Paling Yards Wind Farm

Proposed view north from Abercrombie Road toward the Paling Yards wind farm turbines

LANDSCAPE & VISUAL IMPACT ASSESSMENT

Prepared for:

UNION FENOSA
WIND AUSTRALIA
gasNatural fenosa

Prepared by:

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Green Bean Design – Capability Statement

Green Bean Design (GBD) is an experienced landscape architectural consultancy specialising in landscape and visual impact assessment. As an independent consultancy GBD provide professional advice to a range of commercial and government clients involved in large infrastructure project development.

GBD owner and Principal Landscape Architect Andrew Homewood is a Registered Landscape Architect and member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand.

Andrew has over 20 years continuous employment in landscape consultancy and has completed numerous landscape and visual impact assessments for a range of large scale and State significant infrastructure and renewable energy projects, including wind energy and solar power developments.

Green Bean Design has been commissioned for over 20 wind energy projects across New South Wales, Victoria, South Australia, Queensland and Tasmania including assessments for:

• Silverton Wind Farm	• Boco Rock Wind Farm	• Collector Wind Farm
• Crookwell 3 Wind Farm	• Sapphire Wind Farm	• Willatook Wind Farm
• Eden Wind Farm	• Birrema Wind Farm	• Rye Park Wind Farm
• Paling Yards Wind Farm	• Port Kembla Wind Farm	• Bango Wind Farm
• Deepwater Wind Farm	• White Rock Wind Farm	• Liverpool Range Wind Farm
• Conroy's Gap (Mod 4)	• Mt Emerald Wind Farm	• Granville Harbour Wind Farm

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Executive Summary

GBD has been commissioned by Union Fenosa Wind Australia Pty Ltd (the Proponent) to undertake a Landscape and Visual Impact Assessment (LVIA) for the proposed Paling Yards wind farm and associated development infrastructure (the project).

The project would include up to 59 wind turbines, and for the purpose of this LVIA, the proposed wind turbines have been assessed with a maximum blade tip height of 175 m from ground level to tip of blade and a maximum rotor size of up to 136 m. Associated electrical works include a 500 kV overhead transmission line connection to the existing Mount Piper to Bannaby 500 kV transmission line approximately 10 km north east of the project site.

This LVIA involved desktop studies and site inspections to collect and analyse information to describe and define the characteristics of the landscape in which the project would be located. This LVIA has determined that the landscape surrounding the project has an overall medium to high sensitivity to accommodate change, and represents a landscape that is reasonably typical of landscape character areas that are commonly found in the surrounding areas of the New South Wales Southern Tablelands and the NSW/ACT Border Region Renewable Energy Precinct.

As a landscape with an overall medium to high sensitivity to accommodate change, some recognisable characteristics of the landscape will be altered by the project and result in the introduction of visually prominent elements that will alter some perceived landscape characteristics. Alterations to perceived characteristics may be partially mitigated by existing landscape elements and features within the landscape. The main characteristics of the landscape, patterns and combinations of landform and landcover will still be evident.

The project visibility was determined within the 10 km radius of the wind farm development and illustrated by a series of panoramic photographs and Zone of Visual Influence (ZVI) diagrams. The ZVI diagrams demonstrate the influence of topography on visibility and identify areas from which the wind farm turbines would be visible.

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This LVIA assessed the potential visual impact of the project for residential dwelling locations within the projects 10 km viewshed as well as impacts for motorists travelling along local roads surrounding and through the project site, as well as recreational activities within the neighbouring Abercrombie River National Park. A number of criteria were considered and assessed to determine levels of visual impact.

A total of 48 residential dwelling locations within the project 10 km viewshed have been determined to have a low or nil visual impact. A total of 24 residential dwelling locations would have a low to moderate or moderate visual impact and 6 a medium to high visual impact. All of the residential dwelling view locations with a medium to high visual impact are dwellings located within the project boundary and comprise the involved properties of Paling Yards, Quobleigh and Mingary Park (associated residences)

This LVIA assessed the potential visual impact associated with the assessed 330 kV and assessed and proposed 500 kV transmission line and substation locations. This LVIA determined that the overall visual impact of these elements would be low to moderate (with some potential for high impacts associated with the assessed 330 kV transmission line) due the location of electrical infrastructure items relative to existing view locations together with the screening influence of surrounding topography and vegetation.

A cumulative visual impact assessment was carried out for the Paling Yards wind farm project. The cumulative assessment included the approved Taralga and proposed Golspie wind farm developments to the south and south west of the Paling Yards wind farm project area. None of the approved Taralga wind farm turbines are located within the Paling Yards wind farm 10 km viewshed. A small portion of the proposed Golspie wind farm project area is located within the Paling Yards wind farm 10 km viewshed; however the locations of wind turbines proposed as part of the Golspie project are not yet known. This LVIA determined that there would be limited intervisibility between the Paling Yards wind farm and other approved wind farm developments and that any potential cumulative impact is likely to be low due to both distance between the wind farm developments and location of residential dwellings relative to multiple wind farm developments.

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An Aeronautical Impact and Night Lighting Assessment commissioned by the Proponent has determined that obstacle lighting may be necessary, subject to a detailed and thorough risk assessment to be prepared once the final turbine layout and turbine height are known. This LVIA notes that night time lighting has been determined as not required for the Gullen Range wind farm, and that obstacle lighting has also been removed from the Cullerin wind farm adjoining the Hume Highway to the west of Yass in New South Wales (as illustrated in Figures 33, 34 and 35) as well as wind farms in Victoria.

This LVIA assessed four potential transmission line corridors and determined that the assessed southern 330 kV transmission line corridors (comprising three potential routes and a single connection south to the approved Crookwell 2 wind farm substation) would result in an overall moderate visual impact, with potential for high impact where residential dwelling proximity, and lack of vegetative cover, increases transmission line visibility. The assessed and proposed northern 500 kV transmission line corridor would result in an overall low to moderate visual impact. Accordingly the Proponent is only seeking an approval for the northern 500 kV transmission line corridor option.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of the elements associated with the wind farm, this LVIA acknowledges that the degree to which the wind turbines may be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations.

Introduction

Section 1

1.1 Introduction

This LVIA addresses one of the key requirements of the project Environmental Assessment (EA) to be submitted and assessed under Part 3A of the Environmental Planning & Assessment Act 1979 (EP&A Act).

The LVIA methodology adopted by GBD has been applied to a number of similar LVIA for large scale infrastructure projects, including the Silverton, Boco Rock and White Rock wind farm developments which have been assessed and approved by the New South Wales Department of Planning & Infrastructure (DoP&I) under Part 3A of the EP&A Act.

This LVIA addresses and responds to the Director General's Requirements (DGR's) dated 6th May 2010 for the assessment of potential landscape and visual impacts of the project. **Table 1** outlines the relevant landscape and visual impact assessment requirements of the DGR's and the corresponding section in which they are addressed within this LVIA report.

Table 1 Director General's Requirements

DGR's	LIVA Reference
• provide a comprehensive assessment of the landscape character and values and any scenic or significant vistas of the area potentially affected by the project including both the wind farm and the transmission line. This should describe community and stakeholder values of the local and regional visual amenity and quality, and perceptions of the project based on surveys and consultation. Consideration must be given to impacts on the values of the adjacent national parks, including impacts on wilderness and Greater Blue Mountains World Heritage area values;	Refer LVIA: Section 1, Section 7, and Section15
• assess the impact of shadow "flicker", blade "glint" and night lighting from the wind farm;	Refer LVIA: Section 11 and Appendix A
• identify the zone of visual influence (no less than 10 kilometres) and assess the visual impact of all project components on this landscape;	Refer LVIA: Section 4

Table 1 Director General's Requirements

DGR's	LIVA Reference
• include an assessment of the visual impacts associated with the transmission line, including impacts on local and regional views. Alternative pole designs should be presented and assessed and the potential for undergrounding in sensitive locations should be assessed;	Refer LVIA: Section 13
• include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights) settlements and significant public view points, and provide a clear description of proposed visual amenity mitigation and management measures for both the wind farm and the transmission line;	Refer LVIA: Section 10
• provide an assessment of the feasibility, effectiveness and reliability of proposed mitigation measures and any residual impacts after these measures have been implemented.	Refer LVIA: Section 16

The project would be located within the Oberon Shire Council Local Government Area. The Oberon Shire Council have adopted a Development Control Plan (DCP), Part O of which applies to "Wind Power Generation 2005". Whilst the provisions of the DCP do not apply to the project (which is subject to Part 3A of the EP&A Act), GBD confirms that this LVIA addresses a number of the key DCP requirements with regard to consideration of visual assessment, including:

"*A description of the visual effects including shadow flicker/glinting, photomontages, computer assisted photo simulations or other graphic representations of the appearance of the wind turbines and transmission lines. View shed modelling via the use of a suitable GIS (e.g. MapInfo) is encouraged. Steps to be taken to mitigate any possible negative visual effects are to be included*".

The assessed southern transmission line would include a proposed corridor through the Upper Lachlan Shire Council Local Government Area.

The assessment of potential visual impact associated with Shadow Flicker has been assessed and included in **Section 11** of this LVIA.

This LVIA involved a comprehensive evaluation of the landscape character in which the project and ancillary structures would be located, and an assessment of the potential landscape and visual impacts that could result from the construction and operation of the wind farm, taking into account appropriate mitigation measures. This LVIA is based on technical and design information provided by the Proponent to GBD.

1.2 Draft NSW Planning Guidelines: Wind Farms (December 2011)

The NSW DoP&I issued the Draft Planning Guidelines: Wind Farms (NSW Draft Guidelines) in December 2011, which provide guidance and information for wind farm applicants, consent authorities as well as communities and stakeholder groups. The NSW Draft Guidelines were placed on public exhibition between December 2011 and March 2012; however, had not been finalised or formally adopted by the New South Wales Government prior to completion of this LVIA.

The NSW Draft Guidelines set out key considerations for the upfront assessment of landscape and visual impact for residential dwellings within a 2km radius of proposed wind turbines (through the Gateway Process and Site Compatibility Certification), and specific assessment requirements that may be set out in the NSW DoP&I Director Generals Requirements on a project by project basis. The NSW Draft Guidelines also set out a comprehensive framework for the assessment of landscape and visual impacts including residential dwellings within 2 km proximity of proposed wind turbines. Landscape and visual issues are outlined in Appendix A of the NSW Draft Guidelines 'Meeting assessment requirements - Landscape and visual amenity' (Refer **Appendix C** of this LVIA).

This LVIA has considered and given regard to the NSW Draft Guidelines to the fullest extent practicable, and addresses the key landscape and visual amenity aspects set out in the DoP&I checklist issued to the Proponent in the DoP&I correspondence dated 18 April 2012. The key landscape and visual amenity aspects are set out in **Table 2**.

Table 2 DoP&I Landscape and visual amenity checklist

Key aspects	LVIA Reference/Response
Provide photomontage from all non-host dwellings within 2 km of a proposed wind turbine	There are no non-host dwellings within 2 km of a proposed wind turbine. Photomontages have been prepared from six view locations surrounding the wind farm project site.

Table 2 DoP&I Landscape and visual amenity checklist

Key aspects	LVIA Reference/Response
Identify the zone of visual influence of the wind farm (no less than 10 km) and likely impacts in community and stakeholder values.	This LVIA has identified a 10 km zone of visual influence surrounding the proposed wind farm development and assessed likely impacts in community and stakeholder values (Refer LVIA **Sections 4, 8** and **15**).
Consider cumulative impacts on landscape and views.	This LVIA has considered potential cumulative landscape and visual impacts (Refer LVIA **Section 9**).
Outline mitigation measures to avoid or manage impacts.	This LVIA has outlined mitigation measures to minimise potential impacts (Refer LVIA **Section 16**).

1.3 National Assessment Framework

GBD is cognisant of the Australian Wind Energy Association and Australian Council of National Trust's publication Wind Farms and Landscape Values National Assessment Framework (NAF), June 2007, and have encompassed the general assessment framework outlined in the NAF within the LVIA methodology. In addition to the NAF, the preparation of this LVIA has also included a review of the National Wind Farm Development Guidelines (Public Consultation Draft V2.4 July 2010).

Table 3 outlines the relevant recommendations of the NAF and the corresponding section in which they are addressed within this LVIA report.

Table 3 NAF Recommendations

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
Step 1 Assess the Landscape Values **1A Preliminary Landscape Assessment** • 1A.1 Desktop Review • 1A.2 Seek information from Local Authority • 1A.3 Identify potential community and stakeholder interests • 1A.4 Site survey • 1A.5 Preliminary assessment of landscape values	This LVIA has been prepared through a comparable methodology to that outlined in the NAF and has included a desktop review (pre site inspection) to determine potential view locations as well as establishing the extent and types of landscape characteristics within the 10 km viewshed. Early telephone discussions with the relevant Local Authorities determined that no additional wind farm developments were current other than those notified on the DoPI website: (http://majorprojects.planning.nsw.gov.au/page/project-sectors/transport--communications--energy---

Table 3 NAF Recommendations

NAF Tasks (through Steps 1 to 4)	LVIA Reference/Response
1B Full Landscape Assessment • 1B.1 Define the study area for assessment, including the zone of visual influence • 1B.2 Landscape Character Analysis • 1B.3 Natural and cultural values analysis • 1B.4 Involve communities and stakeholders in identifying landscape values • 1B.5 Document values and analyse significance	water/generation-of-electricity-or-heat-or-co-generation/) Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are included in this LVIA as well as other relevant sections of the **EA**. Site survey and preliminary assessment work has been undertaken and incorporated into this LVIA. The preparation of a separate preliminary assessment of landscape values is not a requirement under the NSW DoPI DGR's. This LVIA addresses the requirements of Step 1B and presents an analysis of key considerations included in the NAF.
Step 2 Describe and Model the Wind Farm in the Landscape • 2.1 Describe the development • 2.2 Model the development • 2.3 Prepare a visual assessment report	This LVIA has described and modelled the project development and selected view points from a range of view locations including residential dwellings, road corridors and public lookouts within the 10 km viewshed.
Step 3 Assess the Impacts of the Wind Farm on Landscape Values • 3.1 Seek community input to potential impacts • 3.2 Identify and describe impacts • 3.3 Identify potential cumulative impacts • 3.4 Identify other relevant factors • 3.5 Evaluate impacts	Community and stakeholder interests have been identified by an ongoing process of direct consultation between the Proponent and relevant stakeholders. The results of the consultative process are outlined and included in this LVIA as well as other relevant sections of the **EA**. This LVIA has identified and described potential landscape and visual impacts associated with the project development as well as potential cumulative impacts resulting from other wind farm projects within the NSW/ACT Border Region Renewable Energy Precinct.
Step 4 Respond to Impacts • 4.1 Changes to location or siting of the wind farm or ancillary infrastructure • 4.2 Layout and design considerations • 4.3 Minor changes and mitigation measures • 4.4 Recommend changes to the development	The development of the project turbine layout has been reviewed and adjusted throughout the preparation of this LVIA. Changes to the layout have occurred as a result of stakeholder consultation and specific concerns directed toward the visual impact of the wind farm from surrounding view locations.

The NAF is noted by its authors as a framework document and does not set out a detailed or prescribed method to undertake an assessment of landscape values. This LVIA has; however, followed the majority of techniques and has tested and determined outcomes for the principal issues that have been raised in the NAF.

1.4 Auswind Best Practice Guidelines (December 2006)

The Auswind Best Practice Guidelines were developed to assist wind farm proponents to implement best practice in regards to the location and siting of wind energy facilities and to conduct wind farm investigations and impact assessments. The guidelines have been subject to revisions following technical reviews and consultation with both industry and broader stakeholder input.

The Guidelines, developed between (the former) Auswind and the National Trust, provide a landscape assessment approach to describe, assess and evaluate the potential landscape and visual impact of a proposed wind energy project. A summary of the approach includes:

- consultation with experts in the analysis of the environments visual characteristics e.g. Landscape Architects;
- preparation of 'Zone of Visual Influence' or 'Seen Area Diagrams';
- preparation of photomontages (also referred to as Visual Simulations);
- determination of cumulative impact from existing wind energy projects;
- investigation of impacts with associated infrastructure elements, including substation, service roads and power lines; and
- assessment of Shadow Flicker.

The Auswind Best Practice Guidelines offer best practice advice and are not a mandatory requirement for wind farm developments within Australia and have been incorporated into this LVIA.

1.5 Methodology

This LVIA methodology included the following activities:

- desktop study addressing visual character and identification of view locations within the surrounding area;

- fieldwork and photography;
- preparation of ZVI diagrams;
- assessment and determination of landscape sensitivity;
- assessment and determination of visual impact;
- preparation of photomontages and illustrative figures; and
- preparation of a Shadow Flicker and Blade Glint Assessment.

1.6 Desktop study

A desktop study was carried out to identify an indicative viewshed for the project. This was carried out by reference to 1:25,000 scale topographic maps as well as aerial photographs and satellite images of the project area and surrounding landscape. A preliminary ZVI diagram was also produced prior to the commencement of fieldwork in order to inform the likely extent and nature of areas within the nominated 10 km viewshed of the proposed wind farm.

Topographic maps and aerial photographs were also used to identify the locations and categories of potential view locations that could be verified during the fieldwork component of the assessment. The desktop study also outlined the visual character of the surrounding landscape including features such as landform, elevation, landcover and the distribution of settlements.

1.7 Preparation of ZVI diagrams

GL-Garrad Hassan Pacific Pty Ltd (GL Garrad Hassan) prepared ZVI Diagrams to illustrate the potential visibility of the wind turbines within the project 10 km viewshed. ZVI Diagrams included visibility from tip of blade and hub height and are illustrated in **Figures 4** and **5**, and detailed in **Section 4** of this LVIA.

1.8 Fieldwork and photography

GBD undertook a total four and a half days of fieldwork associated with the Paling Yards wind farm development:

- two days of general site inspections to determine and confirm the potential extent of visibility of the project and ancillary structures, and to identify landscape characteristics surrounding the wind farm site, and along the proposed transmission line corridors;

- a one day detailed site inspection to determine associated residential dwelling window locations and orientations for a detailed shadow flicker assessment; and
- one day of site photography for the photomontages locations.

1.9 Assessment of landscape sensitivity

The potential impact of the project on the sensitivity of the landscape surrounding the wind farm would result primarily from the capability of the landscape to integrate with, or to accommodate the wind farm.

The capability of the landscape to accommodate the wind farm would result primarily from the nature and degree of perceptual factors that can influence interpretation and appreciation of the landscape, including landform, scale, topographic features, landcover and human influence or modifications.

1.10 Significance of visual impact

The potential significance for visual impact of the project on surrounding view locations would result primarily from a combination of the potential visibility of the wind turbines and the characteristics of the landscape between, and surrounding, the view locations and the wind farm. The potential degree of visibility and resultant visual impact would be partly determined by a combination of factors including:

- category and type of situation from which people could view the wind farm (examples of view location categories include residents or motorists);
- visual sensitivity of view locations surrounding the wind farm;
- potential number of people with a view toward the proposed wind farm from any one location;
- distance of visual effect (between view locations and the wind farm); and
- duration of time people could view the wind farm from any particular static or dynamic view location.

An underpinning rationale for this LVIA is that if people are not normally present at a particular location, such as agricultural areas, or they are screened by landform or vegetation, then there is likely to be a nil visual impact at that location.

If, on the other hand, a small number of people are present for a short period of time at a particular location then there is likely to be a low visual impact at that location, and conversely, if a large number of people are present then the visual impact is likely to be higher.

Although this rationale can be applied at a broad scale, this LVIA also considers, and has determined, the potential visual impact for individual view locations that would have a higher degree of sensitivity to the wind farm development, including the potential impact on individual residential dwellings situated in the surrounding landscape. The determination of a visual impact is also subject to a number of other factors which are considered in more detail in this LVIA.

Whilst this LVIA addresses a number of static elements associated with the project, the assessment acknowledges and has considered the potential visual impact associated with the movement of the wind turbine rotors.

1.11 Photomontages

Eight photomontages have been prepared to illustrate the potential visibility of the project following construction. The photomontages include views toward the proposed wind turbines and the assessed and proposed northern 500 kV transmission line. The photomontage locations were selected by GBD and photographed by GL-Garrad Hassan Pacific Pty Ltd (GH) in conjunction with GBD. The photomontage locations were selected to provide representative views from residential dwellings and within the vicinity of residential dwellings as well as publically accessible areas including road corridors. The photomontage locations are illustrated in **Figure 20** and the photomontages in **Figures 21** to **32**.

1.12 Shadow flicker & blade glint

GL-Garrad Hassan prepared a shadow flicker and blade glint assessment for the project. The results of the shadow flicker and blade glint assessment are included in **Section 11** and **Appendix A** of this LVIA.

Sunlight glint is a phenomenon that results from the direct reflection of sunlight (also known as specular reflection) from a reflective surface that would be visible when the sun reflects off the surface of the wind turbine at the same angle that a person is viewing the wind turbine surface. Glint may be noticeable for some distance, but usually results in a low impact due to frequency of occurrence and the potential influence of local environmental factors including cloud cover.

The surfaces of the wind turbines, including the towers and blades, are largely convex, which will tend to result in the divergence of light reflected from the surfaces, rather than convergence toward a particular point which will also reduce the potential for blade glint.

Location

Section 2

2.1 Location

The project would be located in the south of New South Wales within the NSW/ACT Border Region Renewable Energy Precinct, around 60 km south of Oberon and approximately 140 km west of Sydney. The general location of the project is illustrated in **Figure 1**. The project would extend across two participating rural residential/farming properties, covering an area around 3,900 hectares, administered by the Oberon Shire Council. The Oberon Shire Council covers around 365,900 hectares covering large tracts of the NSW Southern Tablelands and Great Dividing Range. The footprint of the project would therefore occupy a very small proportion of the Councils administered area.

The Australian Bureau of Statistics 2011 Census identifies two State Suburbs within the vicinity of the project site, and include:

- Porters Retreat, 86,800 hectares (population 255 with 112 private dwellings); and
- Wombeyan Caves, 93,400 hectares (population 263 with 242 private dwellings).

The Porters Retreat State Suburb occurs across and to the north of the project site, and Wombeyan Caves to the south. Both State Suburbs are linked by the Abercrombie Road which also passes through, and bisects, the project site. This LVIA identified a total of 78 residential dwellings within the Paling Yards 10 km viewshed which make up around 22% of the combined private dwellings within the Porters Retreat and Wombeyan Caves State Suburbs. There are no Townships or Villages within the Paling Yards 10 km viewshed. The closest Township to the project site is Taralga (population around 285), approximately 25 km to the south of the project site.

There are a small number of National Parks and State Forests in the vicinity of the project. The more significant include the Abercrombie and Blue Mountains National Parks and the Gurnang State Forest. The Abercrombie National Park adjoins the western section of the project site boundary. Covering an area of just over 19,000 hectares, the park includes walking tracks to take in low open forests, creeks and pools. Vehicle based camping facilities are provided at four locations within the park. There are no formal recreational or camping areas within the Gurnang State Forest.The project is also approximately 5 km from the southern portion of the Blue Mountains National Park, which is also part of the Greater Blue Mountain World Heritage Area. Covering an

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)

PALING YARDS WIND FARM -
LOCATION PLAN, REGIONAL CONTEXT (Not to scale)

PALING YARDS WIND FARM -
LOCATION PLAN, STATE CONTEXT (Not to scale)

Figure 1 Location Plan

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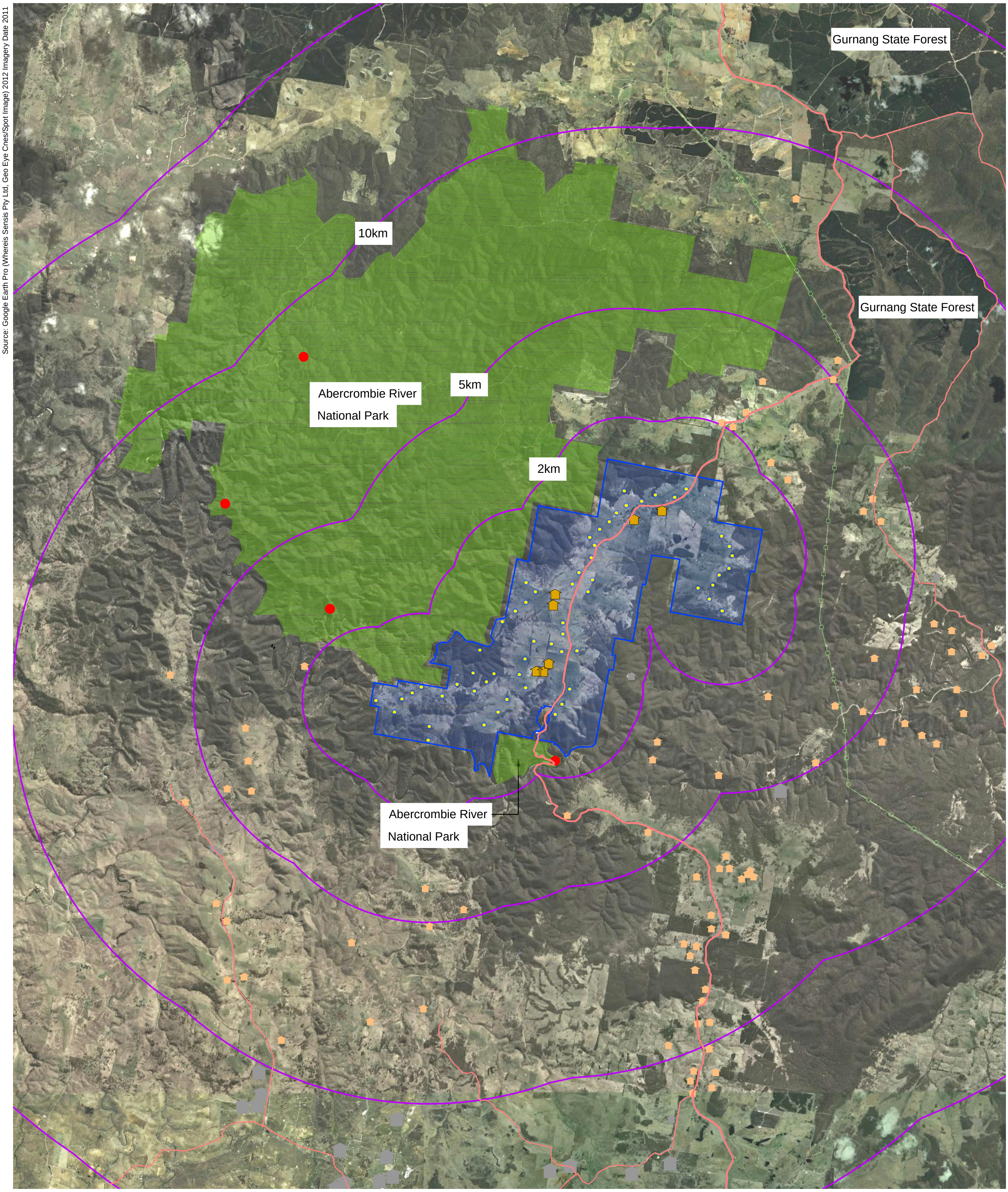
area of approximately 267,000 hectares, the irregular boundary of the park is broken up by areas of urban development, road networks and broader landholdings. Whilst subject to a very high annual visitation by tourists and sightseers, the project would not be visible from any of the key towns and associated attractions along the Great Western Highway.

The location of surrounding National Parks and State Forests are illustrated in **Figure 2**.



Legend

	Associated residential dwelling		Distance from proposed Paling Yards wind turbine		Vehicle based camp site (indicative location)
	Non associated residential dwelling		Local Road		
	Proposed Paling Yards wind turbine indicative layout		Existing 500 kV transmission line		
	Proposed Paling Yards Wind Farm site boundary		Abercrombie River National Park (indicative extent)		

0km 2km

Figure 2 National Parks & State Forests

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Project description

Section 3

3.1 Project description

The key visual components of the project would comprise:

- up to 59 wind turbines with a capacity of up to 4.5 MW each;
- individual transformers and switchgear with associated control systems to be located in the vicinity of the wind turbine towers (in some turbine models transformer equipment would be integrated within the tower or nacelle);
- underground electrical and communication cable network linking turbines to each other within the site boundary;
- on-site substation, internal 33 kV reticulation and a 500 kV transmission line connection to the grid via an off-site substation;
- control room and facilities building;
- up to three wind monitoring masts;
- crane hardstand areas; and
- on site access tracks for construction, operation and ongoing maintenance.

Temporary works associated with the construction of the wind farm that may be visible during construction and operational phases include:

- site office; and
- mobile concrete batching plant and rock crushing facilities.

