Following rains in July and subsequent months substantial recovery of the groundcover occurred, and the level of grazing on the site appeared to be light at the time of the survey, so is unlikely to have much affected the species composition of the groundcover. In many areas, particularly in treeless parts of the ridge tops, this consists entirely of exotics, so the seedbank in these areas could be assumed to have no regeneration potential. However, in areas with shallow, rocky soils and among trees, there are patches where native grasses (mostly *Austrostipa scabra ssp falcata* and *Austrodanthonia spp*) are dominant. Despite a relatively low species diversity, these areas must be regarded as being part of the Yellow Box, Blakely's Red Gum Woodland EEC under the DEC guidelines.

Such areas occur in an eroded gully on the eastern slopes of the site, along Lerida Road North, in areas which may be used to provide access to the site, and in scattered locations along the ridge crest. In some of these areas, the EEC still appears to include a moderate degree of native species diversity and these patches would be of moderate conservation significance. Occurrences along the ridge crest are small and fragmented by areas of exotic vegetation. They are also of very low native plant species diversity, so despite falling within the definition of the EEC, would be of relatively low conservation significance.

The area in a saddle south of the telecommunications tower, despite having patches with a predominantly native groundcover, carries only the trees brittle gum, red stringybark and broad-leaved peppermint. Whether this area is included within the EEC would be open to interpretation. The groundcover is predominantly grassy not shrubby, as it would be in the Widespread Tablelands Dry Shrub/ Tussock Grass Forest, and it is in a landscape which has been substantially cleared it is not possible to say whether red gum or yellow box might formerly have also occurred in this location with the three tree species which still remain there. However, there is no direct evidence, other than a grassy understorey, which could have been created by the impacts of grazing on a formerly shrubby understorey, to suggest that this location carries the Yellow Box, Blakely's Red Gum Woodland EEC.

Species of conservation significance

No plant species listed as threatened in Schedules 1 and 2 of the *Threatened Species Conservation Act 1995* were found on or near the site. An on-line search of the DEC NPWS Wildlife Atlas database for the Gunning 1:100,000 map sheet produced only one threatened plant species which has been recorded in the region. Consequently the search area was enlarged to include the surrounding Yass, Crookwell, Taralga, Goulburn and Canberra map sheets and this resulted in the addition of some grassy woodlands or grasslands on the Southern Tablelands, producing a total of twenty-two threatened species for the wider region.

This assessment has identified that little or no potential habitat for threatened plant species occurs on the site, due to the level of disturbance from clearing, grazing, 'pasture improvement' and weed invasion over most of the site.

One area on a nearby road verge has been identified as carrying potential habitat for the Buttercup Doubletail orchid (*Diuris aequalis*), listed as endangered in NSW under the *Threatened Species Conservation Act 1995* and vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (area indicated on Figure 7.18). The Buttercup Doubletail orchid is a conspicuous species when in flower, with up to 5 large (3cm diameter) pure yellow to orange flowers on a stem to 45cm in height (Bishop, 1996). It is readily distinguished from most other members of the donkey orchids (*Diuris spp*) by the lack of brown markings on the flowers and the erect but strongly backswept petals and recurved green lateral sepals which are often concealed by the labellum.

Bishop states that Buttercup Doubletail orchid grows in drier woodlands or montane forest with a grassy-heathy understorey, on the tablelands between the Blue Mountains and Braidwood, although the Department of Conservation and Environment website states that it may grow in forest, open woodland or secondary grassland (NSW NPWS undated). There are six records from Kanangra-Boyd National Park in the Blue Mountains, but the bulk of the records are from private property or road reserves, so the species is poorly reserved in NSW, and does not occur in any other state. All known populations are small. Information on the DEC website states that a total of 200 plants are known from 20 populations. However, numbers will vary from year to year depending on conditions. The population on the Wombeyan Caves Road alone consists of 200 plants or more in 2005, as numbers recover after the 2002-04 drought (K. McDougall, pers. comm.).

Of the total of 20 sites recorded for this species on the DEC NPWS Wildlife Atlas database, 8 are located around the Braidwood district, and all of these are relatively recent records (1976 to 2001), whereas some of those elsewhere are historical and have not been relocated more recently (Goulburn 1904, Oberon 1955, Federal Highway 21km south of Goulburn 1961). Near Braidwood, typical habitat consists of brittle gum and broad-leaved peppermint woodland, with an open understorey dominated by low shrubs, principally *Daviesia mimosoides*, and the tussock grass *Joycea pallida* (J. Miles, pers. obs.). Habitat similar to this occurs on the road verge between the northern end of the site and the proposed substation site, at the junction of Old Sydney Road and the unsealed road which runs along the northern edge of the site. Brittle gum is the main tree species on this site, with the shrub *Daviesia leptophylla* and various native grasses. This vegetation, in fair to good condition, occupies about 100m west from the junction with Old Sydney Road, with another area of road verge close to the northern end of the site. The area near the road junction was surveyed, and no orchids were found. The survey was conducted during the flowering period for this species (it had been observed flowering near Braidwood on 4 November). However, as not all individuals flower in every season, the possibility remains that the species occurs on the road verge in this location. This is a relatively undisturbed brittle gum (*E. mannifera*) woodland remnant with a good native species diversity and relatively few weeds. Protection of this remnant should be achieved.

An Assessment of Significance was carried out to characterise the potential impact of the proposal on this species and on Yellow Box, Blakely's Red Gum Woodland (Attachment 3.4, Appendix D). This assessment determined that unacceptable impact can be avoided through careful positioning of infrastructure and access routes and the adoption of standard weed and sediment erosion controls.

Impact assessment

In general, impacts on the Yellow Box, Blakely's Red Gum Woodland EEC and threatened species habitat will be minimal on the ridge top and substation site, due to the degraded state of remnants in these areas. However, better quality remnants occur onsite and access routes

should be developed in consideration of this limitation. There is scope to avoid these sensitive areas when planning the access routes. Specific strategies to reduce impacts to an acceptable level are summarised below for each phase of the development. The proposal includes these measures (see also Section 9.2 Draft statement of commitments).

Construction impacts

The impacts of the proposed development to onsite vegetation would almost entirely be confined to the construction phase. Soil disturbance, vegetation trampling and vegetation removal would occur during road establishment and the installation of infrastructure including up to 15 wind turbines, a substation, control room and concrete batching plant. Degradation of habitat may occur through soil loss and the introduction of weeds.

The areas that would be removed as a result of these works are tabulated below. As boundaries between vegetation types are rarely sharply defined, where an item falls on the boundary, tree cover and contours have been used to place the turbine in the more representative zone.

Table 7.6 Areas of impact within each survey zone

Item	Survey zone	Quantity	Area per item (m^2)	Total area (m^2)
Hardstand areas beneath turbines				
Layout A	RIDGE	8 turbines	900.0	7,200.0
	EASTERN SLOPE	3 turbines	900.0	2,700.0
	WESTERN SLOPE	4 turbines	900.0	3,600.0
Layout B	RIDGE	6 turbines	900.0	5,400.0
	EASTERN SLOPE	3 turbines	900.0	2,700.0
	WESTERN SLOPE	6 turbines	900.0	5,400.0
Substation building	RIDGE	1 building	5,625	4,900.0
Control building	RIDGE	1 building		150.0
Bushfire Asset Protection Zone (APZ) for substation and control building **35m APZ = 25m IPA + 10m OPA**				
Inner protection area (IPA)	RIDGE	25m		1,875.0
Outer protection area (OPA)	WESTERN SLOPE	10m		750.0
Concrete batching plant	EASTERN SLOPE	1 plant		3,750.0

Table 7.7 Areas of impact by vegetation type

Totals by survey zone	Vegetation type and comment	Total under Layout A (m^2)	Total under Layout B (m^2)
˜ RIDGE	˜ Exotic pasture. Largely cleared of trees with occasional regrowth. ˜ Most turbines, in both layouts have been placed in existing cleared areas on the ridge. The substation and control building would be located in existing cleared areas. The bushfire IPA is located within existing cleared areas and continued grazing is likely to be sufficient to maintain this area. ˜ The ridge area is the most disturbed, in terms of previous clearing, as well exotic ground cover. Concentration of infrastructure in this area is considered to be the most appropriate.	14,125.0	12,325.0
˜ EASTERN SLOPE	˜ Intermediate between Widespread Tablelands Dry Shrub/ Tussock Grass Forest and the Yellow Box, Blakely's Red Gum Woodland EEC. Given the liberal interpretation recommended by NSW NPWS (undated), these areas would have to be included within the EEC, despite the presence of trees other than yellow box and Blakely's red gum. ˜ Turbines have been located in existing cleared areas. Areas identified as having better native species diversity have been avoided (these include the northern slope, eastern gully and areas alongside Lerida Road North). The concrete batching plant will be an extension of the existing disturbed area and will not result in the clearing of shrubs or trees. ˜ Although vegetation may fall within the broad definition of the EEC, these areas have been considered to have low conservation value.	6,450.0	6,450.0
˜ WESTERN SLOPE	˜ Widespread Tablelands Dry Shrub/ Tussock Grass Forest. ˜ Some tree clearance would be required for turbines and the bushfire OPA. The turbines can be manoeuvred into place during installation so that clearing would be lessened. ˜ The bushfire OPA would require removal of dead limbs, ground level litter and dead material in shrubs, as well as removal of some trees and shrubs to open out the understorey. Mowing or brush-cutting the understorey would be required to maintain a maximum height of 100 mm. ˜ This vegetation type is still relatively intact in the less developed parts of the Goulburn region. The clearing and underscrubbing would be on peripheral vegetation only and would not contribute to fragmenting areas of habitat.	4,350.0	6,150.0

To reduce the impacts of the construction phase on vegetation onsite to an acceptable level, the following measures are required. These are measures to which the proponent is committed (refer to Section 9.2 Draft Statement of commitments).

- The Northern Slope contains an area of higher quality EEC where Yellow Box, Blakely's Red Gum Woodland occurs with a grassy understorey. This area is of moderate conservation significance and should be protected from any impact during the proposed works (NS, Figure 7.18).
- The Yellow Box, Blakely's Red Gum Woodland EEC may be interpreted as being present elsewhere onsite (illustrated on Figure 7.18) in areas with shallow, rocky soils and among trees, where native grasses (mostly *Austrostipa scabra ssp falcata* and *Austrodanthonia spp*) are dominant. These remnants are small and scattered and would be very difficult to map. They have low species diversity and are regarded by this assessment to be of lower conservation significance.

  In general, if infrastructure placement and access trails were placed to avoid treed areas and isolated paddock trees, impact to this community would be largely avoided. A follow-up survey was completed in January 2005, addressing this point. Recommendations for widening specific parts of the proposed route are made in order to avoid unacceptable impacts on the EEC (Attachment 3.4, Appendix F).
- The southern road verge of the Old Sydney Road from the corner of the Old Hume Highway extending 100m west should be protected from impact during road works to access the northern end of the site. This area (mapped on Figure 7.18) potentially provides habitat for the Buttercup Doubletail *Diuris aequalis* and is a relatively undisturbed Widespread Tablelands Dry Shrub/ Tussock Grass Forest remnant with good native species diversity and relatively few weeds. Some areas on the northern road verge also have potential, particularly west of the gully crossing on Old Sydney Road (mapped on Figure 7.18) and should be avoided. These areas would not be impacted by works.
- The existing disturbance (slab and cleared area) 400m from the intersection with the Hume Highway on the east of Lerida Road North, could be used for a concrete batching plant. The site is located at the northern end of the first EEC patch. A few yellow box saplings and one or two trees less than 20 years old overhang the existing slab and may need to be lopped, plus one mature red stringybark with branches leaning towards the road. The understorey here is dominated by annual exotic grasses with the better quality groundcover present on the western side of the road.
- Weed and sediment erosion controls should be implemented to prevent onsite habitat degradation during and following the proposed works.
- After the installation of the infrastructure, disturbed soil should be rehabilitated as soon as practicable in order to resist erosion and colonisation by weeds. This may require restricting stock access and implementing revegetation activities.

Operational impacts

Regular maintenance visits will utilise standard vehicles. Atypical maintenance (such as replacement of parts) may require larger machinery. Operational impacts are not anticipated to generate unacceptable impacts to onsite flora, if risks are thoroughly mitigated. This would include:

- All vehicles onsite would follow established trails and minimise onsite movements.
- Weed controls (including long-term monitoring) should be implemented to prevent onsite habitat degradation during the proposed works.
- Chemicals, including fuels and lubricants, would be stored and handled as per manufacturer's instructions. Where practical, they would be stored offsite. Where they must be stored onsite, they would be housed in a secure building designed to contain any leakages.

- Turbines would be designed to accommodate the full capacity of the fuels and lubricants contained within.

These are measures to which the proponent is committed (refer to Section 9.2 Draft Statement of commitments).

Decommissioning impacts

Decommissioning of the wind turbines would involve similar infrastructure to installation however a reduced level of impact is anticipated as all below-ground structures would remain *insitu*; footings, concrete slabs, underground cabling. The potential for erosion and habitat degradation would relate primarily to vehicle tracks and hard stand areas. It is recommended that:

- Weed and sediment erosion controls should be implemented to prevent onsite habitat degradation during and following the proposed works.
- Disturbed soil would be stabilised and rehabilitated as soon as practicable after works.

These are measures to which the proponent is committed (refer to Section 9.2 Draft Statement of commitments).

7.6.2 Fauna impacts

Existing environment

Habitat types

Four broad habitat types were identified, providing different habitat resources for fauna onsite; woodland ridges, woodland slopes, grassland and wetlands.

- Woodland ridges

  These ridges have high exposure to strong winds. The trees are regrowth and provide few if any small hollows. The understorey is mixed native and exotic species and is grazed. The woodland was fragmented and considered to provide poor habitat for small and medium sized mammals, having greater potential for larger mammals, birds and reptiles.

- Woodland slopes

  The wooded slopes had a greater degree of protection from climate and were generally more vegetated (with the western slope more treed than the eastern slope) with a greater proportion of native species in the understorey. While still fragmented, the contiguous wooded areas were larger, providing greater habitat resources for small, medium and large mammals, birds and reptiles. Wattle, mistletoe and ribbon gum represented foraging resource for birds and arboreal mammals in these areas.

- Grassland

  Much of the site has been cleared for grazing. Exotic species dominate most grassland areas. Ridges are more exposed to the weather than slopes and flats. The amount of biomass varied considerably during 2005, from very little ground cover in August (observed during an initial site visit) to tall grass in November. Seasonally, these areas provide palatable grass forage as well as rocky outcrops and vegetation refuge to small, medium and large mammals, birds and reptiles.

- Wetlands

Several farm dams are present onsite. The surrounding vegetation ranged from abundant juncus to bare clay banks. Several erosion gullies were present. Most of these gullies were dry during surveying but one held small ponds that could harbour frogs and be used by larger fauna.

Important habitat features onsite included hollow-bearing trees (which were rare), gully systems, wetlands and the connectivity between woodland remnants. Much of the site has been cleared for grazing and the remaining trees are largely of a young age. Hence, the number of hollow-bearing trees and recruits to replace these as they senesce is very low. Although severely eroded, gullies and drainage lines onsite often harboured more mature trees and therefore, have an important role in hollow-provision to hollow-dependent fauna. Several farm dams are present onsite, while these appear to have been constructed, they nonetheless provide a resource to aquatic and terrestrial fauna. Although it is fragmented by cleared areas, on a broad scale the wooded areas represent a linear corridor that may facilitate the movement of highly mobile species across the site and to other areas offsite, particularly to the north where woodland and forest are more extensive.

Fauna recorded onsite

Mammals, reptiles, birds and amphibians were targeted during surveying. The survey routine included setting and checking cage and elliot traps over three nights (288 trap nights), birds and reptile searches, frog searches, call play-back, spotlighting and anabat recording. Habitat assessments and animal sign were also recorded.

A diverse faunal assemblage was recorded and it is anticipated that more cryptic species are also present, going undetected due to the limited duration of surveying. In total, 76 species were identified. This included six amphibian species, 46 species of bird, 16 mammal species and eight reptiles (full species list attached in Attachment 3.4, Appendix B).

Threatened species

One threatened species was recorded during field work, the Large-footed Myotis *Myotis adversus,* listed as Vulnerable under the *NSW Threatened Species Conservation Act 1995*. An evaluation of other threatened species with potential to occur onsite was conducted for species listed under the *NSW Threatened Species Conservation Act 1995* by the Department of Environment and Conservation (DEC NPWS Wildlife Atlas, accessed 12 Dec. 2005 - Goulburn and Gunning 1:100,000 map sheets) and/or the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (Matters of national significance web tool, accessed 13 Dec. 2005 – 30km buffer from the site).

For each species, the likelihood of occurring onsite as well as the likelihood of being impacted by the proposal was considered. A potential impact rating was achieved for each species. For example, a species likely to occur onsite in an area where works would occur would be given a high impact rating; a species unlikely to occur on-site and whose habitat requirements do not coincide with areas that would be impacted by works would be given a low impact rating (Attachment 3.4, Appendix C). Species found to have a high or moderate potential to be impacted are then considered in more detail via an assessment of significance.

One species was found to have a high potential impact rating, 14 were found to have a moderate potential impact rating and the remainder, as having low potential to be impacted. Entries for species categorised as high or moderate are extracted below.

Table 7.8 Threatened species with potential to be impacted by the proposal

Threatened species listed under the NSW Threatened Species Conservation Act 1995 and / or the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (Gunning and Goulburn 1:100,000 map sheets, and 30km site buffer respectively). Potential impact is rated based on proximity to suitable habitat, local records and behaviour of these species.

Species	Habitat requirements and study area suitability	Potential to be impacted
Superb Parrot *Polytelis swainsonii* TSC V EPBCv	Nesting habitat on SW Slopes of NSW is often open Yellow Box, Blakely's Red Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nest in small colonies, often with more than one nest in a single tree. May forage up to 10 km from nesting sites. Feed in trees and understorey shrubs and on the ground. Diet consists mainly of grass seeds and herbaceous plants. West of Yass forms part of core breeding population in region. Migrates north in winter to the upper Namoi and Gwydir Rivers. Local record from less than 5 km north-east of site in road verge.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Collision and avoidance impacts may apply to this flocking species. Minimal woodland would be impacted by the proposal. **High potential impact.**
Green and Golden Bell Frog *Litoria aurea* TSC E	Occurs in or near water or very wet areas. It is present in forests, woodlands and shrublands, in open or disturbed areas (Hero *et al.* 1991). Breeding takes place in permanent lakes, swamps and dams with still water (Hero *et al.* 1991).	Marginal potential habitat occurs onsite in the form of farm dams. Habitat may be lost if dams are filled to reduce water bird collision. **Moderate potential impact.**
Eastern False Pipistrelle *Falsistrellus tasmaniensis* TSC V	Roosts and breeds in large trees, in a range of habitats including dry and wet sclerophyll forest, appearing to prefer wet sclerophyll (Hall and Richards 1979). May travel large distances between foraging and roosting sites. The site may contain potential foraging habitat, but unlikely to provide hollows for roosting/breeding. May travel over the site during long distance movements. Therefore this species may be subject to collision or avoidance impacts. This species does not migrate or roost in groups so individuals only would be at risk.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Only minimal woodland would be impacted by the proposal but collision / avoidance impacts may apply. **Moderate potential impact.**

Species	Habitat requirements and study area suitability	Potential to be impacted
Eastern Bent-wing Bat *Miniopterus schreibersii* TSC V EPBCcd	Found in a wide range of habitats, but is constrained by its requirement for caves, man-made tunnels or stormwater channels in which it breeds (Strahan et al. 1995) – not present onsite. Typically, the species forages in well timbered habitats, above the tree canopy (Dwyer, in Strahan *et al.* 1995). Local records occur 15km south of Goulburn and in the Shoalhaven.	Potential foraging habitat is present and wind farm structures may provide roosting opportunities. Only minimal woodland would be impacted by the proposal but collision / avoidance impacts may apply. **Moderate potential impact.**
Eastern Long-eared bat *Nyctophilus timoriensis* EPBC v	Inhabits a variety of vegetation types, including mallee, bulloke but more commonly box/ironbark/cypress-pine. Slow flying agile bat, utilising the understorey to hunt non-flying prey (especially caterpillars and beetles) and will even hunt on the ground. The species roosts in tree hollows, and under loose bark. No regional records. Foraging pattern suggests collision risk is low but avoidance impacts may apply while migrating.	Only minimal woodland would be impacted by the proposal. Potential impact may occur when moving between areas of habitat. **Moderate potential impact.**
Long-footed Myotis *Myotis adversus* TSC V	This species forages on the surface of water bodies such as rivers, lakes and swamps and roosts in caves, mine, tunnels and old buildings (Hall & Richards 1979). No local records occur, although this species was identified by call onsite. This species may forage and migrate in groups, placing it at greater risk of collision with ridge-top turbines.	Foraging habitat is present in the drainage line to the east of the site. This area would not be impacted. Collision / avoidance impacts may apply. **Moderate potential impact.**
Square-tailed Kite *Lophoictinia isura* TSC V	Preferred habitat is open eucalypt forest and woodland (Schodde and Tidemann 1986). The species hunts for passerine birds in the tree tops of the forest (Klippel 1992). Habitat at the site is marginal due to scarcity of forest cover. Recorded in Mundoonen Nature Reserve.	Potential habitat is marginal due to young age of trees and fragmentation but collision / avoidance impacts may apply. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**
Powerful Owl *Ninox strenua* TSC V	Breeding pairs defend large (up to 1000 ha), permanent territories (Blakers *et al.* 1984), usually centred around gullies (Fleay 1968). Nests in large tree hollows (Emison *et al.* 1987). Arboreal mammals form about 80% of the diet of this species (birds form most of the rest), with the Common Ringtail Possum, Greater Glider and Sugar Glider being the most favoured species (Blakers *et al.* 1984). Known from the Mundoonen Nature Reserve and near Collector.	Potential foraging habitat present onsite. Collision / avoidance impacts may apply. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**

Species	Habitat requirements and study area suitability	Potential to be impacted
Grass Owl *Tyto capensis* TSC V	Inhabits tall grassy areas, grassy woodlands, swampy areas, coastal heaths, sedges, cumbungi and crops such as sorghum, sugar cane and grain. It nests in grass tussocks or low shrubs (Pizzey and Knight 2003). Its core distribution is coastal, from northern NSW through QLD, although inland records occur particularly in QLD and NT (Pizzey and Knight 2003).	Suitable swampy habitat occurs to the east of the site, at Wet Lagoon. No potential habitat onsite. Potential impact may occur when moving between areas of habitat. **Moderate potential impact.**
Gang-gang Cockatoo *Callocephalon fimbriatum* TSC V	Feeds in pairs or small flocks on seeds of eucalypts and wattles, primarily in forest, but occasionally towns and farming areas for artificial food resources such as berry-bearing exotic shrubs. It is a seasonal altitudinal migrant. Nesting is in large tree hollows. Recorded approximately 6km south of the site.	Potential foraging habitat is marginal due to young age of trees and fragmentation but collision impacts may apply. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**
Swift Parrot *Lathamus discolour* EPBCe	A non-breeding winter migrant to southern and eastern NSW, where it inhabits eucalypt forests and woodlands (Blakers et al 1984). Feeds on eucalypt blossom and psyllids. No local records.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Only minimal woodland would be impacted by the proposal. Collision and avoidance impacts may apply. **Moderate potential impact**.
Diamond Firetail *Stagonopleura guttata* TSC V	Occurs predominantly west of the Great Dividing Range (Blakers et al. 1984, Schodde and Mason 1999) although local populations are known. Feeds predominantly on the ground on grass seeds, in groups from 5 to 150 individuals (Schodde and Tidemann 1986), nesting in pairs or communally in shrubs and small trees. Restricted largely to ungrazed or lightly grazed woodland remnants of grassy eucalypt woodlands, including Box-Gum and Snow Gum Woodlands, and grassland and riparian areas, and sometimes lightly wooded farmland. May form large flocks during winter and autumn.	Potential foraging habitat is present. Collision and avoidance impacts may apply to this flocking species. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**

Species	Habitat requirements and study area suitability	Potential to be impacted
Speckled Warbler *Chthonicola sagittata* TSC V	Inhabits woodlands and dry forests, generally in inland Australia, particularly those with grassy understorey, often on ridges or gullies. Sedentary, living in pairs or trios and nests on the ground in grass tussocks, dense litter and fallen branches. Forages on the ground and in the understorey for arthropods and seeds. Occupy small remnants, but are yet to be recorded breeding in revegetated areas. Requires relatively intact woodland areas with litter and fallen timber. Locally recorded approximately 18km north of the site.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Collision and avoidance impacts may apply. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**
Brown Treecreeper *Climacterus picumnus* TSC V	Occurs in eucalypt woodlands, mallee and drier open forest of eastern Australia, preferring woodlands lacking dense understorey (Schodde and Tidemann 1986). Feeds on insects in the leaf litter and trunks of trees. Nests in tree hollows, stumps or rotted fence posts. Requires relatively intact woodland areas, nesting in a tree hollow. Locally recorded in Mundoonen Nature Reserve.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Collision and avoidance impacts may apply. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**
Regent Honeyeater *Xanthomyza phrygia* E EPBCe	Distributed through the eastern third of New South Wales, where it inhabits eucalypt forests and woodlands (Blakers et al. 1984). A generalist forager, feeding mainly on the nectar from a wide range of eucalypts (particularly prolifically flowering box and ironbark species) and mistletoes but also eats invertebrates and exotic fruits (Blakers et al. 1984). Key eucalypt species include Yellow Box and Blakely's Red Gum and Red Stringybark, which occur onsite. Large numbers can appear in an area to take advantage of a food source. Recorded locally at Goulburn.	Marginal potential foraging and nesting habitat is present due to previous and ongoing site disturbance. Collision and avoidance impacts may apply to this flocking species. Only minimal woodland would be impacted by the proposal. **Moderate potential impact.**

*Class

TSC E	listed as Endangered in NSW in Schedule 1 of the *Threatened Species Conservation Act 1995*
TSC V	listed as Vulnerable in NSW in Schedule 2 of the *Threatened Species Conservation Act 1995*
EPBCv	listed as nationally Vulnerable in the Commonwealth *Environment Protection Biodiversity Conservation Act 1999*
EPBCe	listed as nationally Endangered in the Commonwealth *Environment Protection Biodiversity Conservation Act 1999*
EPBCce	listed as nationally Critically Endangered in the *Environment Protection Biodiversity Conservation Act 1999*
EPBCcd	listed as nationally Conservation Dependent in the *Environment Protection Biodiversity Conservation Act 1999*

For these 15 species, an Assessment of Significance was conducted, as is required to further investigate and characterise the impact of the proposal, under the *NSW Environmental Planning and Assessment Act* and the Commonwealth *Environmental Protection and Biodiversity Conservation Act*. This step allows the ecology of each species to be considered more thoroughly and specific mitigation measures to be developed to avoid unacceptable impacts, where possible.

