Berrybank Wind Farm Landscape and Visual Impact Assessment Final Report

July 2009

Prepared for Union Fenosa Wind Australia Pty Ltd

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1 Introduction

1.1 Introduction

The Berrybank Wind Farm Project, comprised of 100 wind turbines, is proposed to be located around the township of Berrybank, located on the Hamilton Highway, 130 km west of the Melbourne CBD, and approximately 60km east of Mortlake. (Refer to Figure 1.1). The proposed wind farm site covers approximately 5,034ha across twelve (12) privately owned properties and lies within the area of the Corangamite and Golden Plains Shires.

Union Fenosa Wind Australia Pty Ltd (UFWA) is the proponent of the Berrybank Wind Farm Project and Urbis has been commissioned by Robert Luxmoore and Associates, on behalf of UFWA to undertake a visual impact assessment of the proposed Wind Farm as part of a planning approvals process.

A preliminary landscape and visual assessment, including a summary of community perception studies, was undertaken by ERM in November 2007[1] as a component of a Notification Report, submitted to the Minister for Planning for a determination on whether an EES was required.

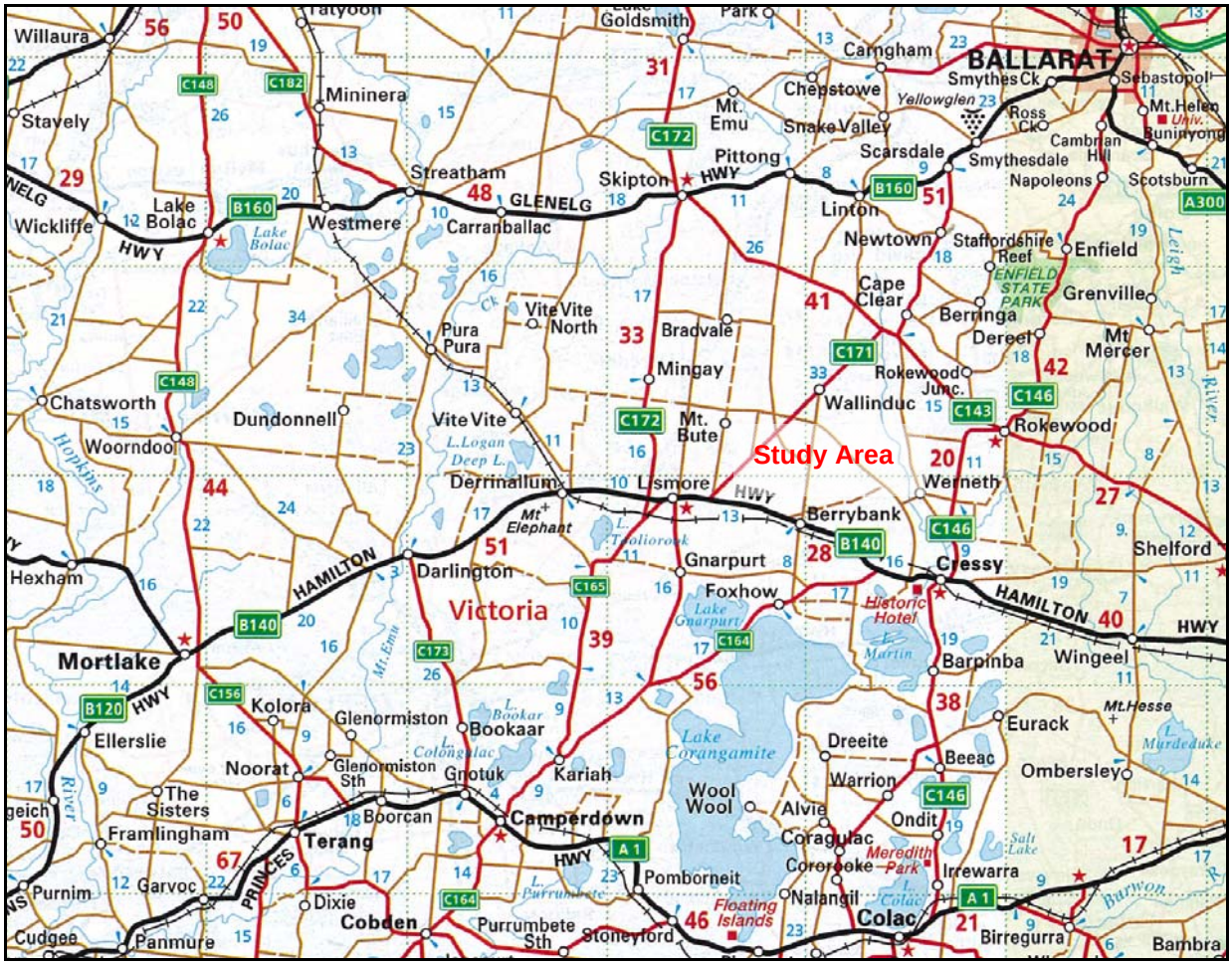


Figure 1.1 – Study area context

1 ERM (November 2007) Berrybank Wind Farm – Notification Report, Preliminary Landscape and Visual Assessment Report

1.2 Study Requirements

The key study requirements from a Landscape and Visual perspective are:

- To identify any sensitive receivers that may be unacceptably impacted (according to relevant guidelines, policies, regulations and/or legislation) by visual amenity impacts from the operation of the proposed Berrybank Wind Farms.
- To address all Wind Farm visual impact related issues.
- To satisfy the requirements of relevant authorities.

1.3 Objectives of the Study

The objectives of this visual impact assessment study are to:

- define the viewshed of the development and define sensitive viewing locations;
- define the landscape character and quality of the setting;
- define community perceptions to wind farms that may influence the sensitivity level of viewers;
- describe the visual character of the main components of the development;
- assess the visual impacts of the development; and
- identify siting and layout measures that will minimise the adverse visual impacts of the development.

1.4 The Study Process

The study process involves the following tasks:

- A review of relevant policy, legislation, standards and guidelines regarding visual and landscape values and develop appropriate standards based on this review.
- A desktop review and site inspection to identify local scenic values, and photograph relevant viewpoints including major and local roads and residences.
- A review of Public perceptions and attitudes towards Wind Farms
- An assessment of the landscape's ability to absorb visual changes associated with the various stages of construction and operation of the project from all relevant viewpoints supported by visual simulations of the site pre-construction, during and post-construction and operation.
- Liaison with project planning and design engineers to optimise the arrangement and design of the Wind Farm and associated infrastructure to mitigate landscape and visual impacts.
- Analysis of the potential for cumulative impact.
- Identification of potential for mitigation measures.
- An assessment of the residual impacts of construction and operation of the project on landscape character and visual amenity for all relevant viewpoints.

1.5 Study Method

The method employed by Urbis has been undertaken in accordance with the consultants brief and requirements of the assessment process. The approach has been based on an analysis of the setting and assessment of the anticipated impacts of the development of the project. The methodology is comprised of a number of components. These are:

- ***Quantitative Assessment (Refer to Appendix A)***
  - How much of the proposed development is visible from particular viewpoints?
- ***Qualitative Assessment***
  - Visual modification – How does the proposed development contrast with the landscape character of the surrounding setting?
  - What is the scenic quality of the landscape setting?
  - Sensitivity – How sensitive will viewers be to the proposed development?

1.5.1 Approach to Assessment

- The method employed by Urbis is based on the Visual Management System (VMS) developed by the US Forestry Service whereby the visual impact of a proposed development is determined by evaluating the degree of visual modification / fit of the development in the context of the visual sensitivity of surrounding land use areas from which a proposed development may be visible. The visual impact resulting from the combination of varying levels of visual modification and visual sensitivity, or viewer sensitivity, is illustrated in **Table 1.1.**

Viewer Sensitivity

Visual Modification	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L

L = Low
M = Moderate
H = High

Level of Visual Impact

Table 1.1 – Visual Impact matrix

Given the diversity of public responses to wind turbines, determination of visual fit within a landscape setting is treated as being of a lower relevance to the determination of visual impact than the sensitivity or perception of a viewer.

Various treatments have been developed during the study process to mitigate the degree of visual modification or visibility of the development from visually sensitive locations. These treatments include wind farm siting and layout, turbine design and colouring and possible foreground landscape screening to sensitive viewpoints.

VISUAL MODIFICATION

The visual modification level of a proposed development can be best measured as an expression of the visual interaction, or the level of visual contrast between the development and the existing visual environment.

Throughout the visual catchment (or Zone of Visual Influence) the degree of modification will generally decrease as the distance from the development site to various viewing locations increases. The quantitative assessment of visibility, i.e., how much is visible, is intertwined with the qualitative aspect of visual compatibility to inform the level of visual modification.

Given the scale, form and appearance of the wind generators, they do not fit the normal definitions of an industrial form. Their form can best be likened to sculptural elements, often evoking very positive reactions from viewers. This is reflected in the response to studies of viewer perceptions. (Refer to Appendix F).

Degree of Modification to the Existing Natural Landscape and Scenic Quality

To determine the level of visual modification, we have also considered the following aspects:

- It has been established through previous studies that scenic quality increases as the presence of water-forms, water edge and water area increase. (Leonard and Hammond, 1984; Halverson, 1970; Zube, 1973; Zube et al, 1974; Brush and Shafer, 1975; Anderson et al, 1976). Scenic quality also increases as topographic ruggedness and relative relief increase. (Leonard and Hammond, 1984; Albert, 1969; Burns and Rundell, 1969; Mellilo, 1970; Anderson et al, 1976). Scenic quality can also increase as the patterning of vegetation increases.
- Where wind turbines have been located in a “cultural” landscape setting, that is one that has been heavily modified over the years by human influences such as farming practices and the introduction of the associated infrastructure of civilisation, it could be argued that the degree of modification to that setting would not generally be as high as locations where the setting remains unmodified. Following this line of argument, wind farms and wind turbines located in cultural or modified agricultural landscapes could be perceived by some as an extension of that culture to a modern sustainable era. In this context it is argued they could be perceived as having a higher degree of visual fit and, therefore, create a lower level of visual modification to the setting.
- As has long been the case in Europe where landscapes have been significantly modified for hundreds of years, cultural landscapes are being recognised in Australia as being of cultural and landscape significance, having values that are different to, but sometimes no less important than, natural, unmodified landscapes.
- Where wind turbines are located so that they are back dropped by sky, the level of visual modification will be lower than locations where they are back dropped by the ground plane, as the colour of sky and clouds will generally be a better match with the colour of the wind generator blades and tower. The movement of the blades is also a better dynamic balance with the movement of clouds, rather than the static nature of the ground plane.
- Where the wind turbines appear as significant elements within a view shed that incorporates a higher visual quality, the visual modification level will be higher for the local and closer sub regional visual catchment, reducing to lower levels at the regional catchment level.

VISUAL SENSITIVITY

Visual sensitivity is a measure of how critically a change to the existing landscape will be viewed from various use areas. Different activities undertaken within the landscape setting have different sensitivity levels. For example, tourists who are using the surrounding landscape as a part of the holiday experience will generally view changes to the landscape more critically than agricultural workers in the same setting. Similarly, individuals may view changes to the visual setting of their residence more critically than changes to the visual setting of the broader setting in which they travel or work.

The visual sensitivity of the development depends on a range of viewer characteristics. The primary characteristics used in this study are:

- Land use.
- Distance of the development from viewers.
- Its visibility from critical viewing areas.
- View angle.

The visual sensitivity of land uses was assessed to assist in determining the visual impact of the development. As distance from the viewer to the proposed development increases, the level of sensitivity reduces.

Visibility – Relationship with Viewsheds

The report defines a number of viewsheds based on distance from the development for the purposes of assessment. The methodology is based on the reduction of impact with an increase in distance between a given viewpoint and the development. (Refer to Appendix A).

Degrees of Field of View Occupied	Potential Visual Prominence – Horizontal Field of View
Less than 5°	***Insignificant*** The development may not be highly visible in the view unless it contrasts strongly with the background.
5° – 30°	***Potentially Noticeable*** The development may be noticeable. The degree that it intrudes on the view will be dependant on how well it integrates with the landscape setting.
Greater than 30°	***Potentially Dominant*** The development will be highly noticeable.

Table 1.2 – Horizontal line of sight – Visual impact / visual prominence

Degrees of Field of View Occupied	Potential Visual Prominence – Vertical Field of View
Less than 0.5°	***Insignificant*** A small thin line in the landscape.
0.5° – 2.5°	***Potentially Noticeable*** The development may be noticeable. The degree that it intrudes on the view will be dependant on how well it integrates with the landscape setting.
Greater than 2.5°	***Potentially Dominant*** The development will be highly noticeable, although the degree of visual intrusion will depend on the landscape setting and the width/spread of the object.

Table 1.3 – Vertical line of sight – Visual impact / visual prominence

Distance from Object	Potential Visual Prominence
7000 metres	***Visibility Diminishing*** The visual prominence of the element progressively diminishes over distance.
2000 – 7000 metres	***Potentially Noticeable*** The development will be noticeable. The degree that it intrudes on the view will increase as distance reduces.
Less than 2000 metres	***Potentially Dominant*** The development may be highly noticeable.

Table 1.4 – Visual prominence in relation to distance and viewshed settings [2]

IMPACTS OF NIGHT LIGHTING

The assessment of the impacts of lighting at night time has been based on – Guidance Notes for the Reduction of Obtrusive Light, published by The Institution of Lighting Engineers, UK, 2005. (Refer to Appendix D).

1.5.2 Viewer Sensitivity Levels

Typical levels of viewer sensitivity to the development specifically developed for the study area and its population based on the Visual Management System (VMS)[3] are outlined in Table 1.2.

[2] *University of Newcastle (2002) Visual Assessment of Windfarms Best Practice. Scottish Natural Heritage Commissioned Report F01AA303A – Page 13.*

[3] Forest Service USDA, *National Forest Landscape Management, Volume 2, Chapter 1, The Visual Management System. Agricultural Handbook No. 462, April 1974.*

Visual Use Area	Foreground		Middleground		Background
	Local Setting		Sub Regional Setting		Regional Setting
	0 - 1	1 - 2km	2 – 4.5	4.5 - 7 kms	> 7 kms
Townships	**H**	**H**	**H**	**M**	**L**
Rural Residences	**H**	**H**	**H**	**M**	**L**
Main Highway – Hamilton Hwy	**M**	**M**	**L**	**L**	**L**
Local Roads	**M**	**M**	**L**	**L**	**L**
Railway Line (Freight)	**L**	**L**	**L**	**L**	**L**
Agricultural Land	**L**	**L**	**L**	**L**	**L**

Legend - H = High, M = Moderate, L = Low

Table 1.5 – Typical visual (viewer) sensitivity

1.5.3 Viewer Sensitivity Perceptions

The Notification Report (Section 3) summarises a number of community studies that consider community perceptions to wind farms. (Refer to Appendix F).

Research has been undertaken by Urbis and ERM in the Notification Report of similar wind farm projects locally and from around the world, particularly community perception studies. A number of the studies reviewed discuss issues other than purely aesthetics. However these other issues all contribute to a viewer's perception and are important to consider. A person's perception of visual impact on the landscape, as well as noise impact, will depend on how unpleasant the wind farm is perceived by the viewer. People hear and perceive things differently, which makes designing a wind farm which everyone will be happy with a difficult task.

In general public support for wind power is very high, but when the development is going to be in their local area the acceptance of wind power decreases (Gipe, 1995).

People object to local projects because of the expected noise and visual impact on the landscape. Studies have shown that public support of wind power usually increases once the wind turbines are installed and operating (Collett 1995).

Generally, people who favour renewable energy are more likely to find the impacts of wind power acceptable and those who are neutral to the idea will accept wind turbines on the landscape if they know they are beneficial to the environment.

The consultation undertaken as part of the development of the Wind Farms and Landscape Values National Assessment Framework[4] confirmed that visual sensitivity can vary widely based on

[4] *Wind Farms and Landscape Values National Assessment Framework. Australian Wind Energy Association and Australian Council of National Trusts, June 2007*.

community perceptions to a wind farm development. Because of the widely ranging reactions to the visual appearance of wind generators, it was not possible to categorise visual user groups into the normal types that would be applied for more typical developments of an industrial nature.

1.6 Policy Considerations

The various parcels of land that comprise the wind farm site, which lie within both Corangamite and Golden Plains Shires, are zoned Farming Zone under both planning schemes.

1.6.1 Corangamite Shire

ESO 1 – Applies to a narrow corridor along Gnarkeet Chain of Ponds Creek and the water bodies of Lake Struan, Lake Gnarpurt, Lake Corangamite and other smaller lakes in the vicinity.

VPO 1 – Applies to a small area of vegetation within the rail reserve.

VPO 2 – Applies to a very narrow band of vegetation within the road reservation of Hamilton Highway, Berrybank – Werneth Road and Darlington Road.

1.6.2 Golden Plains Shire

No overlays of relevance to landscape or scenic quality apply to the area within the Shire.

1.6.3 Policy and Planning Guidelines for Development of Wind Energy Facilities in Victoria (SEAV, 2003)

This document outlines issues to be considered during the planning, construction and operation of wind farms. In relation to Landscape and Visual Impact Assessment it recommends a broad methodology to be followed which is consistent with this study.

1.6.4 Wind Farms and Landscape Values National Assessment Framework

The recognition of the value placed by the local community on the natural and cultural landscape is the intended focus of the National Assessment Framework (NAF). The study was commissioned by the National Trust (Australia) and Auswind. Broad consultation was undertaken with State and Local Government as well as potentially affected communities with the recommended methodology developed in response to issues raised. The methodology applied in this study is consistent with the goals of the NAF.

1.6.5 Policy Summary

While no LSO's apply in the vicinity of the study area, the values protected by VPO's and ESO's can also provide a contribution to overall landscape character. In the case of the overlays present in the vicinity of the study area, the VPO's relate to small areas of vegetation which have a relatively minor influence on the overall landscape character of the setting.. The ESO's relate to the preservation of the environmental values of freshwater lakes. The lakes in the vicinity of the study area do not provide a significant recreation, scenic or tourist function that would result in a heightened level of visual sensitivity to the proposed development.