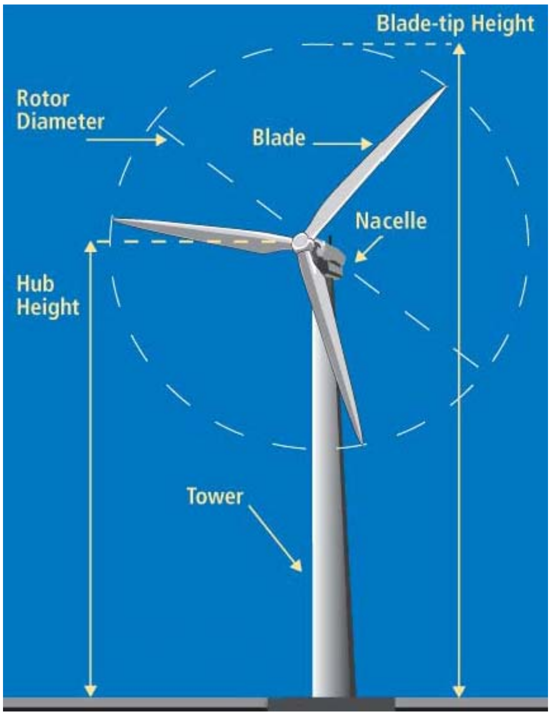
3.2 Wind turbines

The specific elements of the wind turbines comprise:

- concrete foundations;
- tubular tapering steel towers;

- nacelles at the top of the tower housing the gearbox and electrical generator (although not all turbine models include electrical generators within the nacelle); and
- rotors comprising a hub (attached to the nacelle) with three blades.

The following diagram identifies the main components of a typical wind turbine:



Configuration and components of a typical wind turbine

Table 4 outlines the main design parameters for the proposed Paling Yards wind turbines:

Table 4 Paling Yards wind turbines:

Element	Description
Tower height	Maximum of 119 m
Rotor Diameter	Maximum of 136 m
Overall height from ground level to tip of blade	Maximum of 175 m
Proposed number of Paling Yards wind turbines	**Up to 59 turbines**

As new turbines come onto the market, it is possible that the final turbine selected may exceed, in minor respects, the assessed maximum turbine envelope. The indicative Paling Yards wind farm design layout is illustrated in **Figure 3.**

3.3 Wind Monitoring Masts

Up to three wind monitoring masts would be installed on-site, extending up to 119 m in height. The wind monitoring masts would be of a guyed, narrow lattice or tubular steel design. The wind monitoring masts

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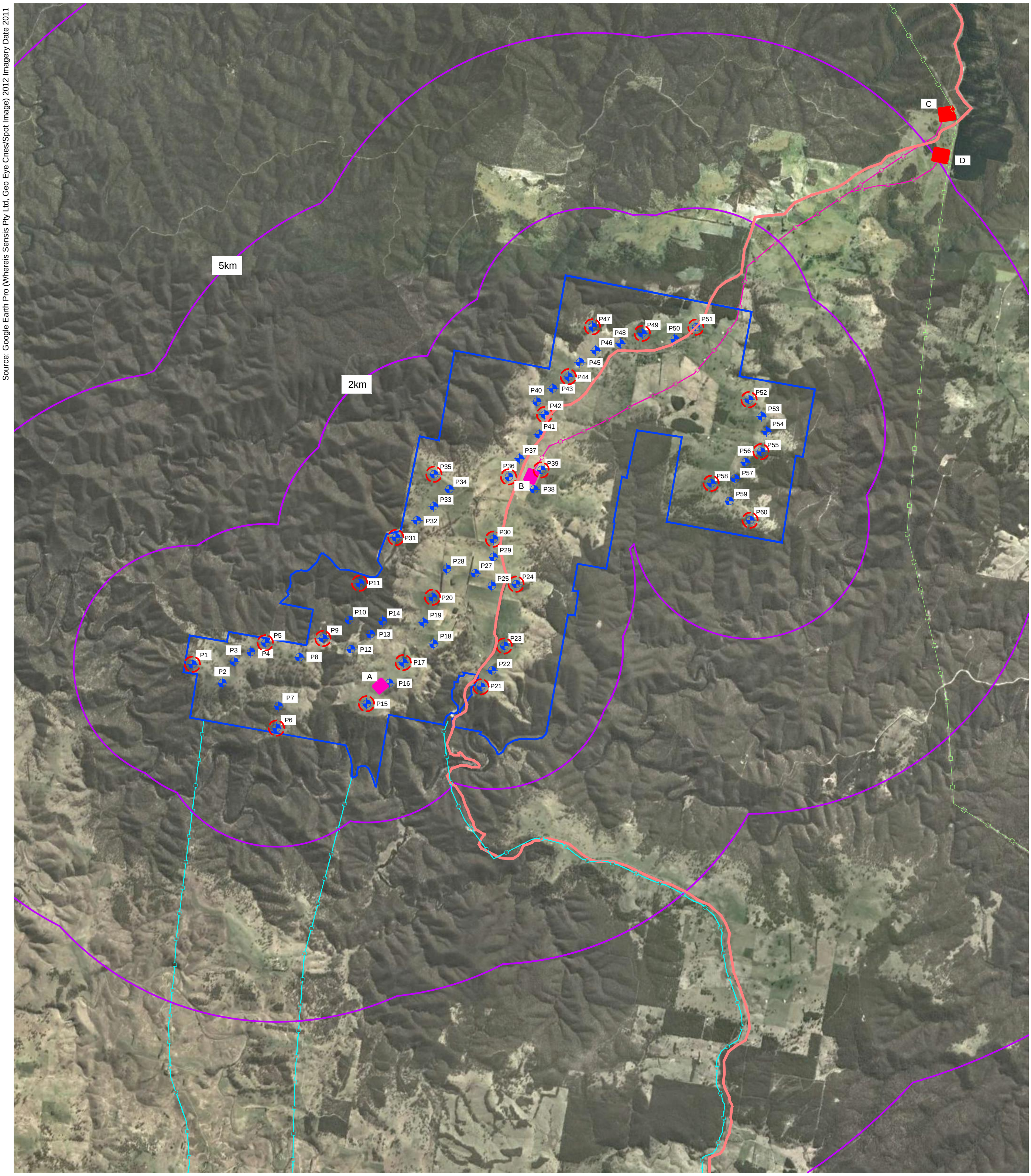

Legend

Local road	Paling Yards wind farm site boundary	Proposed on site substation location options A & B
Existing 500 kV transmission line	Distance from proposed wind turbine	Proposed off site substation location options C & D
P20 Paling Yards indicative wind turbine layout and turbine reference number	Assessed and proposed 500 kV transmission line corridor	
Proposed wind turbine with potential obstacle lighting	Assessed 330 kV transmission line corridors	

0km 2km

Figure 3 Site Layout

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would be unlikely to create a significant visual impact, and are similar in scale, or smaller than a number of surrounding communication masts visible in the landscape surrounding the wind farm project area.

3.4 On-site access tracks

On-site access tracks would be constructed to provide access to turbine locations across the site during construction and operation. During construction the majority of access tracks would be up to 12 m wide to allow for vehicle manoeuvring. Post construction, these access tracks would be partially rehabilitated up to 6 m width to facilitate access for maintenance vehicles during the operational phase. The final access track design would be developed on a number of environmental grounds, including minimising the potential for visual impact by considering:

- overall length and extent;
- need for clearing vegetation;
- potential for erosion;
- extent of cut and fill; and
- potential to maximise rehabilitation at the completion of the construction phase.

3.5 Electrical works

The principal electrical infrastructure (other than the wind turbines) that may be visible within the project would include:

- generator transformers (may be located within the wind turbine nacelle or at the base of the tower);
- one or more collector substations;
- 500 kV overhead transmission lines, electrical conductors and support structures;
- control cables (potentially located underground); and
- operation facilities and control building.

The proposed electrical works are detailed in **Section 13**.

Viewshed, zone of visual influence & visibility

Section 4

4.1 Introduction

A key component of this LVIA is defined by the description, assessment and determination of the viewshed, zone of visual influence and visibility associated with the wind farm. It is a combination of these issues that sets out the framework for determining the significance and magnitude of potential visual impact of the wind farm on view locations within the landscape.

In order to clarify and explain this component of this LVIA, the relationship between viewshed, zone of visual influence and visibility is outlined and defined in **Table 5**.

Table 5 – Definitions

	Definition	Relationship
Viewshed	An area of land surrounding and beyond the project area which may be potentially affected by the wind farm.	Identifies the majority of this LVIA study area that incorporates view locations that may be subject to a degree of visual impact.
Zone of Visual Influence (ZVI)	A theoretical area of landscape from which the wind farm structures may be visible.	Determines areas within a viewshed from which the wind turbines may be visible.
Visibility	A relative determination at which a wind turbine or cluster of wind turbines can be clearly discerned and described.	Describes the likely number and relative scale of wind turbines visible from a view location.

An overview of viewshed, zone of visual influence and visibility is discussed in the following sections.

4.2 Viewshed

For the purpose of this LVIA viewshed is defined as the area of land surrounding and beyond the project area which could be potentially affected by the wind farm. In essence, the viewshed defines this LVIA study area. The viewshed for the project has been divided into a series of concentric bands (at 2 km, 5 km and 10 km distance offsets) extending across the landscape from the wind turbines. The viewshed extent can vary between wind farm projects, and be influenced or informed by a number of criteria including the height of the wind turbines together with the nature, location and height of landform that could limit visibility.

It is important to note that the wind turbines would be visible from some areas of the landscape beyond the 10 km viewshed; however, within the general parameters of normal human vision, a wind turbine at around

175 m to the tip of the rotor blade would occupy a relatively small proportion of a person's field of view from distances in excess of 10 km.

The viewshed is used as a framework and guide for visibility assessment, as the degree of visual significance would tend to be gradated with distance although there are unlikely to be any distinct or abrupt noticeable changes between the nominated distance bands.

4.3 Zone of Visual Influence (ZVI)

The ZVI diagrams are used to identify theoretical areas of the landscape from which a defined number of wind turbines, or portions of turbines, could be visible within the viewshed. They are useful for providing an overview as to the extent to which the project could be visible from surrounding areas.

ZVI diagrams have been prepared by GH including:

- ZVI Diagram 1 from tip of blade; and
- ZVI Diagram 2 from hub height

The ZVI Diagrams are illustrated in **Figures 4** and **5**.

4.4 ZVI methodology

The methodology adopted by GH is a purely geometric assessment where the visibility of the project is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

Calculations have been made to determine the visibility of the wind turbines:

- to blade tips (essentially a view toward any part of the wind turbine rotor, including views toward the tips of blades above ridgelines); and
- to hub height (essentially a view toward half the swept path of the wind turbine blades).

The calculations also take into account the terrain relief and earth curvature.

This assessment methodology is conservative as:

- the screening effects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not be visible at many of the locations indicated on the ZVI diagrams due to the local presence of trees or other screening materials.
- additionally, the number of turbines visible is also affected by the weather conditions at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.
- further, whilst 59 individual wind turbines have been assessed as part of this assessment, turbines P2, P6 and P7 are no longer proposed as part of this project (although they may form a subsequent stage which will be subject to separate approval at that time).

Accordingly, while ZVI diagrams are a useful visualisation tool, they are very conservative in nature.

4.5 ZVI summary

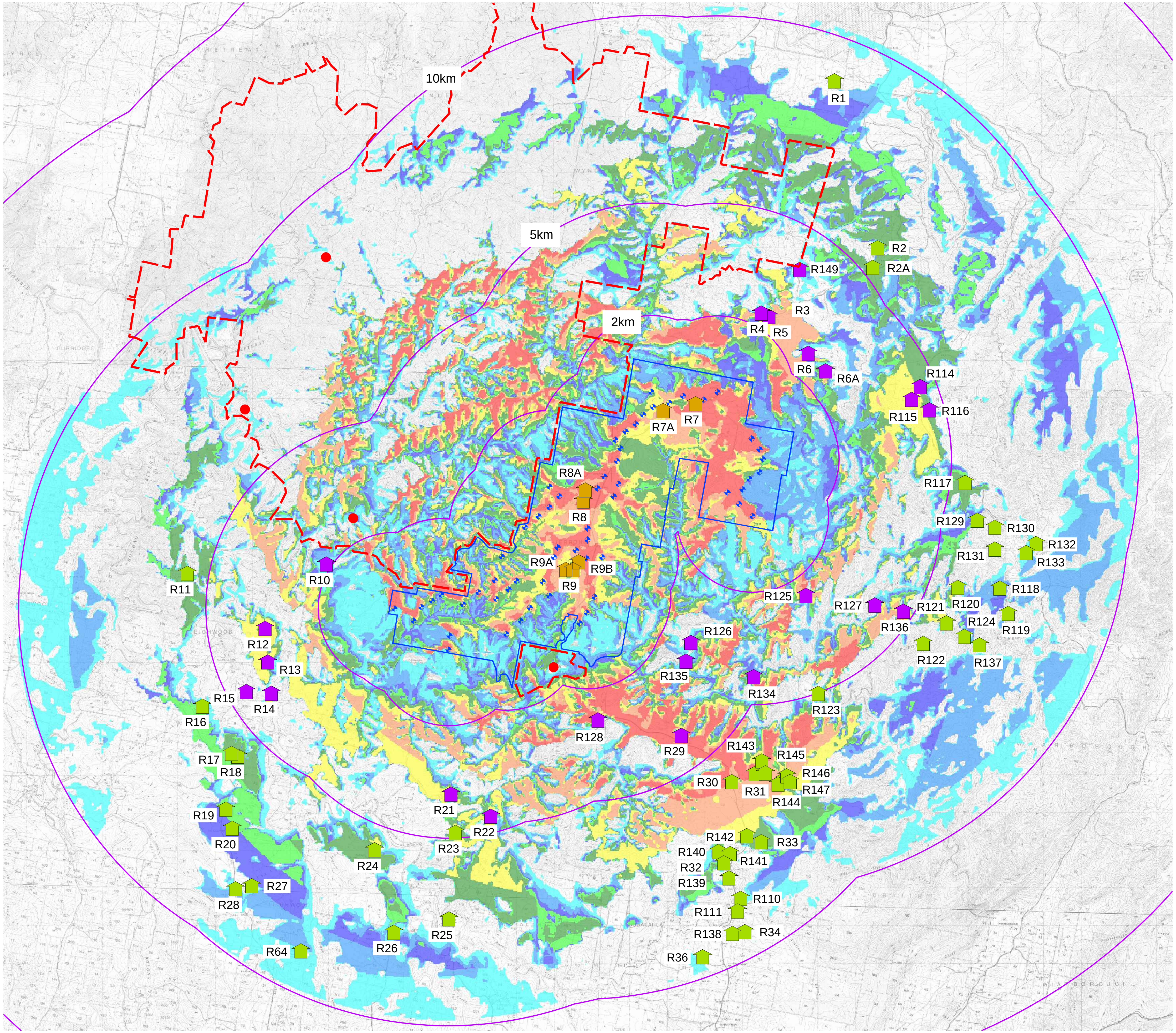
The most extensive and continuous area of visibility toward the project turbines would generally occur where the tips of the wind turbine rotor blades are visible above surrounding ridgelines or vegetation; however, views toward the tips and upper portions of the wind turbine rotors are likely to become less noticeable at reasonably short distances from the wind farm due to the screening influence of topography and dense tree cover. Views toward tip of blade are visually negligible from medium to longer distance view locations.

The ZVI diagrams for ‘tip’ and ‘hub height’ cover similar extents of landscape surrounding the wind farm, and extend toward isolated pockets of rural landscape beyond 10 km of the nearest wind turbine. The number and distribution of turbines visible between ‘tip’ and ‘hub’ height is influenced by ridgelines and surrounding hills for a number of areas between the 5 km to 10 km distance offsets.

The ZVI diagrams illustrate areas of landscape which are likely to offer views toward the wind turbines and demonstrate that the majority of views generally occur within private property and across tracts of unoccupied rural landscape.

The ZVI diagrams also illustrate a number of discrete pockets within portions of the 5 km to 10 km distance offset from which the wind turbines would not be visible, although this band of the viewshed also represents areas from which a greater number of turbines would also be visible.

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)



Legend

ZVI - Tips Visible

- 1 to 5 turbines
- 6 to 10 turbines
- 11 to 15 turbines
- 16 to 20 turbines
- 21 to 30 turbines
- 31 to 40 turbines
- 41 to 50 turbines
- 51 to 59 turbines

- Associated residential dwelling
- Non associated residential dwelling between 2 and 5km of Paling Yards wind turbine
- Non associated residential dwelling between 5 and 10km of Paling Yards wind turbine
- Note: there are no non associated residential dwellings within 2 km of the proposed wind turbines
- Proposed Paling Yards wind turbine indicative layout
- Proposed Paling Yards Wind Farm site boundary
- Distance from proposed wind turbine
- Abercrombie River National Park
- Vehicle based camp site

0km 4km

Figure 4 ZVI Diagram 1
Tip of blade

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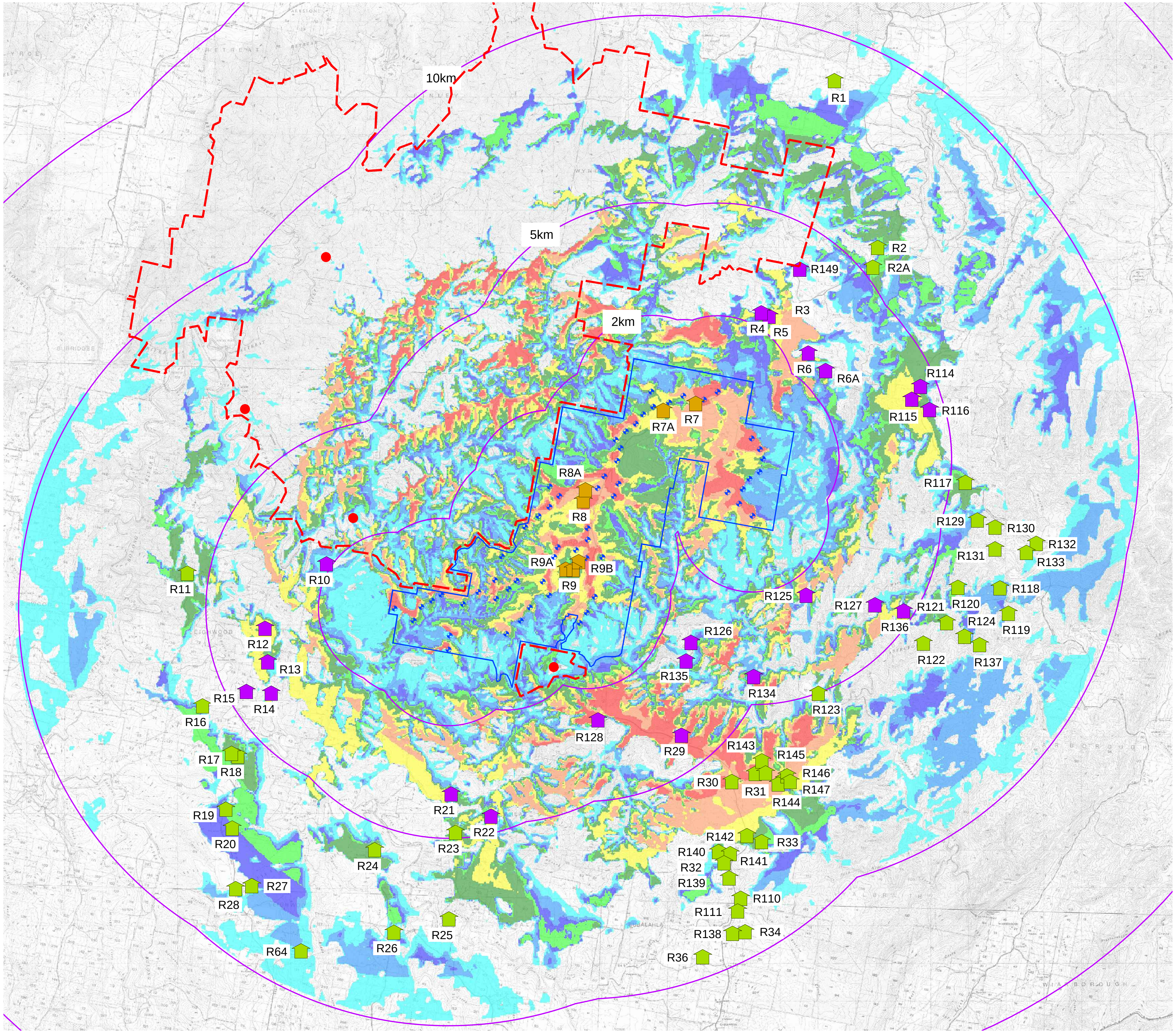

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)

Legend

ZVI - Hubs Visible

- 1 to 5 turbines
- 6 to 10 turbines
- 11 to 15 turbines
- 16 to 20 turbines
- 21 to 30 turbines
- 31 to 40 turbines
- 41 to 50 turbines
- 51 to 59 turbines

- Associated residential dwelling
- Non associated residential dwelling between 2 and 5km of Paling Yards wind turbine
- Non associated residential dwelling between 5 and 10km of Paling Yards wind turbine
- Note: there are no non associated residential dwellings within 2 km of the proposed wind turbines
- Proposed Paling Yards wind turbine indicative layout
- Proposed Paling Yards Wind Farm site boundary
- Distance from proposed wind turbine
- Abercrombie River National Park
- Vehicle based camp site

0km 4km

Figure 5 ZVI Diagram 2 Hub height

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The ZVI diagrams illustrate that the influence of surrounding landform begins to disperse visibility from beyond 5 km, although opportunities to view turbines from elevated, but moderately distant and generally unoccupied areas occur from areas beyond 5 km.

The ZVI illustrate that views toward the Paling Yards wind farm site from the Abercrombie River National Park (to the north and west of the wind farm site) are significantly influenced by topography. Views from the larger proportion of the National Park are physically screened by rising landform. Views may extend toward the wind farm site from east and south east facing slopes and ridgelines in the south portion of the National Park; however these areas are also densely timbered.

It should be noted that the wind turbines, when viewed from distances of around, or greater than 10 km, will generally be less distinct from other distant elements within the same field of view, and that the majority of land within the viewshed comprises rural agricultural land and areas of dense timber growth.

4.6 Visibility

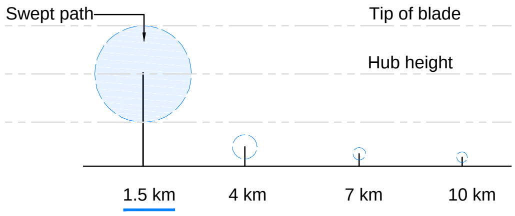
The level of wind turbine visibility within the Paling Yards wind farm 10 km viewshed can result from a number of factors including, but not limited to:

- distance effect;
- movement; and
- relative position.

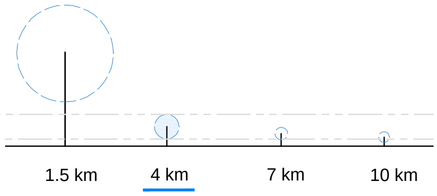
4.6.1 Distance effect

With an increase in distance the proportion of a person's horizontal and vertical view cone occupied by a visible turbine structure, or group of turbine structures, will decline. In order to demonstrate this a series of single frame photographs have been taken from pre-set distances (1.5 km, 4 km, 7 km and 10 km) toward wind turbines at the Capital Wind Farm in New South Wales. The photographs, illustrated in **Figure 6**, demonstrate the degree to which the apparent visible height of a wind turbine decreases with increasing distance (in a negative exponential relationship), and the increasing amount of horizontal skyline visible with an increasing distance.

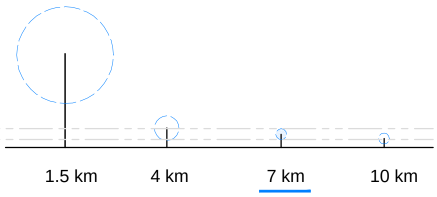
Capital Wind Farm - View distance 1.5 km



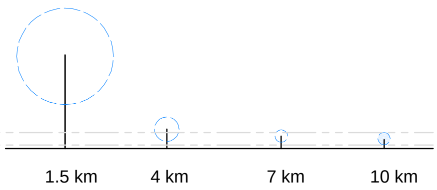
Capital Wind Farm - View distance 4 km



Capital Wind Farm - View distance 7 km



Capital Wind Farm - View distance 10 km



Capital Wind Farm turbines: Suzlon88,
80 m hub height, 88 m rotor diameter

Photographs: Pentax K10D, 50mm lens

Figure 6
Visibility and Distance

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As the view distance increases so do the atmospheric effects resulting from dust particles and moisture in the atmosphere, which makes the turbines appear to be grey thus potentially reducing the contrast between the wind turbines and the background against which they are viewed.

Whilst the distance between a view location and the wind turbines is a significant factor to consider when determining potential visibility, there are other issues which may also affect the degree of visibility. **Table 6** outlines the relative effect of distance on visibility and has been based on empirical research conducted by the University of Newcastle (2002) as well as direct observations made during wind farm site inspections.

Table 6 – Distance effect

Distance from turbine	Distance effect
>20 km	Wind turbines become indistinct with increasing distance. Rotor movement may be visible but rotor structures are usually not discernible. Turbines may be discernible but generally indistinct within viewshed resulting in **Low** level visibility and **Nil** where influenced or screened by surrounding topography and vegetation.
10 km – 20 km	Wind turbines noticeable but tending to become less distinct with increasing distance. Blade movement may be visible but becomes less discernible with increasing distance. Turbines discernible but generally less distinct within viewshed (potentially resulting in **Low** level visibility).
5 km – 10 km	Wind turbines visible but tending to become less distinct depending on the overall extent of view available from the potential view location. Movement of blades discernible where visible against the skyline. Turbines potentially noticeable within viewshed (potentially resulting in **Low to Moderate** level visibility).
3 – 5 km	Wind turbines clearly visible in the landscape but tending to become less dominant with increasing distance. Movement of blades discernible. Turbines noticeable but less dominant within viewshed (potentially resulting in **Moderate** level visibility).
1 – 3 km	Wind turbines would generally dominate the landscape in which the wind turbine is situated. Potential for high visibility depending on the category of view location, their location, sensitivity and subject to other visibility factors. Turbines potentially dominant within viewshed (potentially resulting in **Moderate to High** level visibility).
<1 km	Wind turbines would dominate the landscape in which they are situated due to large scale, movement and proximity. Turbines dominant and significant within viewshed (potentially resulting in **High** level visibility).

4.6.2 Movement

The visibility of the wind turbines would vary between the categories of static and dynamic view locations. In the case of static views the relationship between a wind turbine and the landscape would not tend to vary greatly. The extent of vision would be relatively wide as a person tends to scan back and forth across the landscape.

In contrast views from a moving vehicle are dynamic as the visual relationship between wind turbines is constantly changing, as is the visual relationship between the wind turbines and the landscape in which they are seen. The extent of vision can be partially constrained by the available view from within a vehicle at proximate distances.

4.6.3 Relative position

In situations where the view location is located at a lower elevation than the wind turbine, most of the turbine would be viewed against the sky. The degree of visual contrast between a white coloured turbine and the sky would depend on the presence of background clouds and their colour. For example, dark grey clouds would contrast more strongly with white turbines than a background of white clouds.

The level of visual contrast can also be influenced by the position of the sun relative to individual wind turbines and the view location. Where the sun is located in front of the viewer some visible portions of the wind turbine would be seen in shadow. If the background to the wind turbine is dark toned then visual contrast would tend to be reduced. Conversely where the sun is located behind the view location then the visible portion of the wind turbine would be in full sun.

Local environmental factors Section 5

5.1 Climatic and atmospheric conditions

Local climatic and atmospheric conditions have the potential to influence the visibility of the project from surrounding view locations, and more significantly, from distant view locations. The climate of the New South Wales South Eastern Highlands Bioregion is characterised by a temperate climate of warm summers and no dry season, with elevated areas in the north and south of the bioregion experiencing milder summer conditions in montane climate zones.

The Bureau of Meteorology has collected meteorological data over the past 107 years at Oberon (Springbank) which indicates that there are:

- 81 clear days (annual mean average);
- 101 cloudy days (annual mean average); and
- 84.5 days of rain (annual mean average).

Rainfall would tend to reduce the level of visibility from a number of view locations surrounding the project with the degree of visibility tending to decrease over distance. Rain periods would be likely to reduce the number of visitors travelling through the areas from which the project could be visible, and potentially decrease the duration of time spent at a particular public view location with a view toward the project.

Cloud cover would also tend to reduce the level of visibility of the project and lessen the degree of contrast between the wind turbine structures and the background against which the wind turbines would be visible.

On clear or partly cloudy days, the position of the sun would also have an impact on the degree of visibility of the project. The degree of impact would be largely dependent on the relationship between the position and angle of the sun relative to the view location. Late afternoon and early evening views toward the west would result in the wind turbines silhouetted above the horizon line, and with increasing distance would tend to reduce the contrast between the wind turbine structures and the surrounding landform.