The assessments concluded that significant impact is not anticipated as a consequence of the development for these species. For the Green and Golden Bell Frog, this assessment concluded that a high level of impact can be avoided through careful positioning of infrastructure and access routes and the adoption of standard weed and sediment erosion controls.

For the microchiropteran bats, birds of prey and woodland birds considered, risk of population level impacts exists through ongoing collisions with turbines. The surrounding habitat and local records as well as consideration of mortalities at existing wind farms suggest that the expected levels of collisions would not generate a population level impact however, given the paucity of long-term data available and the lack of rigour in monitoring at many existing wind farms, a level of uncertainty remains. The proposal should incorporate rigorous and properly timed monitoring of collision impacts and protocols so that action can be taken if unacceptable levels of mortalities occur onsite.

Matters of national significance (*EPBC Act 1999*)

Matters of national significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* within a 30 kilometre buffer of the study site were investigated using the EPBC Act search tool (accessed 13 December 2005). As the works would not occur near nor affect creeks or rivers, only terrestrial species were investigated.

Threatened species returned from the search were investigated in the threatened species assessment, summarised above (Table 7.8). An EPBC Assessment of Significance was carried out for the three federally listed species with greater than low potential to be impacted (**Swift Parrot, Superb Parrot, Regent Honeyeater**). Significant impact is not anticipated as a consequence of the development for these species. The surrounding habitat and local records as well as consideration of mortalities at existing wind farms suggest that the expected levels of collisions would not generate a population level impact however, given the paucity of long-term data available and the lack of rigour in monitoring at many existing wind farms, a level of uncertainty remains. The proposal should incorporate rigorous and properly timed monitoring of collision impacts and protocols so that action can be taken if unacceptable levels of mortalities occur onsite.

No migratory species was categorised as having high potential to be impacted. The **Fork-tailed Swift** and **White-throated Needle-tail** were the only listed migratory species categorised as having greater than low potential to be impacted by the proposal (moderate and low-moderate potential, respectively). An EPBC Assessment of Significance was carried out for these two species. It is considered that significant impact can be avoided through the implementation of controls to address sediment and erosion, weeds and hazardous spills and monitoring of collision impacts. Rigorous and properly timed monitoring of collision impacts should be undertaken and protocols developed so that action can be taken if unacceptable levels of mortalities occur onsite.

As a precautionary measure, the proposal was referred to the Commonwealth Department of Environment and Heritage to ensure that they did not consider the proposal to be a matter of national significance. On May 4 2006, the Federal Minister for the Environment, Ian Campbell, determined that the proposed action (development of a wind farm at Cullerin) is not a controlled action pursuant to Section 75 of the *EPBC Act 1999* and therefore, that significant impact on matters of national significance is not expected as a consequence of the proposal.

Impact assessment

Although the site is considered only faunal marginal habitat due to its fragmentation, low amount of mature vegetation and low native species diversity, potential habitat for threatened fauna species and migratory birds occurs on or close to the subject site. Habitat degradation as a consequence of the development can be minimised through careful positioning of infrastructure and access routes and the adoption of standard weed and sediment erosion controls. However, for several microchiropteran bats, birds of prey and woodland birds, potential for population level impacts exists through collisions with turbines.

The surrounding habitat and local records as well as consideration of mortalities at existing wind farms suggest that the expected levels of collisions would not generate a population level impact however, given the paucity of long-term data available and the lack of rigour in monitoring at many existing wind farms, a level of uncertainty remains.

Threatened species identified by this report as being at increased risk include the Eastern False Pipistrelle, Eastern Bent-wing Bat, Eastern Long-eared bat, Large-footed Myotis, Square-tailed Kite, Powerful Owl, Grass Owl, Gang-gang Cockatoo, Swift Parrot, Superb Parrot, Diamond Firetail, Speckled Warbler, Brown Treecreeper and Regent Honeyeater. Migratory species at increased risk include the Fork-tailed Swift and White-throated Needle-tail. Specific strategies to reduce impacts to an acceptable level are summarised below for each phase of the development:

Measures to reduce impacts to an acceptable level are listed for each stage of the development, below. The proposal includes these measures (see also Section 9.2 Draft statement of commitments).

Construction impacts

Loss of habitat and habitat degradation are the key impacts of the construction phase. The development footprint of the proposed wind farm does not contain limiting or particularly significant breeding or foraging habitat for bird species. The site is dominated by birds of woodland edges (magpies, ravens) and also parrots whose foraging and nesting habitat would only be minimally affected by the works. The turbine ridge sites have become a raptor hunting ground primarily due to the presence of rabbits and reptiles, which are common and widespread throughout the agricultural areas of the region.

Assessment of the significance of impact has determined that only a low level of impact would occur as a consequence of activities that would alter habitat onsite. Habitat degradation resulting from the construction of the project is readily avoided and controlled using standard best-practice mitigation methods (sediment and erosion controls, noise controls, weed controls). This would minimise the impact to fauna onsite during construction.

In general, if the locations of works (including temporary activities such as the concrete batching plant) are situated in already cleared areas featuring largely exotic vegetation (which provides low habitat resources) loss of habitat as a result of the works will be low. It is recommended that:

- Measures should be implemented to reduce the impact on native vegetation, as detailed in Section 7.6.1.
- Dams / wet depressions on the ridge line should be filled to remove the potential to attract microbats, waterbirds and prey for raptors. Alternative watering points will be constructed in consultation with affected property owners. (This is only required on properties involved in the project).
- Avoid clearing woodland (particularly in areas specified in the Biodiversity Assessment).

- Avoid clearing isolated paddock trees (these can be used extensively for foraging in fragmented landscapes).

- Retain all hollow bearing trees and locate infrastructure at the maximum distance possible from them, to avoid disturbance to roosting individuals (particularly in areas specified in the Biodiversity Assessment).

Operational impacts

The key impacts anticipated to affect native fauna are related to the operational phase of the wind farm. While construction impacts can be quantified in terms of impact area before site development, operational impacts are largely speculative, being drawn on past experiences at other sites and from what is known of the ecology of different species at risk of collision with wind farm infrastructure.

When considering faunal impacts of operational wind farms, bird and bat strike are the foremost concerns, as inappropriately located turbines have the potential to cause frequent and large numbers of mortalities and may lead to population level impacts. For species that occur at low density in the landscape, relatively low mortality rates can also constitute a threat to a local population.

Impacts on birds and bats are discussed in detail within the Biodiversity report, (Attachment 3.4, Section 5.3). Consideration was given to direct and indirect impacts under the topics of behavioural traits, biology/physiology, population factors, conservation status, local weather patterns, relative location of habitat and prey sources, structural factors of the proposed development, experiences at existing wind farms, habitat utilisation, alienation and fragmentation from breeding or foraging habitat, and alteration to migration behaviour.

It is considered that the potential impacts are manageable with regard to fauna during the operational phase of the wind farm, with the implementation of the following measures:

- A population level impact to species on the wing is not anticipated on the basis of available information however, a level of uncertainty remains. Such an event would not happen in a short time frame; ongoing collision events would be required. The uncertainty about a population level impact can be addressed through rigorous and properly timed monitoring of collision impacts and protocols so that action can be taken if unacceptable levels of mortalities occur onsite. A monitoring program using adaptive management would be employed to ensure impacts are identified and managed to acceptable levels.

- If mortalities exceed a pre-determined threshold, additional mitigation measures should be considered, such as diversion structures, blade painting (refer Hodos *et al.* 2001), turning off blades at critical times, further turbine ridge habitat modification and enhancement of off-site habitats and prey populations.

- To reduce the attractiveness of the ridge to foraging raptors, rabbits should be controlled on the turbine ridges, carrion should be removed from the site as quickly as possible, and young lambs should not graze on the turbine ridges.

Decommissioning impacts

Decommissioning of the wind turbines would involve similar impact types to the construction phase. A reduced level of impact is anticipated however, as all below-ground structures (footings, concrete slabs, underground cabling) would remain insitu reducing the amount of excavation required and associated environmental impacts to soil, water and native vegetation. The required stabilisation of disturbed soil would relate primarily to the redevelopment of vehicle tracks and hard stand areas.

To minimise impacts, the following recommendations should be implemented:

- Weeds and sediment erosion control principles should be developed and implemented.
- Disturbed ground should be stabilised and rehabilitated as soon as practicable after works.

7.7 Land use

7.7.1 Agricultural impacts

Existing environment

The proposed development occurs across four land titles. The zoning of the land is 1 (a) Rural Zone (the development is permissible under the Gunning Local Environmental Plan 1997). In general, it is comprised of cleared flats and ridges with scattered trees to open woodland on slopes. This and surrounding lands are used for grazing sheep and cattle. The pasture is a mixture of native and exotic species. Horses are also kept on properties within two kilometres of the proposed development.

Based on cadastre information, one residence occurs approximately 750m from the ridgeline proposed for the installation of turbines and three additional residences are located approximately one kilometre from the ridge (refer to Figure 3.4). The owners of these residences are all involved in the development. Two additional residences are located within two kilometres of the ridge. The owners of these latter residences are not involved in the development.

Construction and decommissioning impacts

Adverse impacts to agricultural use would be greatest during the construction and decommissioning phases of the development. During these periods, stock would need to be excluded from the works area. Rehabilitation of the site (soil stabilisation and potentially revegetation) would also require stock access to be periodically restricted while vegetation is re-established on disturbed areas. This is considered to be a minor impact. Affected land owners would be compensated for this loss by way of the lease arrangements they enter into with Taurus Energy.

Pasture improvement has occurred onsite. This is the practice of replacing the native understorey species with exotic grasses to improve the production capacity of the land. Where adequate moisture occurs, this can be sustainable; in more marginal areas, the senescence of individuals over summer can leave paddocks bare, susceptible to erosion and weed infestation (pers. obs. J. Miles). In the last 50 years, the southern tablelands of NSW have seen a decline in the productivity of some types of sown pastures (Vere and Dowling 2003). Evidence of sown pasture decline suggests at least an equal role for native pastures; species of Danthonia (which is present onsite) looks to be a particularly valuable component in native systems (Garden *et al.* 1996).

There is an opportunity to improve the native composition of the site and production capacity in some areas onsite. The ongoing expense of resowing exotic species as well as the resultant loss of soil condition and ingress of weeds are good reasons to investigate the sustainability of using native species rather than replacing them with exotics during site restoration. The Cullerin Range site retains some areas of native understorey which, although patchy and degraded, have a level of conservation significance. The rehabilitation and encouragement of native grasses onsite could have production and conservation benefits and should be explored as a potential offset to clearing during the construction phase of project development. Revegetation of disturbed and weedy areas with productive native species, excluding stock from unstable areas as well as management of the timing and intensity of grazing, could be implemented during and following site development to benefit landform stability, native vegetation diversity and may create more drought tolerant pastures.

It is recommended that there be:

- Liaison with involved landowners to restrict stock access to the construction zones during the period of construction.
- Liaison with involved landowners to explore the possibility of enhancing the native component of the understorey in pasture production. This could be incorporated into the site restoration plan which would dictate protocols for the rehabilitation of areas disturbed during construction.

Operational impacts

A minor amount of vegetation would be removed from agricultural use to accommodate the wind farm infrastructure (estimated to be a 4.3ha footprint - including hardstand areas beneath turbines, control building, substation and increases to existing access trails- located in large part within already cleared areas). The operational wind farm is not anticipated to have adverse impacts upon the agricultural use of the site and would provide a benefit as a supplementary drought resistant income stream.

The operational impacts are considered separately for horses and then livestock.

Impact to horses

Horses can be adversely affected by wind storms and therefore there is concern among members of the community that the proposal may have an adverse effect on horses within close proximity of the operational wind farm. For the Cullerin site particularly, high performance show horses are present on the site's eastern boundary (M. Edwards pers. comm. 16 November 2005).

The British Horse Society has prepared a wind farm advisory statement (British Horse Society 2005). This statement suggests that wind farms have safety implications for horses and their riders and drivers of horse drawn vehicles during the construction and operational stages. The safety issues arise due to the natural instinct of the horse, when faced with a perceived threat, to flee. Equally important, the statement notes, is the riders/drivers ability to handle the horse.

The characteristics listed by the British Horse Society as potentially eliciting a dangerous response include:

- The sudden appearance of the turbines in the horses line of sight,
- Low frequency noise emitted by operational turbines,
- Shadows caused by the operational turbines, and the
- Unexpected start up of turbines.

The statement goes on to suggest that all of these features are diminished with distance from the turbines. A 200m buffer was suggested, based on turbines up to 50m in height. For turbines up to 126m high, this may more accurately equate to a 500m buffer zone. The impact of the development on rights of way or other access routes is also suggested as requiring consideration. A 200m minimum buffer distance from access ways is suggested by the British Horse Society.

Although the final turbine layout has not yet been decided, it appears at this stage that the proposed wind turbines would be over 500m from the nearest non-involved property to the east, where horses are kept. The turbines would be on average 500m from Lerida Road North, a public access way linking the new Hume Highway to the Old Hume Highway, but may come closer in some sections of the road. If the aforementioned adjoining property or Lerida Road North is used by horse riders or horse drawn vehicles, it is possible that the characteristics

listed by the British Horse Society may impact the safety of the horse and rider/driver. These are discussed below:

The sudden appearance of the turbines in the horses line of sight:

> Due to the prominence of the turbines along properties to the immediate east of the Cullerin Range and Lerida Road North (which runs parallel to the turbines), the proposal is not anticipated to cause an unacceptably high level of disturbance to horses or horse driven vehicles via their sudden appearance.

Low frequency noise emitted by operational turbines:

> Low frequency or infrasonic noise and vibration has been an impact associated with wind turbines. Low frequency noise describes noise levels below 200Hz (British Wind Energy Association 2005). Improvements to turbine design, particularly the development of upwind blade configurations have reduced this component to a very low level, below the level of human perception (British Wind Energy Association 2005). This has been determined through measurements taken at turbines in the United Kingdom, Denmark, Germany and the USA over the past decade. In response to concerns about associated health problems it has been stated categorically that there is no significant infrasound emitted from current designs of wind turbines (British Wind Energy Association 2005).
>
> Although this is considered to be a non-issue for this proposal (Heggies Australia 2005), potential exposure would occur in transit along Lerida Road North (limited exposure) and on adjoining properties (ongoing exposure). Furthermore, specific room shapes within buildings can sometimes amplify inaudible sounds to an audible level (pers. comm. G. Reutersward February 2006). This would be addressed by ensuring that turbines are at least 500m from non-involved properties. Both turbine layouts (A and B) show that the distance from the Edwards property, where horses are kept, to the nearest turbine is greater than 500m.

Shadows caused by the operational turbines:

> Shadow flicker is produced by the shadow cast by moving turbine blades when the sun is at a low angle (morning and evening). The flickering can cause a nuisance, or if between 8-30 Hz can be a health hazard (Epilepsy Association of Australia). The operational wind turbines are not anticipated to produce a flicker frequency high enough to pose a health risk. Comparable turbines have been rated 0.45 to 0.95 Hz, well below critical levels of 8-30 Hz for public health. The effect of 'chopping the light' attenuates with distance and is not considered, by modellers of shadow flicker (Danish Wind Industry Association 2003) to be noticed beyond 500-1000m from a turbine.
>
> Shadows produced by the turbines are likely to be greatest along properties to the east of the proposal and along Lerida Road North in the afternoon, as the sun sets behind the Cullerin Range. The average distance of turbines from Lerida Road North is 500m, hence the effect is not anticipated to be strong at this distance and would be temporary in duration. As this impact is able to be predicted it can be managed, either by riders avoiding affected areas during the late afternoon or by automatically shutting down turbines at this hour.
>
> - Signage should be placed on local roads to warn riders of this risk.

Unexpected start up of turbines:

> This impact can occur unpredictably while horses are located adjacent to the site or travelling along local roads such as Lerida Road North and Old Sydney Road. The noise and visual impact of the start up may startle horses or their riders, potentially causing an accident. The additional distraction of local traffic may increase the risk.
>
> The impact of the unexpected start up of turbines will vary dependant on the horse, the rider and also the location at the time of turbine start up (turbines start up and shut down independently of each other).

- Signage should be placed on local roads to warn riders of this risk.

Impact to other livestock

Sheep and cattle are grazed on and nearby the Cullerin Range site. Thus, it is important to agriculturalists that the turbines do not constitute a threat to the health of livestock or otherwise adversely affect the production capacity. Less information is available on the impacts of wind turbines on stock than for horses, despite a greater number of practical examples of sheep and cattle grazing near wind farms. It is assumed that the operational impacts of the wind farm would be of most concern, as stock would be excluded from the works area during the installation of the proposal.

For the most part, the discussion on horses could also apply to livestock, which are assumed to be less sensitive to sudden movements and the sight of the turbines given they would be confined to areas within close proximity of the turbines for a longer duration and not walked past the site from other areas, as is the case for ridden horses. This may increase the ability of animals to acclimatise to the characteristics of the operational turbines.

Wind energy organisations promote the ability to continue to graze stock right to the base of wind turbines without ill effect (Union of Concerned Scientists 2005; AusWEA undated (a)). Given the number of wind farms and duration of their operation on grazing land and the lack of data available to indicate adverse impact, it is assumed that the turbines will have minimal impact on livestock grazing onsite and nearby. A 'settling in period' is likely to occur during which livestock become accustomed to the turbines (I. Newton, Wind Farm Manager, Eraring pers. comm. Jan 2005; *AusWEA* undated (b); British Wind Energy Association undated). There is no evidence to suggest that this would be drawn out or adversely impact animal welfare or agricultural productivity.

Agricultural benefit

The proposal would provide a drought resistant supplementary income stream for involved land holders. By way of the lease agreements negotiated with Taurus Energy, land managers could afford to manage the land more sustainably (lesser stocking rate, increased funds to address erosion gullies, benefiting erosion and water quality on and offsite).

There is potential for wind power to become a new rural industry, providing a significant new income stream for rural communities at a time when traditional land uses are under pressure (Warren *et al*. 2005). This point is particularly relevant to the Goulburn area where agricultural profits have been greatly impacted by recent drought and where anticipated climate change is projected to result in a continuation of this trend.

Pittock (2003) observed that a significant proportion of Australian exports are agricultural products sensitive to changes in climate, water availability, carbon dioxide, fertilisation, and pests and diseases. General warming will increase potential evaporation and water demand, potentially reducing the capacity of the land. While plant growth and water-use efficiency may be enhanced as a result of increased carbon dioxide levels initially, after increases in temperature of 2–4 °C and associated rainfall decreases, net effects are projected to be negative by the mid to late 21st century (Pittock 2003). As well as direct impacts, agricultural

profits could be affected by a projected increase in agricultural production in mid to high latitude Northern Hemisphere countries and the subsequent commodity price and world trade impacts (Pittock 2003). The development of land uses compatible with agricultural activities, such as wind power, have potential to provide increased economic security to rural industries. As well, they provide a substitute for carbon emission producing electricity production that is stable (not dependent on other countries) and renewable.

Decommissioning impacts

No mitigation measures beyond the liaison with onsite landowners to restrict stock access to the construction zones during the period of construction and decommissioning is considered to be required.

7.7.2 Tourism impacts

Existing environment

The site occurs between two major transport corridors; the Hume Highway to the south and the Old Hume Highway and Great Southern Railway to the north. The site is highly visible from the former corridor which is a major route for local traffic between Yass and Goulburn and also for inland traffic between Melbourne and Sydney (Canberra - Goulburn and Canberra - Sydney traffic would not travel past the site). Approximately one kilometre to the north-west and north-east of the site, the Old Hume Highway (also known as Cullerin Road) crosses the Cullerin Range. This is a scenic drive which includes the highest point on the road and railway between Sydney and Melbourne. Service centres are located at Yass and Goulbourn, encouraging motorists to stop-over in the area.

Encouragement of specific tourism activities in the area is a strategic objective of the Upper Lachlan Shire Council; these activities include tourist drives, farm stays, bed and breakfasts, festivals and shows (Upper Lachlan Shire Council Annual Report 2004-2005). Other tourism activity types in the area include tours of historic buildings (Post Office, Town Hall, St Peter and St Paul's Catholic Cathedral, the Old Goulburn Brewery, Goulburn Rail Heritage Centre), museums, memorials and galleries (the Goulburn Steam Museum, Rocky Hill War Memorial, Goulburn Regional Art Gallery, Fibre Design Textile Gallery) and nature-based recreation (Wollondilly Walking Trail, Heritage Walking Tour, Bungonia State Recreation Area, Pejar Dam). Historic buildings (some of which are registered on local, state or federal registers) are scattered across the landscape, lending to the rustic rural character of the area. The closest such site is a ruin that occurs at the railway crossing approximately 1.5km north-east of the ridge proposed for works (Figure 7.19).

Construction and decommissioning impacts

The site is not located on a tourist drive, although the Old Hume Highway is noted as a scenic drive through the area. It has heritage appeal, given the location of many old buildings and bridges on this route between Gunning and Goulburn. Only a small section (~250m) would be used for access to the site. The site is located between two transport corridors; the Hume Highway and Old Hume Highway. This would result in a large number of people being exposed to the construction and decommissioning works as trucks and other vehicles turn off and travel up to the ridge.

The exposure would be of limited duration as work would occur over a 3-6 month period and motorists would be in transit during this exposure. Visual impact is considered to be low from highway vantages (Scenic Landscape Architecture 2005). A safety hazard exists as the installation of turbines would be a novel and distracting occurrence close (within 500m) to the Hume Highway.

Figure 7.19 Ruins near Old Hume Highway and railway crossing

A traffic study has been undertaken which concludes with measures to reduce the traffic hazards associated with the proposal (summarised in Section 7.8.1, attached in full, Attachment 3.7).

Operational impacts

The number and type of visitors to the area is not anticipated to be impacted by the operational wind farm on the Cullerin Range. The development is not incongruous with the production-based economy of the area and is not situated near formalised nature-based recreation activities. It would be situated within an historic landscape (rural buildings and ruins are located in the area) however, its close proximity to existing infrastructure, including the Hume Highway and extensive electricity easements, suggests that its placement is also not incongruous with visitors' experiences of the historic character of the area.

The development may generate increased tourism if it is promoted as a tourist destination (pull over area with information or potentially tours of the site). The level of promotion that the development receives will be determined in consultation with the local community, Upper Lachlan Shire Council and the RTA. Promotion of the development is not part of this proposal.

7.7.3 Lifestyle values impacts

Existing environment

For local residents and visitors alike, the rural land use and large land holdings in the area create a landscape amenable to recreation (horse-riding, walking, fishing) and one which many people seek to retire or 'escape' from a more urban environment. The number of people in the Gunning area that commute to Canberra is not currently known (anticipated to be known after the 2006 census - Upper Lachlan Shire Council Annual Report 2004-2005) but the number is likely to be increasing, indicating that the area holds land uses other than the purely functional agricultural use or transient tourist use.

The zoning of the land on and surrounding the site is zone 1(a) Rural Zone, with minimum lot sizes for the purpose of dwellings set at 80ha. The aims of this zone include to maintain the rural character of the area, encourage the use of rural land for agriculture and other forms of development which are associated with rural activity or which require an isolated or rural location, and to protect natural resources including prime crop and pasture land. There is therefore potential in the area for hobby farms or lifestyle blocks of this size.

The rural character of the area was also nominated as an important value of the area by local commercial agriculturalists and residents at the Cullerin open house session in November 2005.