2 The Existing Landscape

This assessment of the landscape and visual issues has been undertaken for the following settings:

- ***Regional –*** More than 7 km from the project area.
- ***Sub–Regional –*** Between 2 km and 7 km from the project area.
  - *Distant Sub–Regional* – Between 4.5 km and 7 km from the project area.
  - *Near Sub–Regional* – Between 2 km and 4.5 km from the project area.
- ***Local –*** Within 2 km of the project area.

2.1 Site Context and Summary

The study area is located primarily to the north of Berrybank and to the east of Chain of Ponds Creek, with a limited number of wind turbines located to the south of the township.

The landscape type of the region is typified by flat to very slightly undulating topography with native and exotic vegetation confined to narrow bands of rectilinear patterning along roadsides and property and paddock boundaries.

Built elements within the landscape of the setting include the major 500kV and 220kV HV lines of the State grid, the railway line to Hamilton and Portland, the Hamilton Highway and local road network and farmhouses and associated buildings scattered throughout the area.

2.2 Landform and Land Use

The wind turbines are proposed to be located on land that gently rises from 150m AHD in the south, to 200m AHD in the north.

The surrounding landscape is used primarily for agriculture, with the main activities being cropping and sheep grazing.

The volcanic cones, such as Mt Elephant 25km to the west, and the stoney rises that form distinct landscape features in other parts of the Western Volcanic Plains are predominately absent from the study area. The adjacent lakes, including Lake Corangamite, are believed to have resulted from the collapse of underground caves formed through volcanic activity.

2.2.1 Regional and Sub-Regional Setting

Within the regional setting, the primary land uses are agricultural, comprised of grazing and cropping / cultivation.

2.2.2 Local Setting

The township of Berrybank is located on the Hamilton Highway in the southern portion of the proposed site.

The land use of the local setting is almost entirely grazing and cropping land.

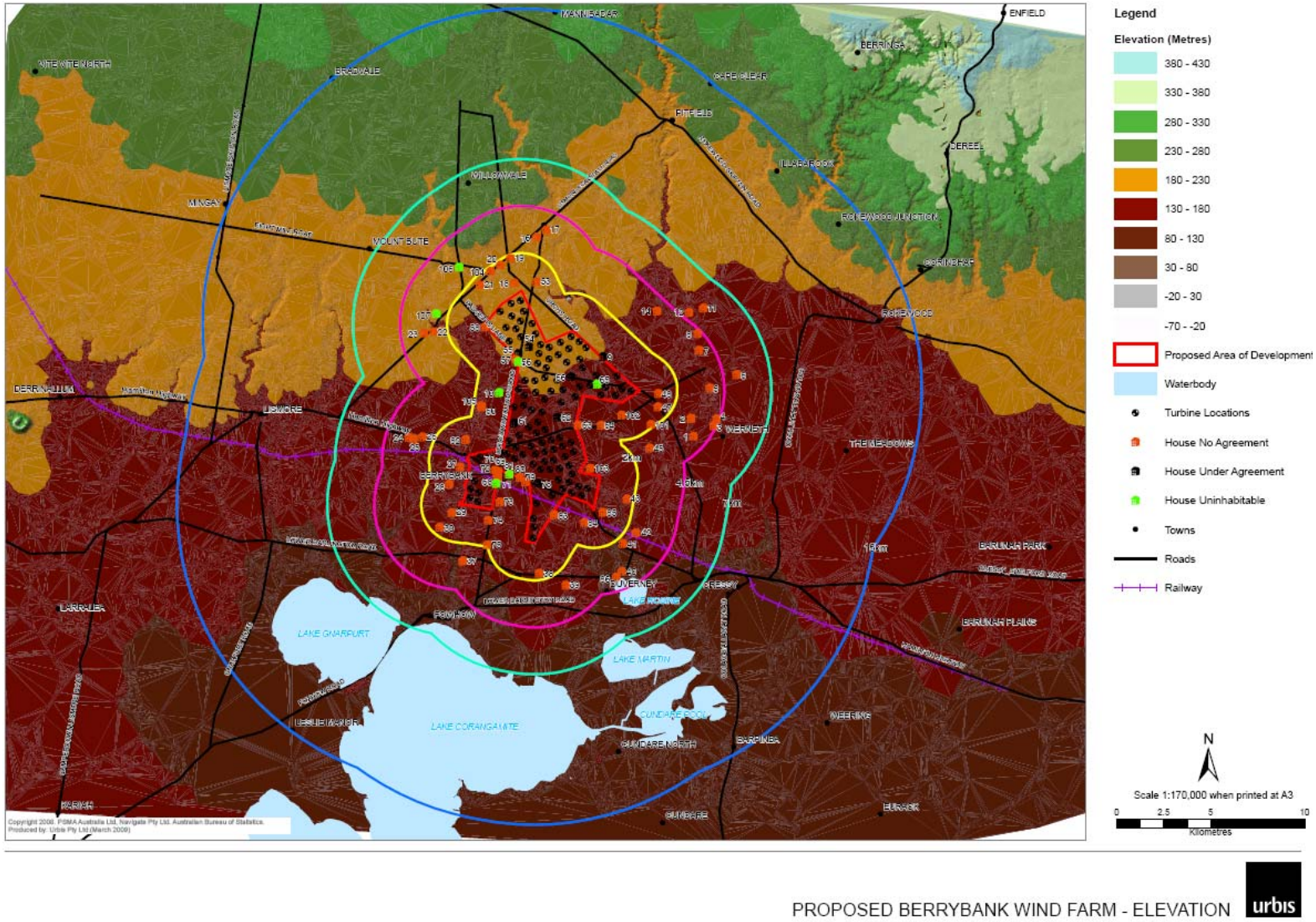
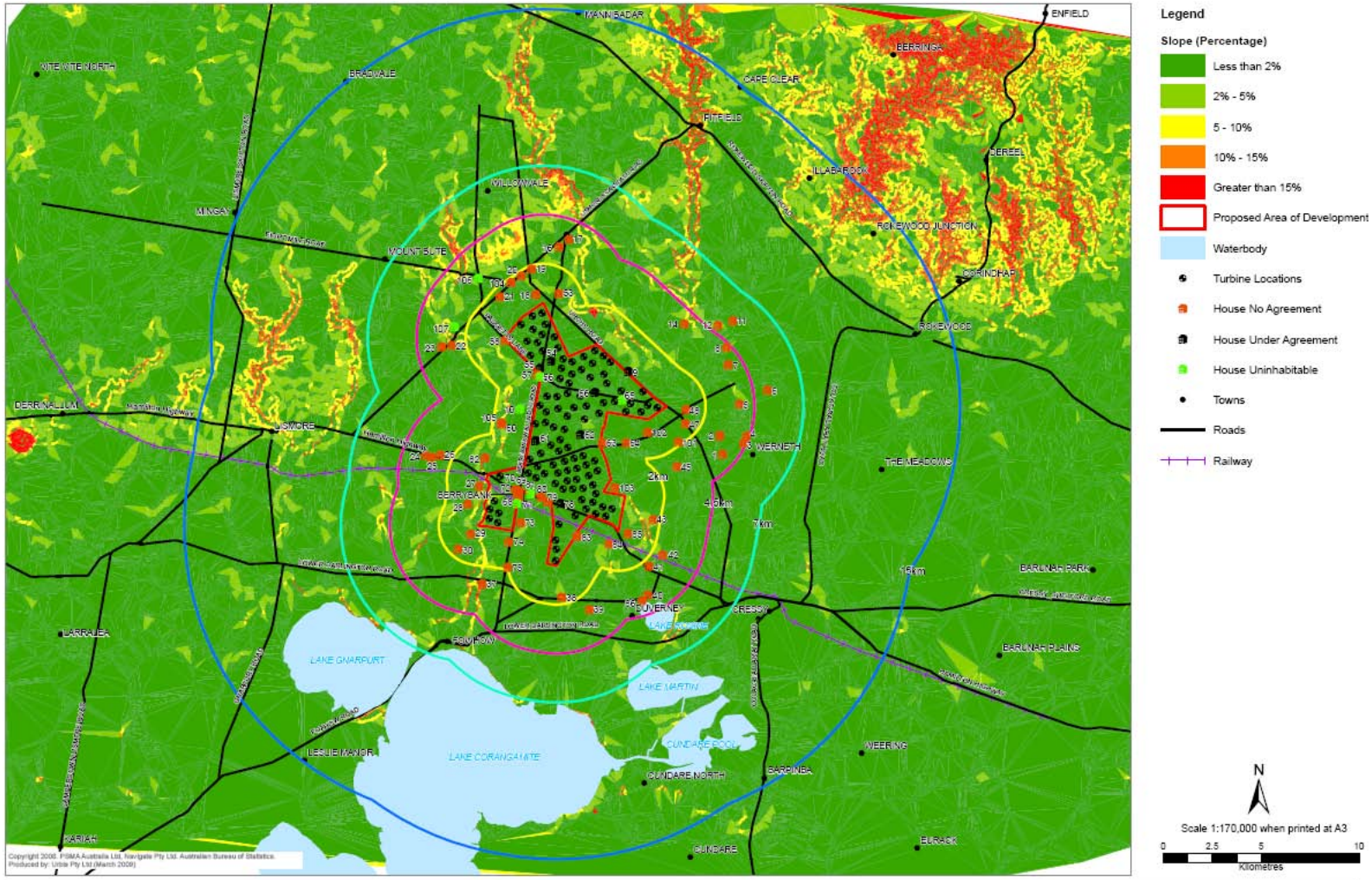


Figure 2.1 – Elevation



PROPOSED BERRYBANK WIND FARM - SLOPE (PERCENTAGE)

Figure 2.2 – Slope

2.3 Vegetation and Landscape Character

The landscape character of the setting prior to European settlement would have been comprised of predominately open grassland with scattered trees and higher concentrations of trees along waterways and around lake edges.

2.3.1 Regional and Sub-Regional Setting

The broadscale agricultural landuses and the relatively flat topography define the vegetation pattern across the landscape, which consists of native and exotic vegetation confined to rectilinear patterning along roadsides and property and paddock boundaries.

Remnant vegetation along the meandering form of Gnarkeet Chain of Ponds Creek provides a break to the regular patterning within the landscape created by the rectilinear plantings.

2.3.2 Local Setting

As for the broader regional and sub-regional landscape, the local setting is generally cleared of trees. The general lack of vegetation results in views that are generally open and expansive. However, rural residences are generally set within a surrounding band of vegetation that provides respite from the wind. This planting, along with roadside windrows, provides effective foreground visual screening to views of the otherwise expansive landscape.

Figure 2.3 – Vegetation cover

2.4 Landscape Values

2.4.1 Pre - European

Prior to European settlement of the area, the Wada wurrung tribe, who shared common language and social ties with the broader group collectively known as the Kulin, inhabited much of the region. Evidence of their inhabitance is known from recorded artefacts such as stone implements as well as historical records. However, much evidence of their occupation has been disturbed by subsequent European settlement activity. Locations that would have attracted activity in the study area include waterways and lake edges.

There is currently no Registered Aboriginal Party (RAP) for the area, although the Maar Land Council has an RAP pending. The landscape as experienced by the aboriginal inhabitants has been subject to significant change.

2.4.2 European Settlement

Berrybank, and the broader area, were initially settled in the early 1840's by sheep graziers. Over the subsequent years, the taller vegetation was mostly cleared, and the species rich grasslands were replaced by pasture grasses and crops.

Between 1852 and 1854, gold miners were attracted to alluvial deposits in the area, although little evidence of this activity in the landscape remains due to subsequent farming activities.

The Maroona – Gheringhap railway line and station at Berrybank was constructed between 1910 and 1920.

Berrybank established as a town on the Hamilton Highway, to support the surrounding rural properties in the early to mid 1900's, the major route between Geelong and Hamilton, and also to Mt Gambier and Portland.

Over time, the larger properties in the area were progressively sold and subdivided. Exotic and native, non – indigenous species were planted as wind breaks around properties, defining the landscape pattern and character that exists today.

2.4.3 Tourism

The rail line that traverses the country side to the south of the proposed site is used for freight. V-line's bus service to the west of the state joins the Hamilton Highway at Derrinallum, and does not traverse the site.

The Hamilton Highway is a key road for transport and tourism to the Hamilton and the Western District and far Victorian west coast as well as Mt Gambier and the South Australian east coast. Typical traffic volumes are in the order of 1,000 vehicles per day. The road also provides an alternative route to the Grampians.

Some tourism attractions exist at Cressy to the east and Lismore to the west of Berrybank, primarily associated with the historic buildings and settings of the townships. The broader region promotes farm stay accommodation.

Given the number of wind farms in the region, it is difficult to foresee that the development of a wind farm at Berrybank has the potential to become a tourist attraction in a similar way that some others that were developed earlier have, as some of the novelty has possibly worn off.

2.4.4 Principles for Assessing Landscape Heritage

The development of a model that acknowledges areas of cultural value within the assessment of landscape quality in areas where the landscape has been significantly altered by human influences was the focus of the National Assessment Framework.

The main relevant principles for the assessment of cultural landscapes are:

- Definition/understanding of aesthetics as cultural significance (and recognition of the need to protect the 'unaesthetic' also);
- Definition of boundaries, views and vistas;
- Definition of landscape values in terms of heritage significance;
- Recognition of interrelationships between aboriginal, historic and cultural values.

A number of the elements listed above are components of an assessment process which is generally undertaken by municipalities or planning authorities to protect areas of cultural, environmental or scenic quality, all values that are interrelated and contributors to Landscape significance. If such values exist within a municipality, they would generally be protected by an overlay control to the planning scheme. Indeed, both Corangamite and Golden Plains Council's have the provision for scenic overlay controls in their planning schemes. However, no such controls apply to the broader study area. Additional research indicates that there are no landscapes of state or national significance within the study area.

2.4.5 Landscape – Cultural Significance and Scenic Quality of the Study Area

The landscape character type of the broader region in which the study area is located is defined by Leonard and Hammond[5] as Western Plains. Based on the assessment of landscape character types, scenic quality and landscape cultural significance, the local and sub-regional setting of the study area can be divided into the following landscape units:

Landscape Unit Area	***Scenic Quality***	***Local Cultural Significance***	***Characteristics/Use***
Agricultural / Pastoral Areas	Low	Moderate	▪ extensive clearing and highly altered landscapes ▪ broad plain with minimal topographic variation
Gnarkeet Chain of Ponds Creek	Low to Moderate	Moderate to High	▪ moderate degree of topographic relief along slightly incised watercourse ▪ some remnant vegetation ▪ presence of intermittent water
Lake Corangamite	Moderate	Moderate to High	▪ extensive clearing and highly altered landscapes ▪ presence of water of a permanent nature
Rural Townships – Berrybank, Gnarkeet, Foxhow and Duverney	Moderate	Moderate to High	▪ presence of mature, exotic vegetation ▪ presence of historic buildings and other built form

Table 2.1 – Landscape Units and Scenic Quality

[5] *Leonard, M., Hammond, R., (1984). Landscape Character Types of Victoria.*

A recent study by Lothian[6] of perceptions of scenic quality and the influence of infrastructure found that, in agricultural landscapes with the attributes of lower scenic quality, wind farms had the effect of increasing the level of scenic quality as perceived by the viewer, as they added an element of visual interest to the otherwise relatively featureless landscape setting. This finding should be considered when evaluating viewer sensitivity as it would have the effect of reducing the level of sensitivity.

In the following Figure 2.4, the ratings given by tested respondents to the quality rating they gave an agricultural setting without a wind farm was less than that with a wind farm present. (Inland Scene 47 – the far right column on the graph).

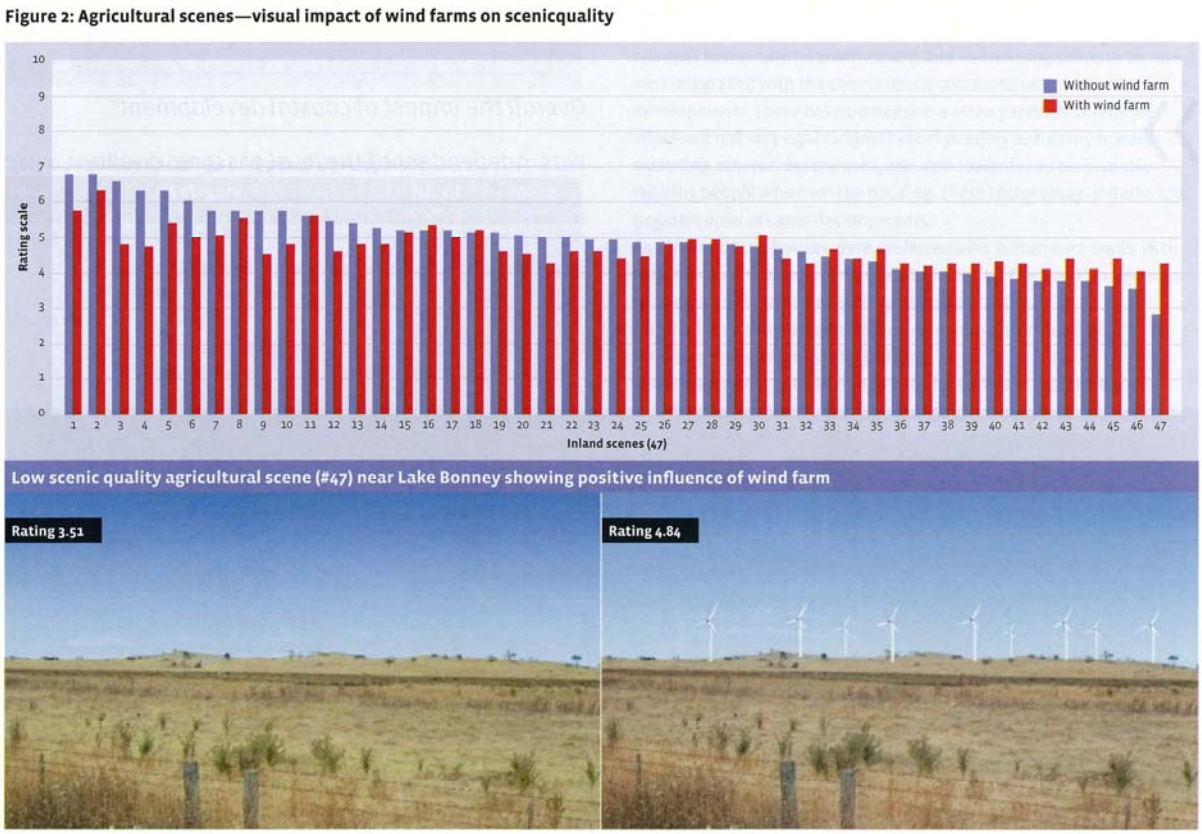


Figure 2.4 – Scenic Preference – Influence of Wind Farms (Source: Lothian – Australian Planner)

2.4.6 Landscape Values and Viewer Sensitivity

Consultation was undertaken with a range of user groups on behalf of UFWA and, whilst this did not draw out any specific responses that inferred that the landscape scenic quality was particularly valued, respondents at the Community Information Day referred to the "Big Sky" and the expansive views that the landscape afforded. The assumption can be made that the local community has an affinity for, and an appreciation of, their landscape.