The extent to which local weather conditions can influence visibility toward turbine structures is illustrated in **Figure 7**.

Image source GBD 2010

PHOTO A - DAY TIME VIEW FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 3.5KM
(13th June 2010)

PHOTO A - Illustrates the visibility of wind turbines against a clear and blue sky backdrop with sunlight from above and to the right of the wind turbines creating a shadow line along the left hand side of the towers as well as portions of the rotor blades.

Image source GBD 2010

PHOTO B - DAY TIME VIEW FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 3.5KM
(10th June 2010)

PHOTO B - Illustrates the visibility of wind turbines against a partly cloudy and overcast backdrop. The wind turbines in cloud shadow appear off white to grey in colour.

Image source GBD 2010

PHOTO C - DAY TIME VIEW FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 3.5KM
(7th July 2010)

PHOTO C - Illustrates the visibility of wind turbines in fog/low cloud cover.

Figure 7
Visibility and Weather

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5.2 Topography and drainage

The topography of the landscape within the New South Wales South Eastern Highlands Bioregion covers a broad area of the dissected ranges and plateaus of the Great Dividing Range extending east toward the Great Escarpment and the western slopes of the inland drainage basins. The project would be located on portions of plateau remnants above steep sided valleys cut by drainage lines, including the Abercrombie River. The elevation of the wind farm site falls gently from the north east toward the south west (at around 1065m to 900m), before falling more steeply south toward the Abercrombie River valley. A number of ephemeral drainage lines occur across the wind farm site, draining to broader valleys north west and south east of the wind farm site, as well as south toward the Abercrombie River valley.

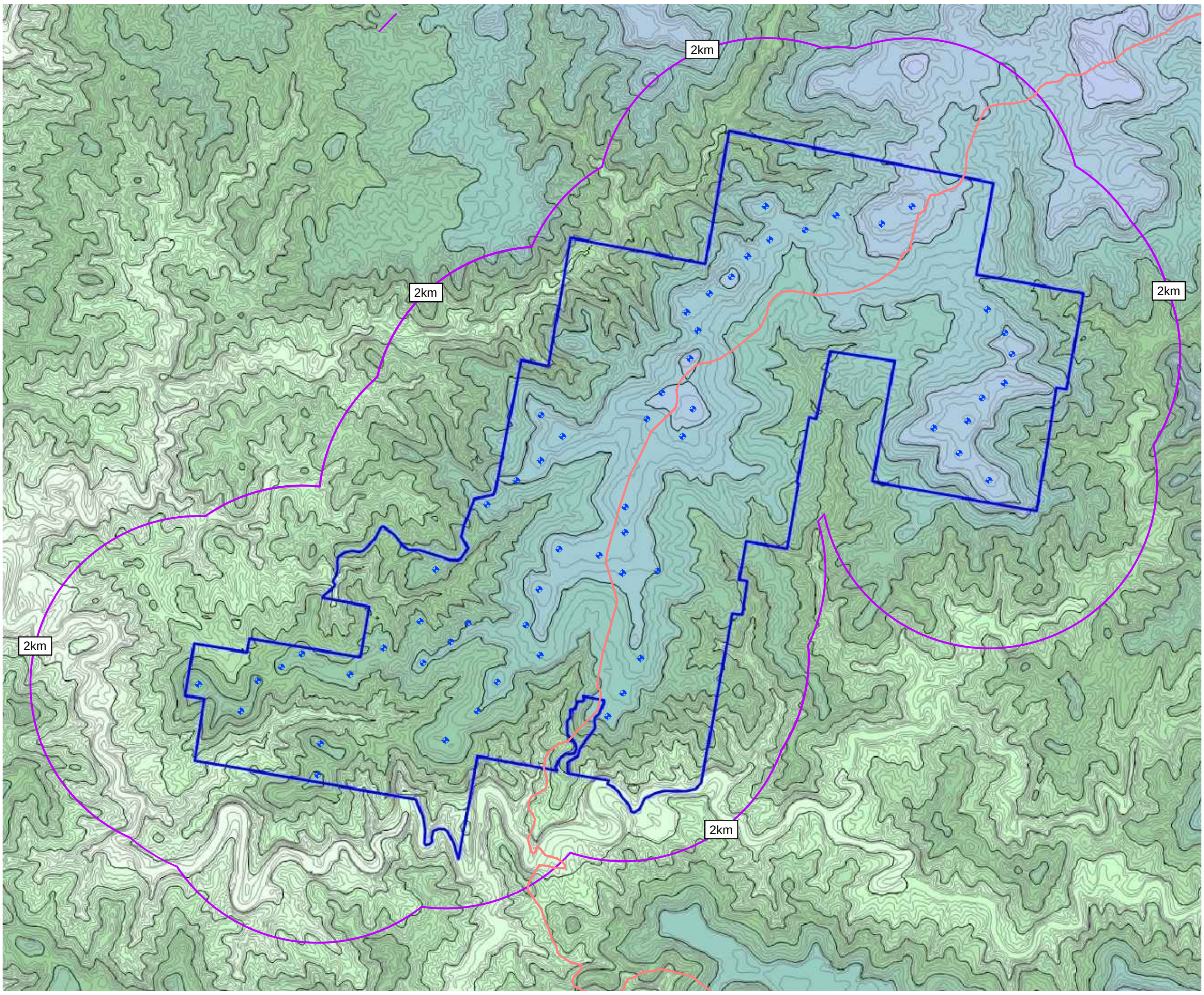
Landform elevation within and surrounding the project site is illustrated in **Figure 8**.

5.3 Vegetation

A detailed survey of existing vegetation has been carried out as part of the biodiversity assessment for the project EA and is summarised in the EA.

In general the landscape within the project site contains vegetation associated with woodland, drainage lines, small ponds/dams and cleared land for pasture and agricultural crop cultivation. Stands of remnant woodland occur within the wider context of a modified landscape which continues to be managed through a variety of farming activities.

The landscape within and surrounding the project site is illustrated in the panorama photographs presented in **Figures 10** to **15**.



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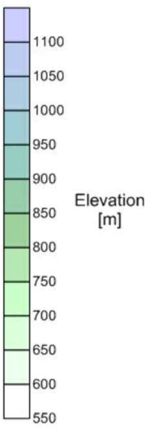

Proposed Paling Yards wind turbine indicative layout

Proposed Paling Yards Wind Farm site boundary

Distance from proposed Paling Yards wind turbine

Abercrombie Road

0km 2km

Figure 8 Topography

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Panoramic photographs (existing views) Section 6

6.1 Panoramic photographs

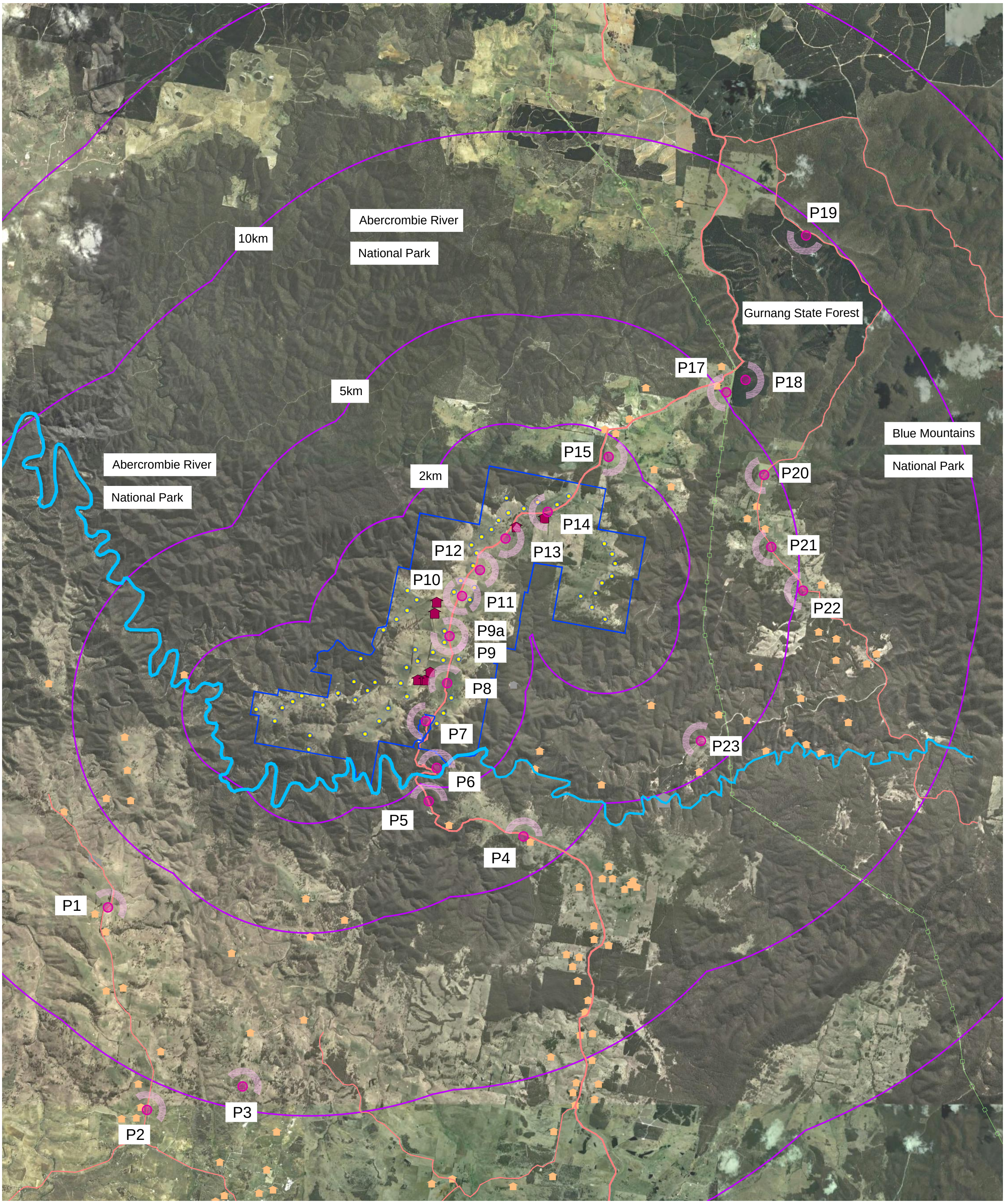
A series of digital photographs were taken during the course of the fieldwork to illustrate existing views in the vicinity of a number of view locations inspected and assessed as part of this LVIA. Individual photographs were digitally stitched together to form a segmented panorama image to provide a visual illustration of the existing view from each photo location.

A GPS coordinate for each panorama photograph location was recorded with an accuracy of around +/- 4m. Additional information including the bearing or direction of each photograph, time of day and prevailing weather conditions was also recorded.

The panoramic photographs presented in this LVIA have been annotated to identify key features or structures located within the existing view. They also indicatively illustrate the general extent and location of potentially visible wind turbines or portions of turbine structures for the project.

The panoramic photograph locations are illustrated in **Figure 9**, and the panoramic photographs illustrated in **Figures 10** to **15**.

The panoramic photographs are not to be confused with the photomontages. The panoramic photographs do not include a representation or model of the wind turbine structures. The photomontages are discussed in **Section 10** of this LVIA, and are illustrated in **Figures 21** to **32**.



Legend

	Local road		Paling Yards proposed wind turbine indicative layout
	Existing 500kV transmission line		Paling Yards wind farm site boundary
	Photo location		Distance offset to proposed Paling Yards wind turbines as noted

0km 2km

Figure 9
Photo Locations

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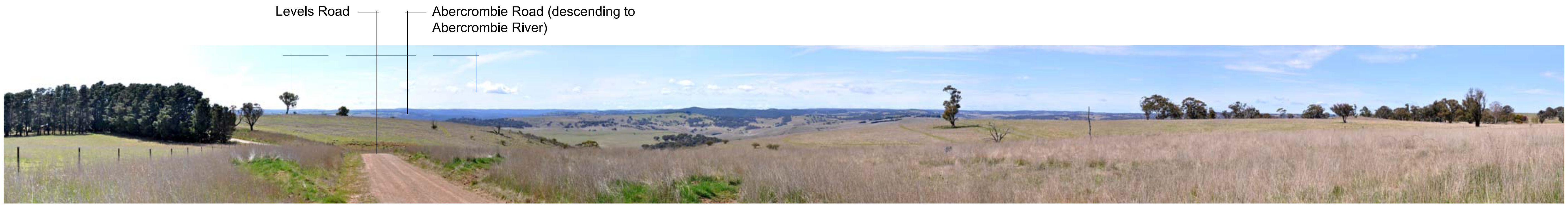

Photo Location P1- View north east from Levels Road, Golspie

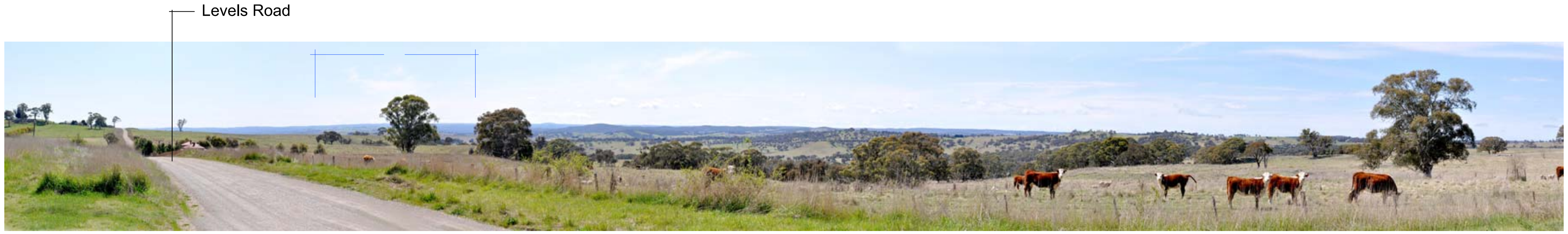

Photo Location P2- View north east from Levels Road, Golspie

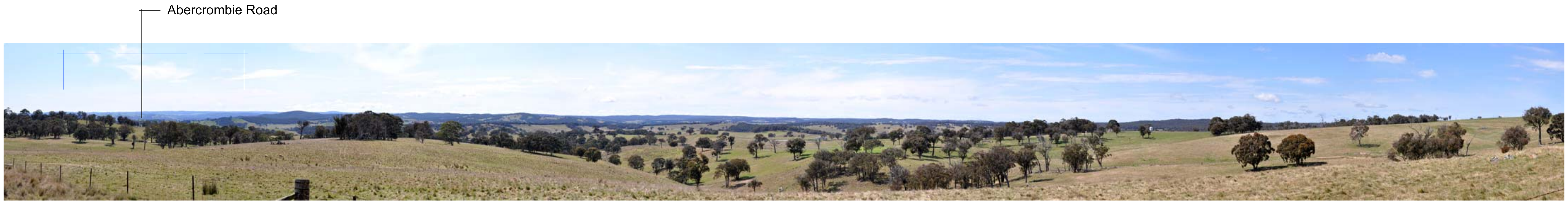

Photo Location P3- View north east from Leighwood Road, Golspie

Photo Location P4- View north east to east from Taralga Road

Indicative extent of Paling Yards Wind Farm turbines

Figure 10 Photo Sheet 1

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Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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Photo Location P5- View north from Abercrombie Road

Photo Location P6- View north from Bummaroo Ford campground (adjacent Abercrombie River)

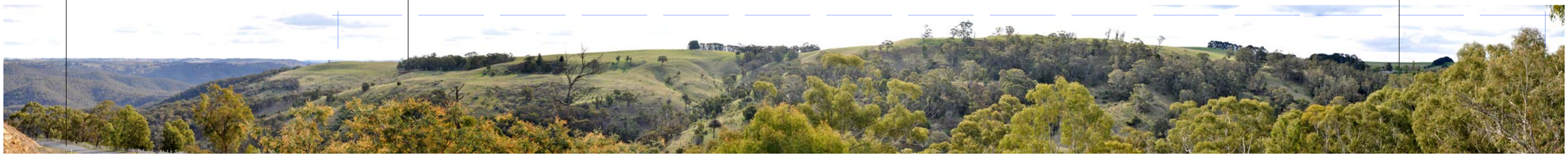

Photo Location P7- View north to west from Abercrombie Road

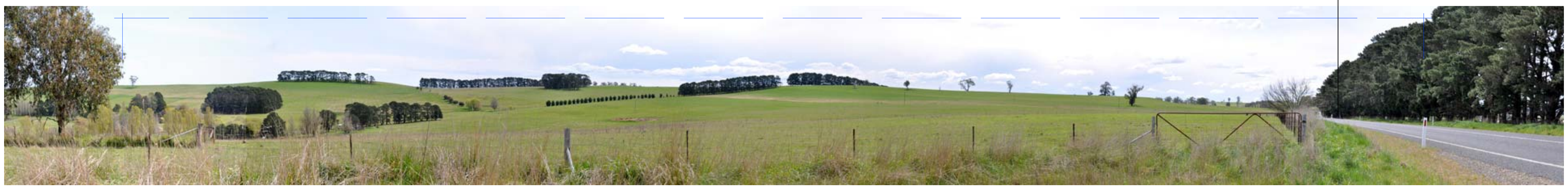

Photo Location P8- View north to west from the Abercrombie Road

Indicative extent of Paling Yards Wind Farm turbines

Figure 11 Photo Sheet 2

Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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PALING YARDS WIND FARM

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Photo Location P9- View south from Abercrombie Road

Photo Location P9a- View north to north east from Abercrombie Road

Photo Location P10- View south to south west from Abercrombie Road

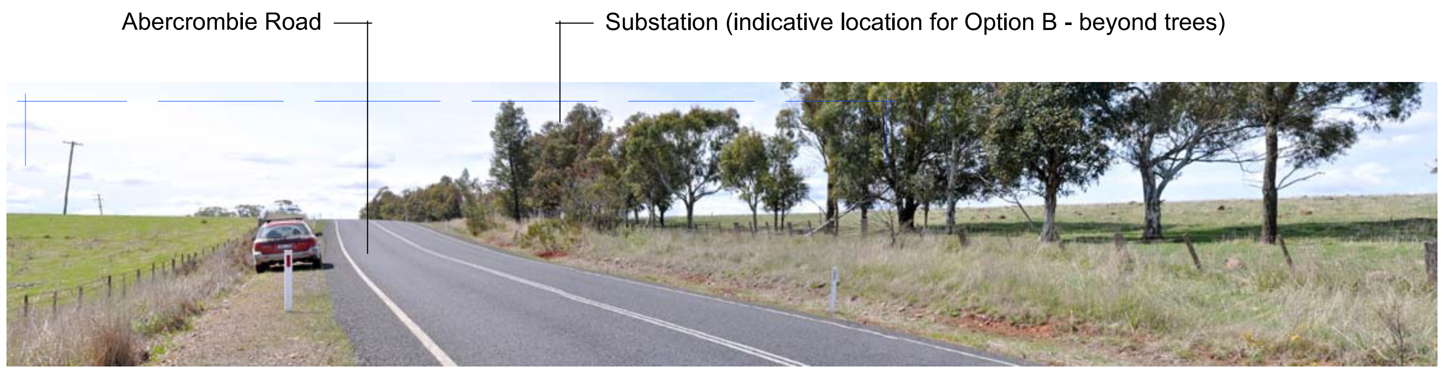

Photo Location P11- View north to north west from Abercrombie Road

Indicative extent of Paling Yards Wind Farm turbines

Figure 12 Photo Sheet 3

Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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PALING YARDS WIND FARM

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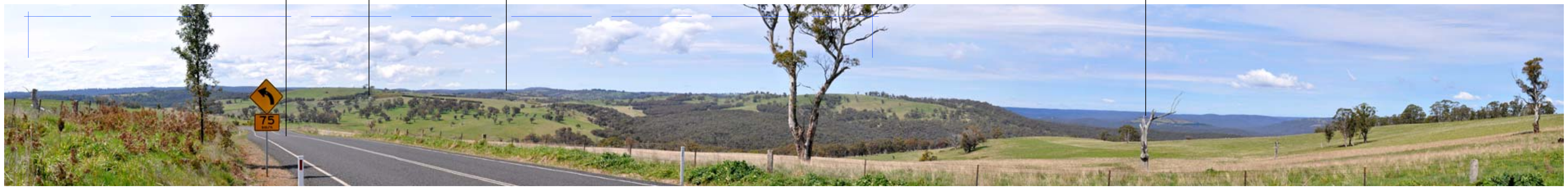

Photo Location P12- View north east to east from Abercrombie Road

Photo Location P13- View north to north east from Abercrombie Road

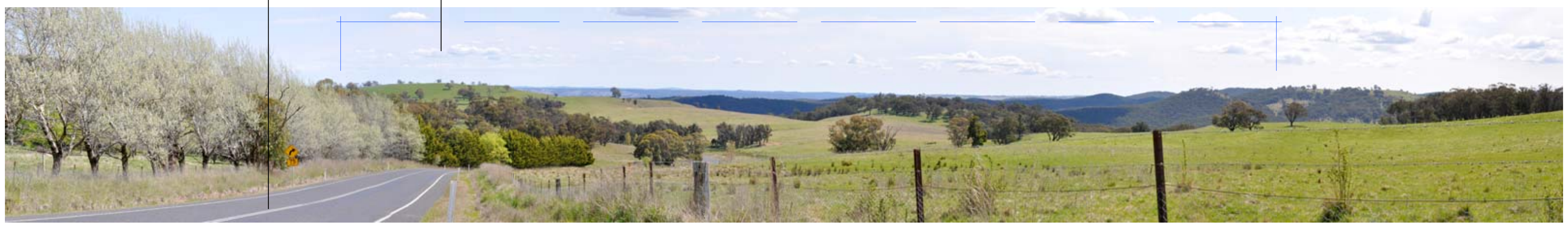

Photo Location P14- View south to south west from Abercrombie Road

Photo Location P15- View north to east from Abercrombie Road

Indicative extent of Paling Yards Wind Farm turbines

Figure 13 Photo Sheet 4

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WIND AUSTRALIA
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PALING YARDS WIND FARM

Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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Photo Location P16- View south to south west from Abercrombie Road

Photo Location P17- View south to south west from Abercrombie Road

Photo Location P18- View north east to east from Goulburn Oberon Road

Photo Location P19- View south to south west from Gurnang State Forest

Indicative extent of Paling Yards Wind Farm turbines

Figure 14 Photo Sheet 5

Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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PALING YARDS WIND FARM

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Photo Location P20- View south west to north east from Jerrong Road

Photo Location P21- View west to south west from Jerrong Road

Photo Location P22- View south to west from Jerrong Road

Photo Location P23- View south to south west from Gurnang State Forest

Indicative extent of Paling Yards Wind Farm turbines

Figure 15 Photo Sheet 6

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PALING YARDS WIND FARM

Note:
The illustrated extent of the Paling Yards Wind Farm is indicative only and does not depict potential turbine height or the degree of actual visibility

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Landscape character areas & sensitivity — Section 7

7.1 Landscape character areas

A fundamental part of this LVIA is to understand and describe the nature and sensitivity of different components of the landscape within the project 10 km viewshed, and to assess the landscape character in a clear and consistent process. For the purpose of this LVIA, landscape character is defined as '*the distinct and recognisable pattern of elements that occur consistently in a particular type of landscape'* (The Countryside Agency and Scottish Natural Heritage 2002).

This LVIA has identified five Landscape Character Areas (LCA's), which occur within the project 10 km viewshed. The five LCA's represent areas that are relatively consistent and recognisable in terms of their key visual elements and physical attributes; which include a combination of topography/landform, vegetation/landcover, land use and built structures (including settlements and local road corridors).

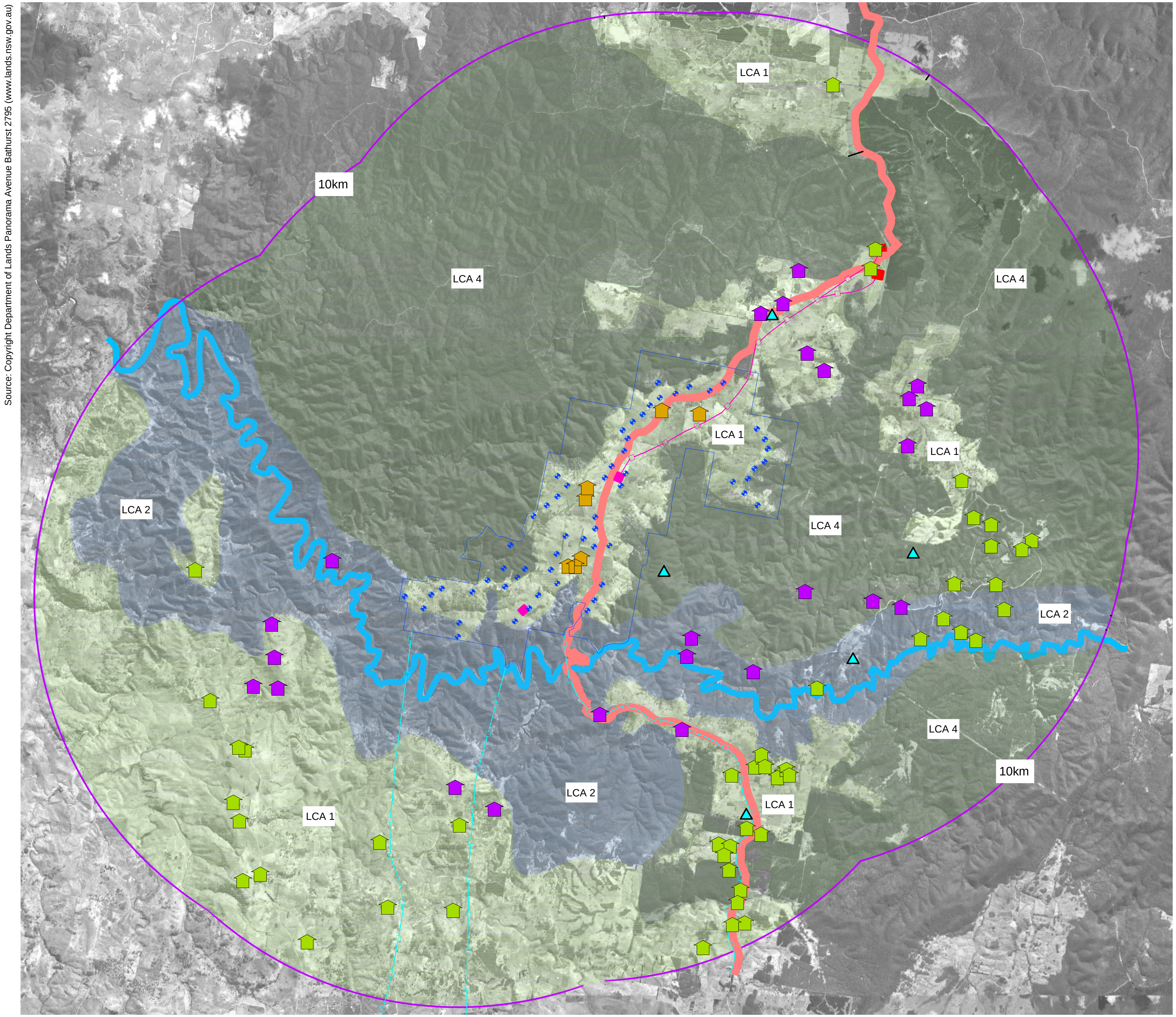
The five LCA's have been identified through a desk top assessment and described during the landscape assessment fieldwork carried out for the LVIA. The five LCA are illustrated in **Figure 16**. The LCA should not be considered as discrete areas, and characteristics within one LCA may occur within adjoining or surrounding LCA's. For the purpose of this LVIA the five LCA are:

- LCA 1 – Undulating pastoral farmland;
- LCA 2 – Abercrombie River Valley;
- LCA 3 – Abercrombie River;
- LCA 4 – Forested hills and ridgelines; and
- LCA 5 – Rural dwellings.

An overview of each LCA is presented below, with further description and assessment provided in **Tables 8** to **12**.

7.1.1 Undulating pastoral farmland

The main area of the undulating pastoral farmland LCA occurs to the west and south west of the Abercrombie River Valley and also within the Paling Yards wind farm site boundary. Small pockets of cleared pastoral land also occur sporadically within the 10 km viewshed, more often associated with land surrounding rural residential dwellings. The undulating pastoral farmland LCA has been largely cleared of tree cover and significantly modified for agricultural production.