Construction and decommissioning impacts

Construction noise, the generation of dust from vehicles and the increased traffic flow during construction and decommissioning would impact on the lifestyle values of the site. Impacts would be experienced by nearby properties as well as properties enroute to the site where the size and number of vehicles would increase and road widening works may be required.

Impacts would attenuate rapidly with distance from the work sites. These impacts would be temporary, occurring over a 6 month period (not continuous in any one location), and would be regulated by occupational health and safety and noise and pollution restrictions. Due to the temporary duration of the impact and the low population density, this is not expected to be an unacceptable level of impact.

To mitigate against the inconvenience of these works to other users of the site, it is recommended that:

- Liaison with onsite landowners to restrict stock access to the construction zones during the period of construction.
- Advertisement of the period of construction in a prominent position onsite as well as in local media, to inform the community of the disruption to affected areas.
- Implementation of dust suppression measures.

Soil and water impacts are discussed in Section 8.1. Traffic impacts are discussed in Section 7.8.1.

Operational impacts

Arguably, the greatest impact of the proposal on lifestyle values would occur during the operational phase of the wind farm. While the operational wind farm would not preclude nearby residential or recreational land uses, the perceived or actual visual, noise and health impacts may adversely affect the experience of those seeking the quiet, rural character of the area.

These impacts are expected to attenuate with distance from the site. Time can also lessen the perceived adverse impacts of a wind farm, as actual experience replaces exaggerated perceptions (cited in Warren *et al.* 2005).

Specialist reports have quantified and assessed the visual, noise and land value impacts of the proposal (refer to attachments for full reports, Attachments 3.1, 3.2, 3.6, respectively). While guideline criteria can be met for both turbine layouts being considered (with the implementation of mitigation measures for Layout B), visual impact (where a direct view of the site exists) is likely to extend to 15km (Scenic Landscape Architecture 2005) and is largely subjective. It has been considered that the landscape is able to absorb the visual impact of the wind farm, given the character types and sensitivities of land users in the area however, high impact has been determined for residences within 5km of the site with a view of the turbines (refer to Section 7.2). Screening would assist to reduce impacts on premises that are subject to high visual impact. Health impacts, similarly, attenuate with distance from the site and are not anticipated

to impact non-involved properties. Safeguards have been recommended to ensure risks are minimised (Section 8.3).

On the basis of these assessments, the impact on the life style values of the site is expected to be manageable.

7.8 Services and infrastructure

7.8.1 Traffic and transport impacts

Existing environment

Bega Duo Designs was commissioned by **ngh**environmental to complete the Traffic Impact Study for the proposed Cullerin Range wind farm. After a scoping exercise, a most likely route was chosen, based on the least number of constraints, and a report was prepared to conform to the *Guide to Traffic Generating Developments,* as recommended by the NSW Roads and Traffic Authority. The report provides a preliminary technical appraisal of the traffic and safety implications arising from use of the proposed route and develops measures for minimising traffic impacts. Sections of the report are extracted below. The report is attached in full, Attachment 3.7.

In identifying the key issues related to traffic and transport impacts, recourse was been made to a letter received from the RTA (19th December 2005, Attachment 2.1), Table 2.1 of the *Guide To Traffic Generating Developments* as well as additional issues included because of the unique nature of the development (including visual effects and the structural condition of the existing road surfaces). The key issues identified with respect to the proposal are:

- Existing road hierarchy and proposals for improvement;
- Impact on road safety;
- Impact on traffic noise;
- Traffic volumes and trends;
- Existing parking and demand;
- Traffic generation;
- Safety and efficiency of internal roads;
- Impact on intersections and surrounding developments; and
- Safety and efficiency of access between the site and adjacent road networks

Site access

The site is bordered by the Hume Highway in the South and the Old Hume Highway (Cullerin Road) in the north. The Hume Highway was duplicated in 1993 and has sufficient capacity for many years at current growth rates. The Old Hume Highway provides an alternative access in both directions. Lerida Road North is a minor council road which connects the Hume Highway with the Old Hume Highway along the eastern side of the Cullerin Range. This road is maintained by Upper Lachlan Shire Council connects Hume Highway with the Old Hume Highway and provides access to several houses. The area around Cullerin is therefore adequately serviced with access roads. Upper Lachlan Shire Council has no future proposals for Lerida Road North. Funding has been obtained for some repair work on the Old Hume Highway (K. Reedy pers. comm. 3 Feb 2006).

Existing access to the site is via steep tracks on the eastern side of the range which connect with Lerida Road North. These tracks are only suitable for vehicles with four wheel drive and are the responsibility of the property owner. The proponent has identified the major access point to the site as being on Old Sydney Road, approximately 500 metres from the Old Hume

Highway. A second potential access point is the existing track at the southern end of Lerida Road North (Figure 7.20).

Existing traffic conditions

Traffic safety is dependant on many variables such as driver behaviour and weather conditions. This section of the report examines the physical constraints of the proposed access roads.

Hume Highway

The Hume Highway is dual carriageway with two lanes in each direction and a design travel speed of 110 km/h. The lanes are separated by a vegetated median approximately 20 metres wide. All major intersections are grade separated and other junctions have auxiliary lanes to ensure that through traffic has minimum interruption from turning vehicles.

The Hume Highway at Lerida Road North is treated as a minor junction by the Roads and Traffic Authority and a right turn auxiliary lane 60 metres long is provided for vehicles travelling from Goulburn. The sight distance provided is adequate for all directions except for the safe intersection sight distance to the west for vehicles entering from Lerida Road North.

Lerida Road North

Lerida Road North is a gravel road ranging between 4 and 6 metres wide. The standard of alignment is variable with very low speeds being necessary when negotiating causeways, grids etc. The road gradient is flat to undulating. The road reserve is not fenced but stock numbers appear to be low. A safe travel speed is estimated to be as low as 40km/hr in its present condition.

Cross drainage is achieved with twelve pipe culverts and two concrete causeways. The pipe culverts are generally in good condition but appear to have insufficient gravel cover to withstand heavy loads. The concrete causeways are in poor condition and additional culverts are required in some locations where water is ponding in roadside drains.

The four small cattle grids would be unlikely to withstand wide, heavy loads. The cattle grid on the Hume Highway Boundary is in good condition and may be designed for Highway type Loadings.

Trees overhang the road at several locations and may restrict the width and height of some loads.

Lerida Road North has adequate capacity for its current usage. The residences are located towards the northern end of the road and therefore most of the substandard sections of the road receive little use. The two dwellings located towards the northern end of the road may be affected by dust and noise. This would be influenced by weather conditions and traffic volumes.

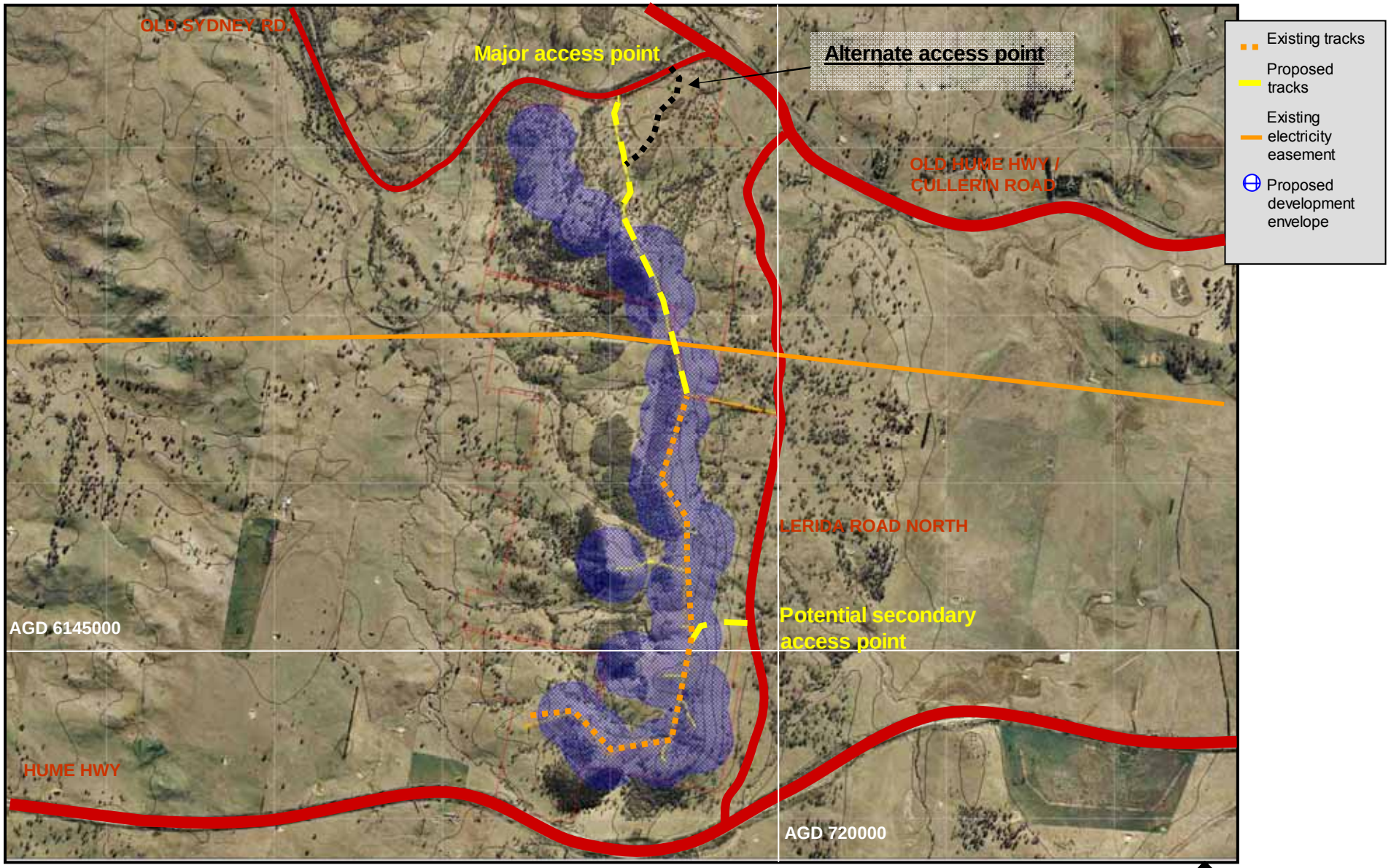

Figure 7.20 Location of the development envelope and access routes

Old Hume Highway

The Old Hume Highway has been retained in its original form since the completion of the new highway in 1993. There appears to have been minimum maintenance on the pavement recently. The line marking and signposting has deteriorated but the route is providing a good level of service for the small traffic volumes present.

The alignment, grading and width to the east towards Breadalbane (approximately 8km) is approaching a 100km/hr standard. The route to the west towards Gunning (approximately 16km) has a low standard section for approximately 7km with two railway bridges, substandard curves and steeper grades.

The section from Lerida Road North junction towards Old Sydney Road (0.66km) which forms part of the proposed route has an 80km/hr standard of alignment and is at least 7.0m wide. The pavement is showing signs of failure in some locations.

The junction with Lerida Road North has adequate sight distance and additional pavement area is available for turns from Lerida Road North towards Old Sydney Road because of the presence of an overtaking lane taper.

Old Sydney Road

Old Sydney Road is an old route of the Highway and has an historic railway bridge approx 1.2km from the intersection with the Old Hume Highway which has a weight restriction. Both access routes considered will depart from Old Sydney at least 500m prior the railway bridge. There will be no requirement for any traffic from the proposed development to use the bridge. A junction provided further west on Old Sydney Road may require the replacement of a culvert at 0.36km from the Old Hume Highway turn off.

The road formation on Old Sydney Road is approximately 6.0m wide and has a gravel surface. The gradients appear to be in the range of 6 to 10 percent. At the junction with the Old Hume Highway, Old Sydney Road approaches at an acute angle. The junction has adequate sight distance provided that traffic approaches the Old Hume Highway at a safe angle.

Existing track to communications tower (potential secondary site access point).

This track joins Lerida Road 1.2km from the Hume Highway and provides a link to the main ridge on Cullerin Range. It has been used for the construction of the communications tower and has grades approaching 20%. It has been subject to erosion. The track has been sheeted with a crushed rock surface on the steep slope but most has been lost due to erosion. It has deep ruts and is unsuitable for 2WD vehicles.

Existing Traffic Volumes

Traffic observations were made during the period 16th to 19th of January 2006 on the Old Hume Highway and Lerida Road Nth. The traffic numbers were observed during a school holiday period and are likely to increase when the school term commences. It is considered unlikely that the increase in traffic will be significant in the determination of the traffic impacts for this development. Traffic volumes were obtained for the Hume Highway from the Roads and Traffic Authority. The Hume Highway in the Cullerin Area has an average annual daily traffic count of 13094 vehicles per day. This equates to 1964 vehicles per hour in the peak hour (two directions). The retention of the Old Hume Highway following the completion of the existing route in 1993 resulted in the duplication of access routes for many of the property owners in the Cullerin area.

The Cullerin area is lightly populated and counts taken for two hours in the morning peak period on 16/01/06 at the northern end of Lerida Road North failed to record any vehicles. Observations for two hours around mid day also failed to record any vehicles. Observations

over the morning peak period on the Old Hume Highway resulted in four vehicles per hour eastbound (towards Breadalbane) and two vehicles westbound (towards Gunning). No vehicles were observed entering or departing Old Sydney Road during the above period.

Impact assessment

The development of the Cullerin Range wind farm has potential to generate traffic and transport impacts during the construction and decommissioning phases. Operational impacts would involve only standard vehicles and are anticipated to be minor. The effect of shadow flicker however, which would occur during the operation of the wind farm, has been discussed below. Decommissioning impacts cannot be anticipated at this time, given the length of time involved (at least 20 years) and unknown factors relating to road upgrades and traffic that will occur in the intervening period.

Construction impacts

It is noted that during construction, light vehicles will operate within 1 hour of the NSW EPA construction noise guidelines recommended hours for work; from 7:00 am to 6:00 pm weekdays and 7:00 am to 1:00 pm on Saturdays, and not on Sundays or Public Holidays. However, the delivery of turbines to the site via oversize vehicles may occur at night, outside the hours stated above, in order to ensure safe passage during low traffic conditions. A Traffic Management Plan developed in consultation with the RTA would be prepared to properly manage traffic impacts identified and the proponent would liaise with the owners of residences on Lerida Road North (two, Springvale and Wandella, both involved with the proposal via lease agreements) as well as an additional residence within 1km of the Hume Highway – Lerida Road North Junction (Illawambra), to ensure that owners have advanced notification of traffic timing.

The volume of traffic in each weight category during the construction phase has been estimated below. Note that some of these activities may overlap.

Table 7.9 Total predicted traffic movement on roads to the site (one way movements)

		Number of traffic movements (one way)		
Activities	*Approximate time period (weeks)*	*Light vehicles*	*Heavy vehicles*	*Oversize and overweight vehicles*
Civil works including trenching for cables	6	600	800	
Establish batch plant and pour footings	4	400	550	
Installation of turbines	4	400	200	230
Construction of substation, cables and facilities building	8	800	300	2
Restoration of site and completion of buildings	6	300	200	
Totals		**2500**	**2050**	**232**

In assessing the impact of the proposal on traffic and transport, the following safety issues have been considered:

- Risk of collisions;
- Traffic noise;
- Shadow flicker from turbines;
- Risk of collision due to fog;
- Driver distraction;
- Obstruction by long loads;
- Wet weather;
- Road surface deterioration; and
- Structural failure of bridges and culverts.

These issues as well as recommended safeguards are outlined for each key location, below.

Hume Highway west of Lerida Road North

The section of Hume Highway approaching Cullerin Range from Goulburn has unobstructed views of the range between 2 and 4 km from Lerida Road North. The construction of many of the wind towers will be highly visible from this section of the highway for westbound motorists. Some motorists could be distracted or might stop on the road shoulder to view the construction.

Shadow flicker may have an impact on traffic safety. Information from the Danish Wind Industry Association suggests that this effect diminishes beyond 500 metres from the wind tower site and is not noticed beyond 1000 metres. The effect is only present when the sun is directly behind the wind turbines. Calculation of shadow flicker and driver cone of vision (see full report, Attachment 3.7) demonstrates the location of the perceived effects in relation to the location of the highway. The normal cone of vision for a vehicle travelling at 100km/hr has been shown at the critical points (100km/hr is the estimated 85th percentile speed for this road). The diagram demonstrates that road users within 1000 metres of the roadside towers will not be looking in a direction which will expose them to shadow flicker irrespective of the sun's location (the diagram has not taken into account the roadside vegetation and obstructions due to cuttings which will reduce the "flicker" effects by masking the view of the towers at many locations).

Safeguards recommended to address traffic and transport impacts include:

- A signposting plan would inform motorists of the approach of the access to the Wind Farm Construction Site to avoid late manoeuvres.
- Information bays could be provided on each approach to the wind farm on the Hume highway with appropriate advance signposting. Truck parking areas are provided on both sides of the Hume highway at Cullerin Range (refer to full report) and these could be used as interim information bays during wind farm construction.
- Following completion of construction the effects of shadow flicker should be monitored from the Hume Highway to determine the degree of impact on westbound motorists.

Hume Highway east of Lerida Road North

Because of the road alignment and vertical grading of the Hume highway, the wind towers will not be as visible on the approach for eastbound traffic as compared to westbound. Driver distraction and shadow flicker may impact on traffic safety.

Safeguards recommended to address traffic and transport impacts include:

- A signposting plan would inform motorists of the approach of the access to the wind farm construction site to avoid late manoeuvres.
- Information bays could be provided on each approach to the wind farm on the Hume highway with appropriate advance signposting. Truck parking areas are provided on both sides of the Hume highway at Cullerin Range and these could be used as interim information bays during wind farm construction.
- Following completion of construction, the effects of shadow flicker should be monitored from the Hume Highway

Lerida Road North / Hume Highway Junction

The sight distance to the west for vehicles entering from Lerida Road North is severely restricted. The Roads and Traffic Authority design guidelines indicate that the "Safe Intersection Sight Distance" for 110km/hr is 330 metres. The safe intersection sight distance presently at the site is reduced to approximately 150 metres. Any increase in traffic leaving Lerida Road North and entering the Hume Highway will impact further on road safety.

The right turn from the direction of Goulburn into Lerida Road North has been provided with an auxiliary lane 60 metres long. This lane would have been the standard length for minor junctions at the time of construction. The increase in traffic movements will have an impact on the safety of the high speed lane and the two lanes of opposing traffic from the west. No acceleration or deceleration lanes are provided at the junction for the traffic to and from Lerida Road for traffic eastbound on Hume Highway. The junction will not have been designed for the long loads expected to turn into Lerida Road from both directions. These turns have the potential of causing the through traffic travelling at 110km/hr to slow in order to avoid a conflict.

Safeguards recommended to address traffic and transport impacts include:

- The roadside vegetation should be cleared on the verge of Hume Highway on the eastbound carriageway between the truck stop and Lerida Road North to increase the safe intersection sight distance to 330 metres.
- The Roads and Traffic Authority are generally not in favour of speed restrictions on the Hume Highway because of the loss in efficiency of the route however, the use of speed controls for specific short term activities would be included in a traffic control plan.

Lerida Road North

The traffic volumes on this road are likely to increase from several vehicles to over 100 per day during concrete pouring operations. The low standard of horizontal and vertical alignment will assist in controlling speed on many sections of the road thereby reducing the severity of any collisions. The larger vehicles will occupy the full width of the roadway increasing the chance of "head on" collisions. The road reserve is not fenced and an increase in traffic will increase the chance of collisions with stock. There will be an increase in traffic noise and dust nuisance for property owners.

The gravel road surface will deteriorate and potholes will form under the increased traffic loads, particularly during wet weather when water ponds in drains and potholes. The broken concrete in the causeways may displace under heavy loads. Structural damage may occur to some of the culverts and the stock grids. The location of trees and other roadside objects have the potential of obstructing the passage of long wide loads. Lack of roadside delineation may impact traffic safety during periods of poor visibility.

Safeguards recommended to address traffic and transport impacts include:

- The pavement, drainage structures and stock grids on Lerida Road North require inspection and possible upgrading. The decision to provide a seal needs to be balanced against the cost of maintenance on the gravel surface. Also to be considered is the cost of dust

suppression and sediment control. The environmental impacts of this work should also be considered.

- Traffic Control Plans and Oversize Vehicle Permits will be required to be prepared and submitted to the Roads and Traffic Authority for all the operations of over size and over weight vehicles.
- There are no speed restrictions on Lerida Road North and excessive speed will increase the impacts of additional traffic. A speed limit should be placed on the road at least for the period of construction. The speed restriction would be included in the traffic management plans to be submitted to the Roads and Traffic Authority.

Lerida Road North / the Old Hume Highway junction.

There will be a significant increase in the movement of vehicles turning to and from Lerida Road North towards the west. For the period of construction the relatively few users of the Old Hume Highway will experience a significant change in conditions due to the increase of traffic. Drivers who are unaware of the changes will be more likely to be involved in collisions.

There is insufficient shoulder width on the northern side of the Old Hume Highway opposite Lerida Road North, to permit a vehicle to pass beside a turning vehicle.

Safeguards recommended to address traffic and transport impacts include:

- A signposting plan for the Old Hume Highway would inform motorists of the change of traffic conditions due to the wind farm construction as they approach the section of the Old Hume Highway between Lerida Road and the Old Sydney Road.
- Road shoulder widening could be provided on the Old Hume Highway at the junction with Lerida Road North in accordance with the Roads and Traffic Authority design guide.

Old Hume Highway

A short section of the Old Hume Highway (0.66km) will experience an increase in traffic volumes and loads. There is a risk of further pavement failures due to heavier and more frequent loads. These failures may be due to poor drainage of the pavement layers. Drainage structures may be damaged or blocked on this section of the Old Hume Highway. The risk of accidents in periods of poor visibility is increased by the lack of maintenance of line marking and signposting.

Safeguards recommended to address traffic and transport impacts include:

- Pavement and drainage repairs will be necessary in the low area 0.28km west of Lerida Road North.
- Clearing of vegetation and mowing to increase sight distance is required on the road verges of the Old Hume Highway.
- The line marking on the Old Hume Highway has deteriorated and requires re- marking.

Junction with Old Sydney Road

Increased traffic will impact on the safety of turning movements because of the lack of pavement markings on the Old Sydney Road and the Old Hume Highway. The existing loose gravel surface will increase stopping distances.

Safeguards recommended to address traffic and transport impacts include:

- Sealing and line marking is required on this junction. The layout should comply with Roads and Traffic Authority design guidelines for rural junctions which would require an angle of approach between 70 an 90 degrees.

Old Sydney Road

The safety and amenity of this section of road is compromised primarily by the lack of a sealed surface.

Safeguards recommended to address traffic and transport impacts include:

- Sealing of the section of the Old Sydney Road between the Old Hume Highway and the proposed access point is desirable to reduce dust and gravel mobilisation. If the sealing is not undertaken, dust suppression and sediment / erosion controls will need to be rigorous and reduced travel speeds should be implemented to ensure safe stopping distances are achievable.

Note: sealing this section of road would not be undertaken as part of the proposal. Dust and sediment / erosion controls as well as reduced travel speeds would be implemented.

General Safeguards

- Traffic Control Plans and Oversize Vehicle Permits will be required to be prepared and submitted to the Roads and Traffic Authority for all the operations of over size and over weight vehicles on all the public roads involved in the transport of materials to the site.
- 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.
- Regular scheduled maintenance of gravel pavements such as grading, watering and drainage control should take place during the construction period.
- Traffic Impacts can be significantly reduced by the scheduling of high impact movements to account for varying traffic flows on the Hume Highway. These movements if possible should be scheduled to periods when heavy fogs are unlikely.
- The traffic impacts outlined should be discussed with Upper Lachlan Shire Council and the Roads and Traffic Authority.

Adoption of all the measures for minimising traffic impacts outlined should reduce the risk of traffic accidents to an acceptable level and minimise structural and environmental damage.

7.8.2 Aircraft hazard impacts

This section was researched and prepared by Martin Poole, Taurus Energy.

The development of the Cullerin Range wind farm would involve the construction of 15 wind turbines that each have a height of up to 126 metres to the blade tip. Due to the height of the structures, the potential implications for aviation safety have been examined. The potential for aircraft hazard would occur only during the *operational phase only* of the wind farm. Air safety issues that have been assessed for the proposed project include:

- Proximity of the proposed wind farm to landing fields,
- Potential intrusion into air traffic zones and regulatory requirements, and
- Potential effects on activities such as aerial spraying of agricultural areas.

Proximity of the proposed wind farm to landing fields

Landing fields may be classified according to whether instrument landings are available. The nearest airfields providing instrument landings are Goulburn, approximately 30km east of the site, and Canberra airport, approximately 55km south of the site. Yass airfield is approximately 50km west of the site, but is not classified for instrument landings.

Obstacle Limitation Surfaces (OLS) are conceptual surfaces associated with a runway, which identify the lower limits of the aerodrome airspace. Above these limits, features can become obstacles to aircraft operations and must be reported to CASA.