Whilst this study based on the identification of homogeneous units based on physical characteristics, but aided by intuitive professional judgement, rate the scenic quality of the landscape as low to moderate, the local community will always have a sense of affinity with the landscape and value it highly. This is often due to the proximity of the development.

[6] *Lothian, Dr Andrew, Scenic Solutions, Visual Impact Assessment of some developments in South Australia, Australian Planner, Volume 45, Number 4, December 2008.*

Consultation undertaken by Wind Prospect Pty Ltd for the proposed Mt Bryan wind farm indicates that support for the development of a wind farm increases significantly once the location of the viewer from the wind farm site increases beyond 10km. Support for the development of a wind farm was found to be lower for viewing locations within 5kms of the proposed site than locations further than 5kms from the site.

3 Description of the Form of the Proposed Wind Farm

3.1 Broad Description of the Project

The development consists of a number of identical elements that define its visual character, are of a large scale and potentially have a significant impact.

A number of wind turbine layouts have been prepared during the design phase to take account of various site constraints, including ecology, noise, radio communications and visual amenity. The preferred option was subjected to a design and siting process based on site sensitivities and visual impact reduction criteria and has been subjected to the assessment process.

The wind farm will consist of 100 wind turbines mounted on towers located on agricultural land. Generated electricity between individual units will be routed through a small transformer at each tower, then via underground electrical cables to the main transformer yard. Gravel access roads will be constructed to each tower, whilst temporary crane hardstands will be installed around each tower to provide a solid foundation for crane operation.

At this stage, 6 options exist for the siting of the transformer compound which will be constructed to allow for connection of the wind farm to the electricity grid. Final connection between the substation and the high voltage distribution network will be via an overhead or underground power line, depending on whether the connection is to a 500kV or 220kV transmission line.

The existing land management or use activities can continue around the turbines and within the boundary of the entire wind farm.

3.2 Components of the Project

The development is comprised of the following components:

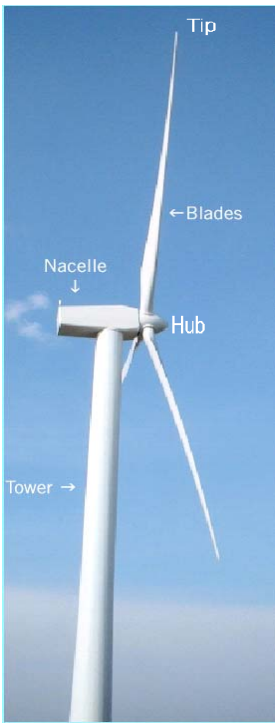
- Wind turbines.
- Anemometer
- MV switchgear and transformer padmount. (Dependant on the ultimate turbine supplier).
- Access tracks.
- Access roads.
- Substation.
- Powerline. (Depending on substation option).

Refer to Figure 3.2: Indicative layout of Berrybank Wind Farm.

3.2.1 Summary of Turbine Details

Refer to Figure 3.1 - Components of a Wind Turbine and Figure 3.2 –Wind Turbine Detail.

Model – A number of wind turbines are under consideration. The largest of these have been used as the basis of the visual assessment, which represents a worst case scenario.



Component	Number / Size
Number of Turbines	100
Hub Height	80m
Blade Length	49m
Rotor Diameter	101m
Tower – Tapered tubular steel	3-4.3m diameter
Height to Blade Tip	131m

Table 3.1 – Details of Proposed Wind Turbines

Figure 3.1 – Components of a Wind Turbine

3.2.2 Layout

The assessment was based on the revised layout provided by Robert Luxmoore and Associates PD-SP-06-05.

The proposed wind farm consists of wind turbines located approximately 500 metres apart. The wind farm extends over an area of approximately 12km north to south and 9 km east to west.

3.2.3 Other Elements

The site development will also contain smaller elements that combine together to provide an overall visual character. These are:

- *Perimeter fencing* – only normal farm fencing will be required.
- *Internal roads* – Gravel access roads will be installed to provide access to each tower. Road length and the area of disturbance will be kept to a minimum and primarily serve as farm access roads following construction. A network of access roads will be installed on private land. The access road width may be narrowed following construction to accommodate a standard vehicle width.
- *Temporary hardstand* – an area of gravel (50 x 50m) will be prepared to provide a stable foundation for crane operation during erection. This will be reduced in size and will be grassed over following completion.
- *Substation / Control Building* – Substations and control buildings will be constructed close to the edge of the site. Two will be required for the site, one for the HV switchyard (SP AusNet), the other for the wind farm (proponent). The building will be constructed to appropriate building standards and will be designed to blend in with the local environment.
- *Signage* – the site may be signed for promotional and identification purposes using small inconspicuous signs.

3.2.4 General Site Clearing / Foundations

This component of the development will involve the clearing of a footprint of approximately 17 x 17m for each tower base. Excavation and earthworks for tower bases and roadworks will be minimal as the site is relatively flat.

The foundation of each tower will be constructed from concrete and steel. The foundation type appropriate for each tower site will be determined by geotechnical survey and designed to withstand extreme loads.

No other site clearing is required, however an all – weather maintenance track will be developed between turbines. All disturbed areas will be reinstated with grass after completion of the works.

3.2.5 Connection to the Electricity Grid

The wind farm will be connected to the distribution network via an underground or overhead connection line, depending on the voltage of the transmission line that the wind farm will ultimately connect to. The connection line will generally be located within road reservations.

3.2.6 Site Development Staging

The construction of the project will occur over approximately 12 - 18 months.

3.2.7 Lighting

As the turbines are higher than 110m, lighting is required to be located on the top of the nacelle, the tallest, non – moving elements, under Civil Aviation Safety Authority (CASA) requirements to prevent plane strike. (Refer to Section 4.9 – Impacts of Night Lighting.) Refer to Berrybank Wind Farm, Aeronautical Impact and Obstacle Marking and Lighting Assessment – Final Report, The Ambidji Group Pty Ltd, for further details.

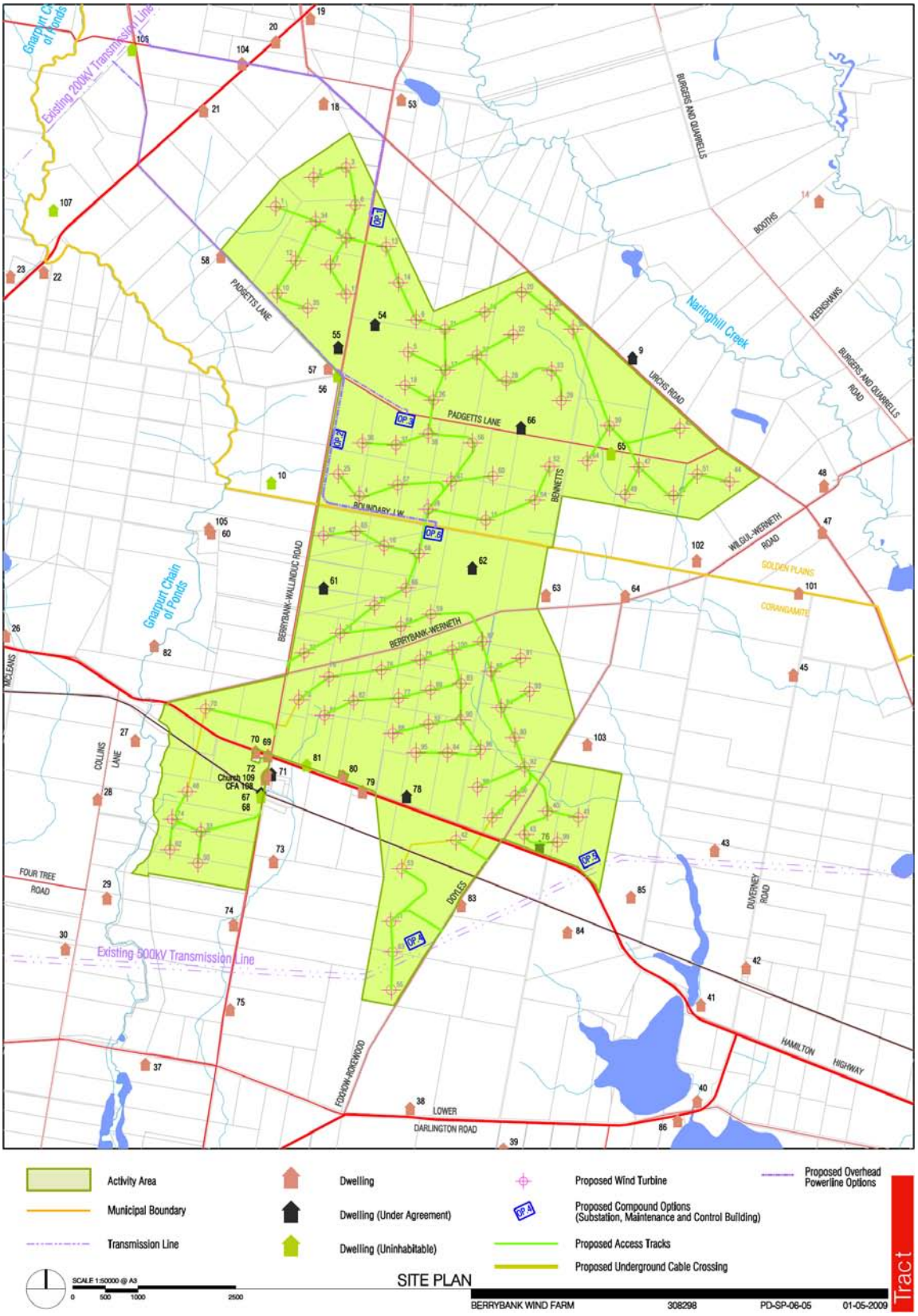


Figure 3.2 – Indicative Layout of Berrybank Wind Farm

4 Assessment of Impact

4.1 Visual Impact – Primary Viewpoints

The critical issues to consider in the assessment of visual impact are:

- Number of sensitive viewing locations.
- Degree to which the proposed wind farm will be visible. The method assumes that if the proposed development is not seen, then there is no resulting impact.

23 viewpoints located within a range of viewing settings, (local, subregional and regional), were chosen for detailed assessment based on their higher levels of viewer sensitivity.

4.2 Viewshed

The viewshed or Zone of Visual Influence (ZVI) is the area from which views of a particular proposed development may be possible. The viewshed of the study area is shown in Figure 4.1.

The Zones of Visual Influence (ZVI) were calculated based on a 3D digital elevation model that included a 16 - 20 km radius of the site and a contour interval of 10 metres. The colours refer to the number of visible turbines with a hub height of 80 m and a blade tip height of 131 m. The ZVI has been prepared for the blade tip height, which is the kinetic component of the wind turbine, as well as the hub height, the static component.

The impacts of vegetative or building screening were not taken into account on the model and the results of the analysis therefore, include many areas that may not have a view due to intervening screening vegetation or buildings. Therefore, the ZVI could be considered to be a worst case scenario. (Refer to Figure 4.1).

4.3 Visual Simulations

Visual simulations of the proposed wind farm were prepared to assist in the impact assessment of the proposal, conveying the final visual image from typical vantage points. Given potential difficulties in gaining access to individual residences, photographs have been taken at the point where the driveway to a residence intersects with the adjacent road network, i.e., the closest publicly accessible location. In many instances, views from the road network actually convey a worse case scenario in terms of visual exposure to the proposed development than views from the residences, which are often surrounded by wind break vegetation which also screens views out from the residence to the surrounding landscape.

Photomontages are representations of the wind farm that are superimposed onto a photograph of the site. The process for generation of these images involves computer generation of a wire frame perspective view of the wind farm and the topography from each viewpoint. To produce the wire frame images, the computer program 3D Studio is used, employing a digital terrain model, with 10 metre contour intervals, to create views of topography and position turbines at given locations and heights. Correct field of view is established by matching the viewing angle of the camera and lens used for photography and its position (both horizontal and vertical) with the wire frame view.

Once the wireframe / rendered views have been created they are taken into Adobe Photoshop, where they are combined with photographs taken from the specified viewpoints, location recorded with GPS. The 2 images are then adjusted by the operator to exactly fit the digital terrain model and rendered for realism, resulting in an image of the proposed wind farm.

The photo simulations based on photography from typical sensitive viewpoints are included within the following analysis section as well as at a larger scale in Appendix E. The images that the photo simulations have been based on have been captured with a Canon 20D SLR digital camera with a lens of 40mm focal length, which is equivalent to a 64mm lens on a 35mm format film SLR which would result in a slightly larger image than the recognised 50mm standard that closely represents the central

field of vision of the human eye. Photomontages have been prepared for a range of indicative viewpoints that represent a variety of distances from the proposed wind farm as well as locations with differing viewing aspects. Refer to Appendix E for photomontage viewing locations.

All of the photomontages have been prepared without including the proposed vegetation screening, effectively representing a worse case scenario. With the proposed mitigation measures incorporated, the actual impact will be less that represented in the photomontages

4.4 Local Influences on Visual Impact

A number of factors at the local level have a direct impact on the visibility of the proposed development and the context in which it will be viewed. These are outlined following:

4.4.1 The Influence of Homestead Vegetation on Visual Amelioration

In order to provide protection from the influences of the environment, particularly sun and wind, Australian farm homestead gardens have traditionally developed a dense band of vegetation to surround an intimate and protected home yard. The effect of this in many instances has been to effectively contain the view shed from the house and surrounding yard itself, screening views to the distance.

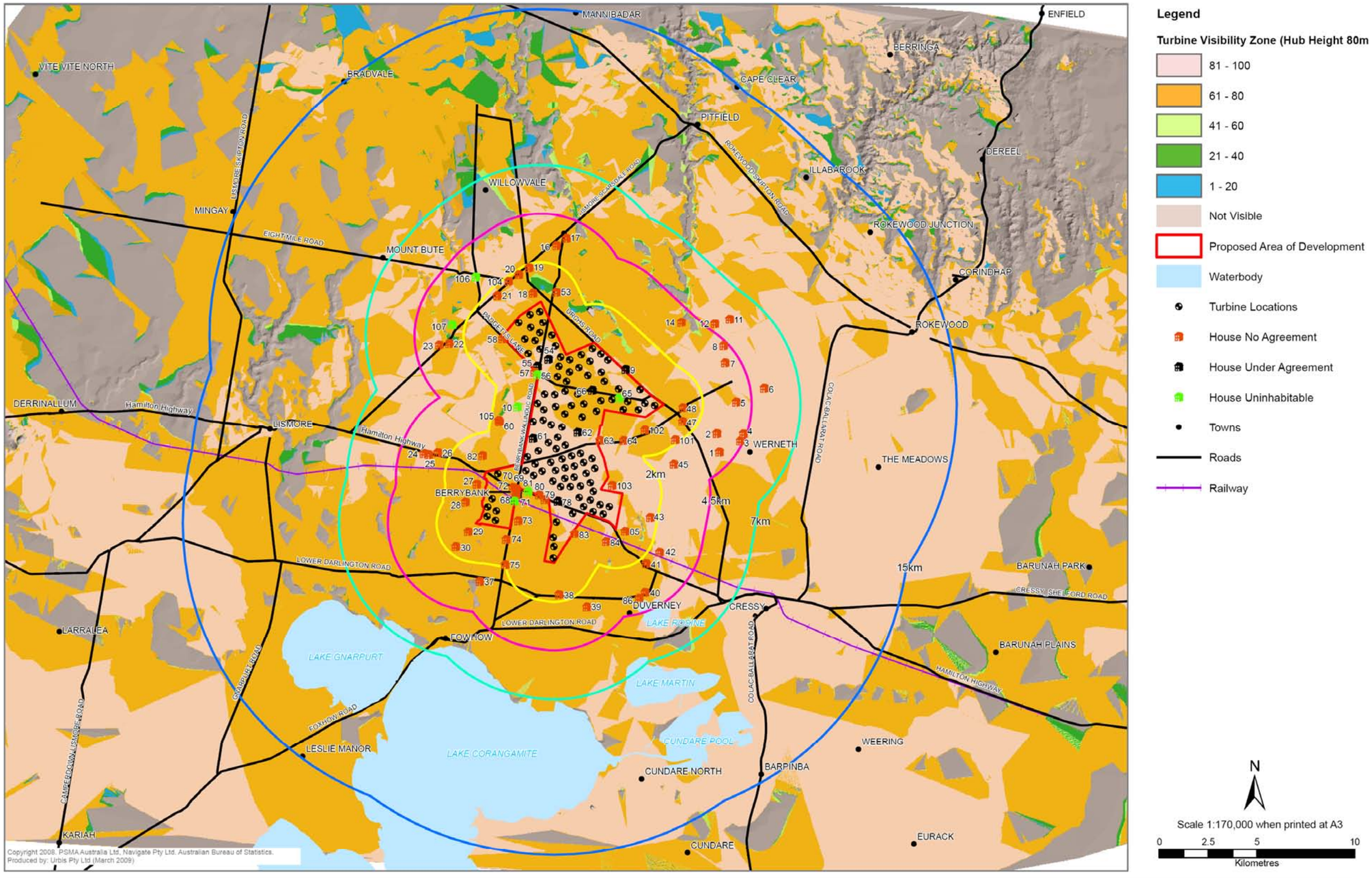
Due to the lack of accessibility to private yards, the site assessment process involved the undertaking of the analysis of views and the taking of photos from the most readily accessible public location immediately adjacent to a homestead, in most cases the point at which the driveway to the property intersected the adjoining public road. Whilst the views from the publicly accessible areas to the proposed development may be uninterrupted, the views from the homesteads, in most cases, are screened or partially screened by the vegetation around the home yard.