Legend

LCA 1 - Undulating pastoral farmland

LCA 2 - Abercrombie River valley

LCA 3 - Abercrombie River

LCA 4 - Forested hills and ridgelines

LCA 5 - Rural dwellings

Abercrombie Road

Associated residential dwelling

Non associated residential dwelling between 2 and 5 km of Paling Yards wind turbine

Non associated residential dwelling between 5 and 10 km of Paling Yards wind turbine

Non-residential structure

Paling Yards indicative wind turbine layout and turbine reference number

Paling Yards wind farm site boundary

Distance from proposed wind turbine

Assessed and proposed 500 kV transmission line corridor

Assessed 330 kV transmission line corridors

Proposed on site substation location options A & B

Proposed off site substation location options C & D

0km 4km

Figure 16
Landscape Character Areas

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The undulating pastoral farmland LCA is sparsely populated and supports a small number of rural residential dwellings and homesteads. Vast tracks of undulating cleared grazing land extend beyond the 10 km viewshed and across the south-western Central Tablelands of NSW. Access to view locations within the LCA is largely restricted by private land; however, middle-ground to distant views can be obtained from sections of the publically accessible local road network. The physical attributes and landscape sensitivity of the undulating pastoral farmland LCA are described and assessed in **Table 8**.

7.1.2 Abercrombie River Valley

The Abercrombie River Valley LCA extends east to west across the project 10 km viewshed below the Paling Yards wind farm site. In addition to the Abercrombie River Valley, the Silent Creek and Retreat River valleys also occur within the 10 km viewshed and (together with a number of minor gullies) form part of the Abercrombie River catchment. A small portion of the Abercrombie River Valley LCA extends into the south portion of the Paling Yards wind farm project area. The Abercrombie River Valley is deeply incised and contained by a number of steep sided hills and prominent ridgelines. The topography forms a high degree of visual enclosure, which is reinforced by dense native tree cover. The Abercrombie River Valley is largely unmodified, but indirectly impacted by agricultural land use beyond the LCA.

The Abercrombie River Valley LCA is sparsely populated and supports a small number of rural residential dwellings and homesteads. Access within the LCA is available from portions of the Abercrombie River National Park as well as private land and short sections of local roads. The physical attributes and landscape sensitivity of the undulating pastoral farmland LCA are described and assessed in **Table 9**.

7.1.3 Abercrombie River

The Abercrombie River LCA extends west to east across the 10 km viewshed and to the south of the Paling Yards wind farm site. The Abercrombie River LCA is bounded north and south by the Abercrombie River Valley LCA. The meandering pattern of the river is largely influenced by geological structures, and forms the principal drainage line and water catchment through the 10 km viewshed. Access to the LCA is available from portions of the Abercrombie River National Park as well as private land and short sections of local roads; however, views are largely enclosed by surrounding topography and dense tree cover. The physical attributes and landscape sensitivity of the Abercrombie River LCA are described and assessed in **Table 10**.

7.1.4 Forested hill and ridgeline

The forested hill and ridgeline LCA occurs to the west, north and east of the Paling Yards wind farm site boundary. The forested hill and ridgeline LCA covers the greater extent of the 10 km viewshed surrounding the project site, and extends north, beyond the 10 km viewshed, into the Blue Mountains National Park.

The forested hills and ridgeline LCA is sparsely populated, supporting a small number of rural residential dwellings and homesteads. Access to the LCA is available from portions of the Abercrombie River National Park as well as private land and short sections of local roads; however, views are largely enclosed by surrounding topography and dense tree cover. The physical attributes and landscape sensitivity of the forested hill and ridgeline LCA are described and assessed in **Table 11**.

7.1.5 Rural dwellings

Rural dwellings do not constitute a singular LCA but do introduce specific elements whose characteristics can be differentiated from the surrounding landscape. Rural dwellings are located within each of the other LCA (with the exception of the Abercrombie River LCA). Rural dwellings introduce constructed elements into the landscape along with a rage of associated rural and agricultural infrastructure. The physical attributes and landscape sensitivity of the rural dwelling LCA are described and assessed in **Table 12**.

7.2 Landscape sensitivity assessment

The British Landscape Institute describes landscape sensitivity as '*the degree to which a particular LCA can accommodate change arising from a particular development, without detrimental effects on its character'*.

The assessment of landscape sensitivity is based upon an evaluation of the physical attributes identified within each LCA, both singularly and as a combination that gives rise to the landscape's overall robustness and the extent to which it could accommodate the wind farm development. The criteria used to determine landscape sensitivity are outlined in **Table 7** and based on current good practice employed in the assessment of wind farm developments. Landscape sensitivity is a relative term, and the intrinsic landscape values of the surrounding landscape could be considered of a higher or lower sensitivity than other areas in the NSW/ACT Border Region Renewable Energy Precinct.

Whilst the assessment of landscape sensitivity is largely based on a systematic description and analysis of landscape characteristics, this LVIA acknowledges that some individuals and other members of the local community would place higher or lower values on the local landscape. These values could transcend preferences (likes and dislikes) and include personal, cultural as well as other parameters.

Table 7 – Criteria for the assessment of Landscape Sensitivity

Landscape Sensitivity Assessment Criteria			
Characteristic	**Aspects indicating lower sensitivity to the wind farm development**	↔	**Aspects indicating higher sensitivity to the wind farm development**
Landform and scale: patterns, complexity and consistency	• Large scale landform • Simple • Featureless • Absence of strong topographical variety	↔	• Small scale landform • Distinctive and complex • Human scale indicators • Presence of strong topographical variety
Landcover: patterns, complexity and consistency	• Simple • Predictable • Smooth, regular and uniform	↔	• Complex • Unpredictable • Rugged and irregular
Settlement and human influence	• Concentrated settlement pattern • Presence of contemporary structures (e.g. utility, infrastructure or industrial elements)	↔	• Dispersed settlement pattern • Absence of modern development, presence of small scale, historic or vernacular settlement
Movement	• Prominent movement, busy	↔	• No evident movement, still
Rarity	• Common or widely distributed example of landscape character area within a regional context	↔	• Unique or limited example of landscape character area within a regional context
Intervisibility with adjacent landscapes	• Limited views into or out of landscape • Neighbouring landscapes of low sensitivity • Weak connections, self contained area and views • Simple large scale backdrops	↔	• Prospects into and out from high ground or open landscape • Neighbouring landscapes of high sensitivity • Contributes to wider landscape • Complex or distinctive backdrops

The landscape sensitivity assessment criteria set out in **Table 7** have been evaluated for each of the five LCA's by applying a professionally determined judgement on a sliding scale between 1 and 5.

A scale of 1 indicates a landscape characteristic with a lower sensitivity to the wind farm development (and would be more likely to accommodate the wind farm development). A scale of 5 indicates a landscape characteristic with a high level of sensitivity to the wind farm development (and less likely to accommodate the wind farm development).

The scale of sensitivity for each LCA is outlined in **Tables 8** to **12** and is set out against each characteristic identified in **Table 7**.

The overall landscape sensitivity for each LCA is a summation of the scale for each characteristic identified in **Tables 8** to **12**. The overall scale is expressed as a total out of 30 (i.e. 6 characteristics for each LCA with a potential top scale of 5). Each characteristic is assessed separately and the criteria set out in **Table 6** are not ranked in equal significance. The overall landscape sensitivity for each of the five LCA has been determined as either:

High (Scale of 24 to **30)** – key characteristics of the LCA will be impacted by the proposed project, and will result in major and visually dominant alterations to perceived characteristics of the LCA which may not be fully mitigated by existing landscape elements and features. The degree to which the landscape may accommodate the proposed project development will result in a number of perceived uncharacteristic and significant changes.

Medium to High (Scale of 16 to **23)** – recognisable characteristics of the LCA will be altered by the proposed project, and result in the introduction of visually prominent elements that will alter the perceived characteristics of the LCA but may be partially mitigated by existing landscape elements and features within the LCA. The main characteristics of the LCA, patterns and combinations of landform and landcover will still be evident.

Medium (Scale 11 to 15) – distinguishable characteristics of the LCA may be altered by the proposed project, although the LCA may have the capability to absorb some change. The degree to which the LCA may accommodate the proposed project would potentially result in the introduction of prominent elements to the LCA, but may be accommodated to some degree.

Low Rating (Scale of 6 to **10)** – the majority of the LCA characteristics are generally robust, and would be less affected by the proposed project. The degree to which the landscape may accommodate the wind farm would not significantly alter existing landscape character.

Very Low or Negligible Rating (Less than 6) the characteristics of the LCA will not be impacted or visibly altered by the proposed project.

7.3 Analysis of landscape sensitivity

The following section of this LVIA provides an analysis of landscape sensitivity within the viewshed of the wind farm development and considers each of the five LCA's.

7.3.1 LCA 1 Undulating pastoral farmland

Plate 1 – Typical view across undulating pastoral farmland

Table 8 – LCA 1, Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Sensitivity Rating	1	2	3	4	5
Landform and Scale		2			
	Landform varies between **large** to **moderate scale** and is relatively **simple** in structure. Topography is generally gently undulating land through cultivated and pastoral farmland areas across plateau and between broad valleys.				
Landcover		2			
	Landcover through this LCA is **simple** and **regular** being largely determined by cultivated crop and pastoral grazing. Pasture areas are visually divided by hedgerows and groups or individual tree planting in some areas of the LCA.				
Settlement and human influence			3		
	A very low density of settlement is **dispersed** with some evidence of contemporary structures including **utility infrastructure** and **agricultural industrial** elements. Human influence is evident through agricultural modification and road construction.				
Movement			3		
	There is **limited** evidence of movement within the LCA with occasional traffic along roads and machinery working within the agricultural landscape..				
Rarity		2			
	The main elements within this LCA are **common** and **well represented** within the NSW/ACT Border Region Renewable Energy Precinct and broader areas of the south western Central Tablelands of NSW.				
Intervisibility			3		
	Views into some portions of this LCA **limited** and **restricted** by surrounding landform which **contains** opportunities for long distant views.				
Overall Sensitivity Rating	(2+2+3+3+2+3 = 15) Medium (Score 15 out of 30)				

7.3.2 LCA 2 Abercrombie River Valley

Plate 2 – Typical view toward steep sided valleys

Table 9 – LCA 2, Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
	Low	**Low to Med**	**Medium**	**Med to High**	**High**
Sensitivity Rating	**1**	**2**	**3**	**4**	**5**
Landform and Scale			3		
	Landform and topography is **distinctive** but with **limited** features.				
Landcover		2			
	Landcover through this LCA is **simple** and **regular** comprising forested hillside and ridgeline areas with limited areas of clearing between valley and ridgeline areas.				
Settlement and human influence				4	
	Settlement is **dispersed** with limited evidence of utility infrastructure and agricultural elements.				
Movement				4	
	There is **limited** evidence of movement within the LCA with occasional traffic along roads and machinery working in surrounding fields.				
Rarity		2			
	The main elements within this LCA are reasonably **common** and **well represented** within the NSW/ACT Border Region Renewable Energy Precinct.				
Intervisibility		2			
	Views into and out of this LCA **limited** and **restricted** by surrounding landform which **contains** opportunities for long distant views from elevated areas.				
Overall Sensitivity Rating	(3+2+4+4+3+2=17) Medium to High (Score 17 out of 30)				

7.3.3 LCA 3 Abercrombie River

Plate 3 – View toward Abercrombie River from the Bummaroo Camp Site

Table 10 – LCA 3, Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Sensitivity Rating	1	2	3	4	5
Landform and Scale		2			
	Landform is generally **simple** alongside the majority of drainage lines through large scale pastoral landscape. Drainage lines are largely **featureless** and have been largely cleared, with tree cover limited to occasional or small groups of trees.				
Landcover		2			
	Landcover through this LCA is **simple** and **regular** comprising cultivated ground or improved pasture.				
Settlement and human influence				4	
	Settlement is **dispersed** with some evidence of **utility infrastructure** and agricultural elements.				
Movement				4	
	There is **limited** evidence of movement within the LCA with occasional traffic along roads and machinery working in surrounding fields.				
Rarity		2			
	The main elements within this LCA are reasonably **common** and **well represented** within the NSW/ACT Border Region Renewable Energy Precinct.				
Intervisibility			3		
	Views into and out of this LCA **limited** and **restricted** by surrounding landform which **contains** opportunities for long distant views.				
Overall Sensitivity Rating	(2+2+4+4+2+3=17) Medium to High (Score 17 out of 30)				

7.3.4 LCA 4 Forested hill and ridgeline

Plate 4 – Typical views across forested hill and ridgeline landscape

Table 11 – LCA 4, Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Sensitivity Rating	1	2	3	4	5
Landform and Scale			3		
	Landform is **large scale** and **simple** with some topographical variation across low hill and ridgeline areas.				
Landcover		2			
	Landcover through this LCA is **simple** and **regular** comprising scattered and denser stands of tree cover.				
Settlement and human influence			3		
	Settlement is **dispersed** with some evidence of **utility infrastructure** and agricultural elements.				
Movement				4	
	There is **limited** evidence of movement within the LCA.				
Rarity		2			
	The main elements within this LCA are **common** and **well represented** within the NSW/ACT Border Region Renewable Energy Precinct.				
Intervisibility		2			
	Backdrops to this LCA are visually **limited** and **restricted** by undulating landform and surrounding ridgelines restricting distant views.				
Overall Sensitivity Rating	(3+2+3+4+2+2=16) Medium to High (Score 16 out of 30)				

7.3.5 LCA 5 Rural dwellings

Plate 5 – Typical view toward rural dwelling and associated infrastructure

Table 12 – LCA 5, Landscape Sensitivity

	Lower Sensitivity		↔		Higher Sensitivity
	Low	Low to Med	Medium	Med to High	High
Sensitivity Rating	1	2	3	4	5
Landform and Scale			3		
	Landform is **large scale** and **simple** with some topographical variation surrounding the majority of rural residential dwellings.				
Landcover		2			
	Landcover through the broader LCA is **simple** and **regular**. Cultural planting around residential dwellings incorporates ornamental plantings as well as tree planting demarcating property boundaries and shelter belt planting.				
Settlement and human influence			3		
	Settlement is **dispersed** with some evidence of **utility infrastructure** and agricultural elements.				
Movement			3		
	There is **limited** evidence of movement within the LCA associated with activities around residences.				
Rarity		2			
	The main elements within this LCA are **common** and **well represented** within the NSW/ACT Border Region Renewable Energy Precinct.				
Intervisibility		2			
	Backdrops to this LCA are visually **limited** and **restricted** by landform blocking views.				
Overall Sensitivity Rating	(3+2+3+3+2+2=15) Medium (Score 15 out of 30)				

7.4 The Abercrombie River National Park

The Abercrombie River National Park occurs within the Abercrombie River Valley, Abercrombie River and Forested Hills and Ridgelines LCA. These LCA have been determined to have 'medium to high' landscape sensitivity.

The Abercrombie Rive National Park covers approximately 19,000 hectares and is located 40 km's south-west of Oberon and 60 km's north of Goulburn. The main section of the park is approximately 15,000 hectares and is located mainly on the north side of the Abercrombie River and to the north and west of the Paling Yards wind farm site. Approximately 4,000 hectares is located to the west of the main section of the park and beyond 10 km of the wind farm site. A smaller third section of around 200 hectares is located to the south of the main section. The location of the park is illustrated in **Figure 2**.

The park incorporates a large area of remnant bushland within the south western Central Tablelands of NSW and contains a diversity of vegetation communities characteristic of montane and tableland species. The park provides opportunities for four wheel drive touring, bushwalking, swimming, fishing, picnicking and camping. The land use, pattern and scale of the park provides a contrast to the significant areas of cleared pastoral land and pine plantations.

7.5 Summary

This LVIA has determined that 2 LCA within the viewshed of the proposed project have a 'medium' sensitivity to accommodate change, and that 3 LCA have a 'medium to high' sensitivity to accommodate change. This LVIA has determined that the LCA have an overall 'medium to high' sensitivity to accommodate change, and that the LCA within the 10 km viewshed represent a landscape characteristics that are reasonably typical of landscape types found in surrounding areas of the NSW/ACT Border Region Renewable Energy Precinct.

As a landscape with an overall 'medium to high' sensitivity to accommodate change, some recognisable characteristics of the landscape will be altered by the proposed project. This will result in the introduction of visually prominent elements that will alter the perceived characteristics of the landscape but may be partially mitigated by existing landscape elements and features within the landscape. The main characteristics of the landscape, patterns and combinations of landform and landcover will still be evident.

Despite being 'naturalistic' in appearance, portions of the NSW/ACT Border Region Renewable Energy Precinct landscape have been heavily modified by agricultural improvement for pasture and arable production post European settlement, as well as exploration and mining for precious metals. Irrespective of the extent and nature of modifications to the landscape, it is not correct to assume that the landscape surrounding the wind farm should be any less valued as a result of modification. Physical change in the appearance of the landscape is an ongoing and constant process from both human and environmental influences and can result in both positive and negative effects.

Significance of visual impact assessment

8.1 Introduction

The significance of visual impact resulting from the construction and operation of the Paling Yards wind farm would result primarily from a combination of:

- the overall sensitivity of visual receptors in the surrounding landscape; and
- the scale or magnitude of visual effects presented by the wind farm development.

The sensitivity of visual receptors has been determined and described in this LVIA by reference to:

- the location and context of the view point;
- the occupation or activity of the receptor; and
- the overall number of people affected.

This LVIA notes that although a large number of viewers in a category that would otherwise be of low or moderate sensitivity may increase the sensitivity of the receptor, it is also the case that a small number of people (such as residents) with a high sensitivity may increase the significance of visual impact.

Table 13 – View Location Sensitivity

View Category	Sensitivity
Residential Properties	***Highest Sensitivity***
Pedestrians (recreational)	▽
Public Recreational Space	▽
Rural employment/farming	▽
Motorists	▽
Business (commercial)	▽
Industry	*Lower Sensitivity*

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Table 14 – Numbers of viewers

Criteria	Definition
Number of viewers	
High	> 400 people per day
Medium to high	100 - 399 people per day
Medium	50 - 99 people per day
Low	10 - 25 people per day
Very low	< 10 people per day

The scale or magnitude of visual effects associated with the project have been determined and described by reference to:

- the distance between the view location and the wind farm turbines;
- the duration of effect;
- the extent of the area over which the wind farm could be theoretically visible (ZVI hub height)
- the degree of visibility subject to existing landscape elements (such as forested areas or tree cover).

An overall determination of visual impact at each view location has also been assessed and determined against the criteria outlined in **Table 15** below:

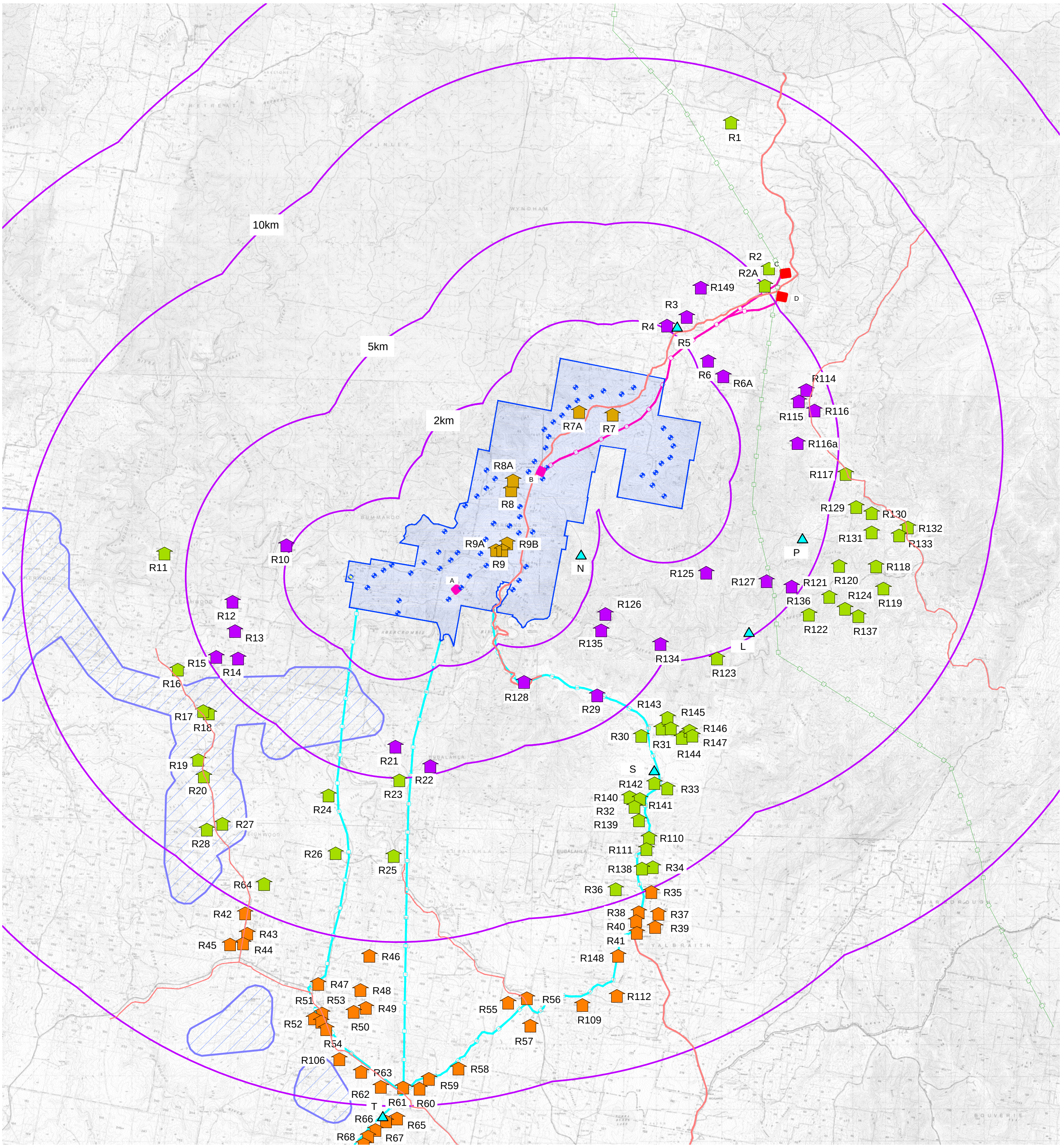
Table 15 – Sensitivity and magnitude assessment criteria

Criteria	Definition
Distance	
Very short	<1 km
Short	1 – 3 km
Medium	3 km – 5 km
Long	5 km - 10 km +
Duration of effect	
High	> 2 hours
Medium	30 - 120 minutes
Low	10 – 30 minutes
Very low	< 10 minutes
Extent of visibility	
High	41 -59 wind turbines visible

Criteria	Definition
Medium	21 – 40 wind turbines visible
Low	11 – 20 wind turbines
Very low	1 – 10 wind turbines visible

The sensitivity and magnitude assessment criteria outlined in **Tables 15** and **16** are used **as a guide** to determine levels of visual significance. The residential views locations surrounding the Paling Yards wind farm are illustrated in **Figure 17**.

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)



Legend

	Associated residential dwelling		Non-residential structure		Distance from proposed wind turbines as noted		Proposed Golspie Wind Farm - indicative project area
	There are no non associated residential dwellings within 2 km of the Paling Yards wind turbines		Existing road		Assessed and proposed 500 kV transmission line		
	Non associated residential dwelling between 2 and 5 km of Paling Yards wind turbine		Existing 500 kV transmission line		Assessed 330 kV transmission line		
	Non associated residential dwelling between 5 and 10 km of Paling Yards wind turbine		Proposed Paling Yards wind turbine indicative layout		Proposed on site substation location options A & B		
	Non associated residential dwelling beyond 10 km of Paling Yards wind turbine		Paling Yards wind farm site boundary		Proposed off site substation location options C & D		

0km 2km

Figure 17
Residential dwellings

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Table 16 Visual significance criteria matrix

			Scale or magnitude of change in view caused by proposed development			
			High	**Medium**	**Low**	**Very Low**
			Very short distance view over a long duration of time. A high extent of wind turbine visibility would tend to dominate the available skyline view and significantly disrupt existing views or vistas.	Short to medium distance views over a medium duration of time. A moderate extent of wind turbine visibility would have the potential to dominate available views with visibility recessing over increasing distance.	Medium to long distance views over a low to medium duration of time. Wind turbines in views, at long distances or visible for a short duration not expected to be significantly distinct in the existing view.	Visible change perceptible at a very long distance, or visible for a very short duration, and/or is expected to be less distinct within the existing view.
Sensitivity of visual receptor		**Indicator**				
	High	Large numbers of viewers or those with proprietary interest and prolonged viewing opportunities such as residents and users or visitors to attractive and/or well-used recreational facilities. Views from a regionally important location whose interest is specifically focussed on the landscape	High	Medium to High	Medium	Low to Medium
	Medium	Medium numbers of residents and moderate numbers of visitors with an interest in their environment e.g. visitors to State Forests, such as bush walkers and horse riders etc…. Larger numbers of travellers with an interest in their surroundings	Medium to High	Medium	Low to medium	Low
	Low	Low numbers of visitors with a passing interest in their surroundings e.g. those travelling along principal roads. Viewers whose interest is not specifically focussed on the landscape e.g. workers, commuters.	Medium	Low to Medium	Low	Very low to low
	Very Low	Very low numbers of viewers or those with a passing interest in their surroundings e.g. those travelling along minor roads.	Low to Medium	Low	Very low to low	Very low

This table is used as a guide only. The descriptions of magnitude and sensitivity are illustrative only. Each case is assessed on its own merits using professional judgement and experience, and there is no defined boundary between levels of impacts.