The operator of a certified aerodrome must monitor the airspace around the aerodrome to ensure that buildings and structures do not infringe the OLS. In the case of Goulburn and Canberra airfields, the Cullerin site and wind turbines would be well beyond and below the respective OLS for Goulburn and Canberra airfields. The proposed structures are not expected to represent hazards or obstructions to these airfields. The Yass airfield, will have an OLS of lesser extent than those with instrument landings and is therefore also unlikely to be affected by the development. CASA has advised that the project is not of concern to the operations at Goulburn and Canberra airfields.

The minor, private airstrips in the local area rely on visual rather than instrument based landings and as the turbines are clearly visible structures it is unlikely that the development would pose any additional hazard to the users of these airstrips.

- Taurus Energy will also provide the location and height of each tower to the Australian Aerial Agriculture Association.

Potential intrusion into air traffic zones and regulatory requirements

Under Civil Air Safety Regulations any person who proposes to construct a structure 110m or more above ground level must inform CASA of that intention and the proposed height and location of the structure. The proponent has advised CASA of the proposal. Taurus Energy is currently in consultation with CASA regarding their requirements for the marking of turbines at the site.

The turbines may have aircraft warning lighting which would comprise a red flashing beacon on the top of the nacelle to meet the requirements of the Civil Aviation Safety Authority (CASA). CASA draft guidelines for aviation warning lighting for a group of wind turbines require that sufficient wind turbines should have red obstacle beacons to indicate the extent of the group. The interval between beacons should not exceed 900m. Accordingly, we expect that 4 to 5 turbines in the proposed project would require aircraft warning beacons.

To address the potential intrusion into air traffic zones:

- Taurus Energy will provide the location and height of each tower to CASA and the RAAF once constructed for inclusion in relevant databases, maps and charts.

Potential effects on activities such as aerial spraying of agricultural areas

The wind turbine structures are not considered to be safety hazards to aerial agriculture operations as the structures are clearly visible and pilots can easily avoid them. However, they may limit the areas of paddock that can be treated using aerial methods. The ridge top and immediate slopes of the site would not be able to be treated using aerial based methods after the installation of the turbines, an area of approximately 4km x 2km (80ha). This land is owned by involved landowners who would be compensated by way of lease agreements entered into with the proponent.

To address the effect of the development on agricultural spraying:

- Taurus Energy will provide the location and height of each tower to the Australian Aerial Agriculture Association.
- Taurus Energy will liaise with landowners whose properties would not be able to be treated using aerial based methods.

7.8.3 Telecommunication impacts

This section was researched and prepared by Anthony Micallef, Taurus Energy.

Existing environment

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 (Bacon 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 (URS 2004).

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 (URS 2004).

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 (URS 2004).
>
> 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 at Cullerin 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 (URS 2004).

While the site proposed for the development of the wind farm is a rural area with relatively sparse housing, a number of communications links and broadcast networks are present in the surrounding region. In addition, a communications tower is located on site, shown in Figure 7.21. This tower is known as Telstra CMTS Site CULLERIN, Site ID 100726 on the Australian Communications & Media Authority (ACMA) RadCom Database.

Figure 7.21 Telstra CMTS Site CULLERIN (view from north)

As with any large structure, there may be circumstances where wind turbines 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 to 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;
- Carry out internal assessment of Fresnel Zones associated with fixed point to point communications links 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 all turbines (including blades) are located outside of this exclusion zone;
- Determine appropriate additional mitigation measures which may be required.

Impact assessment

The possible impact of the proposed 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.** All 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.

Television and Radio Broadcast Services

Existing Services and Facilities

The ACMA RadCom database lists the following broadcasters for television and radio, under postcode 2581 which includes Cullerin.

Television broadcasting: ABC, CBN, CTC, SBS and WIN.

Radio broadcasting: 2ABCFM, 2ABCRN, 2ABCRR, 2GN, 2JJJ, 2RN, 2SNO.

Canberra (Black Mountain) is the nearest TV transmission source for the locality of the proposed Cullerin wind farm, located approximately 60km SSW of the site. There are local repeater stations at Mount Gray (Goulburn) and Braidwood but these serve small localised areas in the proximity of the repeater station. Details of the Canberra television channels are provided in the table below.

Table 7.10 Canberra television channel details

Broadcaster	Channel	Band	Frequency (MHz)
Capital (CTC)	7	VHF	182.25
ABC	9	VHF	196.25
SBS	28	UHF	527.25
WIN	31	UHF	548.25
Prime (CBN)	34	UHF	569.25

The Telstra CMTS Cullerin telecommunications tower is used for local information radio broadcasting services by The Info Radio Network (license no. 1,150,711, 88 MHz, sub-local coverage). All license holders identified via the ACMA RadCom Database within a 25km radius of the wind farm were notified of the proposal by Taurus Energy regarding potential impacts and asked to provide comments. At the time of writing, no concerns have been raised by these license holders regarding possible impacts to television or radio broadcasting services. Taurus Energy will work with organisations to resolve any issues, should they be identified.

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) (Spera 1994). TVI caused by the operation of wind turbines is characterised by video distortion, while the audio component of the signal is not affected (Spera 1994). 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 eg design, height, directionality, power.

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

- Abnormal weather conditions;
- Multipath 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;

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.

Wind turbine interference zone: The zone of interference for a single wind turbine is primarily an elongated zone extending from the turbine structure in the direction away from the transmitter and a zone of shorter but wider extent on the transmitter side. This is shown in Figure 7.22 below, reproduced from the Gunning Wind Farm Environmental Impact Statement – Chapter 11.

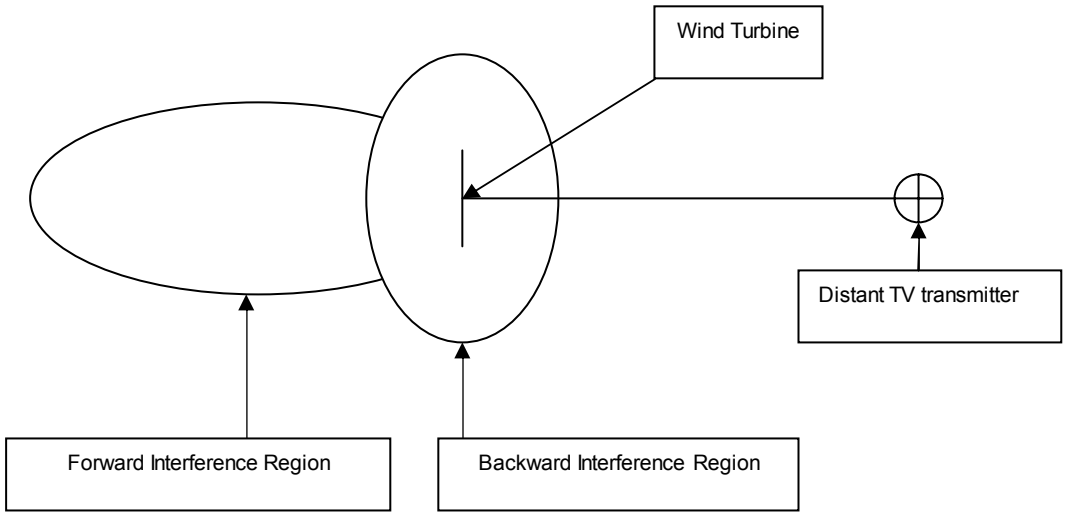

Figure 7.22 Schematic diagram of television signal interference zones around a wind turbine

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. 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 (Delta Electricity 2004). The form of 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 (Delta Electricity 2004).

Measurements of signal strength on the top of the Cullerin Range indicated good signal strength, while locations at the base of the range can have lower signal strength. The situation can increase the potential for interference at receiver locations (Delta Electricity 2004). There are approximately 20 houses within a 5km radius of the proposed wind farm. The location of the wind farm with respect to Black Mountain communications tower can also be seen in the following diagram.

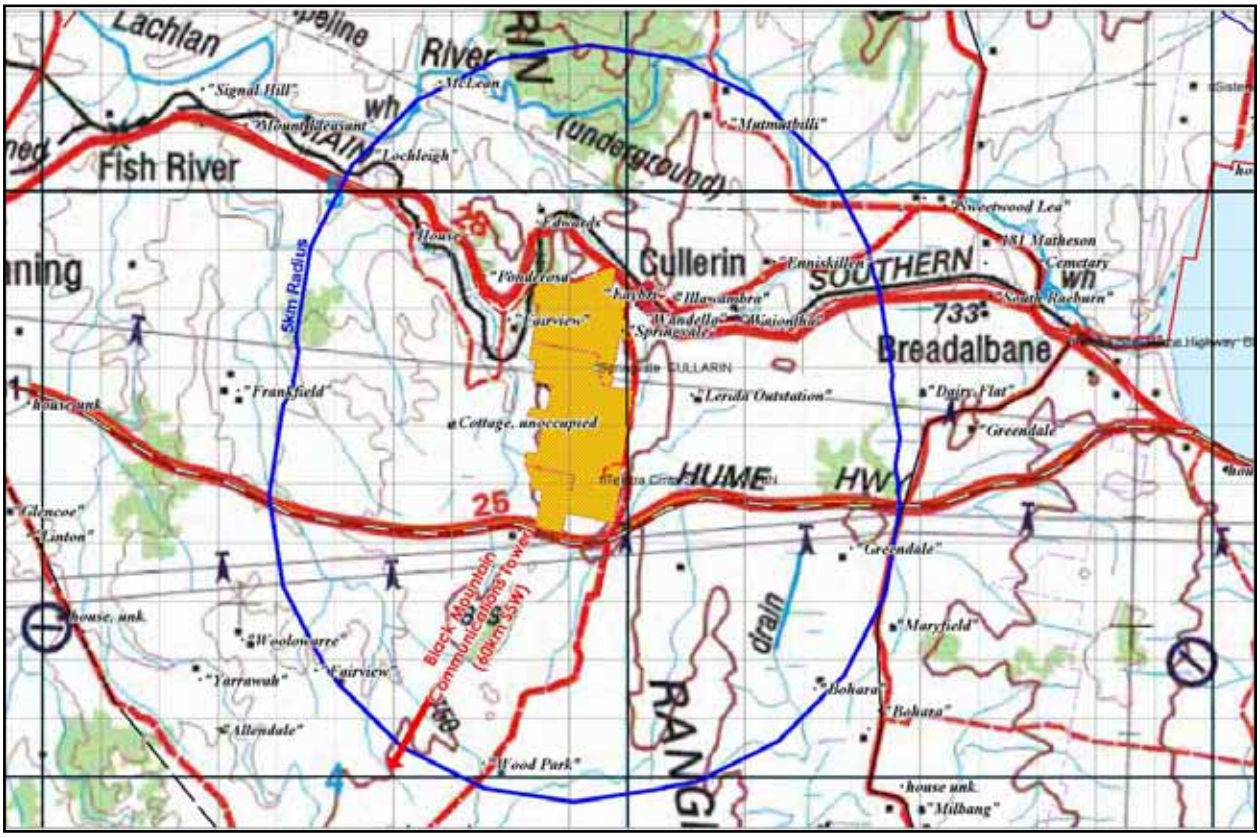

Figure 7.23 House and television tower locations

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.

Mitigation measures

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

- 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 undertake a monitoring program of houses within 5km of the wind farm to determine any loss in television signal strength. 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 Taurus Energy. Should investigations determine that the cause of the interference is due to the wind farm, Taurus Energy will put in place mitigation measures at each of the effected 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; 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 Taurus Energy's cost.

Mobile Phone Services

Existing Services and Facilities

The Telstra CMTS Site Cullerin telecommunications tower is used for mobile telecommunications (CDMA and GSM services as well as high frequency communication links) by Telstra Corporation Ltd, Vodafone Network Pty Ltd and Optus Mobile Pty Ltd / Singtel Optus Pty Ltd.

This section covers CDMA and GSM services (high frequency communications links used for mobile transmission networks are discussed in the next section: Radio Communication Services). Figure 7.24, Figure 7.25, Figure 7.26 and Figure 7.27 show the existing local mobile phone coverage from the three providers (source: company websites).

The ACMA RadCom Database identified the same 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.

Table 7.11 Mobile phone companies using base stations near the proposed wind farm site

Mobile Phone Companies	ACMA Site ID No.
Optus Mobile Pty Ltd / Singtel Optus Pty Ltd	100726, 53802, 202088, 370254.
Telstra Corporation Ltd	100726, 100725, 9505, 100817, 9508, 37299, 36676, 100656, 132337.
Vodafone Network Pty Ltd	100726, 9507, 53802, 370254, 131026.

All companies were notified of the proposal by Taurus Energy regarding potential impacts and asked to provide feedback as to any potential conflicts with their existing networks.

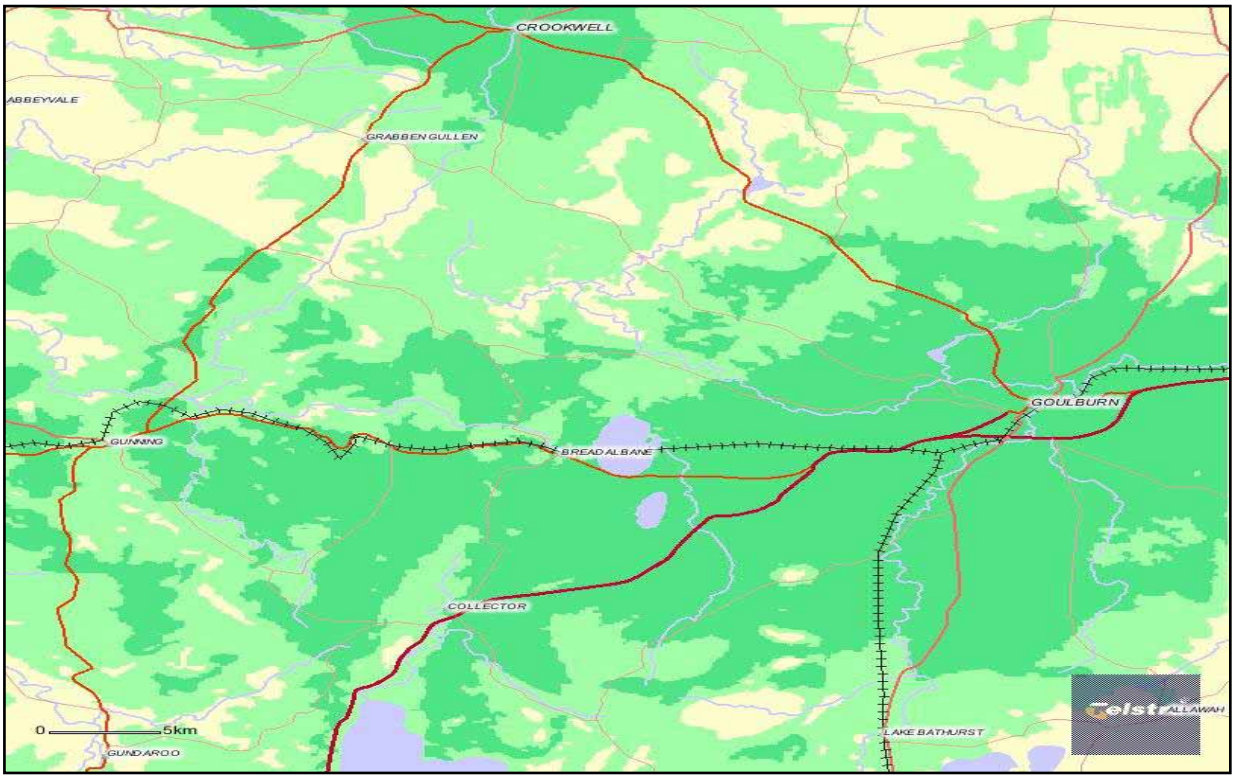

Figure 7.24 Telstra 3G and GSM Coverage

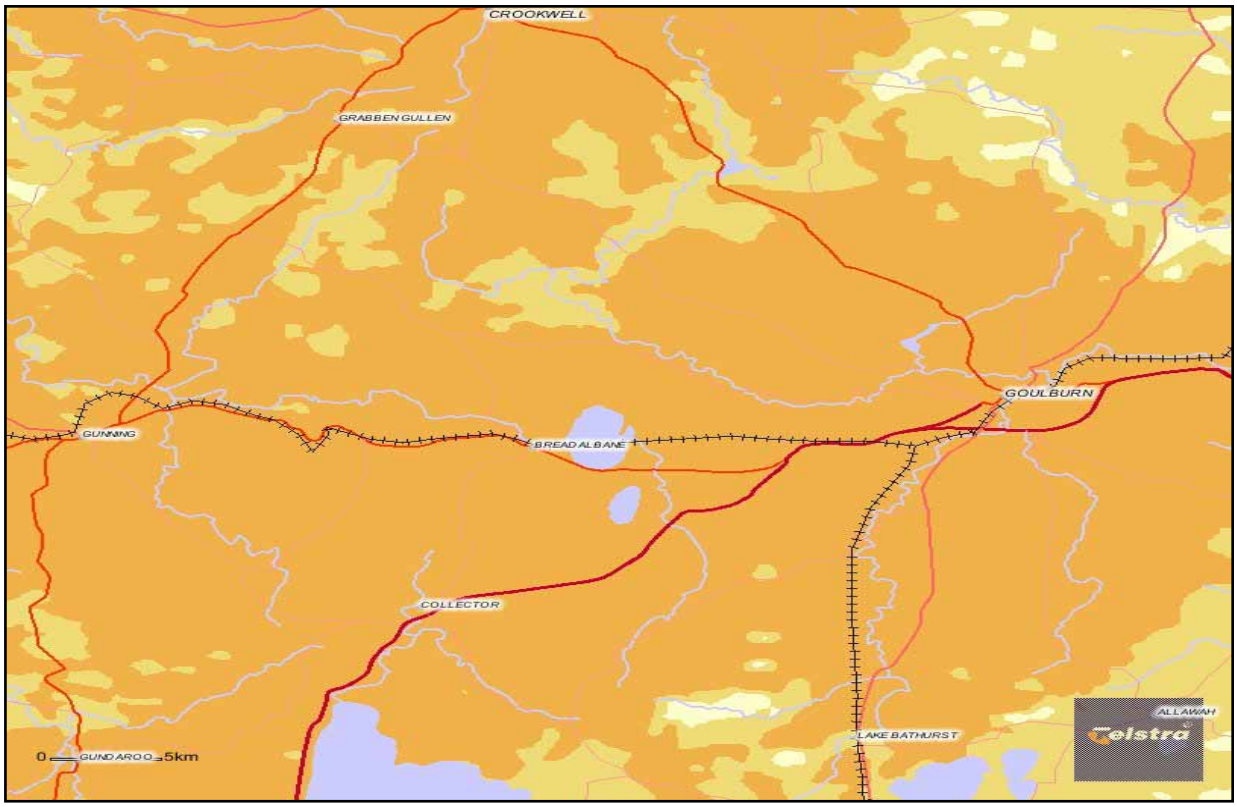

Figure 7.25 Telstra CDMA Coverage

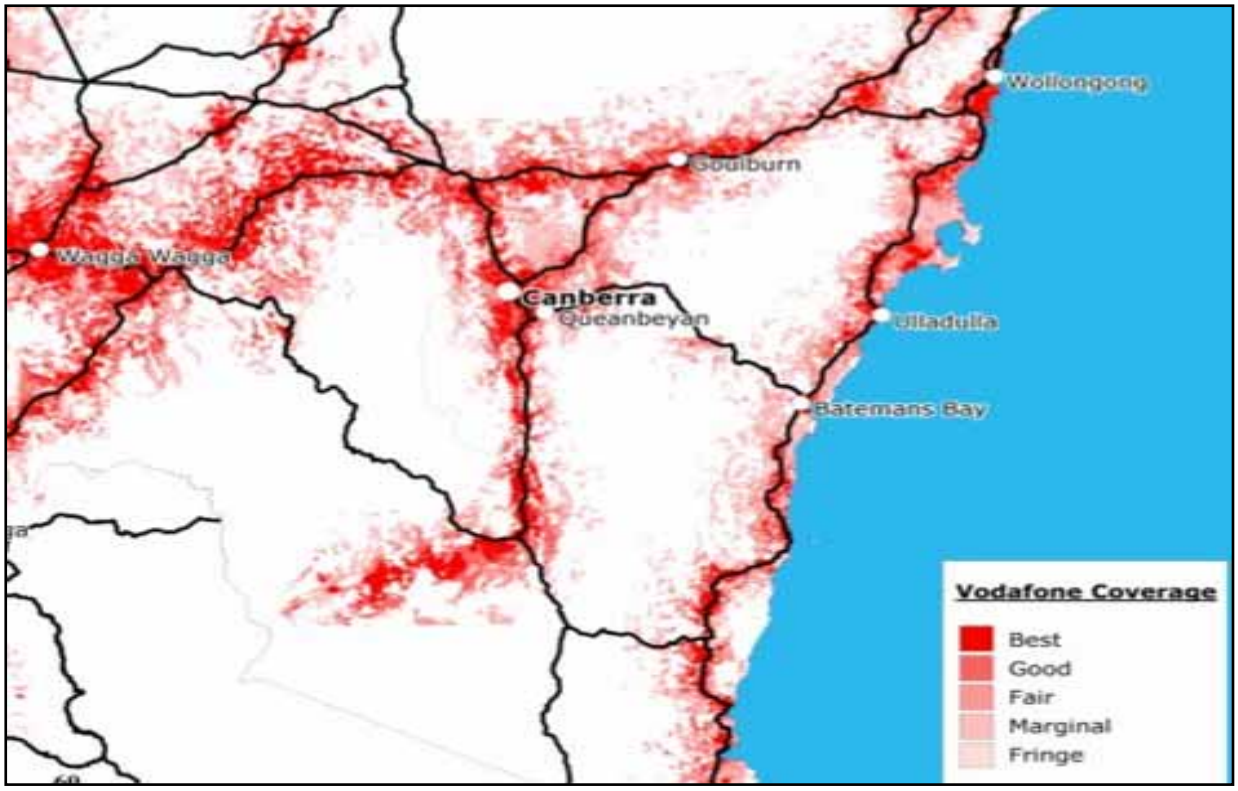

Figure 7.26 Vodafone GSM Coverage

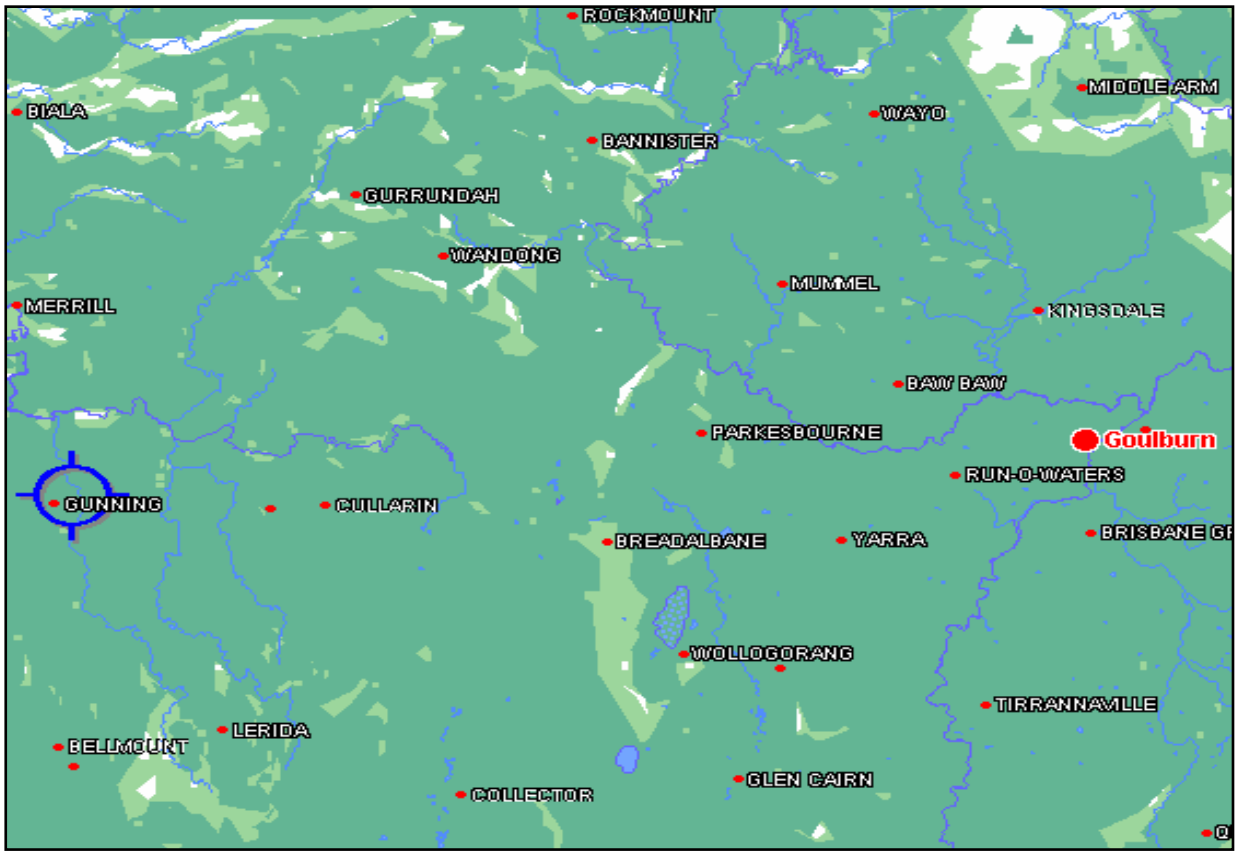

Figure 7.27 Optus GSM Coverage

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 (URS 2004, Chapter 15.4.2)

At Taurus Energy's request, Optus Mobile / Singtel Optus, Telstra and Vodafone each carried out independent investigations of the potential impact to their mobile phone systems. The following responses were received:

Optus Mobile / Singtel Optus

> "There will be some effect on the GSM service performance of the Cullerin BTS due to the varying multipath that would be generated by he moving blades and to radio shadowing from the turbine structure itself. Optus do not have any empirical data to properly assess this but the risk appears very low.
>
> It is expected that the turbines would cause coverage problems from shadowing by the turbine towers (especially to the North) but as the area is close to the turbine farm, we expect this area should not have many Optus customers, so the impact would not be significant.
>
> For GSM mobile voice service, whilst the effect of multipath fading can not be quantified without test data but the effect is expected to be slight. For GPRS data service, jitter resulting from moving blades might cause slight to moderate impact to the performance but this area would have low GPRS data traffic so the customer impact would be very low." (Pers comm., Mr. Trong Ho, Optus).