4.4.2 The Influence of Farm Work Areas on Visual Modification and Viewer Desensitisation

In many instances, the area immediately abutting and outside of the homestead garden is utilised as the works area for the operation of the farm. The presence of the “tools of the trade”, such as material storage areas, farm equipment, silos, sheds, etc., which can take up a considerable portion of the view shed around a house, can have a greater contributing influence on visual modification than other more distant elements.

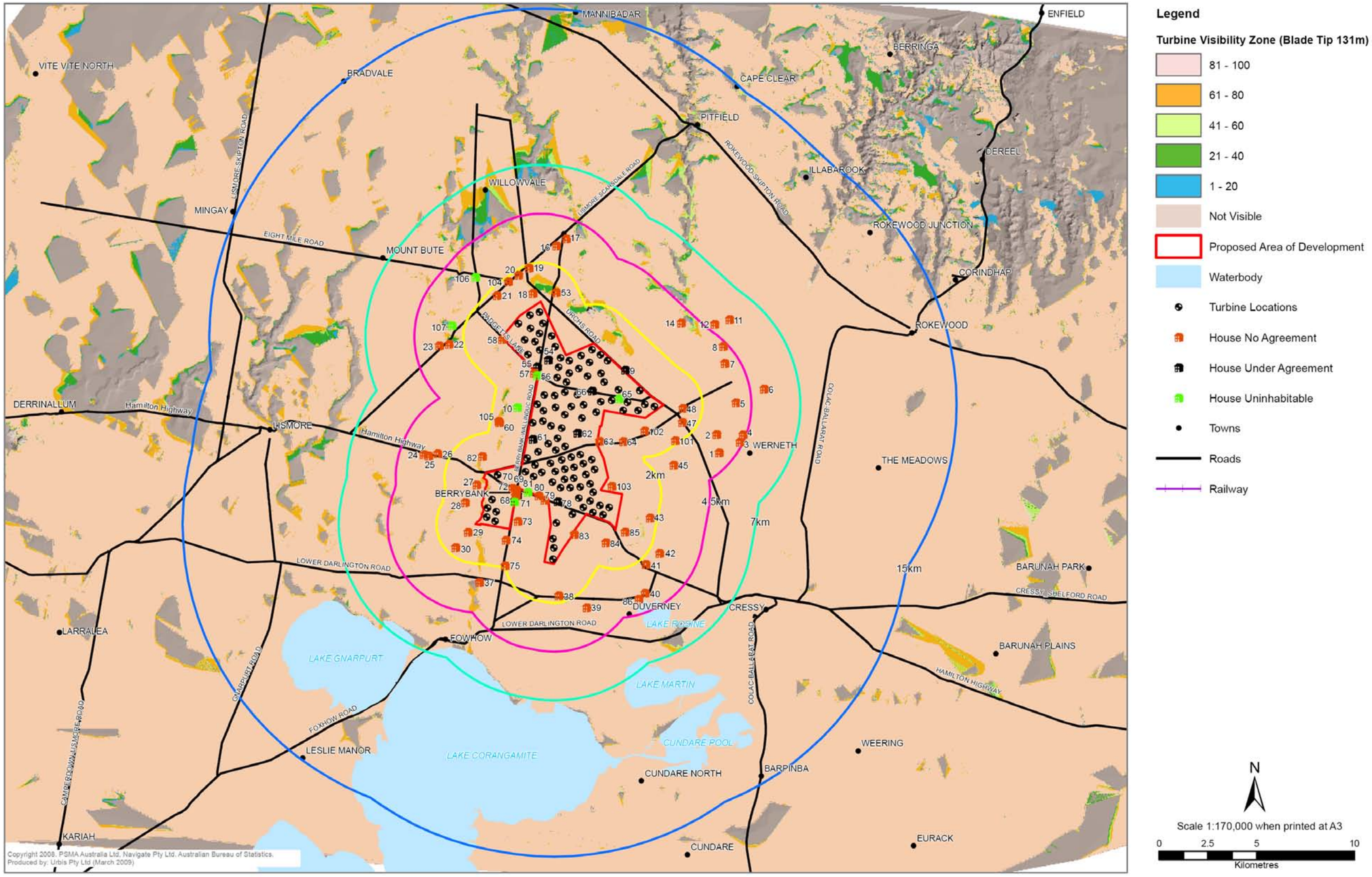
4.5 Quantitative Assessment - Sensitive Sites

The quantitative assessment process has focussed on the visual impact that may result on views for the most sensitive visual settings / land uses, applying the visibility method as described in Appendix A. Low sensitivity visual settings, such as broadscale agricultural areas, have not been considered. (Refer to Figure 4.1 for sensitive viewpoint locations).The quantification of vertical angle is based on the height of the tallest element of the proposed facility (the blades).



PROPOSED BERRYBANK WIND FARM - TURBINE VISIBILITY ZONE - HUB HEIGHT 80M

Figure 4.1 – Viewshed / ZVI and Key Sensitive Viewpoints – Hub Height 80m



PROPOSED BERRYBANK WIND FARM - TURBINE VISIBILITY ZONE - BLADE TIP HEIGHT 131M

Figure 4.2 – Viewshed / ZVI and Key Sensitive Viewpoints – Blade Tip 131m

Viewpoint	Viewshed	Horizontal Distance from Viewer - to closest turbine *(Refer Table 1.4)*	Horizontal Angle *(Refer Table 1.2)*	*Horizontal Potential Visual Prominence*	Vertical Angle *(Refer Table 1.3)*	*Vertical Potential Visual Prominence*
Viewpoint 1 ***Rokewood***	Regional	12.5 km	30°	Potentially Noticeable	$<1^{o}$ Many views screened by vegetation.	Potentially Noticeable
Viewpoint 2 ***Lismore***	Regional	9.5 km	50°	Potentially Dominant	1° Many views screened by vegetation and topography.	Potentially Noticeable
Viewpoint 3 ***Cressy***	Regional	8 km	63°	Potentially Dominant	1° Many views screened by vegetation.	Potentially Noticeable
Viewpoint 4 ***Foxhow***	Sub-Regional	6 km	30°	Potentially Noticeable	2°	Potentially Noticeable
Viewpoint 5 ***Residence 8***	Sub-Regional	4.6 km	55°	Potentially Dominant	2°	Potentially Noticeable
Viewpoint 6 ***Residence 23***	Sub-Regional	4 km	90°	Potentially Dominant	2.5^{o}	Potentially Noticeable
Viewpoint 7 ***Residence 17 (Church)***	Sub-Regional	3.7 km	50°	Potentially Dominant	2.5^{o}	Potentially Noticeable

Viewpoint	Viewshed	Horizontal Distance from Viewer - to closest turbine *(Refer Table 1.4)*	Horizontal Angle *(Refer Table 1.2)*	*Horizontal Potential Visual Prominence*	Vertical Angle *(Refer Table 1.3)*	*Vertical Potential Visual Prominence*
Viewpoint 8 ***Residence 26***	Sub-Regional	3.4 km	114°	Potentially Dominant	2.5°	Potentially Noticeable
Viewpoint 9 ***Residence 45***	Sub-Regional	3.2 km	115°	Potentially Dominant	2.5°	Potentially Noticeable
Viewpoint 10 ***Residence 41***	Sub-Regional	3.4 km	88°	Potentially Dominant	2.5°	Potentially Noticeable
Viewpoint 11 ***Residence 20***	Sub-Regional	2.1 km	50°	Potentially Dominant	4°	Potentially Dominant
Viewpoint 12 ***Residence 47***	Local	1.6 km	95°	Potentially Dominant	4.5°	Potentially Dominant
Viewpoint 13 ***Residence 105***	Local	1.6 km	180°	Potentially Dominant	5°	Potentially Dominant
Viewpoint 14 ***Residence 38***	Local	1.8 km	75°	Potentially Dominant	5°	Potentially Dominant
Viewpoint 15 ***Residence 58***	Local	1 km	120°	Potentially Dominant	3.5°	Potentially Dominant

Viewpoint	Viewshed	Horizontal Distance from Viewer - to closest turbine *(Refer Table 1.4)*	Horizontal Angle *(Refer Table 1.2)*	*Horizontal Potential Visual Prominence*	Vertical Angle *(Refer Table 1.3)*	*Vertical Potential Visual Prominence*
Viewpoint 16 ***Residence 85***	Local	1.4 km	120°	Potentially Dominant	7.5°	Potentially Dominant
Viewpoint 17 ***Residence 63***	Local	1 km	242°	Potentially Dominant	7.5°	Potentially Dominant
Viewpoint 18 ***Residence 83***	Local	1 km	200°	Potentially Dominant	7.5°	Potentially Dominant
Viewpoint 19 ***Residence 28***	Local	1.1 km	95°	Potentially Dominant	7.5°	Potentially Dominant
Viewpoint 20 ***Berrybank***	Local	1 km	295°	Potentially Dominant	8°	Potentially Dominant
Viewpoint 21 ***Residence 18***	Local	1 km	73°	Potentially Dominant	8°	Potentially Dominant
Viewpoint 22 ***Residence 74***	Local	1.1 km	235°	Potentially Dominant	8°	Potentially Dominant
Viewpoint 23 ***Residence 57***	Local	1 km	185°	Potentially Dominant	8°	Potentially Dominant

4.6 Qualitative Assessment

The following section assesses the perceptual responses of viewers to visual change, based on proximity to the proposed development and potential visibility. In all cases, a high level of visual sensitivity has been applied in a “worst case”, conservative approach to visual impact assessment.

The presented photos and photomontages, based on site photography, have been taken at the closest publicly accessible location adjacent to the sensitive viewpoints, the point at which the driveway to the residence intersects the local road network. The following assessment has been prepared based on the likely view possible from the sensitive viewpoint and , therefore, takes into account the effects of screening of views to the proposed development by surrounding vegetation and farm buildings. Only locations with a high level of visual sensitivity have been assessed.

As discussed previously, photomontages have been prepared for a range of indicative viewpoints of varying distances and viewing aspects, rather than for all assessed view points.

4.6.1 Regional Setting – Greater than 7km Distant

Within the regional setting there are numerous small townships or settlements of just a few houses, the closest of which are assessed in detail in Table 4.1 and in the following section.

VIEWPOINT 1- TOWNSHIP - ROKEWOOD

Viewing Situation	Western edge of township.
Viewing Distance	12.5 km to closest turbine.
Visual Setting	Regional.
Landscape Character	Open and expansive, flat to slightly undulating pastoral landscape. Higher density, predominately exotic vegetation throughout township and dense indigenous and exotic along Kuruca Ruc Creek.
Land Use	Secondary Road through rural township.
Visual Sensitivity	Low due to distance.
Potential Visual Impact	Horizontal angle – Potentially noticeable Vertical angle – Potentially noticeable Potential impact - Low Between 81 and 100 turbines will potentially be visible as distant elements, but generally only a limited number will visible from most viewpoints between breaks in vegetation.

Figure 4.3: Character of setting – Main Street of Rokewood

Figure 4.4: Existing view to site from edge of Rokewood township

VIEWPOINT 2- TOWNSHIP - LISMORE

Viewing Situation	Eastern edge of township on Hamilton Highway
Viewing Distance	9.5 km to closest turbine.
Visual Setting	Regional.
Landscape Character	Open and expansive, slightly undulating pastoral landscape. Higher density, predominately exotic vegetation throughout township.
Land Use	Highway through rural township.
Visual Sensitivity	Low due to distance.
Potential Visual Impact	Horizontal angle – Potentially dominant Vertical angle – Potentially noticeable Potential impact - Low to moderate Between 81 and 100 turbines will potentially be visible as distant elements, but generally only a limited number will visible for most viewpoints between breaks in vegetation and topography.

Figure 4.5: Character of setting – Centre of Lismore

Figure 4.6: Existing view to site – From outskirts of Lismore

VIEWPOINT 3 – TOWNSHIP - CRESSY

Viewing Situation	Western edge of town on Hamilton Highway
Viewing Distance	8 km to closet turbine.
Visual Setting	Regional
Landscape Character	Open and expansive, slightly undulating pastoral landscape. Higher density, predominately exotic vegetation throughout township.
Land Use	Highway through rural township.
Visual Sensitivity	Low, due to distance from the site.
Potential Visual Impact	Horizontal angle – Potentially Dominant Vertical angle – Potentially Noticeable Potential impact – Low to moderate Between 81 and 100 turbines will potentially be visible as distant elements, but generally only a limited number will visible from most viewpoints between breaks in vegetation.

Figure 4.7: Character of setting – Centre of Cressy

Figure 4.8: Existing view to site – From edge of Cressy

4.6.2 Sub- Regional Setting – 2 – 7km Distant

Typical sensitive viewpoints within the sub-regional setting include:

- Foxhow settlement
- Numerous rural residences
- Roads – Hamilton Highway, numerous secondary and local roads. (As all of these roads have residences located adjacent to them, the residence has been assessed rather than the road, as it is the point of higher sensitivity.

A representative sample of these viewpoints is assessed below.

VIEWPOINT 4 – SETTLEMENT - FOXHOW

Viewing Situation	From Foxhow Road at northern edge of settlement.
Viewing Distance	6 km to closet turbine.
Visual Setting	Sub-Regional (Distant).
Landscape Character	Open and expansive, slightly undulating pastoral landscape adjacent to Lake Corangamite. Scattered taller vegetation, predominately exotic and native vegetation exists throughout the township.
Land Use	Secondary Road through rural township.
Visual Sensitivity	Moderate, due to distance from the site.
Potential Visual Impact	Horizontal angle – Potentially noticeable. Vertical angle – Potentially noticeable. Potential impact - Low to moderate. Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible from most viewpoints between breaks in vegetation.

Figure 4.9: Character of setting – Foxhow settlement

Figure 4.10: Existing view to site from Foxhow

VIEWPOINT 5 – RESIDENCE 8 ON PITFIELD – CRESSY ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	4.6 km to closet turbine.
Visual Setting	Sub-Regional (Distant).
Landscape Character	The residence is located within bands of surrounding vegetation in the flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	Moderate, due to distance from the site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Low to moderate Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible between breaks in vegetation.

Figure 4.11: Character of setting – Residence 8 on Pittfield – Cressy Road

Figure 4.12: Existing view to site – From Pittfield - Cressy Road

VIEWPOINT 6 – RESIDENCE 23 ON LISMORE - SCARSDALE ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	4 km to closet turbine.
Visual Setting	Sub-Regional (Near)
Landscape Character	The residence is located between bands of surrounding vegetation in the flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High due to proximity to the site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Moderate Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible between breaks in vegetation.

Figure 4.13: Character of setting – Residence 23 on Lismore – Scarsdale Road

Figure 4.14: Existing view to site from Lismore – Scarsdale Road

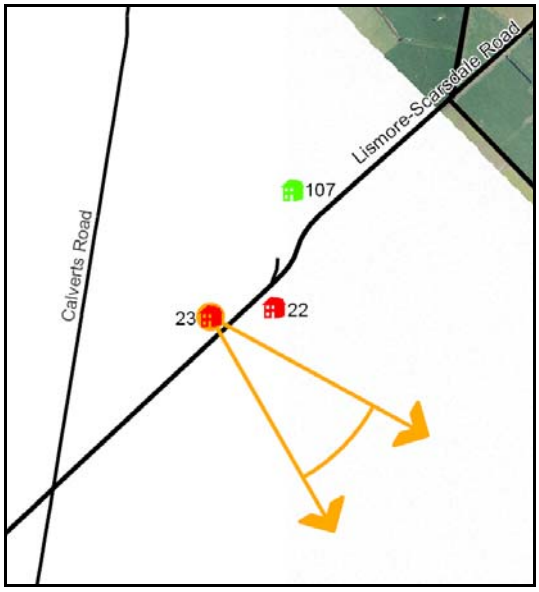


Figure 4.15: Photomontage Viewpoint

Figure 4.16: Photomontage of view to site from near Residence 23 on Lismore – Scarsdale Road following construction of wind farm.

VIEWPOINT 7 – RESIDENCE 17 ON LISMORE - SCARSDALE ROAD (CHURCH)

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	3.7 km to closet turbine.
Visual Setting	Sub-Regional (Near).
Landscape Character	The church is visually open to the road with some adjacent screening vegetation in a flat, open pastoral landscape.
Land Use	Civic / community use in ac cropping / grazing setting.
Visual Sensitivity	Moderate, due to civic use and proximity to the site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Low to moderate Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible between breaks in vegetation.

Figure 4.17: Character of setting of Church on Lismore – Scarsdale Road

Figure 4.18: Existing view to site from Lismore – Scarsdale Road

VIEWPOINT 8 – RESIDENCE 26 ON HAMILTON HIGHWAY

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	3.4 km to closet turbine.
Visual Setting	Sub-Regional (Near).
Landscape Character	The residence is located within a dense band of surrounding vegetation in the flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to the site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Low to moderate due to effect of vegetation screening. Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible between breaks in vegetation.