8.2 Visual significance matrix

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R1	Residential dwelling	Views toward Paling Yards wind turbines blocked by topography and vegetation	8.6 km	Very Low	Potentially long term	High	n/a	Nil
R2	Residential dwelling Proponent in negotiation to purchase property	Views toward Paling Yards wind turbines blocked by topography and vegetation	5.5 km	Very Low	Potentially long term	High	Medium	Nil
R2a	Residential dwelling Proponent in negotiation to purchase property	Views toward Paling Yards wind turbines blocked by topography and vegetation	5 km	Very Low	Potentially long term	High	Medium	Nil
R3 Gusses	Residential dwelling	Views toward Paling Yards wind turbines blocked by topography and vegetation	2.7 km	Very Low	Potentially long term	High	High	Nil
R4 Lucas Crane	Residential dwelling	Views toward Paling Yards wind turbines blocked by topography and vegetation	2.1 km	Very Low	Potentially long term	High	High	Nil

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R5	Non residential structure Rural Fire Shed	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R6 Cobber Creek	Residential dwelling	Views south to west from the dwelling are largely contained by localised rising landform. Views toward the Paling Yards turbines occur from areas surrounding the dwelling	2.4 km	Very Low	Potentially long term	High	High	Medium
R6a	Residential dwelling (Vacant dwelling)	Views toward Paling Yards wind turbines blocked by topography and vegetation surrounding residential dwelling	2.4 km	Very Low	n/a	High	High	Nil
R7 Mingray Park	Residential dwelling (Associated Resident)	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	720 m	Very Low	Potentially long term	High	High	Low to Medium
R7a Part time occupation	Residential dwelling (Associated Resident)	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	940 m	Very Low	Potentially long term	High	High	Medium to High

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R8 Paling Yards North	Residential dwelling Associated Resident	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	560 m	Very Low	Potentially long term	High	High	Medium to High
R8a Tenanted Cottage	Residential dwelling Associated Resident	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	560 m	Very Low	Potentially long term	High	High	Medium to High
R9 Paling Yards South	Residential dwelling Associated Resident	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	610 m	Very Low	Potentially long term	High	High	Medium to High
R9a Tenanted Cottage	Residential dwelling Associated Resident	Views toward the Paling Yards wind turbines will be partially screened by vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.	610 m	Very Low	Potentially long term	High	High	Medium to High
R9b	Temporary visitor	Views toward the Paling Yards wind turbines will be partially screened by	610 m	Very Low	Potentially	High	High	Medium to

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
Shearers quarters	Associated Resident	vegetation surrounding residential dwelling, with more open views toward turbines extending from areas proximate to the residential dwelling.			long term			High
R10 Black Hills	Residential dwelling	Views toward Paling Yards wind turbines largely blocked by topography and vegetation	2.2 km	Very Low	Potentially long term	High	Low	Low (potentially Nil)
R11 Levels Doctor	Residential dwelling	Elevated and long distance views toward Paling Yards wind turbines	5.7 km	Very Low	Potentially long term	High	Medium	Low to Medium
R12 Scots Hill	Residential dwelling	Elevated and medium distance views toward Paling Yards turbines with partial screening provided by ridgeline above the Abercrombie River valley.	3.7 km	Very Low	Potentially long term	High	Medium	Low to Medium
R13	Residential dwelling	Elevated and medium distance views toward Paling Yards turbines	3.9 km	Very Low	Potentially long term	High	Medium	Low to Medium
R14	Residential dwelling	Views toward the project turbines are screened by topography.	4.2 km	Very Low	Potentially long term	High	n/a	Nil
R15	Residential dwelling	Views toward the project turbines are screened by topography.	4.8 km	Very Low	Potentially long term	High	n/a	Nil
R16	Residential	Elevated views toward the Paling Yards	6 km	Very Low	Potentially	High	Low	Low

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
	dwelling	wind turbines are partially screened by ridgeline topography north east of the residential dwelling.			long term			
R17 Seven Gates Acreage with dwelling entitlement	Potential future residential	Elevated views from acreage toward the Paling Yards wind turbines.	6.2 km	Very Low	Potentially long term	High	Low	Low to Medium
R18 The Levels	Residential dwelling	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	6.2 km	Very Low	Potentially long term	High	Low	Low to Medium
R19 Kentuky	Residential dwelling	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	7.6 km	Very Low	Potentially long term	High	Low	Low
R20 Romlo -	Uninhabited	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	7.7 km	Very Low	Potentially long term	High	Low	Low
R21	Residential dwelling	Elevated views toward southern portion of the project, including turbines above the Abercrombie River valley, with some screening provided vegetation surrounding and beyond residential	4.1 km	Very Low	Potentially long term	High	Medium	Medium

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
		dwelling.						
R22	Residential dwelling	View toward Paling Yards wind turbines are screened by topography and vegetation.	4.8 km	Very Low	Potentially long term	High	-	Nil
R23	Residential dwelling	View toward Paling Yards wind turbines are screened by topography and vegetation.	5.1 km	Very Low	Potentially long term	High	-	Nil
R24 Rockwell	Residential dwelling	Elevated and distant views toward Paling Yards wind turbines partially screened by topography.	6 km	Very Low	Potentially long term	High	Medium	Low to Medium
R25 Kelbri	Residential dwelling	View toward Paling Yards wind turbines screened by topography.	7.4 km	Very Low	Potentially long term	High	-	Nil
R26 Dreamland	Residential dwelling	View toward Paling Yards wind turbines largely screened by topography.	7.6 km	Very Low	Potentially long term	High	Low	Low
R27 Eastleig	Residential dwelling	View toward Paling Yards wind turbines largely screened by topography.	8.5 km	Very Low	Potentially long term	High	Low	Low
R28 Greenacres	Residential dwelling	View toward Paling Yards wind turbines largely screened by topography.	8.8 km	Very Low	Potentially long term	High	Low	Low

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R29 Tanjenong	Residential dwelling	Elevated views toward Paling Yards turbines are partially screened by scattered tree cover surrounding property, but some opportunities for more open views from areas within the property.	4.1 km	Very Low	Potentially long term	High	High	Medium
R30 Bubalahla	Residential dwelling	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	5.9 km	Very Low	Potentially long term	High	High	Medium
R31 Wanda Shed	Residential dwelling	Long distance views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	6.4 km	Very Low	Potentially long term	High	High	Low to Medium
R32 Tandara	Residential dwelling	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	7.6 km	Very Low	Potentially long term	High	Low	Low
R33 Cobodong	Residential dwelling	Elevated views toward the Paling Yards wind turbines are partially screened by tree cover and vegetation surrounding residential dwelling.	7.7 km	Very Low	Potentially long term	High	Low	Low
R34 Mangrove	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	9.5 km	Very Low	Potentially long term	High	Nil	Nil

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R36 Carpe Diem	Residential dwelling	Long distance views toward the project turbines are screened by tree cover surrounding and beyond the residential dwelling.	9.6 km	Very Low	Potentially long term	High	Low	Nil
R64 Brooklands	Residential dwelling	Elevated and long distance view toward Paling Yards wind turbines are largely screened by undulating and ridgeline topography.	9.2 km	Very Low	Potentially long term	High	Low	Low (potentially Nil)
T	Non residential structure	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R106	No dwelling located	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R110	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	8.6 km	Very Low	Potentially long term	High	Nil	Nil
R111	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	8.9 km	Very Low	Potentially long term	High	Nil	Nil
R114	Residential dwelling	Elevated views toward Paling Yards turbines are partially screened by tree cover surrounding residential dwelling.	4.4 km	Very Low	Potentially long term	High	Medium	Low to Medium
R115	Residential dwelling	Elevated views toward Paling Yards turbines are partially screened by tree	4 km	Very Low	Potentially	High	Medium	Low to

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
Skysong		cover west of residential dwelling.			long term			Medium
R116	Residential dwelling	Elevated views toward Paling Yards turbines are partially screened by tree cover west of residential dwelling.	4.4 km	Very Low	Potentially long term	High	Medium	Low to Medium
R117	Residential dwelling	Elevated and long distance views toward Paling Yards turbines are partially screened by tree cover west of residential dwelling, with more open views from areas within property proximate to residential dwelling.	5.4 km	Very Low	Potentially long term	High	Medium	Low to Medium
R118 Kyewong	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	6.8 km	Very Low	Potentially long term	High	Low	Nil
R119 Jamanaya	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	7.3 km	Very Low	Potentially long term	High	Low	Nil
R120	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	5.7 km	Very Low	Potentially long term	High	Low	Nil
R121	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	5.9 km	Very Low	Potentially long term	High	Low	Nil
R122	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree	5.7 km	Very Low	Potentially long term	High	n/a	Nil

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
		cover and topography.						
R123 Binercrombie	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	5.2 km	Very Low	Potentially long term	High	n/a	Nil
L	Non residential structure	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R124 Ellobo Sola	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	6.5 km	Very Low	Potentially long term	High	n/a	Nil
R125 Westbrook	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	2.7 km	Very Low	Potentially long term	High	n/a	Nil
R126 Weronga	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	2.9 km	Very Low	Potentially long term	High	n/a	Nil
N	Non residential structure	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R127 Kiah	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	4 km	Very Low	Potentially long term	High	n/a	Nil

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R128 Rock Orchard	Residential dwelling	Elevated views across Abercrombie River valley toward the Paling Yards turbines.	2.8 km	Very Low	Potentially long term	High	High	Medium
R129	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	5.9 km	Very Low	Potentially long term	High	Low to Moderate	Nil
R130 Ormonts	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	6.4 km	Very Low	Potentially long term	High	n/a	Nil
R131	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	6.4 km	Very Low	Potentially long term	High	n/a	Nil
R132 Westfalica	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	7.4 km	Very Low	Potentially long term	High	Low	Nil
R133 The Glenn	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	7.3 km	Very Low	Potentially long term	High	Low	Nil
R134 Cows with	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	2.9 km	Very Low	Potentially long term	High	Low	Nil

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
guns								
R135	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	2.9 km	Very Low	Potentially long term	High	Low	Nil
R136 Dutcha	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	8.1 km	Very Low	Potentially long term	High	Low	Nil
P	Non residential structure	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R137 Uralla	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	7.3 km	Very Low	Potentially long term	High	Low	Nil
R138 Burradale	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	9.4 km	Very Low	Potentially long term	High	Low	Nil
R139 Cherry Hills	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	8 km	Very Low	Potentially long term	High	Nil	Nil
R140	Residential dwelling	Views toward the Paling Yards wind turbines are largely screened by dense	7.2 km	Very Low	Potentially long term	High	Medium	Low to Medium

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
		tree cover.						
R141	Residential dwelling	Views toward the Paling Yards wind turbines are screened by dense tree cover.	7.5 km	Very Low	Potentially long term	High	Medium	Low to Medium
R142	Residential dwelling	Elevated and distant views toward portions of the project.	7.3 km	Very Low	Potentially long term	High	Medium	Low
S	Non residential structure	n/a	n/a	n/a	n/a	n/a	n/a	n/a
R143 Wollumbin	Residential dwelling	Elevated and distant views toward portions of the project.	6.2 km	Very Low	Potentially long term	High	High	Low to Medium
R144 Bimbi	Residential dwelling	Elevated and distant views toward portions of the project.	6.9 km	Very Low	Potentially long term	High	High	Low to Medium
R145 Yarrum	Residential dwelling	Elevated and distant views toward portions of the project.	6.8 km	Very Low	Potentially long term	High	High	Low to Medium
R146 Ba-Roo	Residential dwelling	Elevated and distant views toward portions of the project.	6.9 km	Very Low	Potentially long term	High	High	Low to Medium

Table 17 – Visual significance matrix (Refer **Figure 17** for residential dwelling locations)

View Location	Category of Potential View Location	View context from residence toward Paling Yards wind turbine layouts	Approximate distance to closest turbine	Relative number of people	Period of view	View Location sensitivity	Theoretical visibility rating from residence (Refer ZVI Diagram 1)	Overall significance of visual impact for the '175m tip' design layout
R147	Residential dwelling	Elevated and distant views toward portions of the project with some screening by existing vegetation surrounding residential dwelling.	7km	Very Low	Potentially long term	High	Medium to High	Low to Medium
R149	Holiday house (occasional occupation)	Views toward the Paling Yards wind turbines are screened by dense tree cover and topography.	3.6 km	Very Low	Potentially long term	High	Low	Nil

8.3 Summary of potential visual impact

This LVIA identified a total of 85 potential residential dwelling locations within the project's 10 km viewshed. A total of three residential dwellings were determined to be unoccupied at the time of the field work and have been included and assessed in this LVIA. A total of seven potential residential structures identified at the desk top assessment stage were determined to be non residential structures (or could not be located) during the field work and have not been included or assessed in this LVIA.

An assessment of each potential residential view location indicated that:

- 37 of the 78 residential view locations have been determined to have a nil visual impact;
- 11 of the 78 residential view locations have been determined to have a low visual impact;
- 19 of the 78 residential view locations have been determined to have a low to medium visual impact;
- 5 of the 78 residential view locations have been determined to have a medium visual impact; and
- 6 of the 78 residential view locations have been determined to have a medium to high visual impact.

The six residential dwellings determined to have a medium to high visual impact are associated residences.

Table 18 – Summary of visual impact ratings within 10 km viewshed

Visual Impact Rating within Paling Yards 10 km viewshed (Total from 78 residential dwellings)					
Nil	Low	Low to Medium	Medium	Medium to High	High
37 (47%)	11 (14.5 %)	19 (24%)	5 (6.5%)	6 (8%)	0 (0%)

The field assessment for the majority of residential view locations was undertaken from the closest publicly accessible location. A conservative approach was adopted where there was no opportunity to confirm the actual extent of available view from areas within or immediately surrounding the residence. Given this, it is anticipated that some visibility ratings would be less than those determined subject to a process of verification from private property.

GBD acknowledge that the proposed Paling Yards wind farm may have the potential to impact people engaged in predominantly farming or recreational activities, where views toward wind turbines occur from surrounding agricultural areas. Ultimately the level of visual impact would depend on the type of activities engaged in and the location of the activities, together with the degree of screening provided by local landform or vegetation within individual properties. Whilst views toward the turbines will occur from a wide area of surrounding rural agricultural land, this LVIA has determined that the sensitivity of visual impacts is less for those employed or carrying out work in rural areas compared to potential views from residential dwellings; however the sensitivity of individual view locations will also depend on the perception of the viewer.

It should be noted that the term 'visual impact' does not necessarily imply or represent an individual's negative response toward the visibility of wind turbines, and that perceptions of wind farms amongst individuals within any community can be positive, negative or neutral.

8.4 Public view locations

Opportunities to view the Paling Yards wind turbines from publically accessible locations will be largely restricted to a small number of surrounding road corridors which are predominately limited to Abercrombie Road and the more distant Jerrong Road. Motorist's views will extend toward the wind turbines as the Abercrombie Road approaches the river valley from the south and will continue to occur along the road which extends through the Paling Yards wind farm site for approximately 9.5 km. The design layout will offer short distance and direct views toward wind turbines located within proximity to the road corridor, although wind turbine visibility for drivers and passengers from moving vehicles will be determined by the direction of travel relative to the orientation of the wind turbines, as well as the influence of localised landform (roadside cuttings and undulating landform extending beyond the road corridor).

Roadside tree planting to the south, central and north portions of the project site will provide limited and short term screening to some wind turbines, but given the proximity of wind turbines to the road corridor, the overall screening effectiveness of existing tree planting will be confined to relatively small sections of the road corridor.

Abercrombie Road has a posted speed of 100 km/h through the project site, with advisory reductions in speed at a number of bends. The average vehicular travel time through the project site is approximately 6 to 10 minutes, resulting in a short duration of view for individual trips; however, this duration would increase for people making regular return commuting or shopping trips.

The majority of wind turbines (44 of the 59 maximum) would be located to the west of Abercrombie Road, which would tend to reduce the potential for individual, or groups of wind turbines, interrupting or obstructing views from the road corridor over middle and long distance

The Abercrombie River National Park supports a number of recreational activities which, for the most part, include water based activities such as fishing; canoeing, swimming as well as vehicle based camping sites such as:

- Bummaroo Ford (on the Abercrombie River);
- Silent Creek;
- The Beach (on the Abercrombie River); and
- The Sink (on the Retreat River).

The location of the vehicle based camping sites is illustrated on **Figure 2**. Whilst there are no formal walking tracks within the park, bushwalking is permitted throughout the park. The most popular walking routes are along the Abercrombie River and its tributaries.

Any significant views toward the Paling Yards wind farm site from the vehicle based camp sites, as well as water based recreational activity areas will be predominantly screened by a combination of topography (undulating and complex landforms following drainage lines) and dense tree cover crossing hillsides and ridgelines.

8.5 Future residential dwellings

In general, existing residential dwellings in the vicinity of the project are located below surrounding ridgelines to maximise potential for shelter from prevailing wind. Where exposed, existing residential dwellings tend to include a degree of shelter from windbreak planting or tree planting around dwellings. The tendency to locate residential dwellings predominately in sheltered situations also acts to limit the extent of available views across the surrounding landscape, although a small number of dwellings appear to have been located on properties to take advantage of distant and panoramic views.

Potential future planning for residential dwellings would be able to take advantage of any approved layout design for the project when determining the optimal location for residential dwellings on individual portions of land to minimise views toward wind turbines if desired. In some circumstances future residential dwellings could be located to take advantage of local topographic features in order to screen views toward wind turbines or implement in advance mitigation measures such as tree planting for windbreak and/or screening purposes if desired.

Should residential dwellings be constructed on existing portions of land immediately adjacent to the wind farm site, there is likely to be an associated visual impact not only with additional residential structures within the landscape but also on a range of domestic infrastructure associated with these additional dwellings.

Cumulative visual impact assessment Section 9

9.1 What is cumulative impact assessment?

A cumulative landscape and visual impact could result from a proposed wind farm development being constructed in conjunction with other existing or proposed wind farm developments, and could be either associated or separate to it.

Separate wind farm developments could occur within the established viewshed of the proposed wind farm, or be located within a regional context where visibility is dependent on a journey between each site or an individual project viewshed.

'Direct' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location simultaneously.

'Indirect' cumulative visual impacts could occur where two or more winds farms have been constructed within the same locality, and could be viewed from the same view location but not within the same field of view.

'Sequential' cumulative visual impacts could arise as a result of multiple wind farms being observed at different locations during the course of a journey (such as views from a vehicle travelling along a highway or from a network of local roads), which could form an impression of greater magnitude within the construct of short term memory.

There are a number of proposed, approved and operating wind farm developments within New South Wales which are illustrated in **Figure 18**. The general location of wind farms surrounding the project are illustrated in **Figure 19**. These figures illustrate the location of wind farms known at the time this LVIA was prepared. The number and location of wind farms is likely to change as more wind farm projects are announced or current approvals lapse.

9.2 Other wind farm developments

The DoP&I website identifies a small number of wind farm developments that are currently existing or proposed within the same locality as the project and are identified in **Table 19**.

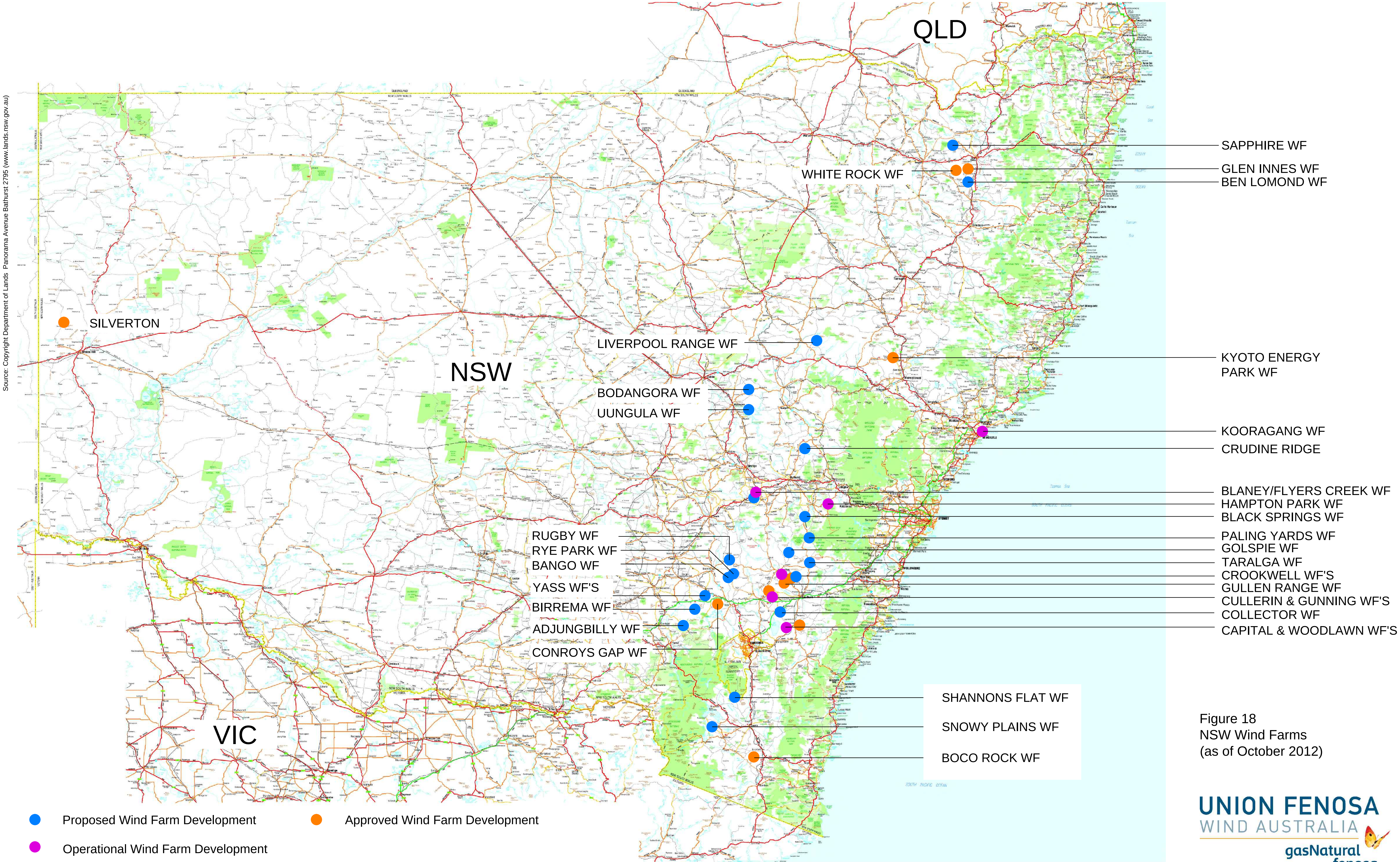
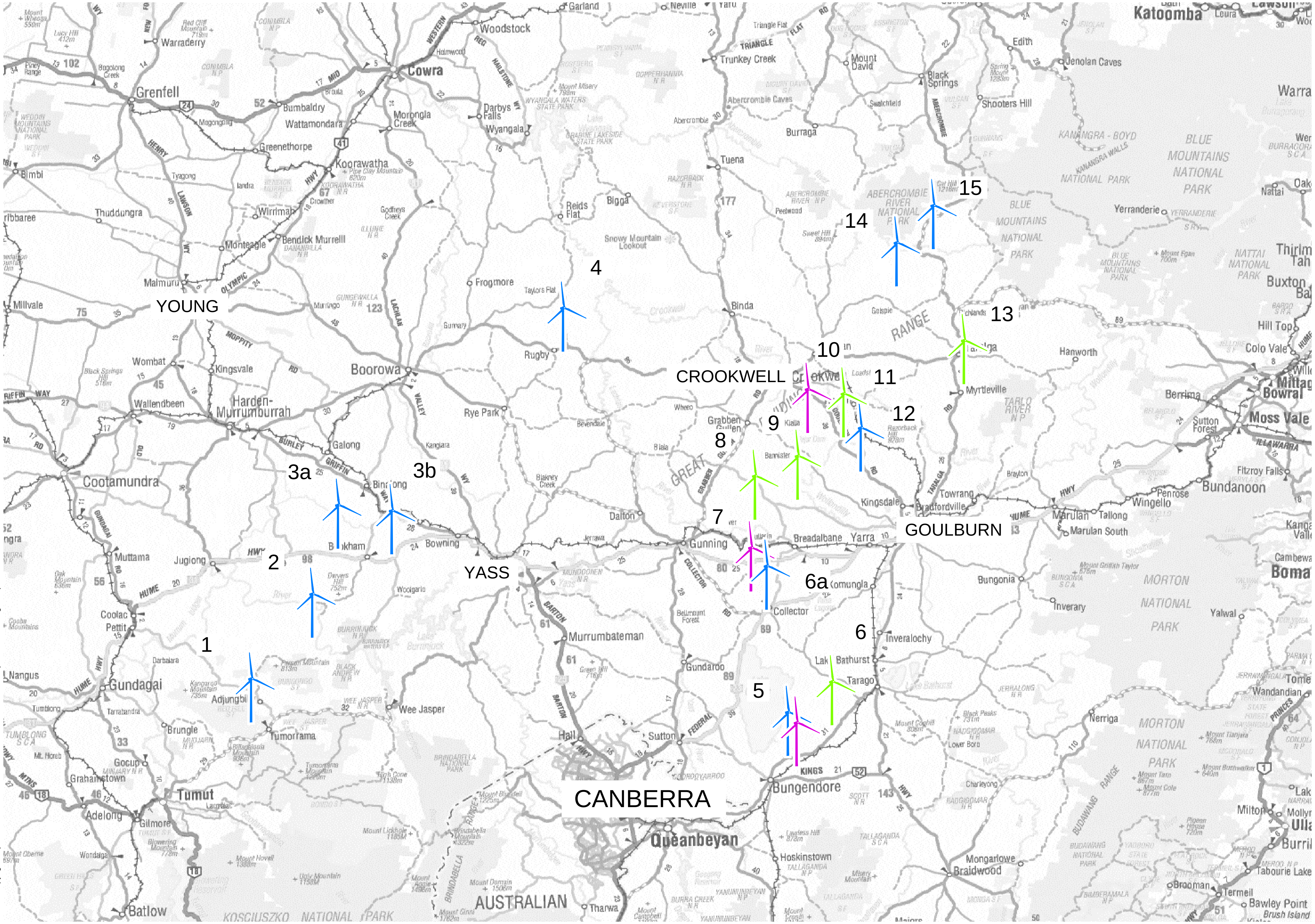


Figure 18
NSW Wind Farms
(as of October 2012)

UNION FENOSA
WIND AUSTRALIA
gasNatural fenosa

PALING YARDS WIND FARM

GREEN BEAN DESIGN
landscape architects



Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)

Legend

1 Adjunbilly Wind Farm
2 Birrema Wind Farm
3a Yass Wind Farm (Coppabella)
3b Yass Wind Farm (Marilba)
4 Rugby Wind Farm
5 Capital Wind Farm (I & II)
6 Woodlawn Wind Farm
6a Collector Wind Farm
7 Cullerin Wind Farm
8 Gunning Wind Farm
9 Gullen Range Wind Farm
10 Crookwell Wind Farm
11 Crookwell 2 Wind Farm
12 Crookwell 3 Wind Farm
13 Taralga Wind Farm
14 Golspie Wind Farm
15 Paling Yards Wind Farm

Proposed wind farm development
Approved wind farm development
Operational wind farm development

Figure 19
NSW Southern Tablelands Wind Farm Locations
(as of October 2012)

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WIND AUSTRALIA
gasNatural fenosa

Not to scale

PALING YARDS WIND FARM

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Table 19 Other Wind Farm Developments

Wind Farm	Proponent or Owner	Status	Number of turbines	Approximate distance between wind farms
Crookwell 1	Eraring Energy Pty Ltd	Operational	8	40 km
Crookwell 2	Crookwell Development Pty Ltd	Approved – Construction Stage	46	41 km
Crookwell 3	Crookwell Development Pty Ltd	Planning stage – not yet approved	30	40 km
Gullen Range	Gullen Range Wind Farm Pty Ltd	Approved - Construction Stage	73	44 km
Golspie	Wind Prospect Pty Ltd	Planning stage – not yet lodged	up to 100	3 km
Taralga	CBD Energy Pty Ltd	Approved - Construction Stage	62	27 km

GBD is not aware of any smaller wind farm developments that are currently lodged, or being assessed by the Oberon Shire Council.

9.3 Cumulative visual impact summary

Intervisibility between the Paling Yards wind turbines and other proposed, approved and operating turbines would potentially occur from discrete elevated and cleared ridgeline areas to the east and south of the project.

The opportunity for ‘direct’ or ‘indirect’ views to other approved wind farms is limited for most of the residential dwellings within the Paling Yards wind farm 10 km viewshed. This is largely due to residential dwelling position and orientation relative to other approved wind farms as well as the distribution of dense and scattered tree cover and undulating topography between the approved wind farm developments.

Long distance views south toward the approved Taralga wind farm would potentially occur from elevated (but unoccupied) portions of land within the Paling Yards wind farm site. The Taralga wind farm is unlikely to result in any significant cumulative visual impacts.

Motorists travelling along the Abercrombie Road would not tend to experience ‘indirect’ cumulative impact as turbine visibility within and beyond the project site is limited by local landform, tree cover and the direction of travel relative to distant views beyond the project. There may be an opportunity for a ‘direct’ view between the Paling Yards wind turbines and those within the proposed Golspie wind farm area from vehicles travelling south along Abercrombie Road. It is not anticipated that this would result in a significant level of cumulative impact due to the potential distance between wind turbines and temporary nature of the view.

A ‘sequential’ view would occur for motorists travelling along the Abercrombie Road although the journey between wind farms would include a range of views extending toward and beyond turbines. The extent and overall visibility of turbines would be influenced by the direction of travel relative to the alignment of wind turbines as well as travel time along the highway and local road network alongside and between various wind farm turbines.

This LVIA has determined that the project is unlikely to result in any significant ‘direct’, ‘indirect’ or ‘sequential’ cumulative visual impact and is unlikely to significantly increase the level of visual impact that has been determined for the nominated view locations in relation to the project development.

Photomontages

Section 10

10.1 Photomontages

The DGR's state that the EA must "*include photomontages of the project taken from potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights), settlements and significant public view points*…"

Whilst it is possible for any residence with a view toward the project turbines to be potentially affected (with a resultant high, moderate or low visual impact), it is not feasible or practical to prepare a photomontage for each and every residence within the project 10 km viewshed.

A total of eight photomontage locations (PM 1 to PM 8) were selected as representative of non associated residential dwellings and the public view locations from surrounding road corridors. Photomontages PM 1 to PM 6 illustrate the proposed wind turbine locations; PM 7 and PM 8 illustrates a typical view toward the assessed and proposed 500 kV transmission line. The photomontages locations are illustrated in **Figure 20**.

The photomontages locations were selected to represent a range of distances between the viewpoint and wind turbines (between 800 m and 4.6 km) to illustrate the potential influence of distance on visibility and resultant visual impact.

The photomontages have been prepared with regard to the general guidelines set out in the Scottish Natural Heritage (2006) Visual representation of windfarms: good practice guidance and British Landscape Institute Advice Note 01/11 (March 2011) Photography and photomontage in landscape and visual impact assessment.

Photography for the photomontages was undertaken by GH and GBD using a tripod mounted Nikon D700 digital single-lens reflex (SLR) camera. A 50 mm focal length prime lens was attached to the Nikon D700 SLR camera which, with a 35 mm equivalent a full frame censor (36 x 23.9 mm Nikon FX format) results in a single photograph image with a 46^{o} view angle.

Each photomontage was generated through the following steps:

- a digital terrain model (DTM) of the project site was created from a terrain model of the surrounding area using digital contours;

- the site DTM was loaded in the GH 'WindFarmer' software package;
- the layout of the wind farm and 3D representation of the wind turbine was configured in GH WindFarmer;
- the location of each viewpoint (photo location) was configured in WindFarmer – the sun position for each viewpoint was configured by using the time and date of the photographs from that viewpoint;
- the view from each photomontage location was then assessed in WindFarmer. This process requires accurate mapping of the terrain as modelled, with that as seen in the photographs. The photographs, taken from each photomontage location were loaded into WindFarmer and the visible turbines superimposed on the photographs;
- the photomontage were adjusted using Photoshop CS3 to compensate for fogging due to haze or distance, as well as screening by vegetation or obstacles; and
- the final image was converted to JPG format and imported and annotated as the final figure.