Telstra

> According to advice from Mr. Ivan D'Amico of Telstra, both GSM and CDMA are transmitting at the Cullerin site. CDMA has only omni-directional antennas; GSM has omni-directional antennas and a panel (directional) arrangement with a panel bearing of 285 degrees (relative to North).
>
> In order to avoid impacts to Telstra services, Telstra advised that for omni-directional antennae they propose a set off distance of 100m from the tower and for panel antennae Telstra propose a 100m (turbine) set-off for 30 degrees either side of the line of sight from the panel.
>
> "The main concern from Telstra's point of view would be physical obstruction of radio path which would inturn alter existing mobile coverage in the area. Provided wind turbines are greater than 100m away from Mobile tower (or in the case of directional panel antennae, not in direct line of site for panel antennas), wind turbines will have minimal effect on existing coverage.
>
> Your proposal appears to satisfy these conditions, thus I see no issues with this proposal." (Pers. comm. Mr. Ivan D'Amico Area Team Manager (Country) – NSW & ACT, Telstra Services, Wireless Access Solutions, Mobile Coverage Delivery)

Vodafone

> Vodafone is currently investigating the issue and Taurus Energy will continue to work with Vodafone to ensure interference to mobile phone services is avoided. It is anticipated that Vodafone would have the same requirements as for other mobile phone carriers, therefore it is likely that the constraint conditions identified by Telstra would be sufficient to eliminate impacts to the Vodafone network.

Mitigation Measures

In preparing the proposed turbine layouts, Taurus Energy has met all physical constraints identified. Accordingly, no additional mitigation measures are required.

Radio Communication Services

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.

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 the potential exists for intereference to line-of-sitght 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.

Taurus Energy 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 map below provides details of the locations of fixed microwave links around the Cullerin site (prepared by Taurus Energy 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, Taurus Energy 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. These zones (as well as the zone showing the 100m set-off from the communications tower mobile phone antennae) are shown cross hatched in the following diagram.

Table 7.12 Radio communication license holders within 25km

ACMA Licence Holder	ACMA Site ID No.
Airservices Australia	9508
Ambulance Service of New South Wales	9506, 9481
Australian Capital Television Pty Ltd	9507
Australian Rail Track Corporation	202399
Capital Media Network Pty Ltd	102238
Commissioner of Police NSW Police	9506, 9481
Department of Commerce	9507
East Australian Pipeline Ltd	9505
Gunning Shire Council	9504, 34919
The Info Radio Network Pty Ltd	100726,102238, 100656
NSW Rural Fire Service	201545,34919
NSW State Emergency Service	9504
Optus Mobile Pty Ltd	100726, 53802, 202088, 370254
Prime Television Southern Pty Ltd.	9507
Roads and Traffic Authority of NSW	35499
Singtel Optus Pty Ltd	53802,202088
Soul Pattinson Telecommunications Pty Ltd	9506
Telstra Corporation Ltd	100726, 100725, 9505, 100817, 9508, 37299, 36676, 100656, 132337
TransGrid	9506
Vodafone Network Pty Ltd	100726, 9507, 53802, 370254, 131026
WIN Television NSW Pty Ltd	9507

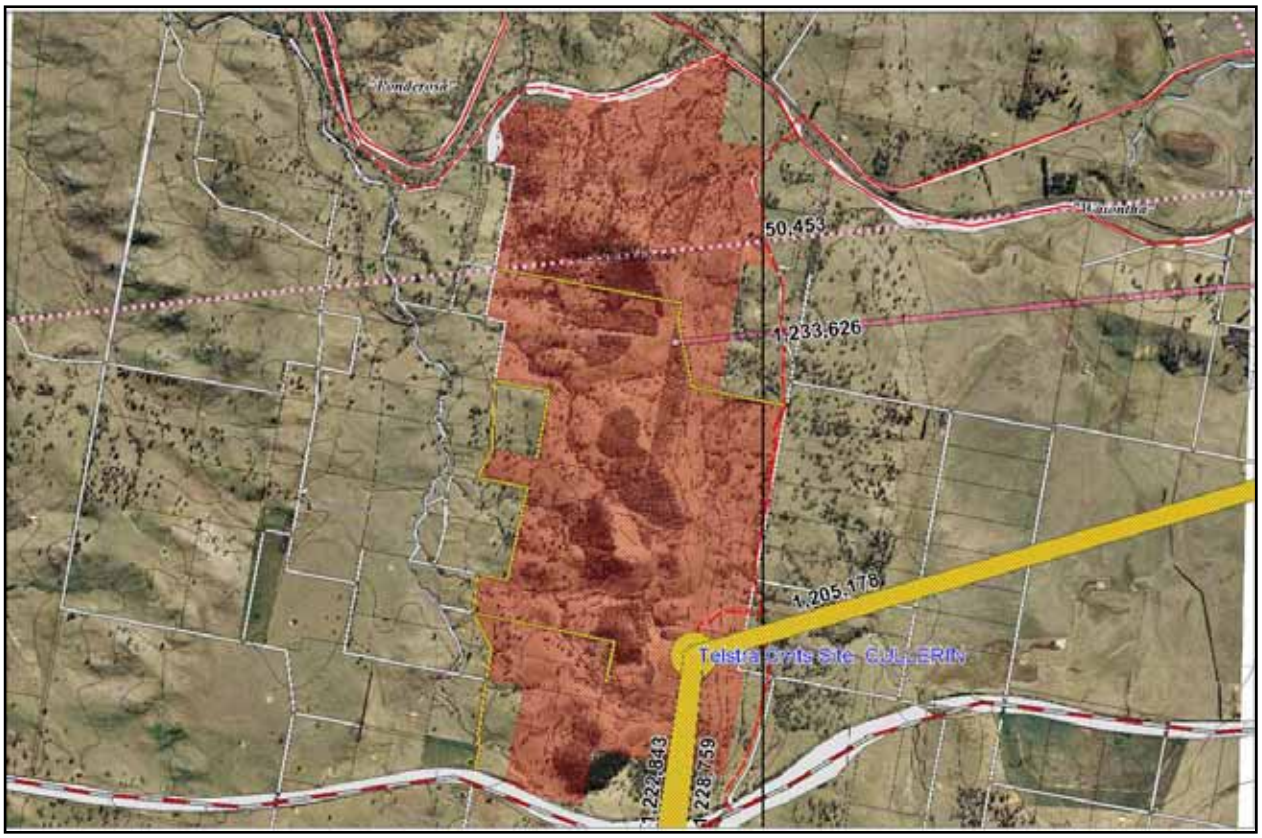

Figure 7.28 Radio communication links and exclusion zones

Five point to point links were identified.

The link between CAA Site Mt Mundoonen and Pacific Power Site Mt Gray, (License No. 50,453) operated by the Commissioner of Police, NSW Police, passes across the site. This link operates in the UHF band at 450.7 MHz.

The link between Spingvale Cullerin and SRA site Mt Gray, licensed by the Rail Corporation of NSW, (License No. 1,233,626) is defined as commencing at a tower located at the site. Taurus Energy has been advised that the communications tower has not been built and the lease for the related site has been terminated as Rail Corporation of NSW no longer requires this link. (Pers comm Paul Hannan, landowner of proposed site).

The link between Telstra CMTS Site Cullerin and Optus Site Marked Tree Road Chaton Ridge Collector, (License No. 1,228,759) operated by Optus Mobile Pty Ltd passes across the site. This microwave link operates at 15,194 MHz.

The link between Telstra CMTS Site Cullerin and WIN Site Chaton Ridge Lake George (License No. 1,222,843), operated by Vodafone Network Pty Ltd passes across the site. This microwave link operates at 12,765 MHz.

The link between Telstra CMTS Site Cullerin and Telstra site Hume Highway Breadalbane (License No. 1,205,178), operated by Telstra Corporation Ltd passes across the site. This microwave link operates at 18,710 MHz.

Additional Radio Communication Licenses

In addition, Taurus Energy contacted all organisations identified as operating radio communication licences (including fixed link communications) within 25km of the wind farm. Each was asked to provide independent comments / advice on the possibility of the wind farm development interfering with their communications links. No organisation within the 25km radius raised concerns. Optus, Vodafone and Telstra provided general guidelines to assist in the planning of the wind farm.

In response to these inquiries, 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)

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)

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 site for panel antennas, wind turbines will have minimal effect on existing coverage.
>
> Your proposal appears to satisfy these conditions, thus I see no issues with this proposal."
> (pers. comm. Mr. Ivan D'Amico, Area Team Manager (Country) - NSW&ACT, Telstra Services, Wireless Access Solutions, Mobile Coverage Delivery)

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, Taurus Energy 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.

Aircraft Navigation Systems

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.

Interference and Impact Analysis

Taurus Energy contacted the Civil Aviation Safety Authority (CASA) and Airservices Australia in relation to the proposal. Both organisations have been notified of the proposed location of the wind farm and have not raised any objections in relation to the project. A review was undertaken with Mr. Ian Priestly of CASA, which did not reveal any transmitters in close proximity to the proposed site. A review of the proposal was also undertaken by Airservices Australia. It was determined that the wind farm site was sufficiently away from the Airservices

Australia transmission link path so as not to be an issue. Airservices Australia confirmed that they do not have any objection to the proposal.

Mitigation Measures

No mitigation measures are required.

7.9 Fire and bushfire impacts

Existing environment

The study area is largely native and exotic pasture, with scattered trees on the eastern, northern and southern slopes and fragmented woodland on the western slope. There is little shrub cover with the understorey being predominantly grassy across the site. There is low connectivity to woodland in the area.

Summer conditions in the Goulburn district can be dry and hot with high wind speeds, producing local grass fire hazards. Potential ignition sources include farm machinery, hay storage, vehicles stopping in long grass on road verges, cigarette butts thrown from car windows and lightening strikes. The elevated position of the proposal site may increase the frequency of lightning strike. The steep topography and absence of built areas or natural fire breaks such as large waterbodies may assist the rate of spread of wildfires.

Factors mitigating fire risks at the site include the sparse and fragmented nature of woodland and forest remnants, the low density of human settlement and assets, the local presence of the Rural Fire Service and a grazing regime onsite and on adjacent land parcels which acts to reduce fuels.

Key issues identified by representatives of the Rural Fire Service during the onsite Planning Focus Meeting (10 November 2005) were:

- Access to the site in the event of a fire;
- Potential for containment lines;
- Potential for the substation to start a fire; and
- Activities such as hot welding in fire danger periods.

The representatives commented that the development was not substantially different to other infrastructure risks in the area and therefore they held no large concerns over the issue from a bushfire risk perspective. It was agreed that these measures could be dealt with in the Statement of commitments (refer to Section 9.2 of this document).

An additional issue is the reliance of the proposal on local RFS volunteers, who have no experience in fighting fires in the vicinity of wind farms, who would be acting in a support capacity to the NSW Fire Brigade in the event of fire (due to the hazardous materials).

These and other relevant issues are discussed below.

Impact assessment

Construction and decommissioning phases

Flammable materials and ignition sources brought onto the site, such as fuels, would increase the risk of fire during the construction period. Correct handling and storage procedures would mitigate against the risk of ignition. Appropriate fire fighting equipment would be held on site when the fire danger is very high to extreme, and a minimum of one person on site would be trained in its use.

The Rural Fire Service would be consulted in regard to the adequacy of bushfire prevention procedures to be implemented on site during construction, operation and decommissioning.

These procedures would in particular cover hot-work procedures and response measures to control any incident.

Operational phase

Turbine ignition

Zilkha Renewable Energy (2002) reports that records from a leading insurer show that fires due to equipment failure are very rare in modern wind turbine designs. In 15 years and with over 12,000 insured turbines, the insurer has had only one case of third party damage from fire caused by a turbine, which was limited to a large haystack. Turbines would automatically shut down if ambient temperatures exceed the safe operating range, or if components overheat.

There remains however, a possibility that electrical failure could produce a fire within a turbine tower. This has been recorded in at least two cases worldwide. In the event of a turbine igniting onsite, the generally low fuel levels in surrounding pasture and fragmented woodland would reduce the intensity of wildfire. The ready visibility of the majority of the turbines and local presence of RFS equipment and personnel would and assist detection, response time and control. In addition, shut down mechanisms would be installed in the wind turbines, and remote alarming and maintenance procedures would also be used to minimise risks.

Lightning rods are installed in turbines to ground lightning strikes in order to minimise risk of damage to the turbines and risk of ignition of a wildfire. Relatively minor damage to turbines may occur from lightning strike. At Crookwell, east of the site, a direct strike resulted in damage to one of the turbine blades, which was repaired onsite. No wildfire resulted.

The risk of turbine ignition is assessed as low, based on the low likelihood of electrical failure or over-heating and a range of factors mitigating the fire hazard.

Aerial cables

Aerial cables would be installed to connect the wind farm to the electricity grid system. If the offsite substation option is realized, this would be over a distance of approximately 2 km. The cable could be routed to avoid trees and forest patches, reducing the need for clearing and eliminating ongoing fire risks from tree growth. Cable routes would be periodically inspected to monitor any regrowth or spread of eucalypts.

Substation and control room ignition

The transformer in the substation facility would contain transformer oil for the purpose of cooling and insulation. The facility would be bunded with a capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater).

Transformer oil would be changed regularly at appropriate intervals by qualified staff to minimise the potential for fire caused by contaminated oil. The oil would be removed from the site and disposed of appropriately.

The substation would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress.

Similarly, an asset protection zone would be maintained around the control room and substation buildings. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities.

Impacts on fire-fighting operations

The turbines have the potential to present a hazard to firefighting helicopters and planes. Given the absence of large waterbodies, these aircraft are unlikely to fly close to the turbines to obtain water for firefighting.

RFS and Council would be consulted regarding safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, and also in the event of an external wildfire threatening the wind farm. The wind farm could be shut down in the event of a fire situation.

Wind farms have been found to influence temperature and wind speed around turbines and have the potential to influence bushfire behaviour. A distance of up to 1.25km (SEDA 2002) around each wind turbine is likely to experience warmer night temperatures and faster wind speeds on average, although this attenuates rapidly with distance from the turbine. While the amount of increase is small (approximately 0.7^{o}C increase and approximately 0.6 metres/second increase at ground level; Baidya, *et al.* 2004) these factors may enhance bushfire conditions, slightly increasing the intensity or rate of spread of a bushfire at the site. Given the already low fire hazard at the site, this minor increase in fire intensity is not considered likely to create problems in terms of the rate of spread or controllability of wildfires.

Impact avoidance and mitigation

- The Rural Fire Service would be consulted in regard to the adequacy of bushfire prevention measures to be implemented on site during construction, operation and decommissioning. These measures would in particular cover hot-work procedures, asset protection zones, and safety, communication, site access and response protocols in the event of a fire originating in the wind farm infrastructure, or in the event of an external wildfire threatening the wind farm.
- Flammable materials and ignition sources brought onto the site, such as fuels, would be handled and stored as per manufacturer's instructions.
- During the construction phase, appropriate fire fighting equipment would be held onsite when the fire danger is very high to extreme, and a minimum of one person on site would be trained in its use.
- The substation facility would be bunded with a capacity exceeding the volume of the transformer oil to contain the oil in the event of a major leak or fire. The facility would be regularly inspected and maintained to ensure leaks do not present a fire hazard, and to ensure the bunded area is clear (including removing any rainwater).
- The substation would be surrounded by a gravel and concrete area free of vegetation to prevent the spread of fire from the substation and reduce the impact of bushfire on the structure. The substation area would also be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress.
- Asset protection zones, based on RFS advice, would be maintained around the control room, sub-station and in electricity transmission easements. Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities.
- Shut down of turbines would commence if components reach critical temperatures.
- Fire extinguishers would be stored onsite in the control building

7.10 Cumulative impacts

Existing environment

The Cullerin Range has high wind speeds and good access to electricity and transport corridors. Therefore, there is potential for other wind farms or similarly large scaled infrastructure to be proposed in the future. Several other wind farms have been proposed for the region. Two are currently constructed (Crookwell I and Blayney), four have approvals (Woodlawn, Crookwell II, Taralga and Gunning) and other proposals are in the planning or assessment phases. Table 7.13 and Figure 7.29 outline the characteristics and locations of these developments.

Impact assessment

Cumulative impacts can result from several inter-related factors. These can include visual, biodiversity, noise, social, economic, traffic, electromagnetic radiation, air quality and water impacts. They can be adverse as well as having potential for environmental gains. Key issues relevant to the Cullerin site are discussed below.

Visual

No other wind farms are currently constructed in the local area (Crookwell is located approximately 26km from the site and would not be visable) although a development has been approved 10km to the north (Gunning wind farm), also on the Cullerin Range. The orientation of the range north-south, suggests that the greatest visual impact will occur to the west and east of the range, where an expanded view of the ridge, and development, would be possible; north and south view points view the turbines in a more clustered arrangement. Local roads travelling in a north-south direction on the eastern and western side of the Cullerin range service townships / villages such as Collector, Breadalbane, Gunning and Gurrundah. There may be some specific locations, for example around Mount Wayo to the North and around Parkesbourne and Breadalbane where both sites are visible.

If all proposed wind farms are developed, the Parkesbourne / Breadalbane area would have potential to see wind turbines to the west (Cullerin), north-west (Gunning), north (Gurrundah) and north-east (Evandale), although not all at the same time. An estimated worst-case scenario for these two areas is shown in Table 7.14. This arrangement may be viewed as surrounding the townships of Breadalbane and Parkesbourne to some extent, although distance, local topography and existing vegetation will, in some locations, reduce this effect.

There is likely to be a growing number of wind farm proposals in the area, with testing towers in several locations further north along the Cullerin Range. This can result in adverse cumulative impact, as the character of the area changes. Alternatively, having more wind farms in the area, they may become more acceptable and present less of a contrast to the existing environment.

Attitudinal surveys of residents near the proposed Taralga wind farm suggested that 2 out of 3 residents objected to the proposal. Surveys indicate that attitudes can change after construction, based on actual experience of a wind farm (Warren *et al.* 2005). Exaggerated perceptions of wind farms are dispelled after living near a wind farm (Elliott 1994; Redlinger *et al.* 2002; SEDD 2002; Braunholtz 2003; SEI 2003a, cited in Warren *et al.* 2005) with more positive feelings about wind farms being recorded closer to the wind farm site than further away (Warren *et al.* 2005). However, additional proposals are likely to increase the opposition to wind farm developments, at least in the short-term. A strategic determination of an upper limit of wind farms in the locality may dispel some of the anxiety related to the uncertainty of future developments and character change in the area.

Table 7.13 Existing and proposed wind farm on/near the Southern Tablelands

Proponent	Name and location	No. of turbines	Distance from Cullerin
EXISTING			
Eraring Energy	Crookwell I, south of Crookwell, installed 1998.	8	26km
Eraring Energy	Blayney, commissioned 2000.	15	Over 100km
APPROVED			
Delta Electricity	Gunning, approved	Approximately 32	10km
Gamesa Energy Australia	Crookwell II, near Goulburn, approved 2005.	60	27km
Woodlawn WindEnergy JV	'Woodlawn', near Tarago, approved 2005.	25	27km
RES Southern Cross	Taralga, approved 2006.	69	60km
PROPOSED			
Bannister / Gurrundah / Kialla	Marubeni Power Systems, currently undergoing assessment.	Approximately 40	15km
Taurus Energy	Evandale, NW of Goulburn, currently undergoing assessment.	Up to 15	20km
EHN (Oceania)	Molonglo Range, near Queanbeyan, currently undergoing assessment.	Up to 60	55km
Taurus Energy	Conroy's Gap, W of Yass, DA being finalised.	Up to 15	65km

Sources: Company websites, media releases and published Environmental Impact Statements

There is considerable existing electrical infrastructure in the area, including the 132 kV transmission line south of Cullerin range and an additional power line that runs across the site itself. The electrical infrastructure present in the region is not considered to be of a scale that will contribute significantly to the cumulative visual impact for the site (Scenic Landscape Architecture 2005). The Hume Highway also presents a built form of similar scale to the proposed Cullerin Range wind farm however, the highway is a horizontal element, which is not considered to create an additional cumulative visual impact (Scenic Landscape Architecture 2005).

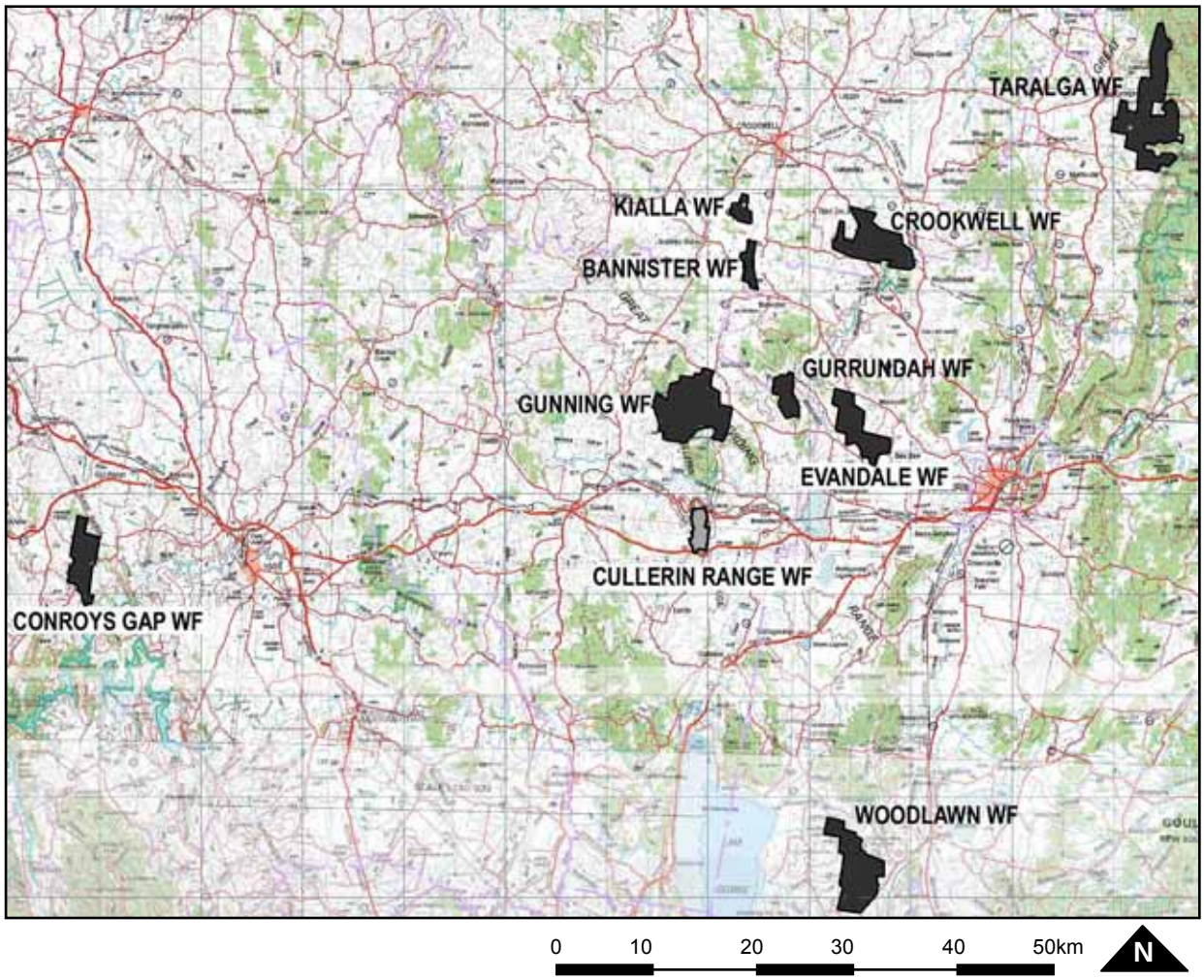

Figure 7.29 Location of approved and proposed wind farms in the region

Table 7.14 Proximity of Breadalbane and Parksbourne to proposed (and approved) wind farms

	Breadalbane	Parkesbourne
Cullerin wind farm	8km	12km
Gunning wind farm (approved)	10km	12km
Gurrundah wind farm	10km	8km
Evandale wind farm	10km	5km

At distances greater than 15km, the visual impact of the infrastructure is considered to be negligible (Scenic Landscape Architecture 2005), therefore cumulative visual impact is considered to be absent at this distance. The development of the proposed wind farm at the Cullerin site is not anticipated to generate a high level of cumulative visual impact, given the distances between developments, orientation of the range and directions where the site would be most visible. Details specific to the visual impact of the proposal are discussed in Section 7.1.