Figure 4.19: Character of setting – Residence 26 on Hamilton Highway

Figure 4.20: Existing view to site
– From Hamilton Highway adjacent to Residence 26

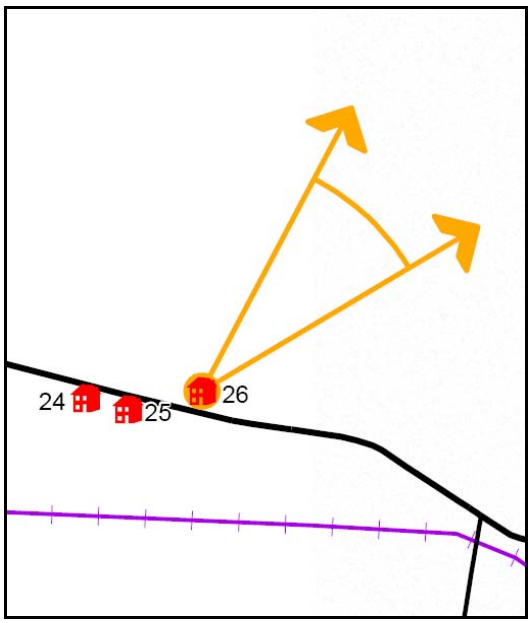


Figure 4.21: Photomontage Viewpoint

Figure 4.22: Photomontage of view to site – From Hamilton Highway adjacent to Residence 26 following construction of wind farm.

VIEWPOINT 9 – RESIDENCE 45 ON DUVERNEY ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	3.2 km to closet turbine.
Visual Setting	Sub-Regional (Near)
Landscape Character	The residence is surrounded by dense vegetation in a flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to the site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Low to moderate due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but a limited number will visible between breaks in vegetation.

Figure 4.23: Character of setting – Residence 45 on Duverney Road

Figure 4.24: Existing view to site from Duverney Road adjacent to Residence 45

VIEWPOINT 10 – RESIDENCE 41 ON HAMILTON HIGHWAY

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	3.4 km to closet turbine.
Visual Setting	Sub Regional (Near)
Landscape Character	The residence has limited scattered vegetation surrounding it within a flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to the site..
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially noticeable. Potential impact - Moderate to high. Between 81 and 100 turbines will potentially be visible as distant elements, but generally a reduced number will visible between breaks in vegetation.

Figure 4.25: Character of setting – Residence 41 on Hamilton Highway

Figure 4.26: Existing view to site from Hamilton Highway adjacent to Residence 41

VIEWPOINT 11 – RESIDENCE 20 ON LISMORE - SCARSDALE ROAD

Viewing Situation	From roadway adjacent to residence
Viewing Distance	2.1 km to nearest setting.
Visual Setting	Sub Regional (Near).
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The residence is surrounded by a dense band of vegetation which generally screens views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to the site..
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Low to moderate due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.27: Character of setting – Residence 20 on Lismore – Scarsdale Road

Figure 4.28: Existing view to site from Lismore – Scarsdale Road adjacent to Residence 20

4.6.3 Local Setting – 0 – 2km Distant

Within the local setting the following sensitive viewpoints exist:

- 34 residences (Non – agreemment landowners)
- Berrybank township
- Hamilton Highway
- Local Road Network

VIEWPOINT 12 – RESIDENCE 47 ON URCHES ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1.6 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence has limited scattered vegetation surrounding it within a flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to the site..
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - High Between 81 and 100 turbines will potentially be visible as distant elements, but a reduced number will visible due to the screening effects of bands of vegetation within the landscape.

Figure 4.29: Character of setting – Residence 47 on Urch's Road

Figure 4.30: Existing view to site from Urch's Road adjacent to Residence 47

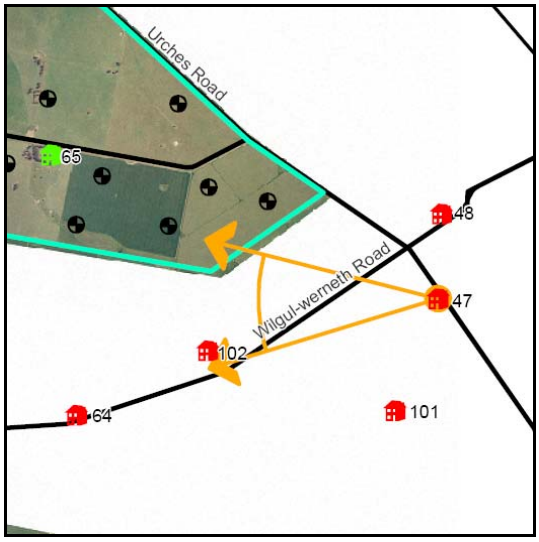


Figure 4.31: Photomontage Viewpoint

Figure 4.32: Photomontage of view to site from Urch's Road adjacent to Residence 47 following construction of wind farm.

VIEWPOINT 13 – RESIDENCE 105 ON BERRYBANK – WALLINDUC ROAD

Viewing Situation	From roadway adjacent to residence
Viewing Distance	1.6 km to closest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The residence has adjacent dense bands of vegetation which partially screen views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate due to screening vegetation of vegetation between the residence and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but generally, from the immediate area of the residence, a reduced number will visible between breaks in intervening vegetation.

Figure 4.33: Character of setting – Residence 105 off Berrybank – Wallinduc Road

Figure 4.34: Existing view to site from Berrybank – Wallinduc Road adjacent to Residence 105

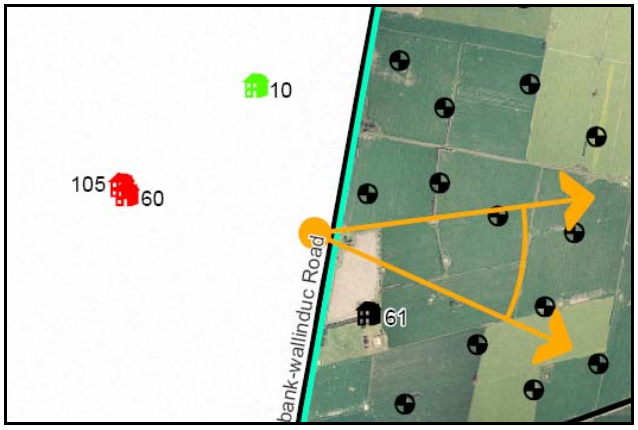


Figure 4.35: Photomontage Viewpoint

Figure 4.36: Photomontage of view to site from Berrybank – Wallinduc Road adjacent to Residence 105 following construction of wind farm. (Outlines of constructed turbines indicated where they are obscured by trees).

VIEWPOINT 14 – RESIDENCE 38 ON LOWER DARLINGTON ROAD

Viewing Situation	From roadway adjacent to residence
Viewing Distance	1.8 km to closest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within a flat to slightly undulating pastoral landscape. The residence is surrounded by groupings of vegetation which screen views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.37: Character of setting – Residence 38 on Lower Darlington Road

Figure 4.38: Existing view to site from Lower Darlington Road adjacent to Residence 38

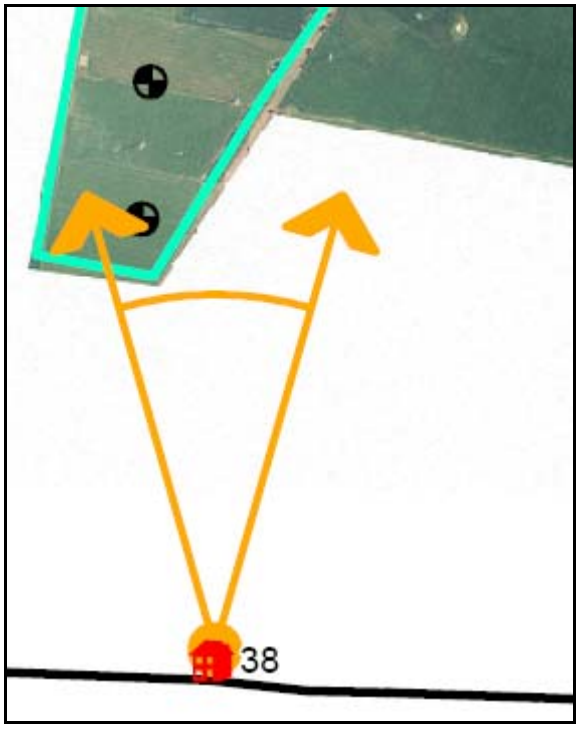


Figure 4.39:Photomontage Viewpoint

Figure 4.40: Photomontage of view to site from Lower Darlington Road adjacent to Residence 38 following construction of wind farm.

VIEWPOINT 15 – RESIDENCE 58 ON PADGETTS LANE

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1 km to closet turbine.
Visual Setting	Local.
Landscape Character	The residence is located within groupings of surrounding vegetation in the flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.41: Character of setting – Residence 58 on Padgetts Lane

Figure 4.42: Existing view to site from Padgetts Lane adjacent to Residence 58

VIEWPOINT 16 – RESIDENCE 85 SETBACK FROM HAMILTON HIGHWAY

Viewing Situation	From roadway adjacent to driveway leading to residence.
Viewing Distance	1.4 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, generally flat pastoral landscape. The residence is located within groupings of surrounding vegetation.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate to high due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible as distant elements, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.43: Character of setting – Residence 85 offset from Hamilton Highway

Figure 4.44: Existing view to site from Hamilton Highway adjacent to Residence 85

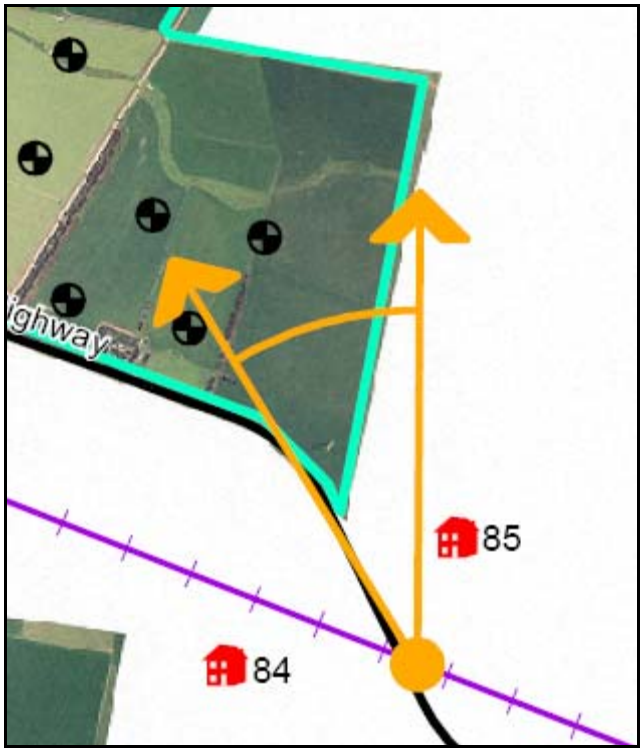


Figure 4.45: Photomontage Viewpoint

Figure 4.46: Photomontage of view to site from Hamilton Highway adjacent to Residence 85 following construction of wind farm.

VIEWPOINT 17 – RESIDENCE 63 ON BERRYBANK – WERNETH ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence is located within groupings of surrounding vegetation in the flat, open pastoral landscape.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate to high due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.47: Character of setting – Residence 63 on Berrybank – Werneth Road

Figure 4.48: Existing view to site from Berrybank – Werneth Road adjacent to Residence 63

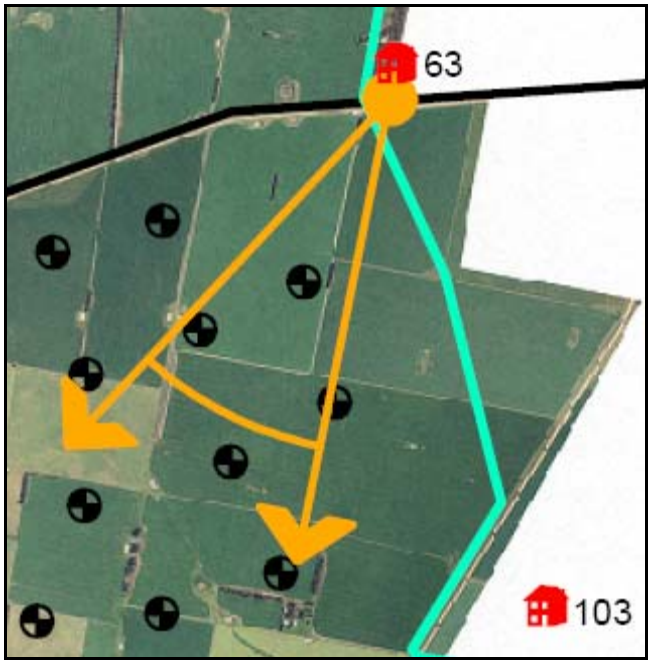


Figure 4.49 :Photomontage Viewpoint

Figure 4.50: Photo Simulation of view to site from Berrybank – Werneth Road adjacent to Residence 63 following construction of wind farm.

VIEWPOINT 18 – RESIDENCE 83 ON DOYLES ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The residence is surrounded by groupings of vegetation, including dense roadside planting, which partially screen views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential impact - Moderate to high due to the effect of vegetation screening between the viewpoint and the site. Between 81 and 100 turbines will potentially be visible, but generally, from the immediate area of the residence, a reduced number will visible between breaks in vegetation.

Figure 4.51: Character of setting – Residence 83 on Doyles Road

Figure 4.52: Existing view to site from Doyles Road adjacent to Residence 83

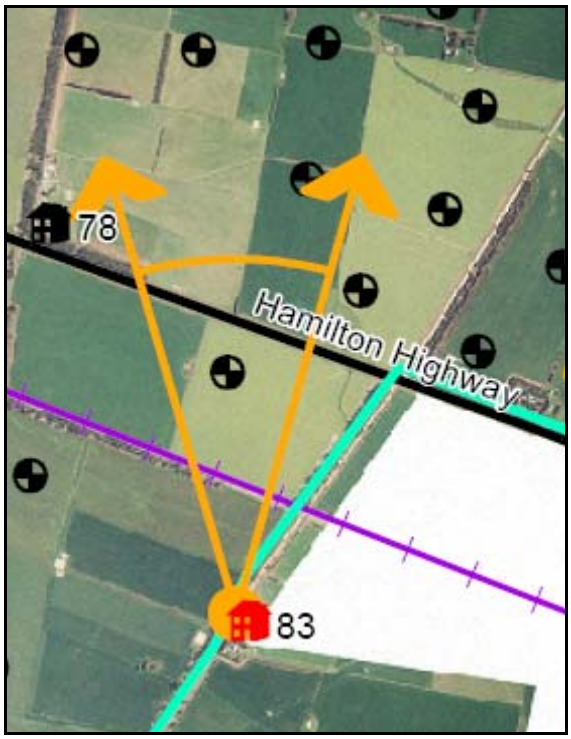


Figure 4.53: Photomontage Viewpoint

Figure 4.54: Photomontage of view to site from Doyles Road adjacent to Residence 83 following construction of wind farm.

VIEWPOINT 19 – RESIDENCE 28 ON COLLINS LANE

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1.1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, generally flat pastoral landscape. The residence is partly surrounded by groups of vegetation but this does not screen views to the site. Gnarkeet Chain of Ponds Creek separates the viewpoint from the wind farm.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential Impact - High. Potentially between 81 and 100 turbines will be visible, dependant on the presence of vegetation. Vegetation along the creek partially screens views of more distant turbines to the east of Berrybank – Wallinduc Road.

Figure 4.55: Character of setting – Residence 28 on Collins Lane

Figure 4.56: Existing view to site from Collins Lane Adjacent to Residence 28

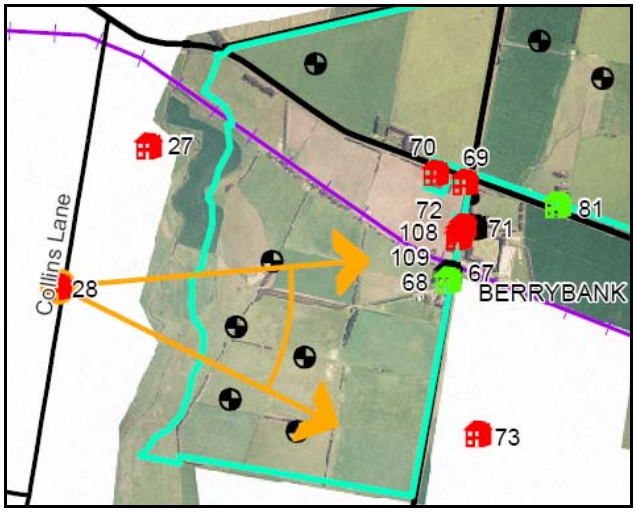


Figure 4.57: Photomontage Viewpoint

Figure 4.58: Photomontage of view to site from Collins Lane Adjacent to Residence 28 following construction of wind farm.

VIEWPOINT 20 – BERRYBANK TOWNSHIP ON HAMILTON HIGHWAY

Viewing Situation	From Hamilton Highway in township centre.
Viewing Distance	1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	Rural town urban setting with generally older, single storey buildings and relatively dense tree cover. Views from the main street to the site are partially screened by vegetation and buildings. However, views from the Hamilton Highway are visually open.
Land Use	Town Centre and Main Highway
Visual Sensitivity	High, due to proximity to site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential Impact - High Potentially between 81 and 100 turbines will be visible, dependant on the presence of vegetation.

Figure 4.59: Character of setting – Berrybank Township

Figure 4.60: Existing view to site – From Berrybank Township

VIEWPOINT 21 – RESIDENCE 18 ON URCH'S ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The residence is surrounded by groupings of vegetation and farm plant and equipment which provide partial screening of views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential Impact Moderate to High, due to partial effects of screening vegetation. Potentially between 81 and 100 turbines will be visible, dependant on the presence of vegetation.