Table 20 identifies the eight photomontage locations, property names (where relevant), corresponding reference number identified in the residential view matrix (**Table 17)** as well as the status of each photomontage location.

Table 20 – Photomontage details

Photomontage Location	Figure Reference	Location name and View Location Matrix reference (R) – (Refer Tables 15 and 16)	Status: Residential (associated) Residential (non associated) Road corridor
PM 1 Levels Road	**Figure 21 Sheet 1** **Figure 22 Sheet 2**	n/a	Unsealed road corridor (minor local road)
PM 2 Rock Orchard (residential dwelling)	**Figure 23 Sheet 1** **Figure 24 Sheet 2**	R128	Non associated residential dwelling (photomontage location south of residential dwelling)

Table 20 – Photomontage details

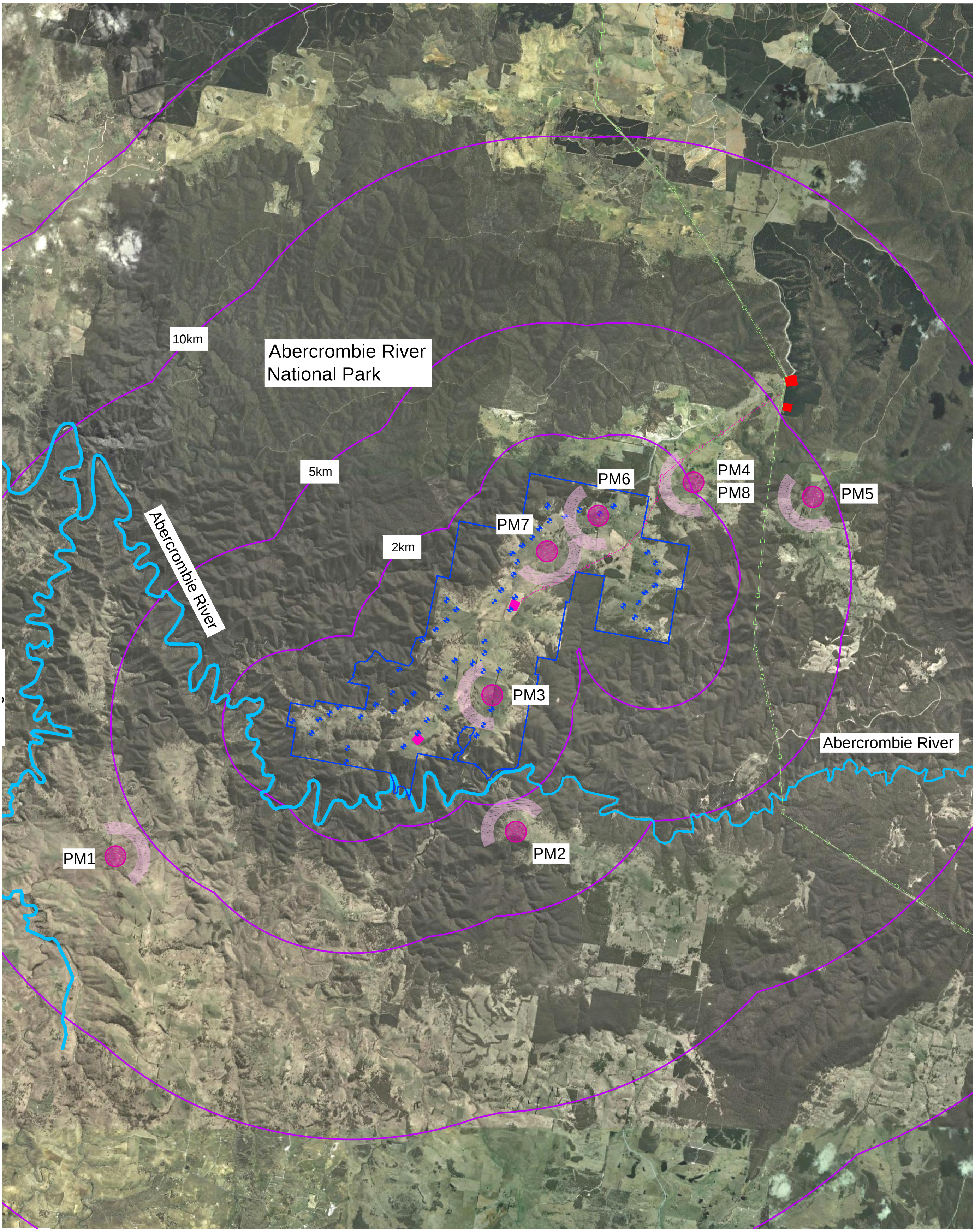
Photomontage Location	Figure Reference	Location name and View Location Matrix reference (R) – (Refer Tables 15 and 16)	Status: Residential (associated) Residential (non associated) Road corridor
PM 3 Abercrombie Road	**Figure 25 Sheet 1** **Figure 26 Sheet 2**	n/a	Abercrombie Road
PM 4 Hilltop (residential dwelling driveway)	**Figure 27 Sheet 1** **Figure 28 Sheet 2**	R6A	Non associated residential dwelling (photomontage location south of residential dwelling from entrance driveway)
PM 5 Jerrong Road	**Figure 29 Sheet 1** **Figure 30 Sheet 2**	n/a	Jerrong Road
PM 6 Mount Hutton (private land)	**Figure 31 Sheet 1** **Figure 32 Sheet 2**	n/a	Hill top on associated property (private grazing land) –provides an elevated longitudinal view north to south along Abercrombie Road.
PM 7 Abercrombie Road	**Figure 42**	n/a	Abercrombie Road – view toward assessed and proposed 500 kV transmission line (turbines not illustrated).
PM 8 Hilltop (residential dwelling driveway)	**Figure 43**	n/a	Non associated residential dwelling (photomontage location south of residential dwelling from entrance driveway). View toward assessed and proposed 500 kV transmission line.

The horizontal and vertical field of view within the majority of the photomontages exceeds the parameters of normal human vision. However, in reality the eyes, head and body can all move and, under normal conditions, the human brain would 'see' a broad area of landscape within a panorama view. Accordingly, the photomontage have been prepared to represent both an extended panorama view as well as a single photographic image representing a static portion for the human field of view.

Whilst a photomontage can provide an image that illustrates a very accurate representation of a wind turbine in relation to its proposed location and scale relative to the surrounding landscape, this LVIA acknowledges that large scale objects in the landscape can appear smaller in photomontage than in real life and is partly due to the fact that a flat image does not allow the viewer to perceive any information relating to depth or distance.

The British Landscape Institute states that '*it is also important to recognise that two-dimensional photographic images and photomontages alone cannot capture or reflect the complexity underlying the visual experience and should therefore be considered an approximate of the three-dimensional visual experiences that an observer would receive in the field'.*

Source: Google Earth Pro (Whereis Sensis Pty Ltd, Geo Eye Cnes/Spot Image) 2012 Imagery Date 2011



Legend

	Paling Yards proposed wind turbine indicative layout		Proposed 500 kV transmission line		Proposed collector substation
	Photomontage location		Paling Yards wind farm site boundary		Proposed switchyard substation
	Existing 500 kV transmission line		Distance offset to wind turbines as noted		

0km 2km

Figure 20
Photomontage Location

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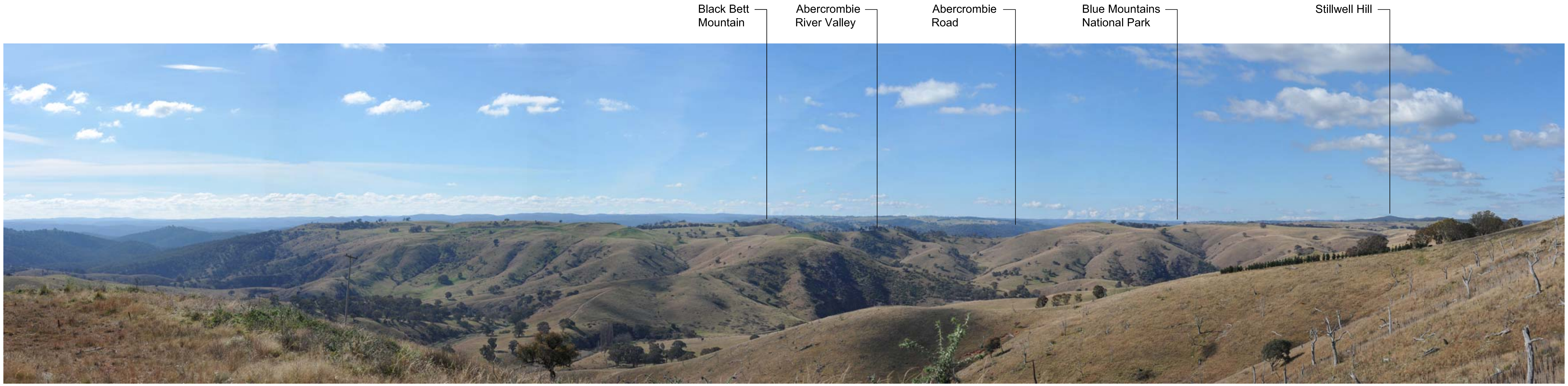
Image Source GBD 2012



Photomontage Location PM 1 Levels Road - Existing view, panorama north to east (Bearing 350° to 110°)

350° 360° 10° 20° 30° 40° 50° 60° 70° 80° 90° 100° 110°

N NNE NE ENE E

Image Source GBD 2012

Photomontage Location PM 1 Proposed view, Levels Road, Extended panorama north to east (Bearing 350° to 110°)

Refer Figure 20 for Photomontage Location.

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 742978 Northing 6210924 (MGA 94z55H). Approximate distance to nearest visible turbine 6 km

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Image Source GBD 2012

Photomontage Location PM 1, Levels Road - Proposed view

Indicative extent of single frame photo
(refer detail below)

Image Source GBD 2012

Photomontage Location PM 1 - Single frame photo detail, proposed view

Figure 22
Photomontage PM 1 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 742978
Northing 6210924 (MGA 94z55H)

Approximate distance to nearest visible turbine 6 km

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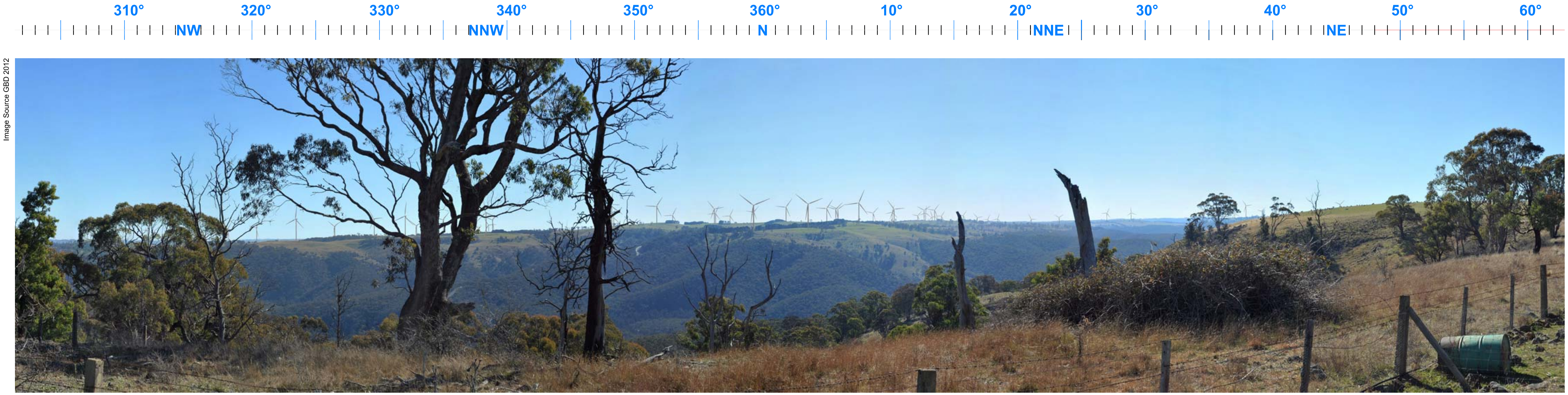
Photomontage Location PM 2 Rock Orchard (residential dwelling) Existing view, extended panorama north west to east north east (Bearing 300° to 70°)



Photomontage Location PM 2 Rock Orchard (residential dwelling) Proposed view, extended panorama north west to east north east (Bearing 300° to 70°)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 753207 Northing 6211629 (MGA94z55H). Approximte distance to nearest visible turbine 2.6 km

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Image Source GBD 2012

Photomontage Location PM 2 - Rock Orchard (south of residential dwelling)
Proposed view

Figure 24
Photomontage PM 2 Sheet 2

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 753207
Northing 6211629 (MGA 94z55H)

Approximate distance to nearest visible turbine 2.6 km

Image Source GBD 2012

Photomontage Location PM 2 - Single frame photo detail, proposed view

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Abercrombie Road

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) Existing view, extended panorama south to west north west (Bearing 170° to 290°)

180° 190° 200° 210° 220° 230° 240° 250° 260° 270° 280° 290°

S SSW SW WSW W

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) Proposed view, extended panorama south to west north west (Bearing 170° to 290°)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 753068 Northing 6215581 (MGA94z55H). Approximate distance to nearest visible turbine 900 m

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Figure 26
Photomontage PM 3 Sheet 2

Image Source GBD 2012

Photomontage Location PM 3 Abercrombie Road (south) - Proposed view

Indicative extent of single frame photo (refer detail below)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 753068
Northing 6215581 (MGA94z55H)

Approximate distance to nearest visible turbine 900 m

Image Source GBD 2012

Photomontage Location PM 3 - Single frame photo detail, proposed view

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Image Source GBD 2012

Photomontage Location PM 4 Hilltop (non associated residential dwelling - driveway) Existing view, extended panorama south south east to west (Bearing 150° to 270°)

160° 170° 180° 190° 200° 210° 220° 230° 240° 250° 260° 270°

SSE S SSW SW WSW W

Image Source GBD 2012

Photomontage Location PM 4 Hilltop (non associated residential dwelling - driveway) Proposed view, extended panorama south south east to west (Bearing 150° to 270°)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 758731 Northing 6221170 (MGA94z55H) Approximate distance to nearest visible turbine 2.4km

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Figure 28
Photomontage PM 4 Sheet 2

Image Source GBD 2012

Photomontage Location PM 4 Hilltop (non asociated residential dwelling - driveway)
Proposed view

Indicative extent of single frame photo
(refer detail below)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 758731
Northing 6221170 (MGA94z55H)

Approximate distance to nearest visible turbine 2.4km

Image Source GBD 2012

Photomontage Location PM 4 - Single frame photo detail, proposed view

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Photomontage Location PM 5 Jerrong Road, Existing view, extended panorama south south east to west (Bearing 150° to 270°)

160° 170° 180° 190° 200° 210° 220° 230° 240° 250° 260° 270°

SSE S SSW SW WSW W

Photomontage Location PM 5 Jerrong Road, Proposed view, extended panorama south south east to west (Bearing 150° to 270°)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 761861 Northing 6219775 (MGA94z55H) Approximate distance to nearest visible turbine 4.6 km

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Figure 30
Photomontage PM 5 Sheet 2

Image Source GBD 2012

Photomontage Location PM 5 Jerrong Road Proposed view

Indicative extent of single frame photo
(refer detail below)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 761861
Northing 6219775 (MGA94z55H)

Approximate distance to nearest visible turbine 4.6 km

Image Source GBD 2012

Photomontage Location PM 5 - Single frame photo detail, proposed view

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Image Source GBD 2012

Photomontage Location PM 6 Hutton Hill Existing view, extended panorama south south west to north west (Bearing 195° to 320°)

200° SSW 210° 220° SW 230° 240° WSW 250° 260° 270° W 280° 290° WNW 300° 310° NW

Image Source GBD 2012

Photomontage Location PM 6 Hutton Hill Proposed view, extended panorama south south west to north west (Bearing 195° to 320°)

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates: Easting 755957 Northing 6220228 (MGA94z55H) Approximate distance to nearest visible turbine 800 m

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Figure 32
Photomontage PM 6 Sheet 2

Image Source GBD 2012

Photomontage Location PM 6 Hutton Hill (private land) Proposed view

Refer Figure 20 for Photomontage Location

Individual panorama photos taken with a Nikon D700 digital SLR camera with 50 mm prime lens.

Photo coordinates:
Easting 755957
Northing 6220228 (MGA94z55H)

Approximate distance to nearest visible turbine 800 m

Image Source GBD 2012

Photomontage Location PM 6 - Single frame view photo, proposed view

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Shadow flicker & blade glint assessment summary Section 11

11.1 Introduction

Due to their height, wind turbines can cast shadows on surrounding areas at a significant distance from the base of the wind turbine tower. Coupled with this, the moving blades create moving shadows. When viewed from a stationary position, the moving shadows appear as a flicker giving rise to the phenomenon of 'shadow flicker'. When the sun is low in the sky the length of the shadows increases, increasing the shadow flicker affected area around the wind turbine.

A shadow flicker and blade glint assessment has been prepared by GH to determine and illustrate the potential impact of shadow flicker and blade glint on surrounding view locations. The detailed shadow flicker and blade glint assessment for the proposed project is included at **Appendix A**.

A shadow flicker assessment may over estimate the actual number of annual hours of shadow flicker at a particular location due to a number of reasons including:

- the probability that the wind turbines will not face into or away from the sun all of the time;
- the occurrence of cloud cover;
- the amount of particulate matter in the atmosphere (moisture, dust, smoke etc…) which may diffuse sunlight;
- the presence of vegetation; and
- periods where the wind turbine may not be in operation due to low winds, or high winds or for operational or maintenance reasons.

11.2 Residents

The results of the shadow flicker assessment for the proposed project determined that 7 residential view locations, each of which are associated residences, may be subject to some levels of shadow flicker. These associated residential view locations are:

- House ID 7;
- House ID 7A;
- House ID 8;

- House ID 8A;
- House ID 9;
- House ID 9A;and
- House ID 9B.

The GH shadow flicker results are detailed in the LVIA **Appendix A**.

11.3 Photosensitive Epilepsy

The Canadian Epilepsy Alliance (http://www.epilepsymatters.com) defines photosensitivity as '*a sensitivity to flashing or flickering lights, usually of high intensity, which are pulsating in a regular pattern – and people with photosensitive epilepsy can be triggered into seizures by them*'. Both the Canadian Epilepsy Alliance and Epilepsy Action Australia (http://www.epilepsy.org.au) estimate that less than 5% of people with epilepsy are photosensitive.

Epileptic seizures caused by photosensitive epilepsy may be triggered by a range of electronic devices including material broadcast by televisions, computer screens or strobing and flashing lights in nightclubs. Seizures may also be triggered by natural light shining off water, through tree leaves or by flickering caused by travelling past railings. Not all flashing or flickering light will trigger a seizure in people with photosensitive epilepsy, and the potential to trigger a seizure may also be dependent on the frequency of flashing or flicker, and the duration and intensity of light.

Epilepsy Action Australia suggest that the frequency of flashing or flickering light most likely to trigger seizures occurs between 8 to 30Hz (or flashes/flickers per second), although this may vary between individuals. It also suggests that 96% of people with photosensitive epilepsy are sensitive to flicker between 15 to 20Hz.

The majority of three bladed wind turbines are unlikely to create a flicker frequency greater than 1Hz (or 1 flicker per second). The flicker frequency for a three blade wind turbine can be calculated by multiplying the hub rotation frequency (in revolutions per second) by the number of blades. As the maximum rotational speed for the Paling Yards wind turbines would be around 20 revolutions per minute (rpm), the hub rotation frequency would be 20rpm divided by 60 seconds resulting in 0.3

revolutions per second. Multiplying 0.3 revolutions per second by three blades equals around 1Hz (or 1 flicker per second).

Given the low flicker frequency associated with the Paling Yards wind turbines, which falls below the range suggested by Epilepsy Action Australia as a potential trigger for photosensitive epileptic seizures, it is unlikely that the proposed Paling Yards wind turbines would present a risk to people with photosensitive epilepsy.

11.4 Motorists

Motorists can experience shadow flicker sensations whilst driving as a result of shadows cast on the road from roadside or overhead objects such as trees, poles or buildings. Under certain conditions the sensation of shadow flicker may cause annoyance and may potentially impact on a driver's ability to operate a motor vehicle safely.

The photograph in **Plate 6** illustrates a typical situation where shadow flicker may be experienced whilst driving along a road where trees cast shadows.

Plate 6 Potential shadow flicker created by trees filtering sunlight across road (Source GBD 2012)

There are no specific guidelines to address the potential impact of shadow flicker on motorists cast by wind turbines across roads, although there are lighting standards that can be applied to minimise the adverse effects of flicker caused by roadside or overhead objects. These standards include *AS 1158:5:2007 (Lighting for roads and public spaces – Part 5: Tunnels and underpasses), section 3.3.8 and CIE 88:2004 (Guide for lighting of roads tunnels and underpasses, 2nd ed.), section 6.14*. The standards suggest that the flicker effect will be noticeable and possibly cause annoyance between 2.5 and 15Hz (2.5 to 15 flickers per second), and that a flicker effect between 4 and 11Hz should be avoided for longer than 20 seconds.

As the potential flicker frequency for the Paling Yards wind turbines is likely to be around 1Hz, it is unlikely that the flicker effect will cause annoyance or impact on a driver’s ability to operate a motor vehicle safely whilst travelling along local roads surrounding the wind farm.

11.5 Blade glint

Glint is a phenomenon that results from the direct reflection of sunlight (also known as specular reflection) from a reflective surface that would be visible when the sun reflects off the surface of the wind turbine at the same angle that a person is viewing the wind turbine surface. Glint may be noticeable for some distance, but usually results in a low impact.

The surfaces of the wind turbines, including the towers and blades, are largely convex, which will tend to result in the divergence of light reflected from the surfaces, rather than convergence toward a particular point. This will reduce the potential for blade glint.

Blade glint can also be further mitigated through the use of matt coatings which, if applied correctly, will generally mitigate potential visual impacts caused by glint.

Night time lighting

Section 12

12.1 Introduction

The proposed Paling Yards wind turbines may require the installation of obstacle lighting. The requirement for obstacle lighting would be subject to the advice and endorsement of the Civil Aviation Safety Authority (CASA). CASA is currently undertaking a safety study into the risk to aviation posed by wind farms and may develop a new set of guidelines to replace the Advisory Circular with regard to lighting for wind turbines that was withdrawn by CASA in mid 2008.

However, in order to ensure that a full assessment was undertaken, the Proponent commissioned an independent aviation safety expert to conduct an Aeronautical Impact and Night Lighting Assessment, to first determine the risks posed to aviation activities by the project. The aeronautical assessment expert carried out an oobstacle llighting aassessment and recommended a turbine lighting layout which would mitigate risks to aviation. The aeronautical assessment recommended that up to 25 wind turbines be lit at night. The Paling Yards wind turbines have been lit to identify the perimeter of the wind farm at longitudinal intervals not greater than 900 m. The proposed lit turbines are illustrated in **Figure 3**. The aeronautical assessment notes that the lighting design would be subject to a final design and confirmation of the turbine model height.

In accordance with the CASA Advisory Circular two red medium intensity obstacle lights are required on specified turbines at a distance not exceeding 900 m with all lights to flash synchronously. To minimise visual impact some shielding of the obstacle lights below the horizontal plane is permitted.

Lighting for aviation safety may also be required prior to and during the construction period, including lighting for large equipment such as cranes.

Potential visual impacts associated with obstacle marking and lighting at night time have not been extensively researched or tested in New South Wales, although some site investigations have been carried out at existing wind farms in Victoria. Investigations have generally concluded that although night time lighting mounted on wind turbines may be visible for a number of kilometres from the wind farm project area, the actual intensity of the lighting appears no greater than other sources of night time lighting, including vehicle head and tail lights.

A series of night time photographs were taken toward the Cullerin wind farm in order to illustrate the visual effect of turbine mounted lighting. These were taken at distances of 500m, 3.5km and 17km and are illustrated in **Figures 33, 34** and **35**. Each night time view is presented below a corresponding day time photograph taken from the same location. It should be noted that following community consultation, and the preparation of an aviation risk assessment, Origin Energy have removed night time lighting from the Cullerin wind turbines.

12.2 Existing light sources

Existing night time light sources are limited in the vicinity of the project, and mostly associated with rural residential dwellings and vehicles travelling along the Abercrombie Road.

Existing lighting is unlikely to be visually prominent and does not emit any significant illumination beyond immediate areas surrounding residential and agricultural buildings.

Lights from vehicles travelling along the local roads provide dynamic and temporary sources of light.

12.3 Potential light sources

The main potential light sources associated with the project would include night time obstacle lights on wind turbines. The assessed and proposed substations will have low intensity security night lighting and additional lighting that may be required for scheduled or emergency maintenance around the wind turbine areas and substations.

12.4 Potential views and impact

The categories of potential views that may be impacted by night time lighting generally include residents and motorists.

Night time lighting associated with the wind farm is likely to have an impact on a number of the residential view locations surrounding the project.

Irrespective of the total number of visible lights, night time obstacle lights are more likely to be noticeable from a residential curtilage rather than building interiors, where night time room lights tend to reflect and mirror internal views in windows, or curtains and blinds tend to be drawn.

Although visible from distances which would exceed the project 10 km viewshed, the intensity of night time lighting would tend to diminish with distance from the lit turbines, and would be more likely to be screened by the influence of topography beyond the site as well as vegetation where located around individual residential dwellings.

In the event that night time lighting were to be installed on the project turbines, a relatively small number of residential dwellings within 5 km of the lit turbines would experience some degree of potential visual impact, including the proximate associated residential dwellings. Night time lighting associated with the wind farm is unlikely to have a significant visual impact on the majority of public view locations. Whilst obstacle lighting would be visible to motorists travelling along the Abercrombie Road, the duration of visibility would tend to be very short and partially screened by undulating landform along sections of the road corridor.

Lighting associated with the assessed and proposed substation locations is unlikely to be significantly visible from surrounding residential dwellings and would not create a significant impact on motorists travelling along Abercrombie Road.

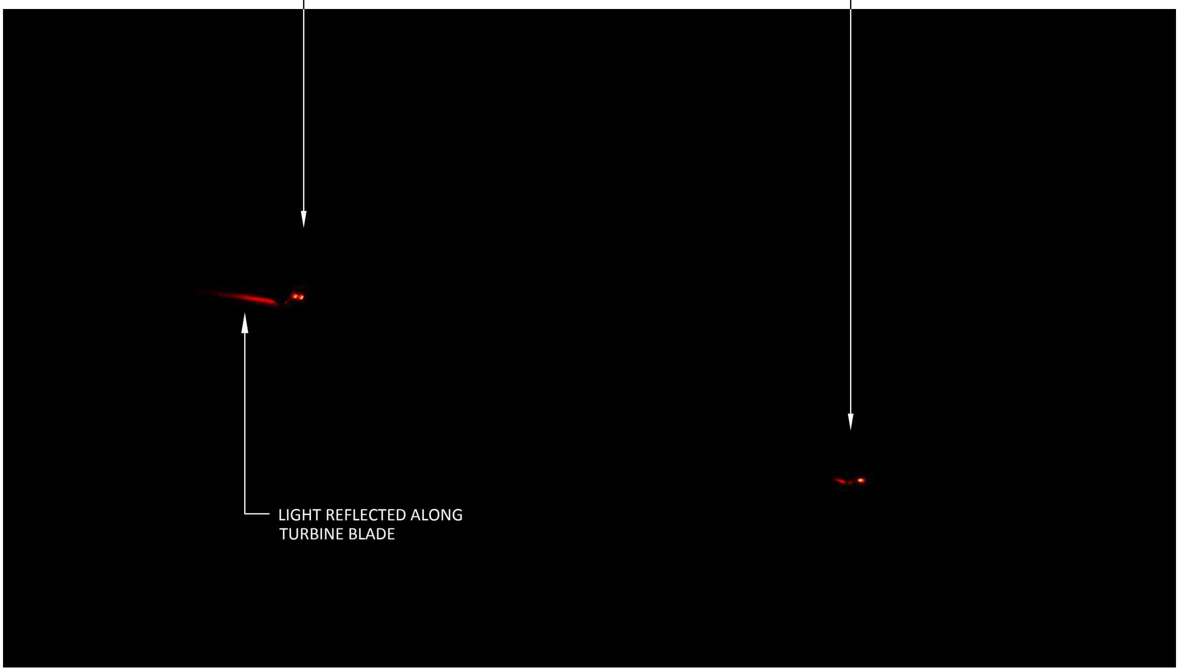
TURBINE
WITH LIGHT

TURBINE
WITH LIGHT

DAY TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 500M

TURBINE
LIGHT

TURBINE
LIGHT



NIGHT TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 500M

Figure 33
Night Lighting Cullerin
wind farm at 500m

CULLERIN WIND FARM NIGHT TIME LIGHTING .
VIEW WEST FROM HUME HIGHWAY AT AROUND
500M DISTANCE.