Biodiversity

The potential for collision is enhanced with increasing numbers of turbines. An extension of development along the Cullerin Range (that is, considering the impacts of the Cullerin site and approved Gunning site to the north) would increase the extent of the collision hazard for bats and birds during the operational phase of the wind farm.

The Cullerin site has been identified as being located parallel to a potential movement corridor for birds, the wetlands and riparian corridor 4km to the east. This is likely to be the northern extent of the movement corridor, and therefore would be unaffected by further development to the north of the Gunning proposal. Forest and woodland is more extensive to the north. Therefore, additional impacts to forest and woodland birds or birds that select these areas as movement corridors is likely to be less at the Cullerin site than north at the Gunning site. The Cullerin site is considered to provide only marginal native vegetation and habitat values and development of the proposed wind farm is not anticipated to generate a high level of cumulative impact on regional biodiversity values.

Noise

Background noise at the Cullerin site is affected by the Hume Highway to the south, the Old Hume Highway to the north and the Southern Railway to the north. Therefore, the additional noise of the wind farm could be expected to generate higher levels at nearby residences. Operational noise impacts have been characterised by contour modelling, summarised in Section 7.3. These levels take into account the existing background levels.

At distances greater than 2km, the noise of infrastructure attenuates to reach background levels, no cumulative impact would result from the operation of the Gunning wind farm to the north, which would be located in excess of 10km from the northern-most turbine.

The development of the Cullerin site may affect subdivision potential within two kilometres of infrastructure during the operational phase of the wind farm, on the basis of noise. Given the high background noise levels recorded at the site, the availability of more suitable land for subdivision (away from the ridges and erosion gullies that characterise the site) and the reversibility of the proposal at the end of the project's life, this impact is not considered to be high.

Telecommunications

The impact of the development on telecommunication interference has been addressed in Section 7.8.3. The proponent has committed to boosting the transmission of radio and tv signals in the area, if they are reduced as a consequence of the operation of the wind farm. This impact can be addressed on a case by case basis and is therefore not anticipated to have a cumulative impact.

Traffic and transport

The impact of the development on road condition and safety has been addressed in Section 7.8.1. The proponent has committed to mitigating safety risks and undertaking to upgrade roads where required, in consultation with the RTA and Upper Lachlan Council. This impact can be addressed on a case by case basis and is therefore not anticipated to have a cumulative impact.

Operational vehicle and safety impacts are anticipated to be low and to only minimally increase risks to motorists and damage to roads. These impacts have been addressed above and are not anticipated to have a high cumulative impact.

Physical impacts

The impact of the development on air, soils and water quality, such as would occur due to the transport and operation of machinery during the construction phase, has been addressed in Sections 8.1. The proponent has committed to mitigating these impacts as part of the

proposal. Most impacts fall into the construction phase, which is unlikely to be concurrent with any other wind farm development. This impact can be addressed on a case by case basis and is therefore not anticipated to have a cumulative impact.

The proposal would provide an additional source of greenhouse-gas emission free electricity to consumers. The installation of remote generation operations also reduces the amount of energy lost during power line transmission over long distances. This contributes to cleaner and more efficient energy production. The cumulative impact of additional wind turbines in the region is a net gain both in terms of climate and air quality when set aside energy generated by fossil fuel combustion. There area is not suitable for hydro-electricity generation and solar generation has so far not appeared to be cost-effective on a large scale.

Social

The increase in the number of wind farms in the region impacts on the local identity of the locality and region. While the development is not considered by this assessment to be incongruous with existing agricultural land use, it may detract from the heritage / rural lifestyle aesthetic that is attracting commuters and retirees to the region. Population growth and rural subdivision are not incompatible with wind farm development (overseas examples sustain much higher densities in closer proximity to wind farms) however, a certain sector of the market may be sensitive to the look and symbolism of the development. This would be enhanced by an increasing number of wind turbines in the region and therefore has a cumulative impact.

Means to address this impact are primarily strategic. Developments should not be sited where they surround an area or present a continuous experience (such as parallel to the transport corridors. Reducing the number of turbines can reduce the dominating appearance of the developments, as can clustering turbines rather than spacing them uniformly. The orientation of the Cullerin Ridge and natural screening features to the north (roadside vegetation and forested ridges) assist to reduce the cumulative impact of the development, when considering in conjunction with the impact of the proposed Gunning wind farm to the north. Nonetheless, localities such as Breadalbane and Parkesbourne may be able to view turbines from several different developments, if they go ahead.

Economic

The proposal would have economic benefits to the local community as discussed in Section 7.4.2. These include lease payments to involved landowners, employment for local contractors and suppliers and increased demand for services in the area such as accommodation, food and fuel, during the construction and decommissioning phases. Additionally, the proponents are considering an appropriate community project/service which could be promoted to address the inequitable distribution of financial benefits (refer to Section 7.4.1).

The cumulative impact of additional wind power developments or similar sized industries is a net gain in terms of the economic injection it provides to the local community. With an increasing number of wind farm proposals in the area, it could be expected that an increasing proportion of contracting and manufacturing needs for these projects could be met locally, due to the increased experience and skill-base.

Impact assessment

Construction and decommissioning impacts

As discussed above, potential for cumulative impacts exists in the construction and decommissioning phases, on account of air and water quality impacts and road safety and road condition impacts. These are more appropriately addressed and mitigated on a case by case basis, thereby addressing the cumulative impact upfront. Mitigation measures for these impact areas are presented in Section 9.2.16.

Positive cumulative impacts would result in the local economy, primarily distributed in the construction and decommissioning phases.

Operational impacts

Operational impacts cumulative impacts may result as a consequence of other similar sized developments also impacting on visual, noise, biodiversity, social and telecommunication elements. These have been discussed above. Only the social parameter, specifically the impact on changing the local identity of the region, was considered to be generative a significant cumulative impact. When considering this proposal in relation to future similar sized developments, consideration should be given to:

- Siting developments so they do not surround a property or locality
- Siting developments so that a continuous experience of similar infrastructure is not unavoidable (such as parallel to the transport corridors).
- For wind farms, reducing the number of turbines and regularity of arrangement (by clustering turbines rather than spacing them uniformly).

7.11 Removal of infrastructure

The effective life of the wind farm can be extended through increased maintenance and component refurbishment towards the end of its life. This gives a wind farm a life of 20-30 years. Therefore, the date of turbine removal is uncertain.

The value of the wind turbines in scrap metal is considered by the proponent to be sufficient to pay for much of the cost of removal and site rehabilitation. Further, a large proportion of the materials used for construction of a wind turbine can now be recycled (Schleisner 2000).

It is expected that a special purpose company would own and operate the wind farm over its life. A provision will be made in that company's accounts to ensure sufficient funds are set aside over the life of the project to cover the cost of the eventual project decommissioning.

To ensure that the site is rehabilitated adequately at the end of the project's life, the following prescriptions would be incorporated into the development:

- Wind turbines, substation, control building, and the associated above ground electricity infrastructure would be removed and the site restored within 12 months of the wind farm being decommissioned.
- Written evidence would be provided to the Director General, that the lease agreement(s) with the site landowners have adequate provisions to meet the decommissioning requirements, that the site be restored to a similar condition as existed before the development, by way of a specific site restoration plan.
- The proponent will ensure that sufficient funds are set aside from operating revenues to decommission the project.

8 ASSESSMENT OF LESSER PRIORITY ISSUES

The issues considered in this section were determined to be of lesser priority than the key issues discussed in Section 7. As such, these issues were assessed in-house, primarily by desktop investigation. While potential for adverse environmental impact is still present, these issues are considered to be more generic with regard to mitigation, managed by way of the environmental safeguards discussed under each parameter. Table 8.1 summarises the issues considered in this section.

Table 8.1 Summary of lesser priority issues

Issue	Refer to:
Climate	Section 8.1.1
Air quality	Section 8.1.2
Soils and landforms	Section 8.1.3
Hydrology	Section 8.1.4
Construction noise	Section 8.2
Safety and health	Section 8.3
Non-indigenous heritage	Section 8.4
Resource impacts	Section 8.5

8.1 Physical impacts

8.1.1 Climate

Existing environment

The site and immediate area ranges from approximately 700 – 850m, with development proposed to be focused on ridges. Data obtained from the Bureau of Meteorology weather station at Goulburn indicate that the highest mean maximum temperature occurs in January (28.1°C) and the lowest mean minimum occurs in July (1.3°C). Although the local topography of ranges and plateaus can result in localised climatic conditions, temperatures onsite are expected to fall within this range.

The mean annual rainfall in the Goulburn area is recorded as 687.8mm, between 1961-1990. However, rainfall in the Goulburn area has been lower than average over three of the last four years. The annual totals for the last four years are as follows: 776.2mm (2000-01), 595.1mm (2001-02), 481.4mm (2002-03) and 453.2mm (2003-04). Highest monthly rainfall historically occurs from May to June. Lowest monthly rainfall historically occurs from November to April.

Goulburn is one of a small number of inland areas of New South Wales that has been targeted for the development of wind farms, due to the reliably high wind speeds recorded on ridges in the area. Davy and Coppin (2003) analysed wind speeds at several sites in South East Australia, including Goulburn. They noted anomalous calms recorded late at night and early in the morning for Goulburn, attributed to the stable atmospheric conditions at night and the

sheltered position of monitoring stations. Summer showed the largest potential for wind generation capacity, with lowest seasonal capacity in autumn.

Climatic data for Goulburn therefore indicates that diurnal conditions in summer can be dry and hot with high wind speeds. This could be expected to produce dusty conditions, particularly in drought where heavily grazed paddocks are prone to wind erosion.

Impact assessment

Construction and decommissioning impacts

No climatic impacts are anticipated to be generated during the construction or decommissioning phases. Dust and erosion mitigation are discussed in Sections 8.1.2 and 8.1.3, respectively.

Operational impacts

Local climate impact

Local climate may be affected to a minor degree by the increase in turbulence caused by the operational wind turbines. Modelling and experimentation on real wind turbines has shown that the mixing effect of thermal layers has very little effect on temperature during the day (Baidya, *et al.* 2004). Recordings taken below wind turbines and averaged over a 24 hour period were observed to be greater than existing ground level wind speeds by approximately 0.6 metres/second and to raise temperatures by approximately 0.7^{o}C (Baidya, *et al.* 2004).

Wind speed impacts have been suggested as being confined to a distance from each turbine equivalent to 10 times the vertical height of the turbine (SEDA 2002). For the turbines considered (a maximum of 126m from the ground to blade-tip), an effect up to 1.26km from each turbine may be expected (attenuating with distance from the turbines). As the local topography is undulating, the horizontal distance from each turbine may be less than this amount in actuality.

The turbines would turn slowly in low wind conditions and faster with increasing wind speeds; hence they would enhance not counter natural wind conditions. The anticipated change in wind speed and temperature at the ground level is not considered large enough to impact vegetation or be in conflict with the continued agricultural use of the land. This impact would be ongoing but minor and is not considered to require mitigation.

Broad climatic impact

The proposal would make a positive contribution to the reduction in greenhouse gas emissions by providing an alternative to electricity sourced from fossil fuels. This constitutes the chief environmental benefit of the proposal, as discussed in Section 4 of this document.

For each Megawatt-hour of electricity consumed in the NSW electricity pool, approximately 1,000 kilograms of greenhouse gases are emitted, primarily from coal fired power stations. The Cullerin Range wind farm would represent a renewable, non-greenhouse gas producing method of electricity generation to meet increasing demand. Every Megawatt-hour of electricity generated by the wind farm would prevent one Megawatt-hour of electricity being generated at a coal fired power station, as well as preventing losses within the electricity transmission system. This represents a reduction of at least 1,000 kilograms of greenhouse gases for each Megawatt-hour of electricity generated.

Reduction in greenhouse gas emission directly contributes to combating the adverse impacts of climate change:

- Extreme Weather,
- Water Impacts,
- Imperilled Ecosystems,
- Global Meltdown of arctic and alpine systems,
- Health issues related to warmer air and water temperatures,
- Economic Risks.

Adverse impacts noted specifically for Australian agricultural communities include an increase in floods, droughts and forest fires. As a consequence of reduced local production capacity in conjunction with increased production in positively affected northern hemisphere countries, the economic impact of climate change is particularly relevant to agricultural economies (AGO 2003) such as the Goulburn-Yass region.

No adverse climate change impacts related to the operational phase are anticipated, due to the wind farm. An energy analysis comparing wind farms to alternative energy production plants is discussed in Section 8.5.

8.1.2 Air quality impacts

Existing environment

The site is located in an extensive agricultural land use zone. Agricultural activities can produce periodic adverse affects on air quality during activities such as sowing pasture, harvesting or slashing pasture. During drought conditions particularly, large areas of bare ground may occur after intensive grazing, fire or periods of low rainfall. This may increase wind erosion with resultant increases in dust levels. Dust storms are known from the region (2001 and 2002) during drought.

The State of the Environment report for the Upper Lachlan Council for 2004 notes reduced air quality in the winter months due to heavy smoke from wood fires. This is more likely to be experienced in urban areas, not onsite or in the immediate vicinity. A wood smoke reduction program was undertaken around the former Gunning and Crookwell local government areas during 2004 to address this issue.

There is no industrial development located in the locality. The region has little manufacturing industry, hence a low level of industrial emissions.

Impact assessment

Construction and decommissioning impacts

Dust and emissions would be generated during excavation works, concrete batching, road works and the transport of machinery. Impacts would be greatest during construction and decommissioning phases. Impacts would be temporary, occurring during a 3-6 month construction period. Similarly, the area that would be impacted would not be great in extent (works areas indicated on Figure 3.8 and Figure 3.9).

The impacts of the proposal during the construction and decommissioning phases are considered manageable with regard to air quality and climate. Mitigation strategies that would be employed during these phases to manage the potential for adverse air quality impacts are listed below.

Table 8.2 Potential impacts from dust and emissions with mitigation strategies

Activities	Mitigation
o Disturbance to vegetation to establish a hardstand area at the base of each turbine. Removal of vegetation may increase wind erosion and airborne dust. Pasture would not be cleared however, compaction would kill individual plants, increasing the potential for erosion.	o Landforms would be stabilised and rehabilitated as soon as practicable after works (see Section 3.4 for rehabilitation principles). o Turbine placement would, where possible, avoid impacts to mature trees.
o Blasting activities to establish turbine footings. Blasting may be required, pending the results of geotechnical investigation, to adequately secure the footings. One house occurs approximately 500m from where blasting may be required. This landowner is involved with the proposal.	o Nearby residences would be informed prior to blasting. o Should controlled blasting be required, it would be carried out in accordance with all relevant statutory requirements.
o A concrete batching plant would be installed onsite. Dust from dry materials and emissions from mixing machinery may occur as a result of the plant. These would be minor and not located near residences.	o The batching plant would not be located near residences. o Dust levels at stockpile sites would be visually monitored. Dust suppression (eg. water sprays) will be implemented if required. o Product stockpiles will be protected from prevailing weather conditions. o Loads of dry materials will be covered where appropriate. o Dust filters will be installed on silos. o Only machinery compliant with emission standards will be used. o Machinery and vehicles will not be left running or idling when not in use.
o Rock crushing to convert excavated materials to road base. The operation of mobile rock crushing equipment may generate dust and vehicle emissions.	o As above
o Excavation of footings for wind turbines and for the control room and substation.	o Excavation would only be commenced during stable, dry weather conditions, operational requirements permitting.

Activities	Mitigation
o Construction of trenches to house underground cables.	o Excavation would only be commenced during stable, dry weather conditions, operational requirements permitting. o Subsoil would be separated from topsoil for rehabilitation purposes. All topsoil from the excavation sites would be stockpiled and replaced to its original depth for seeding and fertilising. On steep slopes, topsoil would need to be stabilised using, for example, jute matting. Any excess subsoil would be removed from the site and disposed of at an appropriate fill storage site. o On the steeper slopes check banks would be installed across the trenchline, approximately 50 metres apart, following closure of the trench. These would discharge runoff to areas of stable vegetation.
o Installation of vehicle tracks and upgrades to existing tracks. This would result in some clearing and compaction of vegetation on the existing road verge.	o Excavation would only be commenced during stable, dry weather conditions, operational requirements permitting. o Landforms would be stabilised and rehabilitated as soon as practicable after works.
o Dust generated by vehicle traffic on dirt roads.	o Should dust generation be of a high level during the transport of machinery near residences, watering of sections of the route would be undertaken to reduce dust.
o Vehicle emissions both onsite and enroute to the site.	o Vehicles and motorised equipment would be maintained so that emissions are minimised.

Operational impacts

The operation of the wind farm will require minimal traffic on roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. None of the wind farm infrastructure will generate emissions that would impact air quality. Therefore, no air quality impacts are anticipated to be generated during the operational phase.

8.1.3 Soils and landforms

Existing environment

The CANRI database (Department of Natural Resources, accessed October 2005) shows that the site is situated on stable land forms, suitable for cultivation. Areas considered to have severe limitations occur to the north and south of the site. These areas would not be impacted by works. The Soil Landscapes of the Goulburn 1:250,000 mapsheet (Soil Conservation Service of NSW 1991) shows that the site consists of two soil units; '**mi'** (Midgee) and '**wy'** (Wyangala) (Figure 8.1).

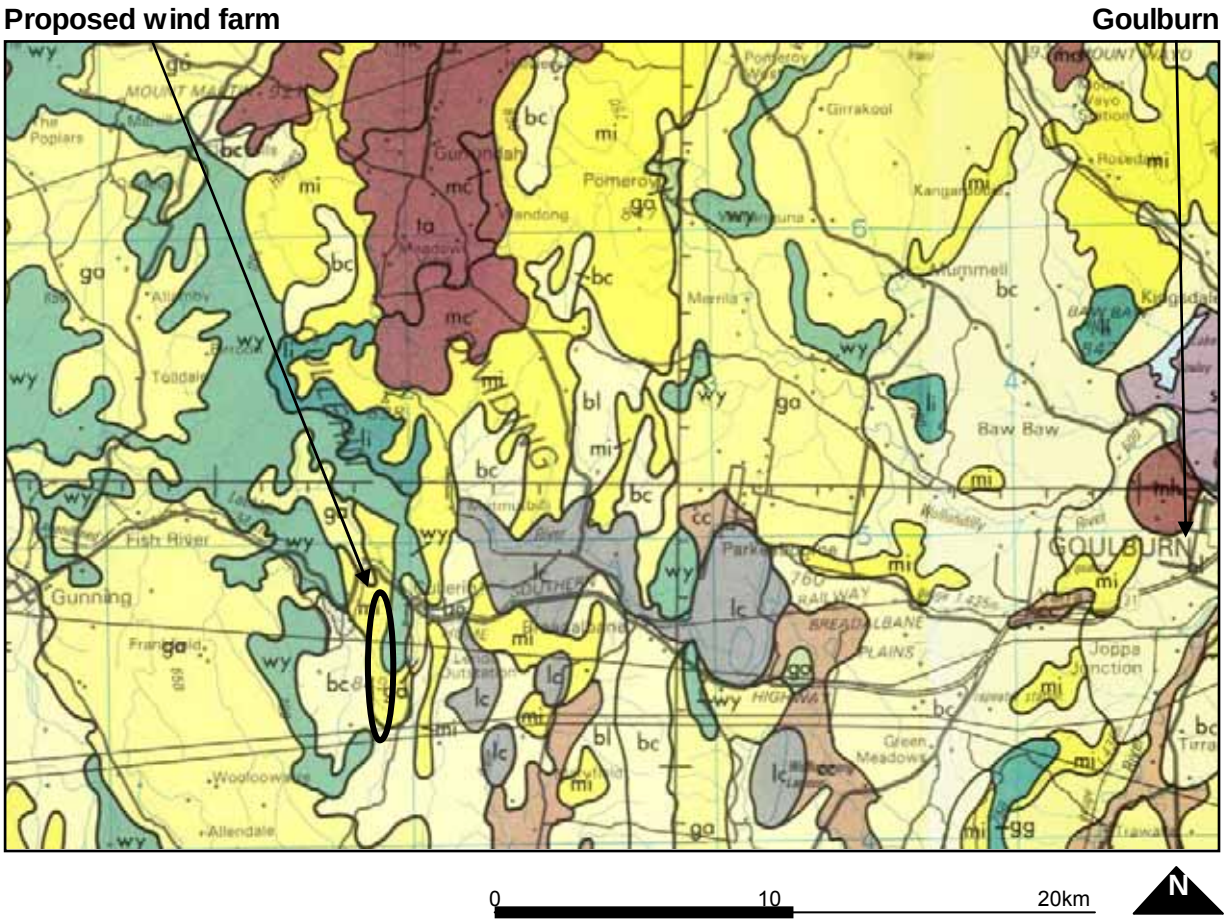

Figure 8.1 Soil types for the local area

'**mi'** (Midgee) occurs on the west and south of the site. Landscapes are rolling to low hills on Ordovician and Devonian and Silurian metasediments. Soils are commonly acid stony yellow earths and yellow podsolic soils on side-slopes and crests, in association with lithosols, red podzolic soils and red earths with soloths on lower slopes. This soil unit is known for widespread minor to moderate sheet erosion. Gullying of drainage lines also occurs (Soil Conservation Service of NSW 1991).

'**wy'** (Wyangala) occurs on the east of the site. Landscapes are rolling granitic low hills and hills with tors and boulders. Siliceous sands, red earths and red duplex soils occur on side-slopes. Yellow duplex soils occur on footslopes and in some drainage lines. Gully erosion is common in drainage lines. Sheet erosion can occur following drought or bushfire and occasional salting occurs in low lying areas (Soil Conservation Service of NSW 1991).

The soils mapping data is patchy for the area however, extensive areas of sodic soils have been indicated near Goulburn (EPA 2004). Sodic soils are those soils with an Exchangeable Sodium Percentage (ESP) greater than 6. When wet, these soils are highly dispersive, adversely impacting soil structure and subsequently landform stability and plant growth. The effect of ESP on soil dispersion is also influenced by organic matter content, clay mineralogy (Australian Soil Classification 2003).

Impact assessment

Construction and decommissioning impacts

Soils onsite are sensitive to erosion and sodicity. No clearing of the extent required to instigate the latter process would be undertaken. Control of erosion (and associated landform stability and sediment mobilisation impacts) are serious issues for works onsite.

Impacts to soil and landforms would be greatest during construction and decommissioning phases. Soil compaction and soil erosion could occur during excavation works, road works and the transport of machinery. A risk of contamination to soils, as hydrocarbons would be used onsite and toilet facilities would be required. The contractor would implement a Spill Control Plan as part of its Erosion and Sediment Control Plan. Spill Control Plans would identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager. The event and clean up processes would be recorded and passed to the Upper Lachlan Shire Council. If the spill or hazard should reach surface waters the EPA must be notified.

Impacts would be temporary, occurring during a 3-6 month construction period. Works, and therefore potential for impact, would be limited to specific areas and would not be great in extent. If mitigation measures are employed the potential for cascading impacts (such as transport of sediment in drainage lines and resultant impacts offsite) can be avoided.

The impacts of the proposal are considered manageable with regard to soils and landforms. Mitigation strategies that would be employed during these phases to manage the potential for adverse environmental impacts are outlined below.

Table 8.3 Potential impacts to soils and landforms with mitigation strategies

Activities	Mitigation
o Disturbance to vegetation to establish a hardstand area at the base of each turbine. Removal of vegetation may increase wind erosion. Turbines would be positioned to avoid mature trees. Pasture would not be cleared however, compaction would kill individual plants, increasing the potential for erosion.	o Landforms would be stabilised and rehabilitated as soon as practicable after works. o Turbine placement would avoid impacts to mature trees, where possible.
o Transport of heavy equipment. Soil compaction would occur as a consequence of the transport of heavy equipment. Compaction can reduce the biotic soil binding mechanisms provided by bacteria and micro invertebrates and leave surface layers of soil more susceptible to wind and water erosion. In lower slope positions, compaction of saturated soils may cause slumping, affecting slope stability and water quality. In the main, areas to be compacted would be confined to already established tracks.	o Tracks would be graded to enhance stability. o Routes would be confined to already disturbed areas, where possible.