Figure 4.61: Character of setting – View to Residence 18 from Urch's Road

Figure 4.62: Existing view to site from Urch's Road adjacent to Residence 18

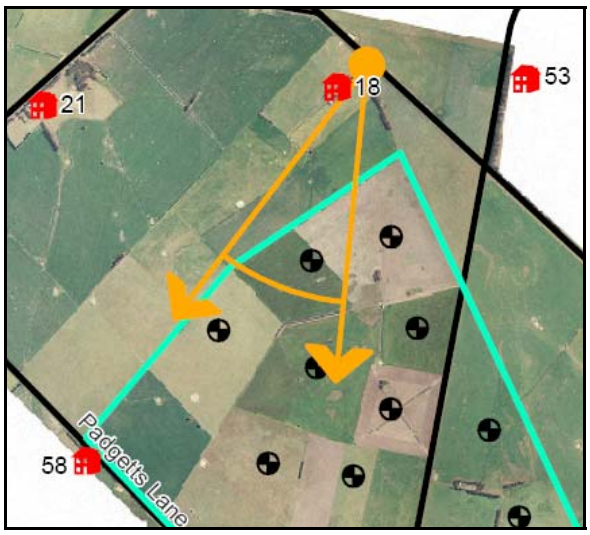


Figure 4.63: Photomontage Viewpoint

Figure 4.64: Photomontage of view to site from Urch's Road adjacent to Residence 18 following construction of wind farm.

VIEWPOINT 22 – RESIDENCE 74 ON BERRYBANK – WALLINDUC ROAD

Viewing Situation	From roadway adjacent to residence.
Viewing Distance	1.1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The existing HV lines are prominent elements within the landscape setting. The residence is surrounded by dense bands of vegetation which partially screen views to the full extent of the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential Impact - High Potentially between 81 and 100 turbines will be visible, dependant on the presence of vegetation.

Figure 4.65: Character of setting – View to Residence 74 on Berrybank – Wallinduc Road

Figure 4.66: Existing view to site from Berrybank – Wallinduc Road adjacent to Residence 74

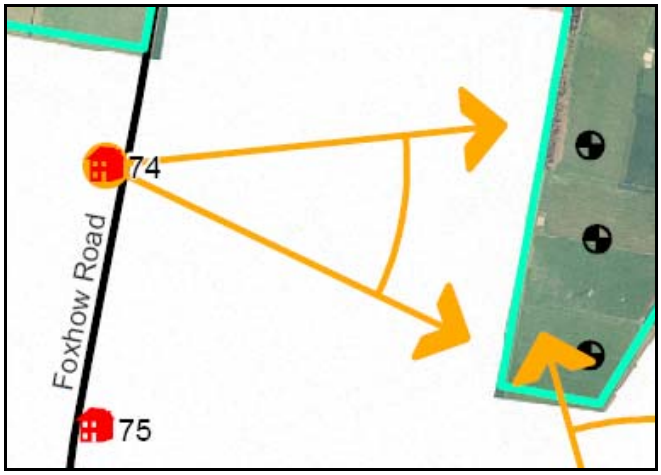


Figure 4.66: Photomontage Viewpoint

Figure 4.67: Photomontage of view to site from Berrybank – Wallinduc Road adjacent to Residence 74 following construction of wind farm.

VIEWPOINT 23 – RESIDENCE 57 ON BERRYBANK - WALLINDUC ROAD

Viewing Situation	From road adjacent to residence.
Viewing Distance	1 km to nearest turbine.
Visual Setting	Local.
Landscape Character	The residence sits within the open and expansive, flat to slightly undulating pastoral landscape. The residence is surrounded by a dense band of vegetation which screens views to the site.
Land Use	Rural residential in cropping / grazing setting.
Visual Sensitivity	High, due to proximity to site.
Potential Visual Impact	Horizontal angle – Potentially dominant. Vertical angle – Potentially dominant. Potential Impact High. Potentially between 81 and 100 turbines will be visible from locations outside of the surrounding garden area. From within the garden area, views will generally be heavily filtered by vegetation.

Figure 4.68: Character of setting – View to Residence 57 on Berrybank – Walllinduc Road

Figure 4.69: Existing view to site from Berrybank – Wallinduc Road adjacent to Residence 57

Figure 4.70: Photomontage Viewpoint

Figure 4.71: Photomontage of view to site from Berrybank – Wallinduc Road adjacent to Residence 57 following construction of wind farm.

4.7 Summary of Visual Impact

Following is a summation of views for a range of typical viewpoints throughout the regional setting of the proposed wind farm. The visual modification level has been determined through a combination of quantitative assessment of occupied field of view and qualitative assessment of visual compatibility with the setting.

Viewing Location	Sensitivity	Visual Modification Level	Visual Impact
Local Setting 0 – 2 km			
Rural Residences (x 34)	**H**	**H**	**H**
Township - Berrybank	**H**	**H**	**H**
Rural Residences – *Agreement Landowners* (x 8)	**L**	**H**	**M**
Local Roads	**L**	**M - H**	**M**
Hamilton Highway	**H**	**M - H**	**H**
Freight Rail Line	**L**	**L**	**L**
Rural Land Uses	**L**	**L**	**L**
Gnarput Chain of Ponds Creek	**L**	**L**	**L**
Sub Regional Setting 2 – 7 km			
Hamilton Highway	**L - M**	**L - M**	**L - M**
Tourist Route	**L - M**	**L - M**	**L - M**
Rural Residences	**M - H**	**L - H**	**L - H**
Township – Dulveney, Foxhow, Gnarkeet	**M - H**	**L - M**	**L - M**
Freight Rail Line	**L**	**L**	**L**
Local Roads	**L**	**L - M**	**L - M**
Rural Land Uses	**L**	**L**	**L**
Gnarput Chain of Ponds Creek	**L**	**L**	**L**
Regional Setting > 7km			
Rural Residences	**L**	**L**	**L**
Hamilton Highway	**L**	**L**	**L**
Local Roads	**L**	**L**	**L**
Rural Land Uses	**L**	**L**	**L**
(H = High, M = Moderate, L = Low)			

Table 4.2 – Summary of Visual Impact

4.8 Summary of Affected Viewers

4.8.1 Quantification of population, tourist numbers and number of residences

The near Sub Regional zone, up to 4.5 km from a turbine, is generally the visual catchment in which the level of visual impact starts to diminish for the most sensitive of land use types and user groups.

The following tables list data collected through the study process in order to attempt to quantify the level of impact of the wind farm on the surrounding area.

User Group	Population (approximate)
Local Population (Including Berrybank) – Non-beneficial only.	**136** (Estimate based on 4.0 per Household)
Hamilton Highway	1000 vpd / 350,000 pa

Table 4.3 - Population and tourist numbers per annum within 5 km of the study area.

Distance to nearest turbine	Number of Residences
Within 2 kilometres	**34**
Between 2 and 5 km in Viewshed (Excludes Berrybank)	**23**

Source: – Locations of Residences identified by desktop and field check.

Table 4.4 - Population numbers within 5 km of the study area.

4.9 Reflection / Glinting / Shadow Flicker

Reflection, glinting and shadow flicker can occur at times of the day when the sun is at a particular angle. An assessment of the predicted impacts of these aspects has been undertaken by Garrad Hassan. (Refer to Berrybank Wind Farm – Shadow Flicker and EMF Study – Garrad and Hassan).

4.10 Cumulative Impact

The landscape and visual impact of the proposed Berrybank wind farm cannot be considered in isolation, as the site is located in a regional setting that includes a number of approved projects that may commence construction in the near future.

Adjacent proposed projects are:

- Darlington Wind Farm, proposed for development at Darlington, approximately 40 km to the west – approximately 150 turbines.
- Mt Gellibrand, approved for development, 35km to the south – 116 turbines.
- Stockyard Hill, proposed for development, 55km to the north – 282 turbines.
- Lal Lal, proposed for development, 60km to the north east – 70 turbines
- Mortlake, proposed for development, 55km to the south west – 96 turbines
-

Given the range of visibility of a wind farm in relatively flat topography with vegetation of approximately 20km, the distribution of existing and proposed wind farms throughout the region will result in few locations that actually would be able to view more than a single wind farm. However, at the broader regional level, particularly for motorists traversing the road network, wind farms may become a common element throughout the landscape.

It is conceivable that the regularity of occurrence of wind farms may result in a cumulative impact in the future as spatial and landscape separation between the various wind farms decrease.

However, it is conceivable that that some of the approved wind farms will not be built. Therefore, a cumulative impact assessment is speculative and dependant on a range of factors outside of the control of a single wind farm developer.

4.11 Impacts of Night Lighting

There is little guidance locally on the assessment of night time visual impact. Therefore, the methodology applied in this study is drawn from the UK. The Institute of Lighting Engineers' (ILE) Guidance Notes for Reduction of Light Pollution includes a range of categories with which to describe the lit situation of the landscape. These environmental zones are supported by design guidance for the reduction of light pollution which can then inform proposed mitigation techniques. (Refer to Appendix D).

4.11.1 The Existing Setting

Throughout the local, sub-regional and regional setting, light is generated from vehicles on the Hamilton Highway and the local road network, the railway freight line and rural residences. Larger towns such as Cressy and Lismore in the regional setting concentrate enough light to generate localised areas that are observable as a soft glow in the night sky.

The setting is generally consistent with Environmental Zone E 1 – Intrinsically Dark Landscapes and Environmental Zone E2 – Low District Brightness Areas as identified in the Guidance Notes for Reduction of Light Pollution. The notes recommend that lighting within the identified zones should have minimal illumination into the sky as well as to adjacent viewpoints in order to maintain the night time setting.

4.11.2 Lighting Sources

The lighting proposed to be employed on the proposed facility will be emitted from a single source:

NAVIGATION WARNING LIGHTS

This is lighting that is installed as part of CASA's requirements[7]. It consists of a light mounted on the top of the nacelle where it will be visible from aircraft.

The key CASA requirements for lighting are:

- Two flashing red medium intensity obstacle lights should be provided per turbine where required.
- The light fixtures should be mounted sufficiently above the surface of the nacelle so that the lights are not obscured by the rotor hub, and are at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction.
- All lights on a wind farm should flash simultaneously.
- Sufficient individual wind turbines should be lit to indicate the extent of the group of turbines.
- The interval between obstacle lighted turbines should not exceed 900m, which is the most prominent (highest for the terrain) turbine(s) should be lit.

[7] *CASA Advisory Circular AC 139-18(0), July 2007. Obstacle Marking and Lighting of Wind Farms.*

To minimise visual impact on the ground plane environment, some shielding of the obstacle lights is allowed for in the CASA guidelines, provided it does not compromise their operational effectiveness. (Refer to Section 5.1).

An assessment of the lighting requirements by the Ambidgi Group indicates that potentially 52 turbines will require obstacle avoidance lighting. Of these, the majority will be located around the perimeter of the wind farm.

4.11.3 Effects of Lighting

From more distant sensitive locations, generally in the distant sub – regional setting, direct views to the navigational lighting will be often obscured from view by vegetation surrounding rural residences. Light spill will not generally be a factor due to the type of light involved – it merely needs to be visible from a distance, illumination of a particular area is not its function. However, on nights when there is low cloud or mist, reflection off the cloud droplets may occur.

The effects of lightning will vary based on distance from the turbine as well as direction of view.

Illumination of the rotating blade occurs as the blade passes close by the light. This can be seen as a gradual increasing and then decreasing of lighting of the blades surface closest to the hub for a very short period of time as they rotate past the light. Blade illumination is quite faint and generally only apparent to observers from locations closer than 1km. As all residences are in excess of 1km from any turbine, blade illumination is not likely to result in a significant visual impact.

Where the lights of turbines are viewed from the nacelle side, they will all appear as synchronised flashing lights. Where the lights are viewed from the blade side, the nacelle mounted lights will be viewed with the blade rotating in front of the light. As the blades rotate at different speeds, the effect of the blades passing in front of the flashing lights at varying speeds will result in the lights across a wind farm appearing as randomly flashing light sources.

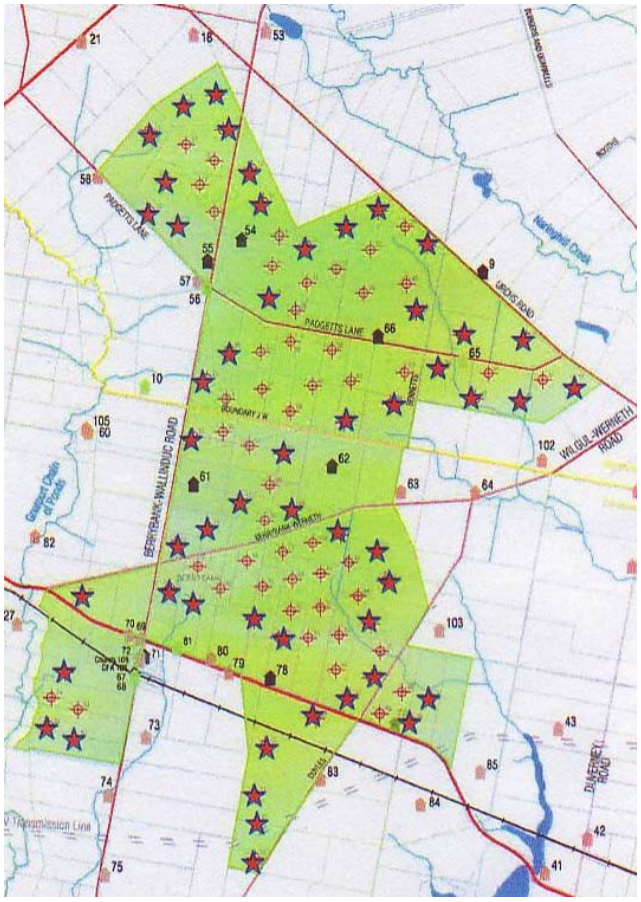
Within the regional setting, for a number of sensitive locations such as rural residences and the Hamilton Highway, visible lighting is most likely to appear as gentle points of light.

From sensitive viewing locations outside of residences and from the Hamilton Highway within the local and sub-regional setting, the navigational lights will be highly apparent.

The exact impact or acceptability of night lighting is difficult to define as it is dependant on individual perceptions and sensitivities as well as the presence of existing light at the viewing source and the effectiveness of shielding as well as the power of the lights. However, as there are a number of dispersed light sources in the regional setting, the blinking lights will most likely result in a low to moderate level of visual intrusion to sensitive viewpoints in the local and sub-regional setting.

The effects of any lighting at the proposed wind farm will not generally be apparent from within the residences at night when the internal house lights are on or from the immediate area around the residences when external lighting is on.

The wind power industry is attempting to work with CASA to review lighting requirements and to possibly develop more visually sensitive responses.



Turbine to be fitted with obstacle light

Figure 4.72: Proposed Obstacle Lighting Layout – Indicative Only (Source: The Ambidgi Group)

Figure 4.73: Photo Simulation of Aviation Lighting

5 Design Guidelines for Amelioration of Visual Impacts

5.1 Wind Farm Design and Rehabilitation Strategies

The following visual treatments, derived from background research and past experience, are recommended to assist in reducing the impact levels of the development and have been considered in the development of the proposal. (Refer to Appendix C – References).

5.1.1 Foreground Visual Screening / Forward Planting

In areas of high visual sensitivity, such as close to rural residences and other areas where amelioration of views to the wind farm may be required, planting may be able to be implemented close to the viewer location. Planting should be placed between the viewing location and the source of intrusion, to achieve effective screening. Planting to screen views of the wind farm should attempt to avoid impeding the existing views to the broader landscape, as this action in itself may result in a visual impact or negative change in views from a sensitive viewpoint. It should be recognised that given the scale, particularly the height of wind generators, that visual screening within a setting is most effective when the screening is close to viewing points. Recommended locations for foreground visual screen planting to occur are shown in Figure 5.1.

5.1.2 Detailed Wind Farm Design Considerations

INFRASTRUCTURE

It is preferable for there to be no permanent above ground structures associated with wind farms apart from the wind generators themselves and the MV transformers adjacent to the turbines. (Dependant on the ultimate turbine model). Service and maintenance buildings located on the site should reflect architectural elements already present in the setting or be screened with planting to reduce visual intrusion upon the surrounding landscape.

The construction of formal access tracks and construction lay down areas within wind farms should be kept to a minimum as access road construction can have a significant physical and visual impact. Allow tracks and lay downs to visually soften through the establishment of naturally generating grass / vegetation cover over their surface, (essentially a reinforced surface with some vegetation for occasional vehicle use), or along their edges and on cut and fill slopes so that they appear like a low key farm track.

Summary of Infrastructure Actions

- Use the local groupings of vegetation to minimise visibility of access and service tracks from key vantage points. Avoid aligning large sections of tracks in straight lines.
- Site service and access roads so that cut and fill are minimised and ensure soils are protected from erosion and slippage.
- Consolidate roads and reduce the need for clearance of large areas of ground cover vegetation for roads. Allow grass to regrow over any areas of disturbance.
- Use of low-profile and unobtrusive building designs to minimise the urbanised appearance or industrial character of sites located in rural or remote areas.
- Use traditional rural building styles of the area in the construction of the substations and other above ground structures.
- Underground all power lines within the site and integrate equipment wherever possible.
- Provide screen planting to the perimeter of substation, maintenance and control compounds.

TURBINE DESIGN AND COLOURING

The wind turbines will have a uniform design, rotational direction and speed, colour, height and rotor diameter to assist in achieving visual consistency throughout the wind farm. Visual uniformity assists in developing harmony between the landscape and the wind turbines.

A light grey or off-white colour works best in temperate climates, where sky is the dominant background, and blades, nacelle and tower should all appear the same colour, so the wind turbine appears visually balanced.

Visual impact can also be minimised by the use of slim, freestanding and tapered towers.