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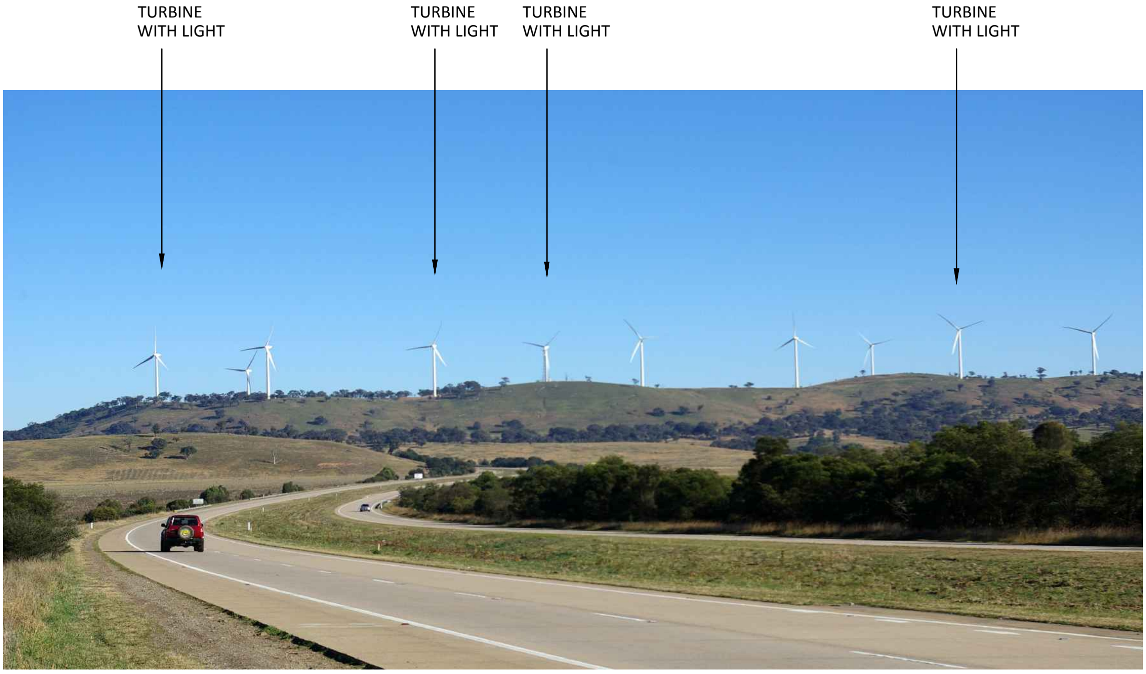
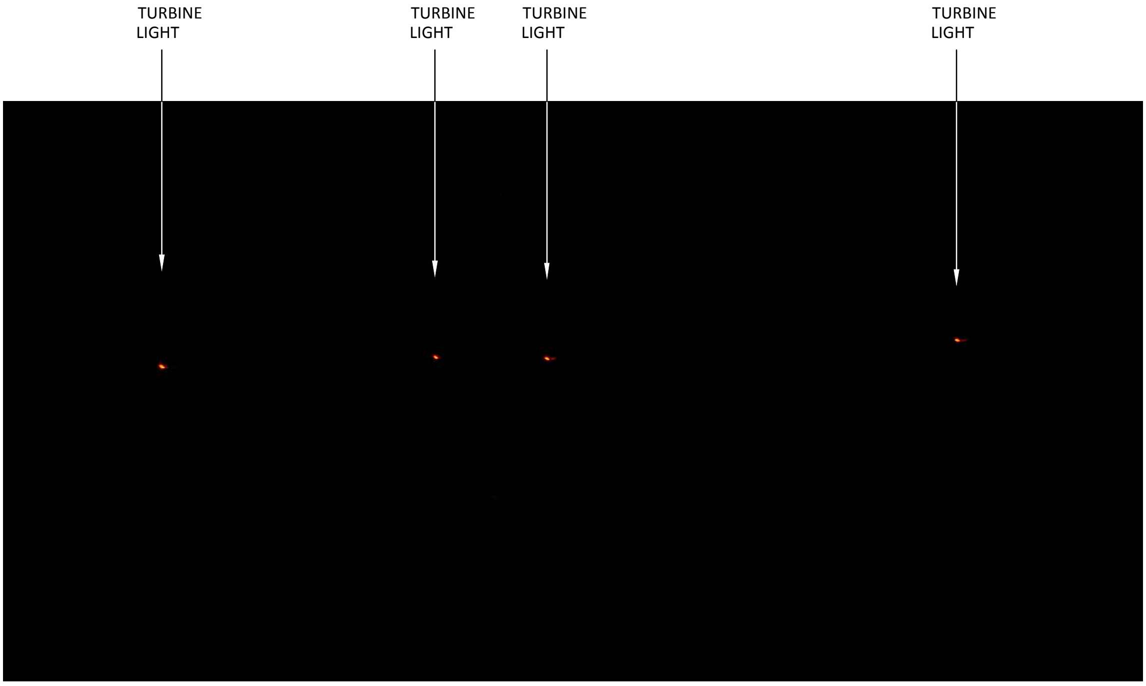


DAY TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 3.5KM



NIGHT TIME VIEW FROM HUME HIGHWAY TOWARD
CULLERIN WIND FARM AT AROUND 3.5KM

CULLERIN WIND FARM NIGHT TIME LIGHTING .
VIEW WEST FROM HUME HIGHWAY AT AROUND
3.5KM DISTANCE.

Figure 34
Night Lighting Cullerin
wind farm at 3.5km

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PALING YARDS WIND FARM

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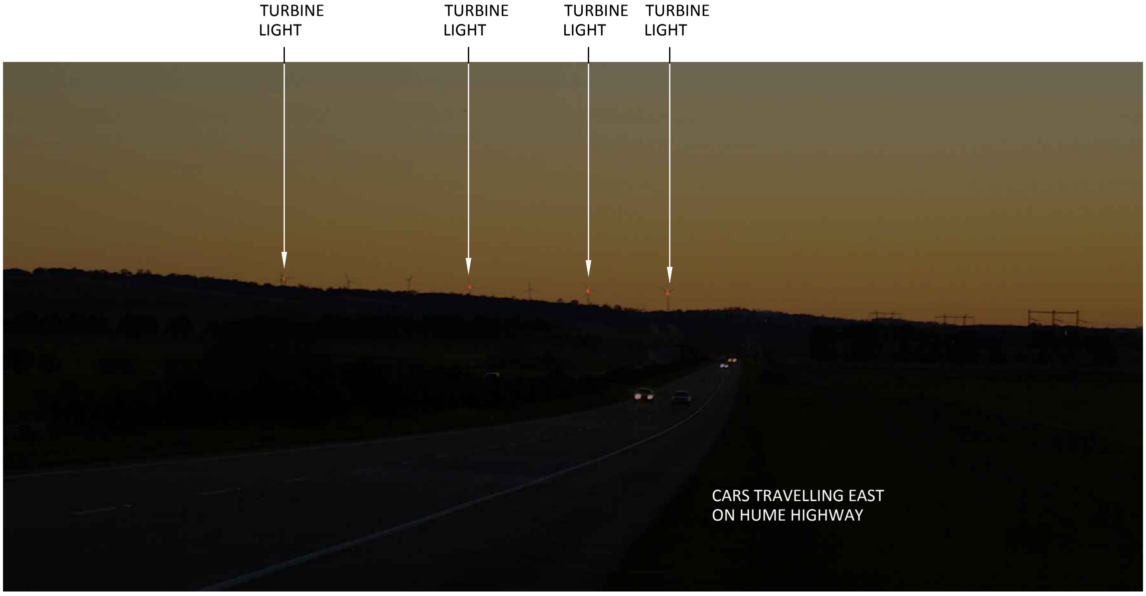
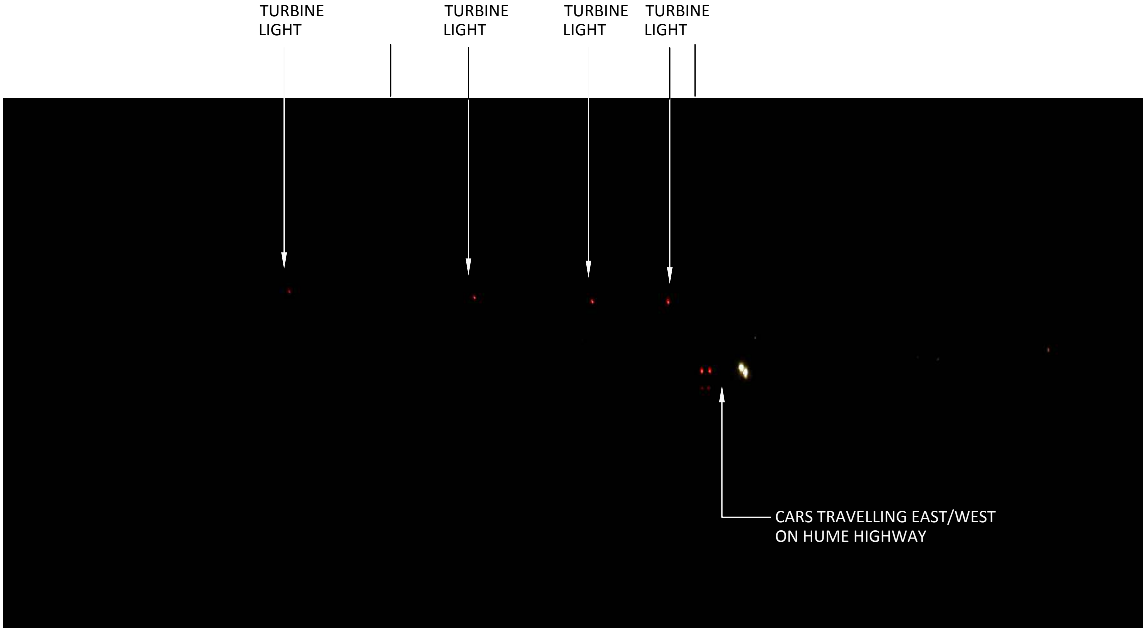


VIEW WEST AT DUSK FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 17KM



VIEW WEST AFTER DARK FROM HUME HIGHWAY TOWARD CULLERIN WIND FARM AT AROUND 17KM

CULLERIN WIND FARM NIGHT TIME LIGHTING . VIEW WEST FROM HUME HIGHWAY AT AROUND 17KM DISTANCE.

Figure 35
Night Lighting Cullerin wind farm at 17km

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Electrical infrastructure works

Section 13

13.1 Introduction

The project would incorporate a range of electrical infrastructure to collect and distribute electricity generated by the wind turbines to the grid such as:

- a high voltage transmission line;
- collector and switchyard substation;
- generator transformers (these may be located within the wind turbine nacelle or at the base of the tower);
- control cables (potentially located underground); and
- an operation facilities building.

The majority of internal electrical connections between the wind turbines would be via underground cabling within the project site.

The existing 500 kV transmission line and surrounding landscape context in the vicinity of the proposed 500 kV substation sites are illustrated in **Plate 7**.

Plate 7 - Existing view south from Abercrombie Road toward the existing 500 kV transmission (Source GBD 2010)

13.2 Potential transmission line corridors

Four potential transmission line corridors have been assessed as part of this LVIA and include:

- three southern 330 kV overhead transmission line corridors from the project site to the approved Crookwell 2 wind farm; and
- one northern 500 kV transmission line corridor to the existing Mt Piper to Bannaby 500 kV transmission line north east of the site..

The landscape along and surrounding the assessed southern 330 kV transmission line corridors is illustrated in **Figures 36** to **39** and the indicative corridors in **Figures 40** and **41**.

13.3 Assessed 330 kV transmission line corridors

The assessed 330 kV transmission line corridors (which include three options for three different potential central corridors) would extend north from the approved Crookwell 2 substation location along the Woodhouselee Road then turn east along Middle Arm Road, before turning north again along Carrabungla Road and Tyrl Tyrl Road to the Golspie Road intersection (around 30 km in length). From the Golspie Road intersection the assessed 330 kV transmission line corridor would continue to extend north along one of three potential corridors that would include:

- a north west route along Golspie Road then heading north across country to the south west corner of the project site (around 17 km in length):
- a north route across country to the south section of the project site (around 14 km in length); and
- a north east connection along Cockatoo Road and Craig's Road before turning north and following Abercrombie Road (around 24 km in length).

13.4 Assessed and proposed 500 kV transmission line connection

The assessed and proposed 500 kV transmission line option would extend around 9km north east from a collector substation (location B) in the central portion of the project site. The 500 kV transmission line would connect to a switchyard substation (location C or D) adjoining the existing Mount Piper to Bannaby 500 kV transmission line.

The 500 kV transmission line is the preferred corridor as, owing to its much shorter length, it will result in significantly lower impacts and improved constructability. Accordingly, the three 330 kV transmission line options are no longer proposed as part of the project.

Photo Location TL1-
View north west from Woodhouselee Rd

Photo Location TL2-
View north along Woodhouselee Rd

Photo Location TL3-
View south along Woodhouselee Rd

Photo Location TL4-
View north along Woodhouselee Rd

Photo Location TL5-
View west from Middle Arm Rd

Photo Location TL6-
View north along Carrabungla Rd

Figure 36
Assessed 330 kV
transmission line corridor
Photo Sheet 1

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Photo Location TL7-
View north along Carrabungla Rd

Photo Location TL8-
View south along Carrabungla Rd

Photo Location TL9-
View north along Tyrl Tyrl Rd

Photo Location TL10-
View north along Tyrl Tyrl Rd

Photo Location TL11-
View south along Tyrl Tyrl Rd

Photo Location TL12-
View south east along Golspie Rd

Figure 37
Assessed 330 kV
transmission line corridor
Photo Sheet 2

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Photo Location TL13-
View north from unsealed road

Photo Location TL14-
View north from unsealed road

Photo Location TL15-
View north west along Golspie Rd

Photo Location TL16-
View north west along Golspie Rd

Photo Location TL17-
View east along Hillas Street, Taralga

Photo Location TL18-
View north along Taralga Rd

Figure 38
Assessed 330 kV
transmission line corridor
Photo Sheet 3

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Photo Location TL19-
View north along Taralga Rd

Photo Location TL20-
View south along Taralga Rd

Photo Location TL21-
View south along Taralga Rd

Photo Location TL22-
View south along Taralga Rd

Photo Location TL23-
View north along Taralga Rd

Photo Location TL24-
View north along Taralga Rd

Figure 39
Assessed 330 kV
transmission line corridor
Photo Sheet 4

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The preferred 500 kV transmission line would extend from a proposed substation within the Paling Yards site boundary to a proposed substation location at the existing Mt Piper to Bannaby 500 kV transmission line located around 6 km north east of the project site.

13.5 Transmission line structure

Electricity generated by the project would be connected to the grid via an overhead 500 kV transmission line. The key visual components of the proposed 500 kV transmission line would comprise:

- single tapered concrete poles 60 m high;
- aluminium alloy 500 kV conductors; and
- an aerial earth wire and communications link.

The design of supporting and tension structures is variable for 500 kV transmission lines and is largely dependent on technical engineering requirements as well as site specific conditions. 500 kV transmission conductors may be supported by single pole, however additional steel work may be required for structural integrity. This will be confirmed at the detailed design stage.

13.6 Substations

The assessed 300 kV substation (location A) and the assessed and proposed 500 kV collector and switchyard substation locations (location B and C or D) are illustrated in **Figure 3.** These locations are subject to the selection of the final connection option as well as a detail engineering design. The assessed 330 kV collector substation (location A) would be situated within the south portion of the project site boundary. The collector substation connection to the assessed and proposed 500 kV transmission line (location B) would be situated within the central portion of the wind farm site. The assessed and proposed 500 kV switchyard substation (location C or D) would be situated adjacent to the existing 500 kV transmission line to the north east of the project site either side of the Abercrombie Road corridor.

Plate 8 – Typical wind farm collector substation (Source Epuron 2009)

The layout of the proposed substation will be developed at the detailed design stage. However, the main visual components of a typical wind farm switchyard substation would likely comprise:

- a single storey control building;
- an access road (or road utilising wind turbine maintenance access track);
- various switch bays and transformers;
- a communications pole;
- lightning masts;
- water tank;
- lighting for security and maintenance; and
- security fencing including a palisade fence and internal chainmesh fence.

Plate 9- Typical 330 kV switchyard substation arrangement- Macarthur substation (Source GBD 2009)

Each of the alternative substation locations (A or B and C or D) would not be significantly visible from surrounding view locations, including residences and the Abercrombie Road, due to surrounding tree cover and undulating landform. In particular this LVIA notes that:

- the assessed 330 kV collector substation (location A) would be located away (and not readily visible) from residential dwellings within and beyond the project site;
- the assessed 330 kV collector substation (location A) would be largely screened by existing trees and not significantly visible to motorists travelling along the Abercrombie Road;
- the assessed and proposed 500 kV collector substation (location B) would be located to the east of the Abercrombie Road corridor within the central portion of the project site and subject to some partial filtering of views by existing roadside tree planting;
- the assessed and proposed 500 kV switchyard substation (locations C or D) would be located adjacent to the existing Mount Piper to Bannaby 500 kV transmission line, either to the north or south of Abercrombie Road and would not be visible from surrounding residential dwellings. The substation locations, and more likely location D, would be visible to motorists travelling along the Abercrombie Road; however, views would tend to be indirect and very short in duration.

13.7 Visual absorption capability – (transmission line infrastructure)

Visual Absorption Capability (VAC) is a classification system used to describe the relative ability of the landscape to accept modifications and alterations without the loss of landscape character or deterioration of visual amenity. The application of a VAC classification system is not particularly useful for large scale structures such as wind turbines and has not been applied to the assessment of the landscapes ability to accept the wind turbines; however, it can be applied to smaller ancillary structures, such as transmission line infrastructure, where scale and form is more readily absorbed by elements (topography and vegetation) within the surrounding landscape. VAC relates to physical characteristics of the landscape that are often inherent and often quite static in the long term.

Undulating areas with a combination of open views interrupted by groups of trees and small forested areas would have a higher capability to visually absorb the proposed substation and transmission lines without significantly changing its amenity.

On the other hand, areas of cleared vegetation on level ground with limited screening, or areas spanning across prominent ridgelines without significant vegetation, would have a lower capability to visually absorb the proposed substation and transmission lines without changing the visual character and potentially reducing visual amenity.

Given the extent and combination of existing natural and cultural character within the wind farm site, the capability of the landscape to absorb the key components of the electrical infrastructure would be primarily dependent upon vegetation cover and landform.

For the purpose of this LVIA, the VAC ratings have been determined as:

Low – electrical infrastructure components would be highly visible either due to lack of screening by existing vegetation or surrounding landform (e.g. open flat farmland cleared of vegetation, or steep hillside crossing ridgeline).

Medium – electrical infrastructure components would be visible but existing vegetation and surrounding landform would provide some screening or background to reduce visual contrast.

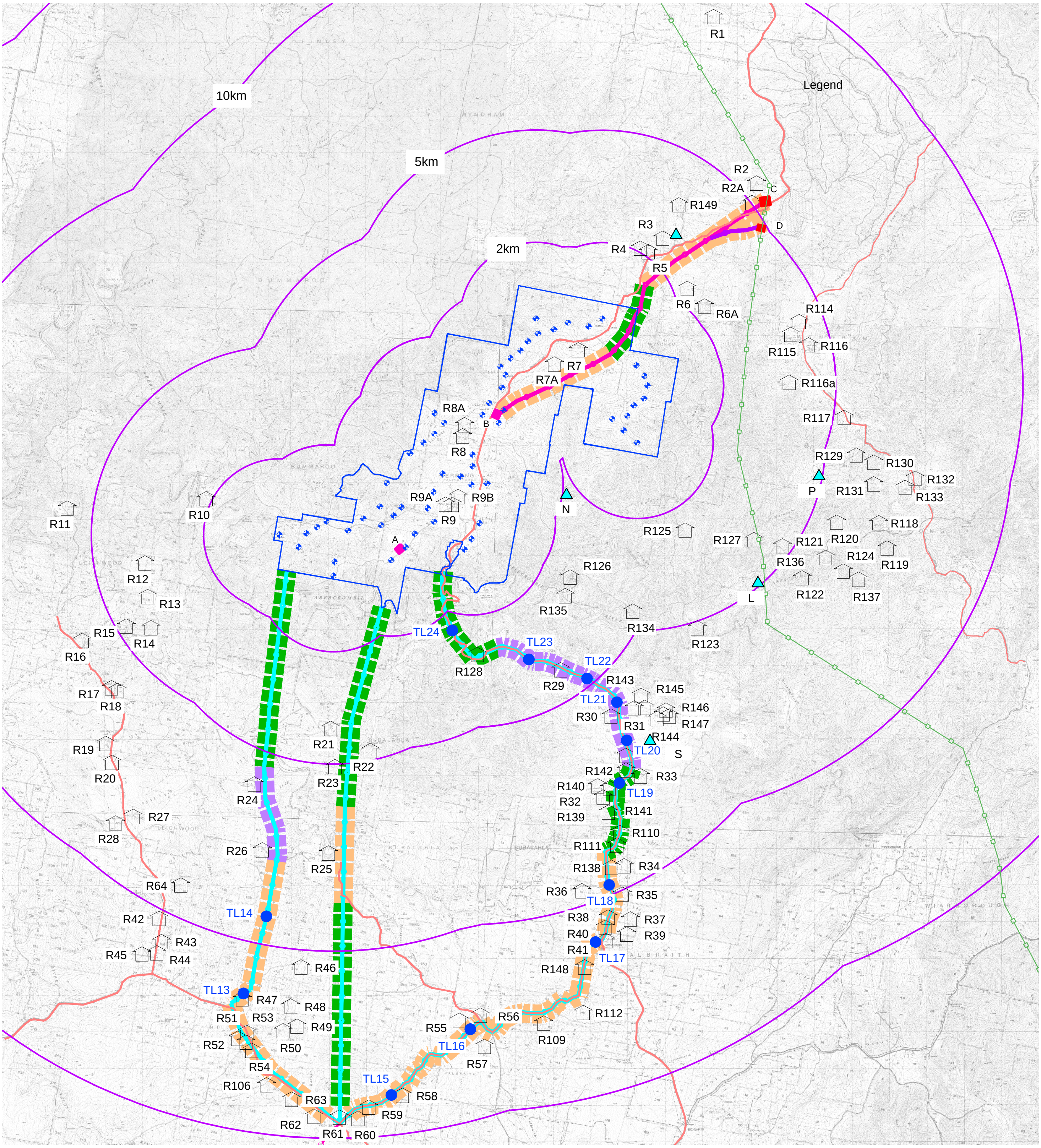
High – electrical infrastructure components would be extensively screened by surrounding vegetation and undulating landform.

The VAC of the landscape along and surrounding the assessed 330 kV and the assessed and proposed 500 kV transmission line corridors is illustrated in **Figures 40** and **41**.

The landscape along the majority of the assessed transmission line routes, including the potential substation sites and 330 kV and 500 kV transmission line connections to the grid, would be considered to have a relatively moderate VAC, with some ability to accept modifications and alterations without the loss of landscape character or deterioration of existing levels of visual amenity.

The overall moderate level of VAC would largely result from the location of the proposed transmission line routes relative to densely timbered hill sides, more gently undulating landforms and scattered tree cover, including tree planting alongside road corridors.

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)



Legend

Residential dwelling	Proposed off site substation location Options C & D	Visual Absorption Capability (VAC)
Non-residential structure	Paling Yards proposed wind turbine indicative layout	High
Local road	Paling Yards wind farm site boundary	Medium
Existing 500kV transmission line	Distance from proposed wind turbine location	Low
Assessed 330 kV transmission line corridor photo location TL13	Assessed 330 kV transmission line corridors	
Proposed on site substation location Options A & B	Assessed and proposed 500 kV transmission line corridor	

0km 2km

Figure 40
Assessed 330 kV transmission line VAC north and central corridors

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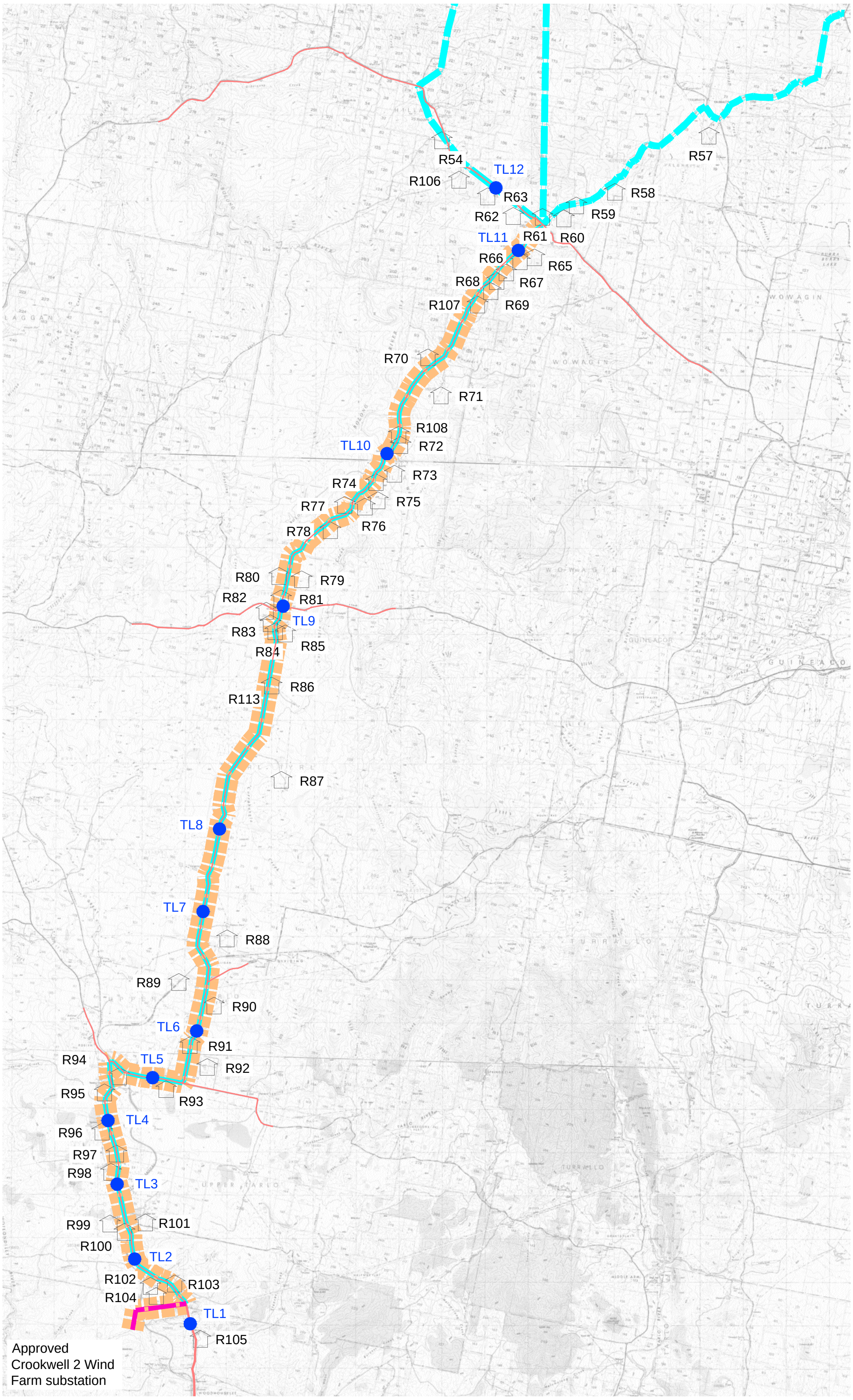

Source: Copyright Department of Lands Panorama Avenue Bathurst 2795 (www.lands.nsw.gov.au)

Legend

Residential dwelling

Local road

Assessed 330 kV indicative transmission corridors

Assessed 330 kV transmission line corridor photo location TL6

Visual Absorption Capability (VAC)

High

Medium

Low

Figure 41
Assessed 330 kV transmission line VAC south

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The moderate VAC would also tend to reduce the potential for cumulative impacts to occur where views toward the existing transmission line included views toward proposed electrical infrastructure elements.