Activities	Mitigation
o Blasting activities to establish turbine footings. Blasting has potential to impact on the stability of landforms.	o While the soils onsite are prone to erosion, they are not considered to be unstable and therefore the impacts of blasting on landforms and their stability is anticipated to be low. o ANZECC guidelines for control of blasting impact at residences would be adhered to.
o Excavation of footings for wind turbines and for the control room and substation. Works would cause gross soil disturbance, create stockpiles and thereby represent a high risk of erosion and mobile sediment generation. These works would occur in discrete areas and could be managed to avoid erosion during and following construction works.	o Excavation would only be commenced during stable, dry weather conditions, operational requirements permitting. o Subsoil would be separated from topsoil for rehabilitation purposes. All topsoil from the excavation sites would be stockpiled and replaced to its original depth for seeding and fertilising. On steep slopes, topsoil would need to be stabilised using, for example, jute matting. Any excess subsoil would be removed from the site and disposed of at an appropriate fill storage site. o On the steeper slopes check banks would be installed across the trenchline, approximately 50 metres apart, following closure of the trench. These would discharge runoff to areas of stable vegetation.
o Vehicle and machinery operation. Hydrocarbon spills during refuelling of equipment are a risk during the construction, operation and decommissioning phases.	o Site storage areas would be identified, and be bunded to prevent loss of any pollutants. o Hydrocarbon spill kits would be stored at the site. o Machinery would be operated and maintained in a manner that minimises risk of hydrocarbon spill. o Maintenance or re-fuelling of machinery would be carried out in hard-stand areas (ie. existing or proposed road surface or hard-stand areas beneath turbines, not on areas that either contain native vegetation, or would be revegetated). o Where chemicals are used, their application and disposal would comply with manufacturers recommendations.
o Rock breaker and gravel storage. Compaction would result from the rock-breaking equipment and stockpile sites. These would be temporary.	o Landforms would be stabilised and rehabilitated as soon as practicable after works.
o Concrete batching plant operation. Concrete would be made onsite, to be used in the footings of the turbines and onsite buildings. Concrete wash can impact upon the chemical fertility of the soil.	o Concrete wash would be deposited in an excavated area, below the level of the topsoil.

Activities	Mitigation
o Risk of spills (hydrocarbons and wastes)	o Provide toilet facilities for construction workers. o Minimise risk of chemical spills and ensure prompt and effective clean up of any accidental spills.

Operational impacts

The operation of the wind farm will require minimal traffic on roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. No soil or landform impacts are anticipated to be generated during the operational phase.

8.1.4 Hydrology (water quality and water-table impacts)

Existing environment

The site is situated in the Lachlan catchment. The Lachlan River is the largest in the area. It is located approximately one kilometre north of the development site. Creeks are marked as occurring approximately 2.5km to the east and 2km to the west of the main ridgeline proposed for development. Many of these are seasonal. Banks appear extensively denuded in the area with active erosion gullies forming onsite and in the immediate vicinity. An extensive wetland area occurs 4km east of the site.

The Upper Lachlan Catchment frequently has nutrient concentrations higher than those recommended for the protection of modified aquatic ecosystems, primarily related to turbidity (Thurtell 2003). Higher nutrient concentrations can increase the extent and duration of toxic algal blooms. Measures recommended to reduce these levels, include addressing catchment and in-stream erosion, the degradation of stream banks and riparian areas throughout the catchment (Thurtell 2003).

Impact assessment

Construction and decommissioning impacts

The water bodies in the area are sensitive to input from erosion. Construction would be focussed on ridges and therefore no water body would be directly impacted by the proposed development. Rivers and wetlands may be impacted indirectly through turbid run-off, however. Measures could be implemented to restrict run-off and thereby curtail offsite impacts.

Impacts to water quality would primarily relate to the transport of equipment and vehicles within close proximity to drainage lines and the generation of mobile sediment and potentially pollutants, during construction. Water table impacts are not anticipated. In total, approximately 3.5 kilometres of new track would be installed. Minor upgrades to existing tracks may also occur. Increased compacted areas would increase the amount and turbidity of runoff, to a minor extent. While traversing these tracks, there is potential for the leakage of fuels or other hydrocarbons which could find their way in to drainage lines.

Dust, mobile sediment and vehicle emissions generated during transport, excavation and blasting works may also find their way into drainage lines. This could lead to elevated levels of sediment and turbidity in stormwater discharged and therefore reduce water quality. Where water pools, increased nutrients can rapidly reduce the oxygen content with toxic effects to aquatic environment and biota that inhabit them.

Additionally, there is a risk that construction materials such as alkaline concrete wash would be discharged from the construction sites. Chemicals are found in paints, acids for cleaning

surfaces, cleaning solvents, concrete products, soil additives used for stabilisation and other purposes, concrete-curing compounds, fuels as well as other sources. When used or stored improperly, these chemicals can become mixed with stormwater and carried by sediment and runoff from construction sites. Eutrophication of surrounding waters could also occur from the use of fertiliser (during revegetation), and nutrient release from sediments as a result of erosion and release of turbid waters during construction.

Although the site has sensitive receptors, the impacts of the proposal are considered manageable with regard to water quality. Specific activities that would be undertaken, and their potential environmental impacts are listed below. Mitigation strategies that would be employed to manage the potential for adverse environmental impacts are outlined in the table below.

Table 8.4 Potential impacts to site hydrology with mitigation strategies

Activities	Mitigation
o Generation of mobile sediment. Blasting, excavation and vehicular traffic may result in increased levels of sediment in nearby waterways.	o All vehicles onsite would follow established trails and minimise onsite movements o All bridges used would be assessed prior to works to ensure that they are able to bear the projected loads of the laden vehicles. o Sediment traps would be installed wherever there is potential for sediment to collect and enter waterways. o Excavation would only be commenced during stable, dry weather conditions, operational requirements permitting. o On the steeper slopes check banks would be installed across the trenchline, approximately 50 metres apart, following closure of the trench. These would discharge runoff to areas of stable vegetation. o Stabilisation and rehabilitation of disturbed ground would be carried out as soon as practicable after works. o Stockpile sites would be identified and turbid water discharged from these treated by a combination of silt fencing and temporary mulching/seeding.
o Generation of pollutants. There is a risk that pollutants from vehicles and machinery (fuels and other hydrocarbons), concrete batching, rehabilitation works (fertilisers, herbicides) may be leaked and transported via runoff into nearby waterways.	o Site storage areas would be identified, and be bunded to prevent loss of any pollutants. o Hydrocarbon spill kits would be stored at the site. o Machinery would be operated and maintained in a manner that minimises risk of hydrocarbon spill. o Maintenance or re-fuelling of machinery would be carried out in hard-stand areas (ie. existing or proposed road surface or hard-stand areas beneath turbines, not on areas that either contain native vegetation, or would be revegetated). o Where chemicals are used, their application and disposal would comply with manufacturers recommendations. o The concrete batch plant would include an in-ground water recycling / first flush pit to prevent dirty water escaping onto the site, and would be fully remediated after the construction phase.
o Impacts to the water table.	o Not applicable.

Operational impacts

The operation of the wind farm will require minimal traffic on roads/tracks that would have been upgraded to accommodate heavy loads during the construction phase. No water quality impacts are anticipated to be generated during the operational phase.

8.2 Construction noise add concrete batch plant

Existing environment

The site proposed for the development is bounded by the Hume Highway to the south and the Old Hume Highway, Old Sydney Road and Great Southern railway line to the north, separated by a distance of approximately 4km, north to south. Extensive grazing occurs on a mix of exotic and native pastures. Therefore, existing background noise includes relatively constant traffic noise from the Hume Highway, intermittent traffic noise from the less used northern roads and railway line as well as periodic noise generated from local traffic and agricultural vehicles and machinery.

Receptors in the area include residences, local traffic as well as infrequent walkers and horse-riders. Based on cadastre information, one residence occurs approximately 750m from the ridgeline proposed for the installation of turbines and three additional residences are located approximately one kilometre from the ridge (refer to Figure 3.4). The owners of these residences are all involved in the development. Six additional residences are located within two kilometres of the ridge. The owners of these latter residences are not involved in the development. Horses are kept in a property nearby (within 2km) and it is likely that Lerida Road North and the Old Sydney Road are used recreationally for horse-rides and walks. No schools, churches or other public venues occur within 2km of the site.

Depending on weather conditions, turbine installation can occur at a rate of 2-4 turbines per week, suggesting a two month installation period. Additional time is required prior to turbine installation for civil construction and site preparation as well as after installation, for site rehabilitation. This total construction period would be in the order 6 months, pending weather conditions and staging of works. Residences nearby would be exposed to construction noise for the entire construction period (although works would not occur continuously at any one site), whereas recreational users of the area would be affected less and may even choose alternate routes during the construction phase due to the increased traffic and activity during this period.

Impact assessment

Construction and decommissioning impacts

Two types of noise would be associated with the development; noise generated during construction and noise generated during operation of the wind farm. Operational noise is discussed in Section 7.3. Identification of construction noise sources and modelling of construction activities were completed by Heggies Australia. Extracts from this report (attached in full, Attachment 3.2) are cited below for general construction and blasting activities.

<u>General construction</u>

Construction activities would include;

- Construction of access roads
- Establishment of turbine tower foundations and electrical substation
- Digging of trenches to accommodate underground power cables
- Erection of turbine towers and assembly of wind turbines.

The equipment required to complete the above tasks will typically include;

- Excavator/grader, bulldozer, dump trucks, roller,

- Bucket loader, rock breaker, drill rig, excavator/grader, bulldozer, trucks (dump, flat beds, concrete)
- Excavator, flat bed trucks, cranes, fork lift, and various 4WD and service vehicles.

The NSW EPA construction noise guidelines recommend noise level goals and hours for work. The hours of work for construction sites is limited from 7:00 am to 6:00 pm weekdays and 7:00 am to 1:00 pm on Saturdays, with no construction taking place on Sundays or Public Holidays. For construction programmes that are shorter in duration (less than 4 weeks) it is considered acceptable for construction noise levels to exceed background noise levels by up to 20 dBA. For construction periods of less than 26 weeks (6 months) it is considered acceptable for construction noise levels to be up to 10 dBA above background noise levels. The EPA Guideline identifies noise-sensitive locations as residential premises, schools, hospitals, places of worship, parks and wilderness areas. Apart from the transport of machinery, which can be routed to avoid sensitive locations, the works would not occur within close proximity of residential areas, schools etc.

The anticipated construction period is anticipated to be less than 6 months, with civil works expected to span approximately 3 months, however, due to the large area of the wind farm site intensive works will be located within a distance of potential impact for each surrounding residential receiver for only very short and intermittent periods of time. It is therefore considered appropriate that construction noise levels up to 20 dBA above background noise levels would be considered acceptable for short term intensive civil works that are anticipated to produce high noise levels.

A concrete batch plant is proposed to be established on the access road, approximately 500 metres north of the Hume Highway to the South East of the site. The nearest affected receiver would be approximately 2.4 km from the batch plant

Two ‘worst case’ area of works was chosen; one for the northern area of the site and one for the southern area of the site. The concrete batch plant was also included. The resulting predicted construction noise level for the relevant ‘worst case’ scenario is summarised in Table 12 of the Noise Impact Assessment, Attachment 3.2, together with typical background noise levels obtained during the background noise monitoring campaign.

The predicted ‘worst case’ construction noise impacts are for most receiver locations, below the existing typical daytime background noise level. Some northern receivers (Springvale, Wandella, Illawambra) are anticipated to receive elevated construction noise levels when civil works are located nearby, however, due to the anticipated short period of localised works would likely be considered satisfactory.

Springvale is the only location predicted to marginally exceed (3 dBA) short term construction noise guidelines. This impact is a result of access road construction when all associated machinery is operated in close proximity to the residence. Consideration should be given to staging of works in this vicinity or alternative to locating the access road further from residents to minimise impacts. In consideration that the predicted levels represent typical ‘worst case’ construction scenarios and are generally within limits which would be considered acceptable, it is unlikely that construction noise will cause any unnecessary impact.

Blasting works

The ground vibration and airblast levels which cause concern or discomfort to residents are generally lower than the relevant building damage limits. The NSW EPA advocates the use of the ANZECC guidelines for assessing potential residential disturbance arising from blast emissions. The ANZECC guidelines for control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear. The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dB Linear at any time.
- The recommended maximum for ground vibration is 5 mm/s, Peak Vector Sum (PVS) vibration velocity. It is recommended however, that 2 mm/s (PVS) be considered as the long-term regulatory goal for the control of ground vibration. The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.
- Blasting should generally only be permitted during the hours of 9:00 am to 5:00 pm Monday to Saturday. Blasting should not take place on Sundays and public holidays.
- Blasting should generally take place no more than once per day.

The Australian Standard 2187.2-1993 "Explosives - Storage, Transport and Use. Part 2: Use of Explosives" does not present human comfort criteria for ground vibration from blasting. It does however make mention of human comfort level for airblast in saying the "a limit of 120 dB for human comfort is commonly used". This is consistent with the ANZECC guidelines.

As part of the civil works it is expected that infrequent blasting will be required to clear obstacles and prepare wind turbine foundations. It is anticipated that a single blast per every 2-3 days may be required for a period of approximately 2 weeks. Blasting may be required in some areas to clear large rock outcrops to prepare turbine foundations.

The proposed wind farm site is a green field site where no previous blasting or blast monitoring has been conducted and therefore no specific site laws exist. A site law derived from measurement data at a different site was used to determine an indicative result.

Based on the blast emissions site laws, calculations were also conducted to indicate the allowable MIC's for compliance with the general EPA Human Comfort criteria of 115 dB Linear (airblast) and 5 mm/s (ground vibration). The closest anticipated distance between blasting and residences would be approximately 800 metres. At this distance the predicted Maximum Instantaneous Charge (MIC) of up to 50 kg is likely to produce an airblast overpressure to an acceptable level of 115 dB Linear.

It is evident that the anticipated blasting is likely to meet all human comfort limits and building damage assessment criteria are easily met.

Operational impacts

Noise that would be generated during the operational phase of the development is addressed in Section 7.3.

Table 8.5 Potential impacts of construction noise with mitigation strategies

Activities	Mitigation
o Noise generated by construction and installation of the wind farm. Potential sources of noise and vibration include drilling equipment, excavation and earthmoving machinery, concreting and rock crushing equipment and power tools. Blasting may be required. These activities would occur during a 3-6 month construction period.	o Works would comply with the Environment Protection Authority's construction noise criteria for working times and emission levels. o Machinery would use appropriate and effective exhaust mufflers and compressor silencers. o Works would be staged in the vicinity of Springvale to minimise impacts. o Noise complaints would be responded to rapidly using monitoring equipment. If EPA Guideline restrictions are being exceeded, appropriate noise reduction strategies would be employed, such as the re-orientation or re-positioning of machinery, re-scheduling of noisy activities, installation of temporary noise barriers, improved vehicle noise control, reduced work times and the use of 'quiet work practices' (such as reducing or relocating idling machinery).The need for, and the timing and location of the proposal would be well publicised and explained to improve community tolerance of noise emissions. o ANZECC guidelines for control of blasting impact at residences would be met.
o Noise generated by heavy vehicles enroute to the site. It is estimated that 160-240 large vehicle movements are expected to occur over a three month period (a maximum of 20 heavy or oversized vehicle movements in any one day).	o As above, and o A traffic management plan will be prepared with input from RTA.

8.3 Safety and health

Existing environment

An element of risk is present to workers and the public, during the construction and operational phases of the proposal. Construction activities pose safety risks for workers, the public and stock onsite and enroute to the site. Electromagnetic fields, shadow flicker and infrasound are issues that have been associated with the operational phase of wind farms and may pose health impacts. Turbines may also pose a risk if inadequate anchorage results in the turbines, parts of them, becoming detached. These issues are discussed below. (Risk of fire is discussed in Section 7.9).

Construction activities

Risks inherent in wind farm construction activities relate to the size and movement of infrastructure (large rotating blades at great height), high voltage electricity and high wind speeds. The risks are similar to working on other large infrastructure, such as tall buildings and transmission lines. No member of the public has been killed by a wind farm. Fourteen construction or operation staff have been killed world wide, most during construction-related activities, since the early 1970s (SEDA 2004). Industry practice has improved over this time and many dangerous activities have been eliminated or reduced; for example, climbing (SEDA 2004). Standard work place practices, such as restraints, fall arrest systems, protective clothing, procedures that ensure infrastructure remains stationary during specific activities,

emergency response protocols and equipment and reminders of the requirement for workers to take responsibility for their safety are able to address a large component of the risk.

Each stage of construction (travel, installation, site restoration) involves different risk types and levels. Construction works would take place over a 6-9 month period, utilising main and local roads. Considering traffic flow to and from the site, 160-240 large vehicle movements are expected. Works would be spread over several locations, including individual turbines sites and sections of road works. Construction impacts at any one location would not be continuous.

Turning off the Hume Highway presents a risk to construction traffic and other motorists. Local traffic, although of low volume, will be exposed to changed traffic conditions. Stock is unfenced along Lerida Road North, which would be used to access the site, presenting a collision risk.

The safety issues associated with construction traffic have been discussed in Section 7.8.1. An access route has been selected which, with the implementation of recommended environmental safeguards, will minimise risks to workers, the public and stock during the construction phase.

Workers would be required to install and maintain the proposed wind farm development. Similar risks will be present during site restoration. These risks relate to the operation of large machinery, heights, works in the vicinity of high voltage lines as well in the handling of materials such as hydrocarbons. These risks are considered manageable with the implementation of workplace safety protocols.

Electromagnetic fields (EMFs)

Electromagnetic fields are generated by operational electrical equipment, including transmission lines, substations, and the wind turbines. Transmission lines and electrical devices generate 50 Hz electric and magnetic fields in their vicinity. While electric fields can be reduced both by shielding and with distance from operating electrical equipment, the magnetic field component can only be reduced with distance. Electromagnetic fields can have acute and chronic impacts.

Due to the type and configuration of equipment, the electromagnetic fields will be different in different locations onsite. The transmission lines would generate greater EMFs than the wind turbines and would be located closer to the ground (and therefore closer to potential receptors). In a 33kV transmission line, the load may be ‘unbalanced’ (greater at one end than the other) and located closer to the ground than in a 132kV line and may therefore generate higher EMFs. Therefore, consideration must be given to the placement of all EMF producing infrastructure and to the proximity and duration that receptors (people and stock) would be exposed.

High voltage lines can produce magnetic field exposure to receptors (people and stock standing beneath them) of up to 80 milligauss (mG). This is far less than the 1000mG limit recommended for 24 hour exposure (National Health and Medical Research Council Interim Guidelines on Limits of Exposure to 50/60 Hz electric and magnetic fields).

The ridgeline containing wind turbines as well as the area around the substation and electricity easements would be generating EMFs and therefore public access should be limited. These areas would not be accessed by the general public (excluding the potential that the site may in future be used as an educational facility) and would only periodically be accessed by maintenance staff and property owners. Hence, the opportunity for human exposure to EMFs will be low. Acute impacts are not anticipated as a consequence of the low exposure rates in combination with the low likelihood that people or stock would stand directly beneath the lines for extended periods. Onsite, underground cabling would be used where practicable; this reduces the electric component of EMF by shielding. The turbines and substation would be located as far as practicable from residences.

The National Health and Medical Research Council evaluated the evidence on chronic exposure and stated that to date, chronic low-level exposure to 50/60 Hz fields has not been established to increase the risk of cancer (p.14, NHMRC 1989). However, as a precautionary

measure, all EMR generating infrastructure will be sited as far as practicable from residences. The distance from receptors addresses the magnetic component of EMF.

Shadow flicker

Shadow flicker is produced by the shadow cast by moving turbine blades when the sun is at a low angle (morning and evening). The resulting flicker can cause a nuisance, or if between 8-30 Hz can be a health hazard (Epilepsy Association of Australia).

The effect of 'chopping the light' attenuates with distance and is not considered, by modellers of shadow flicker (Danish Wind Industry Association 2003) to be noticed beyond 500-1000m from a turbine. The operational wind turbines are not anticipated to produce a flicker frequency high enough to pose a health risk. Comparable turbines have been rated 0.45 to 0.95 Hz, well below critical levels of 8-30 Hz for public health.

The area that would be impacted by shadow flicker was assessed as part of the Traffic and transport assessment, Section 7.8.1 (Attachment 3.7). Considering the drivers field of view, only limited exposure it anticipated to shadow flicker within 500-1000m of a turbine and no exposure is present less than 500m from a turbine.

The effect of the spinning turbines can also cause some people to feel nauseated, similar to a feeling of travel sickness. This may be a driving hazard for affected motorists, particularly if motorists are unable to avoid a view of spinning turbines, whilst travelling within close proximity of the site. When approaching the site, an uninterrupted view of turbines is present in some sections of the Hume Highway. As for shadow flicker, no direct view is present within 500m of a turbine. As the turbines will be elevated above the road surface (approximately 50-100m), it is possible to avoid looking directly at the turbines while driving.

Stability of turbines

The turbines, at up to 126m in height, would represent a hazard if inadequate anchorage resulted in a turbine falling over or if a blade were to detach itself during operation and fall to the ground. Ice may also be propelled from the blades in extremely cold conditions. The likelihood of these events occurring within 210m of a turbine has been calculated as 1:10,000,000 (Taylor and Rand 1991, cited in SEDA 2004).

Due to the size of component parts, objects are not likely to fall far from the turbine. Three hundred meters has been suggested as the upper buffer distance required to ensure no buildings or populated areas are within range (SEDA 2004). The SEDA article also notes that this will always be less than the buffer required to meet visual and noise criteria. Mitigation of these risks comes down to receiving and implementing sound geotechnical advice during construction, choice of a reliable turbine and proper installation and maintenance of the turbines.

Wind turbines have been installed in earth quake prone zones around the world, however these areas usually have legislation governing infrastructure design, unlike the Upper Lachlan Shire.

Impact assessment

Construction and decommissioning impacts

Construction sites can create a public safety hazard and therefore, risks must be mitigated. During the construction and decommissioning phases, there is a risk to workers and to motorists, due to the construction works required and the large volume of heavy vehicles. Occupational Health and Safety procedures and traffic management investigations would be implemented to reduce these risks, as outlined in Table 8.6.

Table 8.6 Potential impacts to public safety with mitigation strategies

Activities	Mitigation
o Health risks to workers and the general public would be present during construction and decommissioning of the wind farm, including: Risk of injury during construction works. Risk of injury during transport of equipment to the site. Risk of injury to the public. Risk of injury to stock.	o Workplace health and safety protocols would be developed to minimise the risk of fire for workers during construction and during maintenance in the control room and amenities. o The safety of the workforce would be managed by strict safety procedures, good design of site tracks, and regular maintenance. If an incident occurs, communications to ambulance or medical services would be via phone or radio. o Traffic management investigations will be used to ensure that roads and bridges are adequate to handle the loads required and to identify strategies to reduce the risk to other motorists during the construction and decommissioning phase (refer to Section 7.8.1). o Site fencing would be installed where work staff consider that there is a risk to the safety of the general public (ie. when the trench is left open for extended periods).

Operational impacts

During the operational phase of the development, there is potential to generate health risks such as through exposure to electromagnetic fields and shadow flicker. These impacts are considered to be manageable by implementation of mitigation strategies, discussed below.

Table 8.7 Potential safety impacts with mitigation strategies

Activities	Mitigation
o Health impacts to workers and the general public during the operation of the wind turbines, including: Risk to trespasses Risk to stock.	o Start-up and shutdown (including safety shutdowns) are fully automated, with manual interruption available via onsite control systems and remote computer. o The substation area would be surrounded by a security fence as a safety precaution to prevent trespassers and stock ingress. o During construction and decommissioning, stock would be excluded from the works area (excluding road works)
o Generation of electromagnetic fields	o Appropriate substation design criteria of Country Energy would be adhered to. o Onsite, underground cabling would be used where practicable to reduce the electric component of EMFs. o The turbines, substation and transmission lines would be located as far as practicable from residences (to reduce the potential for both chronic and acute exposure).

Activities	Mitigation
o Generation of shadow flicker	o If shadow flicker is found to be a nuisance to residents or motorists, conditions can be pre-programmed into the control system and individual wind turbines automatically shut down whenever these conditions are present.

8.4 Non-indigenous heritage

Existing environment

The Gunning and Goulburn regions have strong links to the agricultural settlement history by Europeans. A draft heritage review of the Goulburn region was prepared in 2003 by the Goulburn City Council and for the Mulwaree Shire in 2002-2004. These reviews compiled an impressive inventory of places of heritage significance in the locality, indicative of the rich built heritage resource and status of the area as one of Australia's finest heritage destinations (Goulburn City Council 2003).

Tourism in the area is largely based on the region's historic land use and settlement patterns (tourist drives, farm stays, bed and breakfasts, agricultural festivals and shows, tours of historic buildings, museums and memorials). An assessment of the impact of the proposal on tourism activities has been undertaken in Section 7.7 Land use.

Historic buildings are concentrated in Goulburn however, several occur at a greater distance and lower density in and around local villages, being relics of stations and cultural infrastructure which include schools, main houses, shearing sheds, churches and cemeteries. These scattered features add to the historic rural character of the area. The closest such site is a ruin that occurs at the railway crossing approximately 1.5km north-east of the ridge proposed for works. Approximately one kilometre from the site is the Old Hume Highway (also known as Cullerin Road) which provides a less travelled scenic drive between Goulburn and Gunning.