Summary of Turbine Design Actions

- Use of uniform colour, structure types, surface finishes and direction of rotation to minimise project visibility.
- A light blue / white / grey colour has proven to work best in locations where the turbines are back dropped by sky and clouds.
- Non reflective paint must cover all of the structure, including fastenings between the blades and the hub.
- Control the placement and limit the size, colour and number of labels or markings placed on individual turbines or advertising on fences and facilities.
- Prohibit lighting except where required for aircraft safety, minimising the contrast between the wind farm and the night time landscape of the area.

TURBINE PLACEMENT AND PATTERN

The placing and size of wind farms is very important in terms of the impact created on the landscape. Fewer and more widely spaced turbines present a more pleasing appearance than tightly packed arrays.

The spacing of turbines should be generally regular to give a consistent and repetitive pattern. The perception of motion is intensified when turbines are closely spaced, are of mixed designs or rotate in different directions. The design of the proposed wind farm provides for a generally regular spacing.

Summary of Placement Actions

- Controlling the location of different turbine types, densities and layout geometry to minimise visual impacts. Mixing of turbine types and rotational direction should be avoided.
- Lines of turbines responding to the contours work better in undulating locations.
- Roughly equally spaced turbines create better rhythm and harmony in the landscape, although a degree of consolidation is preferable to being too broadly spaced.

LIGHTING

Security lighting throughout the wind farm and the substation should be minimised to decrease the contrast between the wind farm and the night - time landscape of the area. Motion detectors should be used to activate night - time security lighting when required.

Air navigation lights should be spaced over the array, particularly at the extremities. They are not required on every tower.

According to the CASA requirements, shielding may be provided to restrict the downward spill of light to the ground plane through the following measures:

- No more than 5% of the nominal light intensity should be emitted at or below 5° below horizontal.

- No light should be emitted at or below 10° below horizontal. (Refer to Figure 5.2)
- Where two lights are mounted on a nacelle, dynamic shielding or light extinction for the period that a blade is passing in front of the light is permissible providing that at all time at least one light can be seen, without interruption, from every angle in azimuth.

An additional measure to reduce the potential incidence of reflection off the rotating blades at night is the treatment of the rear of blades, near where they affix the hub, with a non – reflective coating.

It is recommended that the proponents continue to monitor CASA lighting requirements and implement as much shielding or lower light candescence as allowable. It should be noted that the lighting at Mt Miller Wind Farm in South Australia, which was subject to a review visit by the Chair of the Planning Panel for the Oaklands Hill Wind Farm, was baffled to ensure that light spread was restricted to -0.5^{o} below horizontal and $+2.5^{o}$ above horizontal, a much reduced extent than that specified by CASA.

REFLECTION / GLINTING

Glinting of the blades may occur when the sun reflects off them, depending on sun angle and viewing location. Glinting is significantly reduced when non - reflective paints are used. This will be the case on the blades proposed for Berrybank. The connection points between the blades and the hubs can also potentially glint and these should be painted with non – reflective paint also.

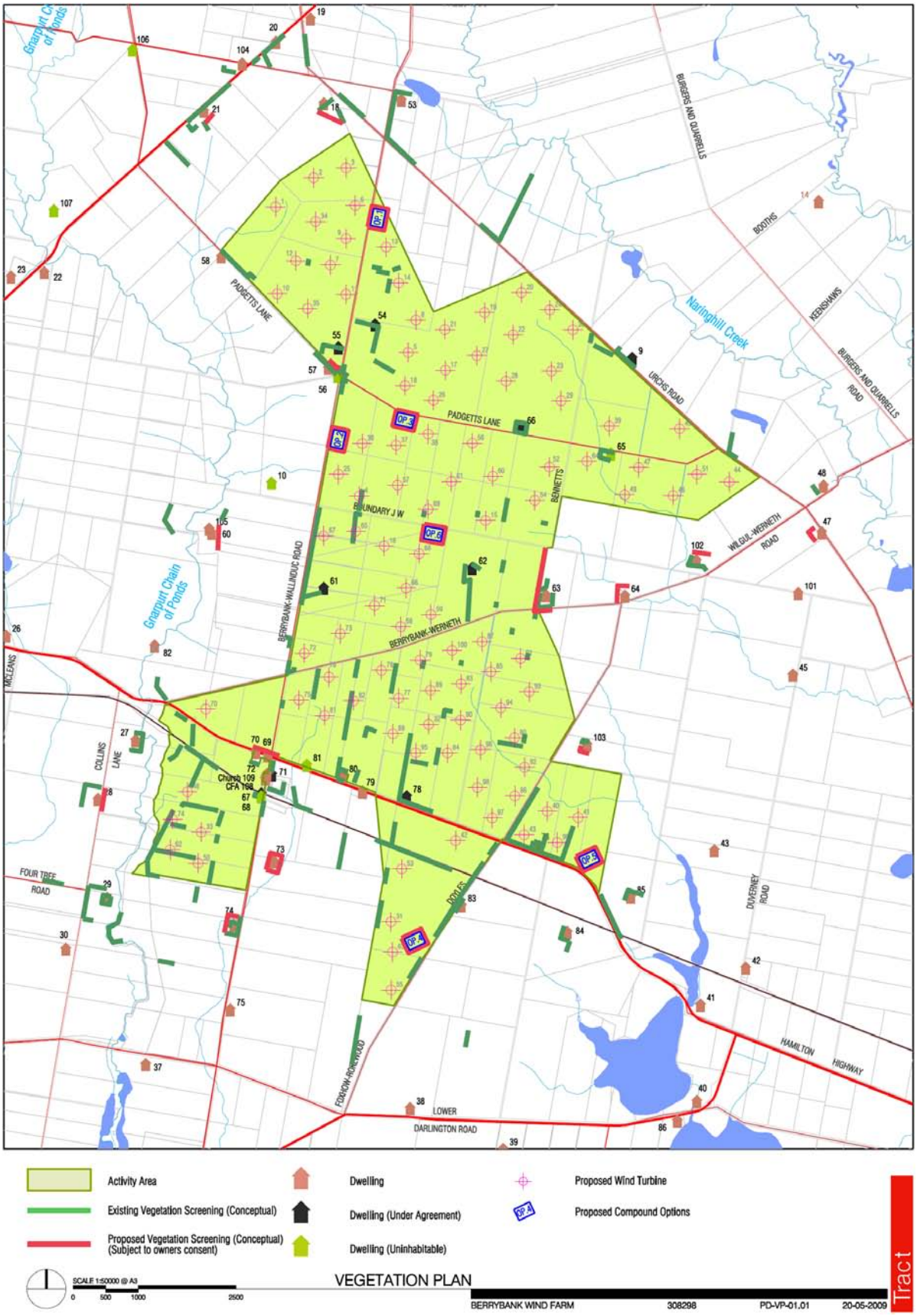


Figure 5.1: Locations of Recommended Foreground Visual Screen Planting

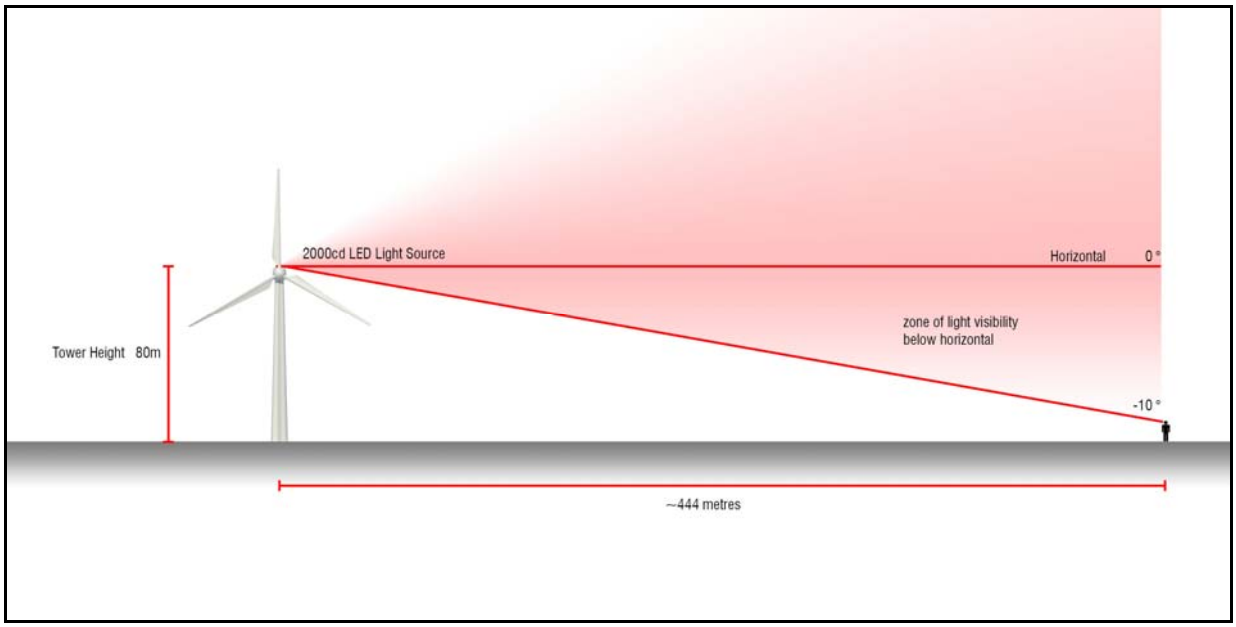


Figure 5.2: CASA Recommended Obstacle Lighting Spread

6 Conclusion

A key consideration in the assessment of visual impact will be the perception of local residents to elements that evoke a variety of responses.

6.1 Perceptions of Change

Whilst the degree to which a development the scale of the proposed Berrybank Wind Farm is visible from certain vantage points can be quantified, the degree to which the viewers will be impacted is influenced by an individual's perceptions of what change will bring.

As indicated by the research of other case studies of community perception, acceptance to the wind farm will vary widely depending on the viewer's preferences and biases. The residents and users of the landscape surrounding the site will reflect a range of sensitivities.

The degree to which the changes to the landscape are perceived negatively will in the end depend on the actual users / residents. Users of major roads such as the Hamilton Highway, particularly tourists, may perceive it as a feature. Indeed, the recent study by Lothian indicated that viewer perceptions to images of landscape settings lacking contrast and features showed positive responses to the introduction of wind farms into the setting. This means that for the majority of non – resident viewers, the wind farm may be seen as a positive addition to the landscape.

6.2 Visual Impact

The project, as proposed, will change the landscape of the setting at the local, sub regional and, to a lesser extent, the regional level.

As mentioned in the assessment process previously, the landscape character of the setting is already highly modified by past activities.

Many of the homesteads in the area have a dense band of vegetation surrounding an intimate and secluded home yard. The effect of this, in a number of cases, has been to effectively contain the view shed from the house and surrounding yard itself, blocking more distant views.

Additionally, in many instances, the area immediately abutting and outside of the homestead garden is utilised as the works area for the operation of the farm. The presence of the "tools of the trade", such as material storage areas, farm equipment, silos, sheds, etc., which can take up a considerable portion of the view shed around a house, can have a greater contributing influence on visual modification than other more distant elements. Therefore, the area immediately outside of the home yard may be perceived by some as being a part of a "work scape", to be changed and managed according to primarily economic drivers. The resulting effect may be the desensitizing of those who live and work within the setting to other more distant changes to the landscape.

6.3 Cumulative Impact

Multiple wind farms, proposed for the broader region, will not generally be able to be seen from individual viewpoints. Therefore for static viewing locations, the cumulative impact will be negligible. However, for vehicles traversing roads throughout the broader region, multiple wind farms may result in an unacceptable change to the landscape setting for some viewers.

6.4 Night Lighting

The CASA requirements of night obstacle lighting introduce an additional impact into the assessment of wind farms. The presence of pulsing lights in an otherwise dark, night-time landscape may result in an impact that is unacceptable to many residents. However, lighting sources are present within the setting and obstacle lighting will not generally be visible from within residences at night.

6.5 Connector Powerline

The connector powerline from the wind farm sub station to the main grid, which is generally located offset from the road network to reduce impact, will generally be compatible with the roadside landscape of the setting. The use of pole-like structures, albeit at a larger scale, should the powerline by located above ground, are consistent with elements found within many rural settings and will, therefore, have a minimal level of visual impact. Should final design resolution studies identify that the powerline line be located underground, the resulting visual impact will be negligible.

6.6 Effectiveness of Amelioration Measures

The amelioration measures incorporated into the design process, such as the design of access tracks to ensure minimisation of track length, in conjunction with recommended actions such as screen planting at sensitive residential viewpoints and around substations, will have a positive effect on reducing the visual impact of the proposed wind farm, particularly sensitive static viewpoints such as rural residences.

Appendix A Visibility Rationale

Visibility – Relationship with Viewsheds

The report defines a number of viewsheds based on distance from the development for the purposes of assessment. The methodology is based on the reduction of impact with an increase in distance between a given viewpoint and the development. These viewsheds or settings are:

- **Local Setting** – up to 2km from the development
- **Sub Regional Setting** – between 2km and 7km from the development
- **Regional Setting** – beyond 7km of the development

These distances have been established based on previous studies undertaken by URBIS. They are based on the reduction of visibility of objects in the distance as the field of view reduces.

Horizontal Line of Sight

It is generally accepted that the central field of vision for the human eye covers a horizontal angle of approximately 50 degrees to 60 degrees. Given both eyes see simultaneously and that there is a degree of overlap, a central field of view results in a person looking straight ahead. ***(Refer to Figure A.1).***

In the production of visual simulations, a 50mm lens on a 35mm film format is most widely used as it captures a field of view of approximately 46 degrees, similar to that of the view from one eye. Two photos taken with a 50mm lens produced as a panorama, with a degree of central overlap, capture the central field of view in a similar way to that of the human binocular view (binocular field).

Within the central field of vision, the viewed image is sharp, colours are separately defined and depth perception occurs.

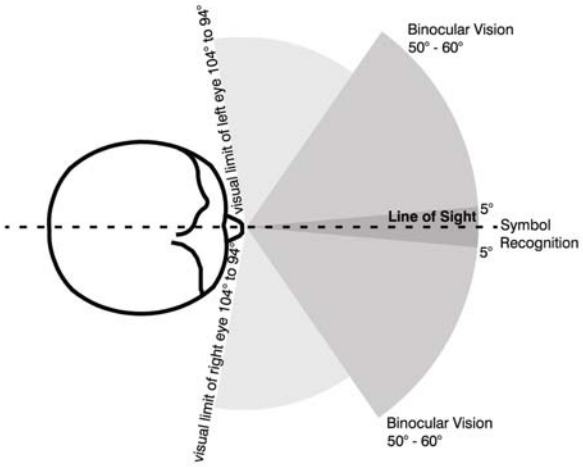


Figure A1 – Horizontal Line Of Sight

Visual Impact / Visual Prominence

The potential visual impact of a development will, to a large extent, depend on how much of the central field of vision that it occupies. In relation to the assessment of mining sites that often extend across the landscape, the calculation of horizontal view angle is not the only factor to be considered.

Degrees of Field of View Occupied	Potential Visual Prominence – Horizontal Field of View
Less than 5°	***Insignificant*** The development will not be highly visible in the view, unless it contrasts strongly with the background.
5° – 30°	***Potentially Noticeable*** The development may be noticeable. The degree that it intrudes on the view will be dependant on how well it integrates with the landscape setting.
Greater than 30°	***Potentially Dominant*** The development will be highly noticeable.

Vertical Line of Sight

As for the horizontal line of sight, there is also a vertical central field of view. If we assume that the horizon is 0° then the eye clearly defines colour, field of view and has image sharpness for an angle of approximately 25° upwards and 30° downwards. However, in reality, the typical line of sight for a standing person at ground level is approximately 10° below the horizon line. ***(Refer to Figure A.2).***

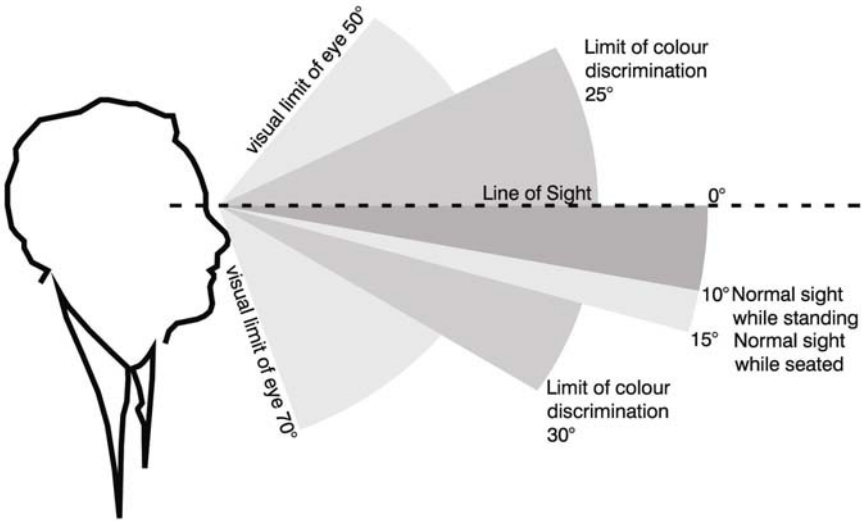


Figure A2 – Vertical Line Of Sight

Visual Impact / Visual Prominence

Objects that occupy a small proportion of the vertical field of view are visible but not dominant, particularly when they occur within landscapes that have been modified by human activity.

Degrees of Field of View Occupied	Potential Visual Prominence – Vertical Field of View
Less than 0.5^{o}	***Insignificant*** A small thin line in the landscape.
0.5^{o} – 2.5^{o}	***Potentially Noticeable*** The development may be noticeable. The degree that it intrudes on the view will be dependant on how well it integrates with the landscape setting.
Greater than 2.5^{o}	***Potentially Dominant*** The development will be highly noticeable, although the degree of visual intrusion will depend on the landscape setting and the width / thickness of the object.

Visual Prominence in Relation to Distance and Viewshed Settings

The following distances relating to visual prominence are based on the previous field of view exercises. The distances also relate to the distances for the setting types in the visual assessment methodology.