Heritage registers exist at the Commonwealth, state and local level. The State of the Environment 2004 lists sixty places of cultural or historic significance in the Upper Lachlan Council Area on various heritage registers as of June 2004 (eleven items appear on more than one register). Little information was available on the condition and management of listed sites. Privately owned heritage items in the Council area are noted as being at particular risk due to lack of sufficient funds to manage them. A summary of heritage listings is presented in Table 8.8 (ACT Commissioner for the Environment 2004).

Table 8.8 Summary of heritage listings in the Upper Lachlan Shire Council area

Name of register	Number of places
World Heritage	1
Register of the National Estate	
Cultural places	11
Natural places	6
Aboriginal places	1
State Heritage Register	5
Section 170 NSW State agency heritage registers	5
Local Environment Plan (LEP)	42

World Heritage

The southern tip of the Greater Blue Mountains Area falls within the Council area and was inscribed on the World Heritage List in December 2003. This area is over 75km from the site proposed for the Cullerin Range wind farm.

Register of the National Estate

Within 30km of the Cullerin site proposed for the wind farm, five sites occur that have been registered on the Commonwealth National Estate Register as **historic items**:

i) Collingwood Homestead, 5km north-east of Gunning (~12km north-west of site);

ii) Frankfield Homestead Group, 6km east-south-east of Gunning (~6km west of site);

iii) St James Chapel on Kippilaw, 12km west of Goulburn (~19km east of site);

iv) Tirranna Garden Farm Complex and Cemetery, 7km south-south-west of Goulburn (~27km east of site); and

v) Wollogorang Garden, 7km south-east of Breadalbane (~15km east of site).

(Matters of National Environmental Significance search tool).

Significant features of these sites include historically important for its association with the early history of the area, interesting architectural features, extensive range of building types and styles, reflects the important place of the Christian faith in the nineteenth century, reflects more than 150 years of pastoral activity, important for its aesthetic quality, age and style (source: Matters of National Environmental Significance search tool).

Two sites occur that have been registered on the Commonwealth National Estate Register as natural items**:**

i) Fossil Leaf Beds Specimen, Oolong Creek, Dalton; and

ii) Lake George Quaternary Site, 2km south of Collector

(Matters of National Environmental Significance search tool).

Significance of these items relates to them being the sole remaining example of the Dalton fossil leaf deposit on view to the public and in the vicinity of the type locality, and provision of the longest relatively continuous Quaternary continental sequence yet available from Australia, respectively (Matters of National Environmental Significance search tool).

Aboriginal places are discussed within Section 7.5: Archaeological assessment.

State and local heritage registers

In NSW there are two types of statutory heritage listings. As defined by the NSW State Heritage Register, a property is a heritage item if it is:

i) listed on the State Heritage Register, a register of places and items of particular importance to the people of NSW, and/or

ii) listed in the heritage schedule of the local council's Local Environmental Plan (LEP).

Approval must be gained from the Heritage Council when making changes to a heritage place listed on the State Heritage Register, or when excavating any land in NSW where you might disturb an archaeological relic.

The site proposed for the Cullerin Range wind farm is covered by the Gunning LEP 1997. Schedule 2 of the LEP lists heritage items in the area. Heritage significance may be attributed to an item on social, architectural, natural, scientific, archaeological, aesthetic, historic or cultural grounds (Gunning LEP 1997). Tables 8.8 and 8.9 detail the items listed under the state and local registers for localities within the vicinity of the site proposed for works.

Table 8.9 Heritage items listed under the Gunning LEP for Breadalbane, Collector and Dalton

Breadalbane

Places on heritage registers in or near Breadalbane

Name	Location	Town / Nearest Town	Date Listed			
			LEP	State Heritage Register	Register Of The National Estate	Other Register
Anglican Church (All Saints)	Corner of Collector & Cullerin roads	Breadalbane	1997			
Breadalbane Public School (Former)	Corner of Old South Road & Gurrundah Street	Breadalbane	1997			
Roman Catholic Church (St Brigid's)	Old South Road	Breadalbane	1997			
Sweetwood Lea (formerly Archers Inn)		Breadalbane	1997			
Raeburn Homestead (including stables)	Old South Road	Breadalbane	1997			

Collector

Places on heritage registers in or near Collector

Name	Location	Town / Nearest Town	Date Listed			
			LEP	State Heritage Register	Register Of The National Estate	Other Register
Bushranger Hotel (formerly the Commercial Hotel)	24 Church Street	Collector	1997			
Lake George Quaternary Site	Federal Highway	Collector			1986	
Murray's Lagoon stone lined channel outlet	Old Federal Highway	Collector	1997			
Roman Catholic Church (St Batholomews)	Bourke Street	Collector	1997			
Uniting Church	Bourke Street	Collector	1997			
Winderadeen	Federal Highway	Collector	1997			
Wollogorang	Federal Highway	Collector (via Breadalbane)	1997		1978	
Wollogorang Garden	Federal Highway	Collector (via Breadalbane)			1992	

Dalton

Places on heritage registers in or near Dalton

Name	Location	Town / Nearest Town	Date Listed			
			LEP	State Heritage Register	Register Of The National Estate	Other Register
Anglican Church	Jobson Street	Dalton	1997			
Dalton Primary School	Jobson Street	Dalton	1997			
Dalton Public Hall	Chapel Street	Dalton	1997			
Eschol		Dalton	1997			
Fossil Leaf Beds Specimen		Dalton			1982	
Oddfellows Hall	Chapel Street	Dalton	1997			
Royal Hotel	Corner of Gunning & Chapel streets	Dalton	1997			
Uniting Church	Chapel Street	Dalton	1997			

Table 8.10 Heritage items listed under the Gunning LEP for Gunning

Gunning

Places on heritage registers in or near Gunning

Name	Location	Town / Nearest Town	Date Listed			
			LEP	State Heritage Register	Register Of The National Estate	Other Register
Anglican Church and surrounding buildings	Biala Street	Gunning	1997			
Boureong (formerly Albert Vale)		Gunning	1997		1978	
Building	22 Hume Street	Gunning	1997			
Caxton Cottage (Single Storey Shop) (part of Shop Group)	87 Yass Street	Gunning	1997			
Caxton House (Double Storey Terrace) (part of Shop Group)	83-85 Yass Street	Gunning	1997			
Collingwood	5 km Northeast of Gunning	Gunning	1997		1978	
Cottage	11 Gundaroo Street (11 Collector Road)	Gunning	1997			
Court House and Police Station	Corner of Yass & Warrataw streets	Gunning	1997		1978	
Frankfield Homestead (including Conservatory, Stables, Blacksmiths shop, Old Kitchen, Old Bath House, garden, trees and dam)		Gunning	1997		1978	
Gunning Railway Signal Box Movable Relics	Main Southern Railway	Gunning		1999		SRA s.170 Register (1999)
Gunning Railway Station And Yard Group		Gunning		1999		SRA s.170 Register (1997)
Hotel Group, includingTelegraph Hotel	82-84 Yass Street	Gunning	1997			
Manufacturers Mutual Insurance Building	105 Yass Street	Gunning	1997			
Mundoonen Nature Reserve	Hume Highway	Gunning			1978	
Public School	Yass Street	Gunning			1978	
Shop (single storey) (part of Shop Group)	81 Yass Street	Gunning	1997			
Shop Group	81-87 Yass Street	Gunning	1997			
St Edmund's Anglican Church and Rectory and Uniting Church	Biala Street	Gunning	1997			

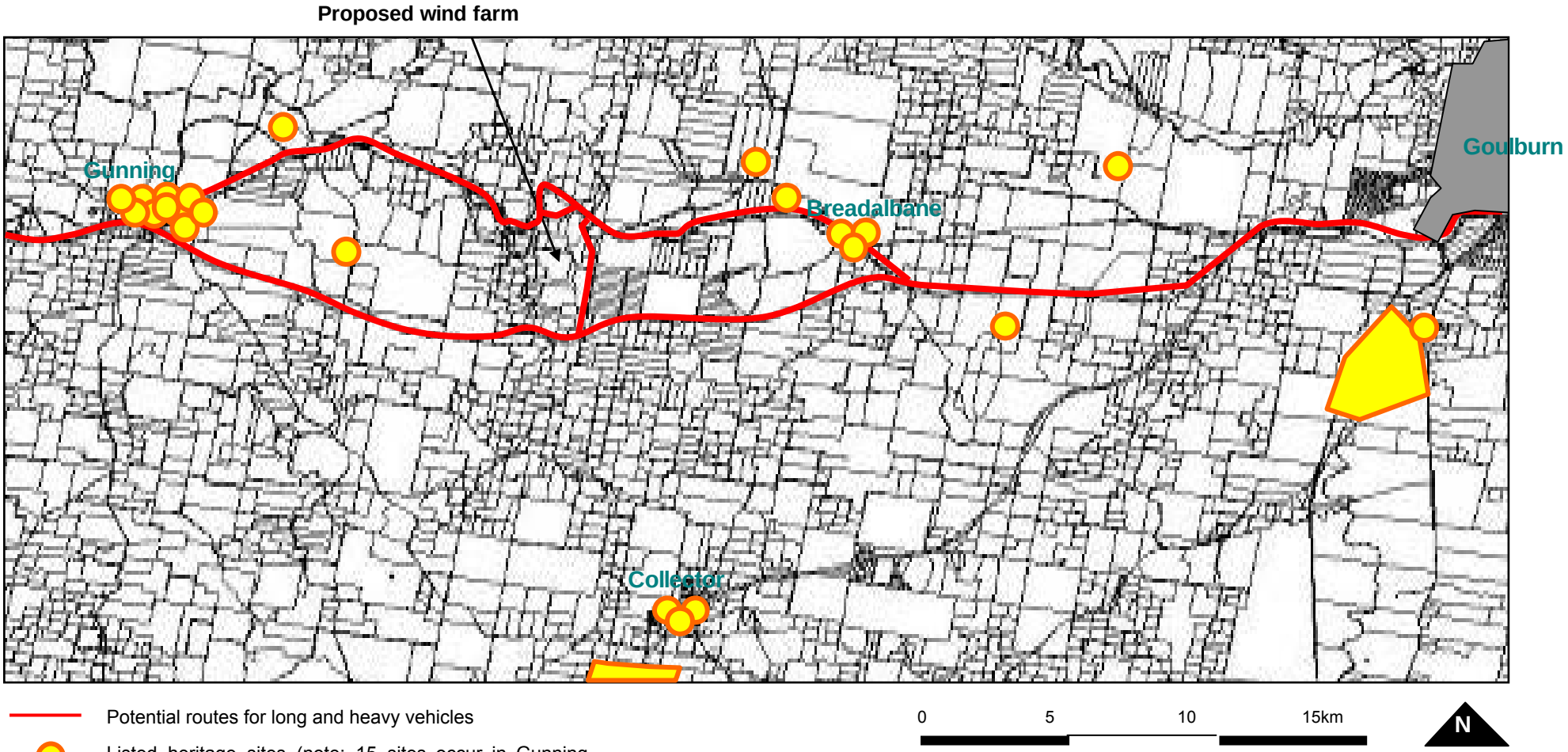

Figure 8.2 Distribution of heritage items in the vicinity of proposed access routes

Unlisted items

During a vehicle based assessment in the locality, several historic features were observed. Rail way bridges are present where the Southern Railway crosses the Old Hume Highway and drainage lines. On Wollogorang Road, large residential and agricultural buildings were observed. On Gurrundah Road several old characteristic cottages are present. The closest such site is a ruin that occurs at the railway crossing approximately 1.5km north-east of the ridge proposed for works (Section 7.7.2, Figure 7.19).

Figure 8.2 shows the distribution of listed heritage items in the area and potential routes for the movement of large and heavy vehicles to the Cullerin Range site.

Impact assessment

The NSW Heritage Council provides the following eight points outlining the potential impacts of wind farms on heritage items:

> "Wind development is a relatively young industry in Australia. While growth over the last three years has been huge on an international scale, Australia still has a relatively small uptake of wind power.
>
> While the Heritage Council supports renewable energy development, it recognises that if inappropriately planned, wind farm developments can potentially adversely affect heritage items and cultural landscapes.
>
> The Heritage Council encourages strategic approaches to renewable energy planning, development and management to eliminate or minimise these affects. It is important that any issues regarding this young industry are identified and addressed in its early stages.
>
> An impact is any effect on heritage items, including cultural landscapes, which would not have occurred in the absence of the development. An adverse impact is one that leads to the loss of heritage value.
>
> Identifying the significance of an impact requires consideration of not only the magnitude of the impact and its likelihood of occurring but also the value and importance placed on the heritage item.
>
> There are two major concerns when considering the appropriateness of a wind farm in or near a heritage item: wind farms within the curtilage of a heritage item and wind farms outside the curtilage of a heritage item.
>
> A wind development has the potential to affect any of the seven criteria for the assessment of a heritage item. It is these criteria that the Heritage Council of NSW bear in mind, when assessing an applications for change to a heritage item. If the proposed change is likely to materially affect the item, it is likely that amendments to the proposal will be requested.
>
> Heritage is a non-renewable resource. Once it is lost it cannot be replaced. Early consideration, planning and intervention are essential to ensure that we conserve our most valued heritage items."
>
> Source: NSW Heritage Office 2003

As no generic assessment principles can be applied, assessment must be on a case by case basis. The wind farm would not occur within the curtilage of a heritage item. As several sites are in the locality, Section 6.5 of the Heritage Council Advice has been considered (provided below).

"The proposal of a wind development outside the curtilage of a heritage item is also of concern to the Heritage Council of NSW.

If a wind farm development is located within the vicinity of a heritage item it has the potential to materially affect the heritage items values that are recognised in the assessment criteria.

A heritage item needs to be considered in the context of the history and historical geography of the area surrounding it. When identifying the heritage items of a given area, a purely visual approach is inadequate. It is important to understand the underlying historical influences which have shaped and continue to shape the area" (Heritage Office & DUAP 1996).

If the proposed wind development is within the vicinity of heritage items or potential heritage items, the proponent should contact the heritage consent authority (NSW Heritage Office, or local government) early in the process to discuss the development and potential affects on the heritage items.

The Heritage Council of NSW recommends that the proponent review the Local Environment Plan and State Heritage Register to identify any listed heritage items within the vicinity of the proposed development.

In addition to consulting the LEP and SHR, a proponent should also review the existing local heritage study (if available), to identify any other potential heritage items within the vicinity of the proposed development.

The proponent should not assume that because a heritage item is not listed on the LEP or SHR that it should not be conserved (many state significant cultural landscapes have not yet been listed on the SHR, for example). The local heritage study will help proponents identify these non-listed items, as well as any potential archaeological relics.

A statement of heritage impacts should be submitted with the development application, considering any potential material affects on the heritage item. This should be accompanied by a statement of heritage significance, conservation policy and management guidelines for the items identified as being potentially materially affected by the development.

Local Government will need to review the potential material affects on these heritage items when considering the application. A well considered and comprehensive consideration of all aspects in the submission will assist local government in making their decision on the development.

The information gathered through this process will assist a proponent when addressing the community about the proposed development. Concerns regarding heritage and cultural landscapes have been a central concern of communities when considering wind farm applications in the past.

An effective strategy to manage the affects on heritage items will assist in ensuring communities that their valued heritage has not only been assessed but will also be conserved."

Source: Wind Farms and Heritage, NSW Heritage Council Advice

The guidelines of the NSW Heritage Office have been considered in the following impact assessment.

Construction and decommissioning impacts

The construction and decommissioning phases have the potential to materially affect local heritage items; several listed items occur in the locality. Between 160-240 large vehicle movements would occur to bring infrastructure and machinery onto the site. Although the works would not take place within close proximity of any listed heritage items, the transport of heavy and large vehicles on roads passing these items may subject the sites to increased levels of dust and vibration. If extreme, the latter impact has potential to adversely affect the structural integrity of built structures.

The proposed route for heavy vehicles is along the new Hume Highway, north along Lerida Road North, west along a small section of the Old Hume Highway and Old Sydney Road and then south onto the site (refer to Section 7.8.1, Figure 7.20). A traffic study has been completed for this route and, with mitigation measures employed to improve safety and trafficability, this route appears the most preferable (refer to Section 7.8.1).

An unlisted ruin, potentially of a railway station building, occurs opposite the northern end of Lerida Road North. Vehicles utilising the northern end of Lerida Road North may come within 150m of this feature (refer to Section 7.7.3, Figure 7.7). Traffic impacts such as the generation of dust and vibration, are not anticipated to impact upon this site materially, due to the distance involved and the routing of the railway line between the site and the preferred vehicle route. The cumulative temporary impact of vehicles may generate minor additional impacts on this site however, they are considered minor in comparison to the ongoing impact of rail traffic and the current poor state of this feature.

Smaller vehicles may also utilise the Old Hume Highway between Gunning and Goulburn. Travelling along the Old Hume Highway, between Gunning and the site, involve passing within 500m of 'Collingwood', listed on the National Register. The road is sealed at this point and as the vehicles would not be heavy or long, the additional traffic impact on this site is anticipated to be minor.

Large and heavy vehicles would not travel through the main street (Yass Street) of Gunning or travel near Breadalbane, Collector or Dalton and therefore would not impact sites in these areas or detract from the rural / scenic quality of these areas. Large and heavy vehicles would not travel along the Old Hume Highway, except for a small section (~250m) to turn onto Old Sydney Road, and would therefore have only a minor impact on the experience of motorists on this scenic drive.

The selected route would avoid travelling near listed heritage sites and appears from Figure 8.2 and investigations above to be the most preferable, with regard to heritage values of the area.

To further reduce the potential for impact to heritage values during the construction and decommissioning phases of the wind farm, it is recommended that the following measures be employed:

- Inform the Upper Lachlan Shire Council and NSW Heritage Council regarding the proximity of final access routes to listed heritage items).
- Implementation of a Traffic Management Plan to define appropriate access routes and measures needed to ensure that the additional traffic load required during construction and decommissioning does not adversely affect buildings nearby as well as road infrastructure.

Operational impacts

While the proposal would not have direct impacts on heritage features during the operational phase, the construction of infrastructure onsite (turbines, control building, substation) that will be present for the life of the project may detract from the heritage aesthetic desired by the community and important in projecting an attractive image to motorists in transit and visitors to the area.

To reduce the potential for impact to heritage values during the operational phase of the wind farm, it is recommended that the following measures be employed:

- Infrastructure should be sited to minimise viewing from local roads and highways. While it is recognised that the wind turbines must be located on ridges, additional infrastructure such as control buildings could be placed in less visible locations. Screening should be considered for buildings that would be visible from roads.
- Building design, materials and colour should be appropriate to the heritage values of the area. Overly modern or industrial design and materials would detract from the area's heritage values.
- Underground rather than overhead transmission should be used where it would not result in inappropriate risks to soils and land forms. Although extensive existing electricity transmission infrastructure is present on the site and to the south, the cumulative impact of the development should be reduced where possible.

8.5 Resource impacts

Life cycle analysis

Life cycle analysis (LCA) is based on careful accounting of all energy and material flows associated with a system or a process. This approach covers the whole project life cycle, from the extraction of raw materials to the disposal of materials at the end of the poject's. LCA is particularly relevant for renewable technologies, where it is often argued that the energy used to produce the technology is not 'paid back' during the lifetime of the technology (Schleisner 2000). For all the materials used in the process, LCA estimates of energy and emissions based on the total life cycle of the materials, i.e. the total amount of energy consumed in procuring, processing, working up, transporting and disposing of the respective materials (Schleisner 2000).

In Schleisner's (2000) analysis of two wind farms in Denmark, the energy 'payback' time was modelled to be 0.26 years for a wind farm on land. That is, in approximately 3 months, the energy produced by the wind farm had 'paid back' the energy consumed in producing, installing and decommissioning that wind farm. It was found that 94% of the materials used for construction of a wind turbine could be recycled (Schleisner 2000); the percentage is likely to be related to local facilities. The value of the materials able to be sold for reuse can be used to offset the cost of decommissioning the wind farm and rehabilitating disturbed areas.

A life-cycle assessment has been conducted by Vestas for a Vestas V90-3.0MW wind turbine, similar to those that would be installed on the Cullerin Range. As is typical for such an assessment, Vestas divided the life-cycle into four phases: production, transportation, operation and disposal. This assessment looked only at the turbines and did not consider associated infrastructure such as transmission lines, substation and control building.

By far the greatest consumption of energy and resources occured in the production phase. Raw materials required include iron ore of the construction of steel components and their casings as well as crude oil to make the epoxy materials used in blade construction. These resources are limited and considered non-renewable, when the rate of extraction is compared to the rate of formation.

In contrast, the transportation, operation and disposal phases were relatively minor. For the sized wind farm that is proposed for the Cullerin Range which and is located on a major transport corridor, the transportation resources related to the fuel consumed by vehicles transporting, installing and maintaining the turbines would be minor.

During the operational phase (based on a 20-30 year life-span and taking into account the maintenance required over this period) the costs begin to be offset by the operational capacity of the turbines. The turbines proposed for the Cullerin Range have greater efficiency in producing energy than smaller sized turbines, due to the optimised comparative weight of the larger turbines.

Disposal encompasses the fuels required to dismantle and transport the turbines as well as the disposal of materials.

Using a functional unit of 1 kW hour as a basis for comparison, Vestas provide the following comparisons between phases of the 3MW wind turbine life-cycle and CO2 emissions between other energy producing power stations (Tables 8.10 and 8.11).

Table 8.11 Break down of the energy consumed during phases of the life cycle of a Vestas V90-3MW.

A Vestas V90-3MW turbine is expected to generate 157,800MWh during a 20 year lifetime, repaying energy required to produce the turbine in approximately 6.6 months. Energy required to produce, transport, operate and dispose of the turbine has been converted to MWhs to facilitate comparison with total energy produced..

	Onshore Vestas V90-3MW
Production phase	7,795 MWh
Transport phase	74.00 MWh
Operation phase	14.00 MWh
Disposal phase	-3,572 MWh
Total	*4.311 MWh*

Table 8.12 Comparison of CO2 emissions produced per kilowatt hour.

Using energy output (kWh) to compare emissions, the wind turbine produces a small fraction of the CO2 emissions of coal or gas-fired power stations.

	CO2 produced
Onshore Vestas V90-3MW turbine	8 grams per kWh
Gas-fired power station	467 grams per kWh
Coal-fired power station	826 grams per kWh

Hence, by comparison to major electricity generating methods employed in Australia, wind farms rate favourably based on:

- CO2 emissions produced per kilowatt hour of energy produced
- Potential to reuse and recycle component parts, and
- Energy payback time in comparison to the life span of the project.

Construction and decommissioning impacts

The majority of resource use and waste generation would occur during the construction and decommissioning phases.

Use of resources

The construction of the proposed wind farm, including associated infrastructure, would require the use of various resources, such as concrete and other masonry products (footing, slabs, hardstand areas, building elements), materials associated with the operation of machinery, and motor vehicles (fuels and lubricants) and other construction materials (metals, glass, plastics). These materials are not currently depleted or restricted in supply however, increasing scarcity and environmental impacts are becoming apparent from the use of fossil fuels and other non-renewable resources.

The impact of works on woodland habitat, a natural resource that can be considered to be in short supply in the region, has been addressed in Sections 7.6.1 and is considered acceptable.

The proposal therefore, would not place significant pressure on the availability of local or regional resources.

Creation of waste

Solid waste is one of the major pollutants caused by construction. Solid waste would be generated from a number of activities including limited vegetation removal and construction activities, including material from packaging, building materials, scrap metals, sanitary wastes, plastic and masonry products. Hazardous wastes would be present onsite; these include sanitary wastes, hydrocarbons and fertilisers. During decommissioning similar wastes would be generated.

A key strategy of construction and decommissioning works would be to minimise waste from the construction site, reuse or recycle waste where possible and implement protocols to minimise the risk of spills.

To minimise adverse environmental impacts it is recommended that:

- Waste would be reused or recycled whenever possible. Separate recyclable materials receptacles would be provided (eg. For glass, plastics and aluminium).
- Packaging materials and general construction wastes would be disposed, with Council's approval, at Council operated waste disposal centres.
- Toilet facilities would be provided for onsite workers and sullage from contractor's pump out toilet facilities would be disposed at the local sewage treatment plants or other suitable facility agreed to by Council.
- Surplus topsoil would be stockpiled on site during construction, and following construction would be spread on the site (particularly over hardstand areas and access roads) to assist in revegetation.

- Excavated material would be used in road base construction and as aggregate for footings where possible, surplus material would be disposed of in appropriate locations on site (on agreement with the landowner), finished with topsoil, and revegetated.
- Risk of chemical spills would be minimised and protocols would be in place to ensure prompt and effective clean up of any accidental spills.

  The contractor would implement a Spill Control Plan as part of its Erosion and Sediment Control Plan. Spill Control Plans would identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur. Any spill that occurs, regardless of size or type of spill, would be reported to the Construction Manager. The event and clean up processes would be recorded and passed to the Upper Lachlan Shire Council. If the spill or hazard should reach surface waters the EPA would be notified.

Operational impacts

Resources required during the operational phase include fuel for maintenance vehicles, lubricants for oil changes in the turbines and replacement parts if required that may consist of metal and plastic based products. The discussion and safeguards above apply equally to this phase, although resources requirements and wastes are anticipated to be much lower. All wastes would be removed by contractors and maintenance staff. No local garbage service would be used.