Distance from Object	Potential Visual Prominence
7000 metres	***Visibility Diminishing*** The visual prominence of the element progressively diminishes over distance.
2000 – 7000 metres	***Potentially Noticeable*** The development may be noticeable. The degree that it intrudes on the view will increase as distance reduces.
Less than 2000 metres	***Potentially Dominant*** The development will be highly noticeable.

Appendix B Glossary of Terms

Amelioration – The ability to reduce the visual impact of a development through siting, design, colour or screening.

Sensitivity – The degree to which various user groups will respond to change based on their expectation of a particular experience in a given setting, i.e. the expectation of a high level of visual amenity in a national park.

Modification Level – The degree to which a development contrasts or blends with its setting.

Visual Impact – The result of assessing the sensitivity level of a viewer and the modification level of a development.

Viewshed – The area visible from a particular viewing location.

Zone of Visual Influence (ZVI) – The area over which an object can be seen within the landscape

Visual Amenity – The qualities of a landscape setting that are appreciated and valued by a viewer.

Viewer Perception – The way in which people respond to what they are seeing as influenced by things other than purely visual, – i.e. noise and economic benefits.

Appendix C Research References

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Zube, Ervin H., Thomas W. Anderson, and William P. MacConnell. 1976. Predicting Scenic Resource Values. In: Studies in Landscape Perception. Edited by Ervin H.

Zube. Publication No. R-76-1. Institute for Man and His Environment. Amherst: University of Mass. p. 6-69.

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Appendix D Guidance Notes for the Reduction of Intrusive Light

Guidelines prepared by the Institution of Lighting Engineers, U.K.

The Institution of Lighting Engineers

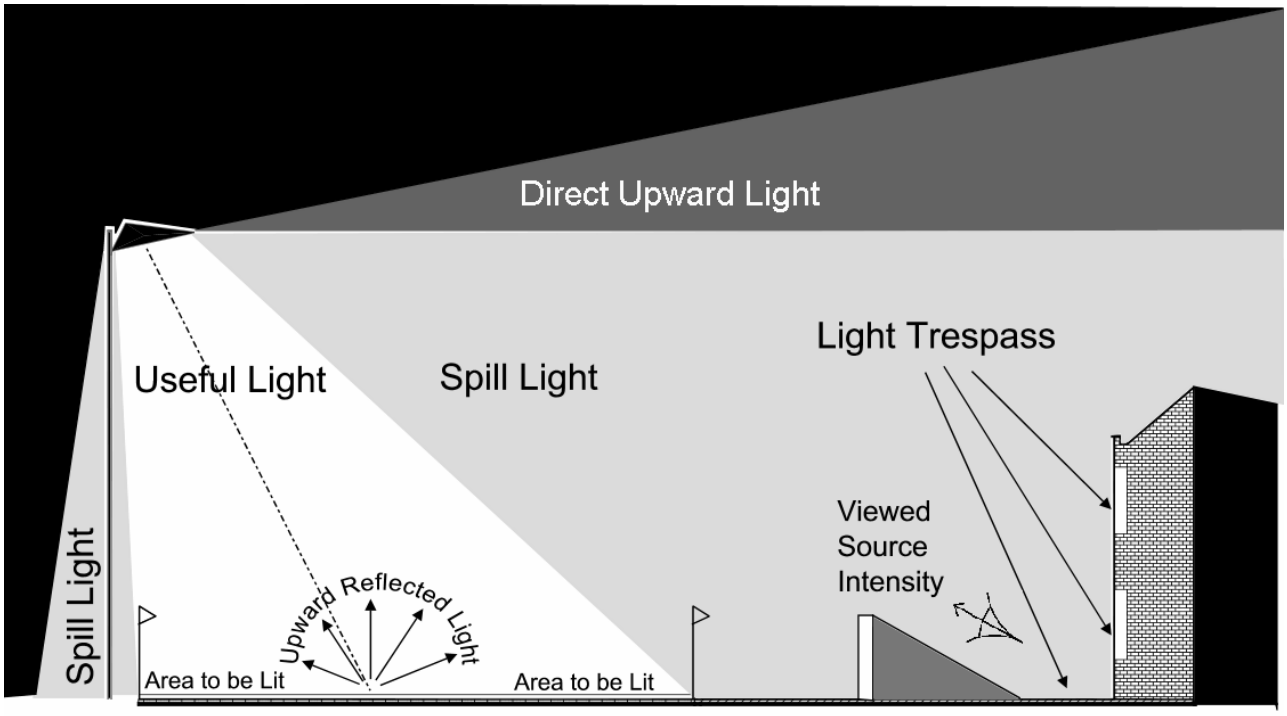
E-mail ile@ile.org.uk Website www.ile.org.uk

GUIDANCE NOTES FOR THE REDUCTION OF OBTRUSIVE LIGHT

ALL LIVING THINGS adjust their behaviour according to natural light. Man's invention of artificial light has done much to enhance our night-time environment but, if not properly controlled, **obtrusive light** (commonly referred to as light pollution) can present serious physiological and ecological problems.

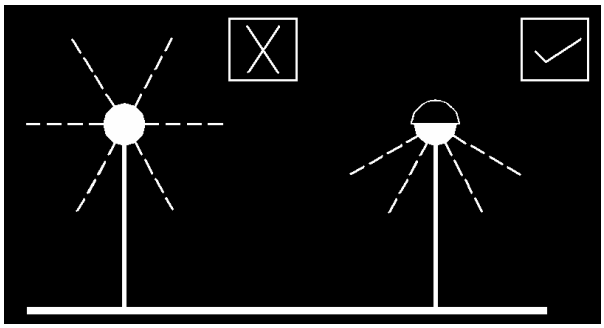
Obtrusive Light, whether it keeps you awake through a bedroom window or impedes your view of the night sky, is a form of pollution and can be substantially reduced without detriment to the lighting task.

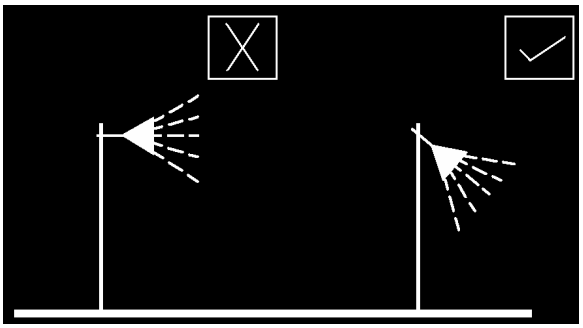
Sky glow, the brightening of the night sky above our towns, cities and countryside, **Glare** the uncomfortable brightness of a light source when viewed against a dark background, and **Light Trespass**, the spilling of light beyond the boundary of the property or area being lit, are all forms of obtrusive light which may cause nuisance to others, waste money and electricity and result in the unnecessary emissions of greenhouse gases. Think before you light. Is it necessary? What effect will it have on others? Will it cause a nuisance? How can I minimise the problem?



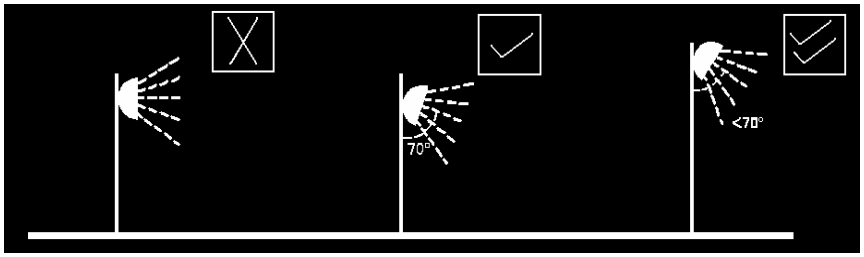
Do not "over" light. This is a major cause of obtrusive light and is a waste of energy. There are published standards for most lighting tasks, adherence to which will help minimise upward reflected light. Organisations from which full details of these standards can be obtained are given on the last page of this leaflet.

Dim or switch off lights when the task is finished. Generally a lower level of lighting will suffice to enhance the night time scene than that required for safety and security.



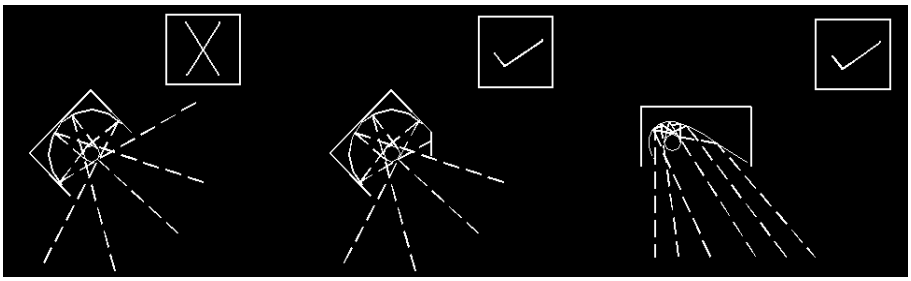


Use specifically designed lighting equipment that minimises the upward spread of light near to and above the horizontal. Care should be taken when selecting luminaires to ensure that appropriate units are chosen and that their location will reduce spill light and glare to a minimum. Remember that lamp light output in LUMENS is not the same as lamp wattage and that it is the former that is important in combating the problems of obtrusive light

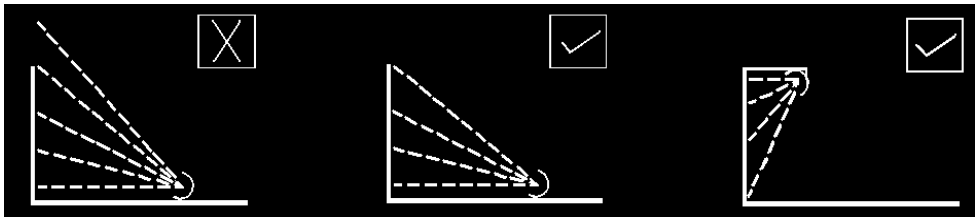


Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is not more than 70°. Higher mounting heights allow lower main beam angles, which can assist in reducing glare. In areas with low ambient lighting levels, glare can be very obtrusive and extra care should be taken when positioning and aiming lighting equipment. With regard to domestic security lighting the ILE produces an information leaflet GN02 that is freely available from its web site.

The UK Government will be providing an annex to PPS23 Planning and Pollution Control, specifically on obtrusive light. However many Local Planning Authorities (LPA's) have already produced, or are producing, policies that within the new planning system will become part of the local development framework. For new developments there is an opportunity for LPA's to impose planning conditions related to external lighting, including curfew hours.



For sports lighting installations (see also design standards listed on Page 4) the use of luminaires with double-asymmetric beams designed so that the front glazing is kept at or near parallel to the surface being lit should, if correctly aimed, ensure minimum obtrusive light. In most cases it will also be beneficial to use as high a mounting height as possible, giving due regard to the daytime appearance of the installation. The requirements to control glare for the safety of road users are given in Table 2.



When lighting vertical structures such as advertising signs direct light downwards, wherever possible. If there is no alternative to up-lighting, as with much decorative lighting of buildings, then the use of shields, baffles and louvres will help reduce spill light around and over the structure to a minimum.

For road and amenity lighting installations, (see also design standards listed on Page 4) light near to and above the horizontal should normally be minimised to reduce glare and sky glow (Note ULRs in Table 1). In sensitive rural areas the use of full horizontal cut off luminaires installed at 0° uplift will, in addition to reducing sky glow, also help to minimise visual intrusion within the open landscape. However in many urban locations, luminaires fitted with a more decorative bowl and good optical control of light should be acceptable and may be more appropriate.

ENVIRONMENTAL ZONES:

It is recommended that Local Planning Authorities specify the following environmental zones for exterior lighting control within their Development Plans.

Category	Examples	
E1:	**Intrinsically dark landscapes**	National Parks, Areas of Outstanding Natural Beauty, etc
E2:	**Low district brightness areas**	Rural, small village, or relatively dark urban locations
E3:	**Medium district brightness areas**	Small town centres or urban locations
E4:	**High district brightness areas**	Town/city centres with high levels of night-time activity

Where an area to be lit lies on the boundary of two zones the obtrusive light limitation values used should be those applicable to the most rigorous zone.

DESIGN GUIDANCE

The following limitations may be supplemented or replaced by a LPA's own planning guidance for exterior lighting installations. As lighting design is not as simple as it may seem, you are advised to consult and/or work with a professional lighting designer before installing any exterior lighting.

Table 1 – Obtrusive Light Limitations for Exterior Lighting Installations

Environmental Zone	Sky Glow ULR [Max %] (1)	Light Trespass (into Windows) Ev [Lux] (2)		Source Intensity I [kcd] (3)		Building Luminance Pre-curfew (4)
		Pre- curfew	Post- curfew	Pre- curfew	Post- curfew	Average, L [cd/m2]
E1	0	2	1*	2.5	0	0
E2	2.5	5	1	7.5	0.5	5
E3	5.0	10	2	10	1.0	10
E4	15.0	25	5	25	2.5	25

ULR = **Upward Light Ratio of the Installation** is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky.

Ev = **Vertical Illuminance in Lux** and is measured flat on the glazing at the centre of the window

I = **Light Intensity in Cd**

L = **Luminance in Cd/m2**

Curfew = **The time after which stricter requirements (for the control of obtrusive light) will apply**; often a condition of use of lighting applied by the local planning authority. If not otherwise stated - 23.00hrs is suggested.

***** = From Public road lighting installations only

(1) **Upward Light Ratio** – Some lighting schemes will require the deliberate and careful use of upward light – e.g. ground recessed luminaires, ground mounted floodlights, festive lighting – to which these limits cannot apply. However, care should always be taken to minimise any upward waste light by the proper application of suitably directional luminaires and light controlling attachments.

(2) **Light Trespass (into Windows)** – These values are suggested maxima and need to take account of existing light trespass at the point of measurement. In the case of road lighting on public highways where building facades are adjacent to the lit highway, these levels may not be obtainable. In such cases where a specific complaint has been received, the Highway Authority should endeavour to reduce the light trespass into the window down to the after curfew value by fitting a shield, replacing the luminaire, or by varying the lighting level.

(3) **Source Intensity** – This applies to each source in the potentially obtrusive direction, outside of the area being lit. The figures given are for general guidance only and for some sports lighting applications with limited mounting heights, may be difficult to achieve.

(4) **Building Luminance** – This should be limited to avoid over lighting, and related to the general district brightness. In this reference building luminance is applicable to buildings directly illuminated as a night-time feature as against the illumination of a building caused by spill light from adjacent luminaires or luminaires fixed to the building but used to light an adjacent area.

Table 2 – Maximum Values of Threshold Increment from Non-Road Lighting Installations				
Light Technical Parameter TI	**Road Classification** (5)			
	No road lighting	ME5	ME4/ ME3	ME2 / ME1
	15% based on adaptation luminance of 0.1cd/m^2	15% based on adaptation luminance of 1cd/m^2	15% based on adaptation luminance of 2 cd/m^2	15% based on adaptation luminance of 5 cd/m^2

TI = **Threshold Increment** is a measure of the loss of visibility caused by the disability glare from the obtrusive light installation

(5) **Road Classifications** as given in BS EN 13201 - 2: 2003 Road lighting Performance requirements
Limits apply where users of transport systems are subject to a reduction in the ability to see essential information. Values given are for relevant positions and for viewing directions in path of travel. See CIE Publication 150:2003, Section 5.4 for methods of determination. For a more detailed description and methods for calculating and measuring the above parameters see CIE Publication 150:2003.

RELEVANT PUBLICATIONS AND STANDARDS:

British Standards:
www.bsi.org.uk

BS 5489-1: 2003 Code of practice for the design of road lighting – Part 1: Lighting of roads and public amenity areas
BS EN 13201-2:2003 Road lighting – Part 2: Performance requirements
BS EN 13201-3:2003 Road lighting – Part 3: Calculation of performance
BS EN 13201-4:2003 Road lighting – Part 4: Methods of measuring lighting performance.
BS EN 12193: 2003 Light and lighting – Sports lighting

Countryside Commission/DOE
www.odpm.gov.uk

Lighting in the Countryside: Towards good practice (1997) *(Out of Print)*

CIBSE/SLL Publications:
www.cibse.org

CoL	Code for Lighting (2002)
LG1	The Industrial Environment (1989)
LG4	Sports (1990+Addendum 2000)
LG6	The Exterior Environment (1992)
FF7	Environmental Considerations for Exterior Lighting (2003)

CIE Publications:
www.cie.co.at

01	Guide lines for minimizing Urban Sky Glow near Astronomical Observatories (1980)
83	Guide for the lighting of sports events for colour television and film systems (1989)
92	Guide for floodlighting (1992)
115	Recommendations for the lighting of roads for motor and pedestrian traffic (1995)
126	Guidelines for minimizing Sky glow (1997)
129	Guide for lighting exterior work areas (1998)
136	Guide to the lighting of urban areas (2000)
150	Guide on the limitations of the effect of obtrusive light from outdoor lighting installations (2003)
154	The Maintenance of outdoor lighting systems (2003)

Department of Transport
www.defra.gov.uk

Road Lighting and the Environment (1993) (Out of Print)

ILE Publications:
www.ile.org

TR 5	Brightness of Illuminated Advertisements (2001)
TR24	A Practical Guide to the Development of a Public Lighting Policy for Local Authorities (1999)
GN02	Domestic Security Lighting, Friend or Foe

ILE/CIBSE Joint Publications
ILE/CSS Joint Publications

Lighting the Environment - A guide to good urban lighting (1995)
Seasonal Decorations – Code of Practice (2005)

Campaign for Dark Skies (CfDS)
www.dark-skies.org

NB: These notes are intended as guidance only and the application of the values given in Tables 1 & 2 should be given due consideration along with all other factors in the lighting design. Lighting is a complex subject with both objective and subjective criteria to be considered. The notes are therefore no substitute for professionally assessed and designed lighting, where the various and maybe conflicting visual requirements need to be balanced.