13.8 Potential visual impact (transmission line infrastructure)

The potential visibility and resultant visual impact of the proposed transmission line would primarily result from the combination of two factors:

- The extent to which the transmission line would be visible from surrounding areas; and
- The degree of visual contrast between the transmission line and the surrounding landscape that would be visible from surrounding view locations.

The overall visual impact is generally determined by a combination of factors including:

- The category and type of situation from which people may view the components of the transmission line (e.g. resident or motorist);
- The potential number of people with a view toward components of the transmission line from any one view location;
- The distance between a person and components of the transmission line; and
- The duration of time that a person may view components of the transmission line.

13.9 Assessed 330 kV transmission line options potential visual impact

The three assessed 330 kV transmission line corridors would be visible from multiple residential dwellings along the south (Woodhouselee to Golspie Road) and central route options (Golspie Road to the project site), as well as from a number of road corridors adjoining the proposed transmission line routes. The assessed 330 kV transmission line corridors would be visible to a number of people residing in dwellings along the transmission line corridors, although a final design alignment would be required to determine actual numbers of viewers and their distance toward the transmission line. The duration of visibility would vary for residents and motorists, although the length of the assessed 330 kV transmission line would result in longer view periods when compared to the assessed and proposed 500 kV transmission line option.

13.10 Assessed and proposed 500 kV transmission line potential visual impact

The assessed and proposed 500 kV transmission line would not be significantly visible from any surrounding associated or non associated residential dwellings within or beyond the project site due to a combination of topography and scattered tree cover. Whilst some sections of the transmission line would be visible to motorists travelling along the Abercrombie Road, there would be some potential for partial screening provided by roadside and scattered tree cover. Overall the assessed and proposed 500 kV transmission line corridors would result in a lesser degree of visual impact than the assessed 300 kV transmission line corridors due to:

- a shorter distance of constructed and visible transmission line;
- a significantly lower number of surrounding residential dwellings located within the vicinity of the transmission line; and
- a reduced requirement for vegetation clearing to establish a transmission line easement.

The assessed and proposed 500 kV transmission line corridor has been identified as the preferred option for this reason and the three alternative assessed 330 kV transmission line corridors are no longer proposed as part of the project.

Photomontages representing a view toward the assessed and proposal 500 kV transmission line are presented in **Figures 42** and **43**.

Photomontage Location PM 7 Abercrombie Road - Existing panorama view south east to south, south of Mingary Park (associated residential dwelling)

Photomontage Location PM 7 Abercombie Road - Proposed panorama view, south of Mingary Park (associated residential dwelling)

Figure 42
Photomontage PM 7

Typical view toward proposed 500 kV transmission line from Abercrombie Road

Refer Figure 19 for photomontage PM7 location. Wind turbines not shown.

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Photomontage Location PM 8 Hilltop (non associated residential dwelling - driveway) Existing view, extended panorama south south east to west.

Photomontage Location PM 8 Hilltop (non associated residential dwelling - driveway) Proposed view, extended panorama south south east to west.

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Figure 43
Photomontage Location PM 8

Typical view toward proposed wind turbines and assessed and proposed 500 kV transmission line from Hilltop non associated residential dwelling driveway.

Refer Figure 19 for photomontage PM 8 location.

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Pre-construction and construction

Section 14

14.1 Potential visual impacts

There are potential visual impacts that could occur during both pre-construction and construction phases of the project. The wind farm construction phase is likely to occur over a period of around 18 months, although the extent and nature of pre-construction and construction activities would vary at different locations within the project area.

Plate 10 and **11 -** Illustrating typical general construction activities during turbine construction

Plate 12 - Illustrating general construction activities at the Capital wind farm site, including views toward cranes, partial construction of towers and laydown areas.

The key pre-construction and construction activities that would be visible from areas surrounding the proposed wind farm include:

- ongoing detailed site assessment including sub surface geotechnical investigations;
- various civil works to upgrade local roads and access point;
- construction facilities, including portable structures and laydown areas;
- various construction and directional signage;
- mobilisation of rock crushing and concrete batching plant (if required);
- excavation and earthworks; and
- various construction activities including erection of wind turbines, monitoring masts and substation with associated electrical infrastructure works.

The majority of pre-construction and construction activities, some of which would result in physical changes to the landscape (which have been assessed in this LVIA report), are generally temporary in nature and for the most restricted to various discrete areas within or beyond the immediate wind farm project area. The majority of pre-construction and construction activities would be unlikely to result in an unacceptable level of visual impact for their duration and temporary nature.

Perception and public consultation Section 15

15.1 Perception

People's perception of wind farms is an important issue to consider as the attitude or opinion of individual people adds significant weight to the level of potential visual impact.

The opinions and perception of individuals from the local community and broader area were sought and provided through a range of consultation activities. These included:

- door knocking within the Paling Yards wind farm 3 to 5 km viewshed;
- door knocking along the Paling Yards transmission line route options;
- leaflet drops and local media presentations;
- dedicated project web site including feedback provisions; and
- individual stakeholder meetings.

The attitudes or opinions of individuals toward wind farms can be shaped or formed through a multitude of complex social and cultural values. Whilst some people may accept and support wind farms in response to global or local environmental issues, others may find the concept of wind farms completely unacceptable. Some may support the environmental ideals of wind farm development as part of a broader renewable energy strategy but do not consider them appropriate for their regional or local area. It is unlikely that wind farm projects will ever conform or be acceptable to all points of view; however, research within Australia as well as overseas consistently suggests that the majority of people who have been canvassed do support the development of wind farms.

Wind farms are generally easy to recognise in the landscape and to take advantage of available wind resources are more often located in elevated and exposed locations. The geometrical form of a wind turbine is a relatively simple one and can be visible for some distance beyond a wind farm, and the level of visibility may be accentuated by the repetitive or repeating pattern of multiple wind turbines within a local area. Wind farms do have a significant potential to alter the physical appearance of the landscape, as well as change existing landscape values.

15.2 Public consultation

A door knock exercise was carried out by the proponent for all residential dwellings within a 3 to 5 km radius of the project. A public consultation 'Information Day' will be held once the EA is placed on public exhibition.

15.3 Quantitative research

Whilst published Australian research into the potential landscape and visual impacts of wind farms is limited, there are general corresponding results between the limited number that have been carried out when compared with those carried out overseas.

A recent survey was conducted by ARM Interactive on behalf of the NSW Department of Environment, Climate Change and Water (September 2010). The survey polled 2,022 residents across the 6 Renewable Energy Precincts established by the NSW Government; including the NSW/ACT Border Region Renewable Energy Precinct. Key findings of the survey indicated that:

- *97% of people across the Precincts had heard about wind farms or turbines, and 81% had seen a wind farm or turbine (in person or the media);*
- *85% of people supported the construction of wind farms in New South Wales, and 80% within their local region; and*
- *79% supported wind farms being built within 10km of residences and 60% of people surveyed supported the construction of wind turbines within 1 to 2km from their residences.*

These results are reflected in other surveys including the community perception survey commissioned by Epuron for the *Gullen Range Wind Farm Environmental Assessment (August 2008).* The results of the survey, which targeted a number of local populations within the Southern Tablelands, suggested that around 89% of respondents were in favour of wind farms being developed in the Southern Tablelands, with around 71% of respondents accepting the development of a wind farm within one kilometre from their residential dwelling.

These general levels of support for wind farm developments have also been recorded for a number of wind farm developments around Australia as well as overseas.

Auspoll research carried out in February 2002 on behalf of a wind farm developer for a wind farm project in Victoria included just over 200 respondents. The results indicated that:

- *Over 92% of respondents agreed that wind farms can make a difference in reducing greenhouse emissions and mitigating the effects of global warming;*
- *Over 88% disagreed with the statement that wind farms are ugly;*
- *Over 93% of respondents identified 'interesting' as a good way to describe wind farms, over 73% nominating 'graceful' and over 55% selecting 'attractive';*
- *Over 79% of respondents thought that the wind farm would have a good impact on tourism, with 15% of respondents believing that the wind farm would make no difference; and*
- *Over 40% of respondents believed that the impact of the wind farm on the visual amenity of the area would be good, with 40% believing that it would make no difference.*

A September 2002 MORI poll of 307 tourists conducted in Argyll (United Kingdom) indicated that:

- *43% maintained that the presence of wind farms had a positive impression of Argyll as a place to visit;*
- *43% maintained that the presence of wind farms had an equally positive or negative effect;*
- *Less than 8% maintained it had a negative effect; and*
- *91% of tourists maintained that the presence of wind farms in Argyll made no difference to the likelihood of them visiting the area.*

There is no published Australian research on community attitudes to the impact of wind farms on landscape and visual issues before and after construction. However, overseas research in the United Kingdom conducted by MORI in 2003 indicated that:

- *Prior to construction 27% of people polled thought problems may arise from wind farm impact on the landscape; and*

- *Following construction the number of people who thought the landscape has been spoiled was 12%.*

The majority of research carried out to date has focussed on public attitudes to wind farms and does not provide any indication for acceptable or agreed thresholds in relation to numbers and heights of turbines, and the potential impact of distance between turbines and view locations.

15.4 The broader public good

Whilst visual perceptions and attitudes of local communities toward wind farm developments are an important issue, and need to be assessed locally in terms of potential landscape and visual impacts, there is also an issue of the greater potential public benefit provided by renewable energy production. Wind farms are expected to make a contribution toward meeting the Government's commitment that 20% of Australia's electricity supply comes from renewable energy sources by 2020.

In the 2006 Land and Environment Court decision to grant, on an amended basis, consent for the construction of a wind farm at Taralga, Chief Judge Justice Preston said in his prologue to the judgement:

"The insertion of wind turbines into a non-industrial landscape is perceived by many as a radical change which confronts their present reality. However, those perceptions come in different hues. To residents, such as members of the Taralga Landscape Guardians Inc. (the Guardians), the change is stark and negative. It would represent a blight and the confrontation is with their enjoyment of their rural setting.

To others; however, the change is positive. It would represent an opportunity to shift from societal dependence on high emission fossil fuels to renewable energy sources. For them, the confrontation is beneficial – being one much needed step in the policy settings confronting carbon emission and global warming.

Resolving this conundrum – the conflict between the geographically narrower concerns of the guardians and the broader public good of increasing the supply of renewable energy – has not been easy. However, I have concluded that, on balance, the broader public good must prevail".

Whilst the exact circumstances between the Taralga wind farm and the Paling Yards wind farm may differ, the comments provided by the Chief Judge make it clear that, in the circumstances of that case, there was a need for the broader public good to be put before the potential negative impacts on some members of the local community. Similar reasoning can be applied to the project.

Mitigation measures Section 16

16.1 Mitigation measures

The British Landscape Institute states *'the purpose of mitigation is to avoid, reduce, or where possible remedy or offset any significant negative (adverse) effects on the environment arising from the proposed development' (2002).* In general mitigation measures would reduce the potential visual impact of the project in one of two ways:

- firstly, by reducing the visual prominence of the wind turbines and associated structures by minimising the visual contrast between the wind turbines and the landscape in which they are viewed; and
- secondly, by screening views toward the wind turbines from specific view locations.

In relation to the first form of mitigation, the design of the turbine structures has been highly refined over a number of years to maximise their efficiency. The height of the supporting towers and dimensions of the rotors are defined by engineering efficiency and design criteria. Consequently, modification of the turbine design to mitigate potential visual impacts is not considered a realistic option.

Colour is one aspect of the wind turbine design that does provide an opportunity to reduce visual contrast between the turbine structures and the background against which they are viewed. The white colour that is used on a majority of turbine structures provides the maximum level of visual contrast with the background. This maximum level of visual contrast could be reduced through the use of an appropriate off white or grey colour for the turbines where the visual contrast would be reduced when portions of the turbine were viewed against the sky as well as for those portions viewed against a background of landscape. The final colour selection would, however, be subject to the availability of turbine models on the market at the time of ordering and to aviation safety requirements.

The potential visual impact of the project from specific view locations could be mitigated by planting vegetation close to the view locations. For instance, tree or large shrub planting close to a residence can screen potential views to individual or clusters of turbines. Similarly roadside tree planting can screen potential views of turbines from portions of road corridors.

The location and design of screen planting used as a mitigation measure is very site specific and requires detailed analysis of potential views and consultation with surrounding landowners. Planting vegetation would not provide effective mitigation in all circumstances and can reduce the extent of existing views available from residences or other view locations.

There is greater potential to mitigate the visual prominence for some of the ancillary structures and built elements associated with the wind farm through the appropriate selection of materials and colours, together with consideration of their reflective properties.

The potential visual impacts of vehicular tracks providing access for construction and maintenance can be mitigated by:

- minimising the extent of cut and fill in the track construction;
- re-vegetating disturbed soil areas immediately after completion of construction works; and
- using local materials as much as possible in track construction to minimise colour contrast.

16.2 Summary of mitigation measures

A summary of the mitigation measures available for the wind farm and transmission line infrastructure is presented in **Tables 21** and **22**.

Table 21 - Mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
Consider options for use of colour to reduce visual contrast between project structures and visible background.	✓			
Avoid use of advertising, signs or logos mounted on turbine structures, except those required for safety purposes.			✓	✓

Table 21 - Mitigation measures summary

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
If necessary, design and construct site control building and facilities building sympathetically with nature of locality.	✓		✓	
If necessary, locate substations away from direct views from roads and residential dwellings.	✓		✓	
Enforce safeguards to control and minimise fugitive dust emissions.		✓	✓	✓
Restrict the height of stockpiles to minimise visibility from outside the site.		✓	✓	
Minimise construction and operational activities that may require night time lighting, and if necessary use low lux (intensity) lighting designed to be mounted with the light projecting inwards to the site to minimise glare at night.		✓	✓	✓
Minimise cut and fill for site tracks and revegetate disturbed soils as soon as possible after construction.		✓	✓	
Maximise revegetation of disturbed areas to ensure effective cover is achieved.			✓	
Consider options for planting screening vegetation in vicinity of nearby residences and along roadsides to screen potential views of turbines. Such works to be considered in consultation with local residents and authorities.	✓	✓	✓	
Undertake revegetation and off-set planting at areas around the site in consultation and agreement with landholders.	✓	✓	✓	

Table 22 – Substation and transmission line summary of mitigation measures

Safeguard	Implementation			
	Design	Site Preparation	Construction	Operation
A careful and considered route selection process to avoid sensitive view locations and loss of existing vegetation where possible.	✓		✓	
Wherever possible, select angle positions in strategic locations to minimise potential visual impact (e.g. avoiding, where possible, skyline views) and to provide a maximum setback from residential dwellings and road corridors.	✓		✓	
Selection of suitable component materials with low reflective properties.	✓		✓	
Selection of suitable storage areas for materials or plant with minimum visibility from residences and roads with screening where necessary.			✓	
Design for strategic tree or shrub planting between view locations and the transmission line.	✓		✓	

Subject to any conditions of approval, the proponent would commit to implementing landscape treatments to screen and mitigate the potential visual impact of the wind farm for individual neighbouring properties within an appropriate distance from the wind farm project area, subject to consultation and agreement with individual property owners.

Conclusion Section 17

17.1 Summary

In summary, this LVIA concludes that the project would have an overall low significance of visual impact on the majority of non-associated residential view locations as well public view locations, including sections of the Abercrombie and Jerrong Roads. The project would have a medium to high impact on six associated residential view locations within the project site boundary.

This LVIA determined the overall landscape character sensitivity to be medium to high. Some recognisable characteristics of the LCA's will be altered by the proposed project, and result in the introduction of visually prominent elements that will alter the perceived characteristics of the LCA's but will be partially mitigated by existing landscape elements and features within the LCA's. The main characteristics of the LCA's, patterns and combinations of landform and landcover will still be visually evident from within and beyond the project site boundary.

The LCA's identified and described in this LVIA are generally well represented throughout the Oberon Shire Council and surrounding Local Government Areas and more generally within other regions across the NSW/ACT Border Region Renewable Energy Precinct. This LVIA has determined that the landscape surrounding the project will have some ability to accommodate the physical changes associated with the wind farm and its associated structures.

This LVIA determined that the project would have a medium to high visual impact on 6 associated residences out of the 78 residential view locations within the project 10 km viewshed. This medium to high visual impact would largely result from the proximity of wind turbines to the associated residential dwellings or orientation of dwellings relative to the wind turbines.

The majority of residential dwellings surrounding the wind farm are strategically situated within the landscape to mitigate exposure to inclement weather, or have adopted measures to reduce these impacts by planting and maintaining windbreaks around residential dwellings. The extent of windbreak planting reduces the potential visibility of the wind farm from a number of residential view locations in the surrounding landscape.

The project would be visible from a small number of local roads including the Abercrombie Road. This LVIA has determined that views toward the Paling Yards wind turbines would generally result in a low impact for the majority of motorists travelling through the area.

This LVIA has determined that the construction of the project would not result in significant ‘direct’, ‘indirect’ or ‘sequential’ cumulative impacts when considered against any existing or proposed wind farm developments, including the approved Taralga and Crookwell 2 and proposed Golspie wind farm projects. Intervisibility between approved and proposed wind farms is influenced by undulating landform and tree cover within and beyond the Paling Yards 10 km viewshed.

The potential substation locations and assessed transmission line options are unlikely to result in a significant visual impact for the majority of surrounding residential or public view locations. A combination of distance, undulating landform and tree cover between substation and transmission line components to surrounding view locations would tend to result in a moderate to high visual absorption capability and reduction in overall visibility.

This LVIA has determined that the assessed and proposed 500 kV transmission line connection option would have a lesser degree of visual impact than the assessed 330 kV transmission line connection options to the approved Crookwell 2 wind farm substation. The 500 kV transmission line corridor has been identified as preferred option and the assessed 330 kV transmission line corridors are no longer proposed for this reason.

Both pre-construction and construction activities are unlikely to result in an unacceptable level of visual impact due to the temporary nature of these activities together with proposed restoration and rehabilitation strategies. The preferred location for some of the construction activities, including the on-site concrete batch plant and rock crusher, would generally be located away from publicly accessible areas, with the closest residential view locations generally comprising associated landowners.

Night time obstacle lighting would have the potential to be visible from surrounding view locations, as well as areas beyond the project 10 km viewshed. The level of visual impact would diminish when viewed from more distant view locations, with a greater probability of night time lighting being screened by landform and/or tree cover. It should also be noted that the night time lighting installed on the Cullerin wind farm (as illustrated in this LVIA) has been decommissioned by Origin Energy following a risk based aviation assessment. A number of recent wind farm developments in New South Wales have also been approved without a requirement for night time lighting, including the Gullen Range and Glen Innes wind farms. A number of other operational wind farm developments, including some in Victoria, have also had night lighting decommissioned.

Although some mitigation measures are considered appropriate to minimise the visual effects for a number of the elements associated with the wind farm, it is acknowledged that the degree to which the wind turbines would be visually mitigated is limited by their scale and position within the landscape relative to surrounding view locations.

The Proponent has engaged in ongoing consultation with local residents and made a number of adjustments to the location of individual turbines to minimise visual impacts where possible.

Subject to any conditions of approval, the proponent would commit to implementing landscape treatments to screen and mitigate the potential visual impact of the wind farm for individual neighbouring properties within an appropriate distance from the wind farm project area, subject to consultation and agreement with individual property owners.

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Appendix A – GL Garrad Hassan Shadow Flicker Assessment

GL Garrad Hassan

SHADOW FLICKER AND BLADE GLINT ASSESSMENT FOR THE PROPOSED PALING YARDS WIND FARM

Client	Green Bean Design
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Revision History

Issue	Issue Date:	Summary
A	12 Sept 2011	Original Issue
B	20 Jan 2012	Revised turbine layout with multiple turbine scenarios. Theoretical Shadow flicker time of day plots added. Theoretical Shadow Flicker at window locations added.
C	8/08/2012	Revised turbine layout with two new turbine scenarios.
D	4/12/2013	Final.

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1 EXECUTIVE SUMMARY

Garrad Hassan Pacific Pty Ltd (GL GH) has been commissioned by Green Bean Design (GBD) to independently assess the shadow flicker in the vicinity of the proposed Paling Yards Wind Farm (PYWF). The wind farm proponent is Union Fenosa Wind Australia (UFWA). The results of the work are reported here. This document has been prepared pursuant to the GL GH proposal P1149/PP/01 Issue A, and is subject to the terms and conditions contained therein.

The Director-General's Requirements (DGRs) for the preparation of an Environmental Assessment (EA) for the Paling Yards Wind Farm state that the EA must assesses the impact of shadow "flicker" and blade "glint" from the wind farm. In accordance with these DGRs, this report makes the findings and recommendations discussed below.

Shadow flicker involves the modulation of light levels resulting from the periodic passage of a rotating wind turbine blade between the sun and a viewer. The duration of shadow flicker experienced at a specific location can be determined using a purely geometric analysis which takes into account the relative positions of the sun throughout the year, the wind turbines at the site, and the viewer. This method has been used to determine the shadow flicker duration at sensitive locations neighbouring the proposed Paling Yards Wind Farm.

However, this analysis method tends to be conservative and typically results in over-estimation of the number of hours of shadow flicker experienced at a dwelling [1]. As such, an attempt has been made to quantify the likely reduction in shadow flicker duration due to turbine orientation and cloud cover, and therefore produce a prediction of the actual shadow flicker duration likely to be experienced at a dwelling.

UFWA has supplied a layout for the wind farm consisting of 59 turbines, surveyed locations of houses in the vicinity of the wind farm, and elevation contours for the area [2]. These have been used here to determine the theoretical duration of shadow flicker at each dwelling.

In NSW there are no specific Guidelines on how to assess shadow flicker generated by wind turbines. However, a number of assessments have applied the Victorian Planning Guidelines [3] which recommend a shadow flicker limit of 30 hours per year in the area immediately surrounding a dwelling.

In addition, the EPHC Draft National Wind Farm Development Guidelines [4] recommend a limit on the theoretical shadow flicker duration of 30 hours per year, and a limit on the actual shadow flicker duration of 10 hours per year. The Draft National Guidelines also recommend a modelling methodology.

An estimate of shadow flicker duration has been undertaken by assessing theoretical shadow flicker and also by assessing predicted actual shadow flicker hours by taking into account two of the factors (turbine orientation and cloud cover) which are likely to reduce the actual shadow flicker duration to values well below the theoretical duration.

The modelling shows that based on the methodology recommended in the Draft National Wind Farm Development Guidelines, there are seven existing dwellings that are predicted to experience some shadow flicker. All dwellings were assumed to have two storeys, and the modelling was undertaken at 2 m and 6 m above ground.

When considering the maximum shadow flicker duration within 50 m of each dwelling, seven dwellings are predicted to experience theoretical shadow flicker duration in excess of 30 hours per year.

When considering the actual shadow flicker duration, which takes into account the reduction of shadow flicker due to turbine orientation and cloud cover, seven dwellings are found to experience more than the limit of 10 hours per year.

Therefore, compliance with both the Victorian Planning Guidelines and the Draft National Wind Farm Development Guidelines is not predicted to be achieved for seven of the provided dwelling locations. However, GL GH understands that UFWA will negotiate an agreement with the inhabitants of these dwellings. It should be noted that some additional potential sources of conservatism are still included in the assessment. For example, screening due to vegetation is not considered in this desktop assessment.

To assist UFWA negotiate an agreement with these dwellings, detailed time of day theoretical shadow flicker durations have been presented along with detail theoretical shadow flicker durations at key window locations for the key effected houses.

Blade glint involves the reflection of light from a turbine blade, and can be seen by an observer as a periodic flash of light coming from the wind turbine. Blade glint is not generally a problem for modern turbines provided non-reflective coatings are used for the surface of the blades.

2 DESCRIPTION OF THE PROPOSED WIND FARM SITE

2.1 Site description

The Paling Yards site is located approximately 46km south of Oberon in the Oberon Shire Council. The general location of the area of interest is shown in Figure 1. A more detailed contour map of the region surrounding the proposed wind farm, which also includes proposed turbine locations, can be seen in Figure 3.

The proposed Paling Yards site (the site) is located on the Great Dividing Range, New South Wales. The site is located on a land parcel with an area of 39 sq km.

The site consists of moderately complex terrain with rolling undulating, some areas of steep slopes, and with site elevation ranging between 933 m and 1046 m above ground level (agl).

The site is predominantly cleared farmland.

2.2 House locations

A list of the co-ordinates of dwellings in the vicinity of the wind farm has been provided by UFWA [5]. Due to the distance limit of the shadows cast by wind turbines as described in Section 3, only houses within 2 km of the proposed wind farm have been considered in the current analysis, and are shown in Table 1.

Detailed GPS coordinates and photos of window locations, external corners and window heights around the key effected residences have been provided by GBD [6]. Four window locations have been used for each residence as requested by UFWA [7] and are shown in Table 2.

All co-ordinates presented in this report are in MGA Zone 55 (GDA94 datum).

2.3 Proposed Wind Farm layout

GBD has supplied the layout of the wind farm, which is composed of 59 wind turbines. The proposed turbine options are shown below:

	Option 1:	
Hub height	**Diameter**	**Turbine Locations:**
80 m	100 m	P19, P20, P24, P32, P33, P34, P38, P44, P45, P46, P48, P50, P51
91 m	117 m	All other locations
	Option 2:	
Hub height	**Diameter**	**Turbine Locations:**
80 m	100 m	P19, P20, P24, P32, P33, P34, P38, P39, P44, P45, P46, P47, P48, P50, P51
107 m	136 m	All other locations

These parameters were used for the shadow flicker modelling.

A list of co-ordinates of proposed turbine locations has been provided by UFWA [8], with the grid coordinates given in MGA Zone 55 (GDA94 datum). These co-ordinates, together with the identifiers which have been supplied by UFWA are shown in Table 3.

Figure 3 shows a map of the site with the proposed turbine layout and surrounding house locations.

3 PLANNING GUIDELINES

The Paling Yards Wind Farm DGRs cite two guidelines require the potential impacts of shadow flicker to be assessed. The guidelines are the NSW Wind Energy Facilities Draft EIA Guidelines [9] and the Auswind Best Practice Guidelines [10].

However, in NSW there are no specific Guidelines for the assessment shadow flicker generated by wind turbines that provide detailed methodologies to assess impacts of shadow flicker. A number of assessments have applied the Victorian Planning Guidelines which currently state;

> *"The shadow flicker experienced immediately surrounding the area of a dwelling (garden fenced area) must not exceed 30 hours per year as a result of the operation of the wind energy facility".*

In addition, the EPHC Draft National Wind Farm Development Guidelines released in 2010 [4] include recommendations for shadow flicker limits relevant to wind farms in Australia.

The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration should not exceed 30 hours per year, and that the actual shadow flicker duration should not exceed 10 hours per year. The guidelines also recommend that the shadow flicker duration at a dwelling should be assessed by calculating the maximum shadow flicker occurring within 50 m of the centre of a dwelling.

The Draft National Guidelines provide background information, a proposed methodology and a suite of assumptions for assessing shadow flicker durations in the vicinity of a wind farm. The analysis contained in this report has met, if not exceeded, the recommendations of these guidelines.

The impact of shadow flicker is typically only significant up to a distance of around 10 rotor diameters from a turbine [11] or approximately 1 km for a modern wind turbine. Beyond this distance limit the shadow is diffused such that the variation in light levels is not likely to be sufficient to cause annoyance. This issue is discussed in the Draft National Guidelines where it is stated that:

> *"Shadow flicker can theoretically extend many kilometres from a wind turbine. However the intensity of the shadows decreases with distance. While acknowledging that different individuals have different levels of sensitivity and may be annoyed by different levels of shadow intensity, these guidelines limit assessment to moderate levels of intensity (i.e., well above the minimum theoretically detectable threshold) commensurate with the nature of the impact and the environment in which it is experienced."*

The Draft National Guidelines therefore suggest a distance equivalent to 265 maximum blade chords[1] as an appropriate limit, which corresponds to approximately 800 to 1050 m for modern wind turbines (which typically have maximum blade chord lengths of 3 to 4 m). The UK wind industry and UK government consider that 10 rotor diameters is appropriate, which corresponds to approximately 800 to 1100 m for modern wind turbines (which typically have rotor diameters of 80 to 110 m).

The Draft National Guidelines also provide guidance on blade glint and state that:

> *"The sun's light may be reflected form the surface of wind turbine blades. Blade Glint has the Potential to annoy people. All major wind turbine manufacturers currently finish their blades with a low reflectivity treatment. This prevents a potentially annoying*

[1] The maximum blade chord is the thickest part of the blade.

> *reflective glint from the surface of the blades and the possibility of a strobing reflection when the turbine blades are spinning. Therefore the risk of blade glint from a new development is considered to be very low."*

GL GH considers that the recommendations of EPHC draft national guidelines meet, if not exceed, the recommendations of both the NSW Wind Energy Facilities EIA Guidelines and the Auswind Best Practice Guidelines.

The NSW government recently released draft NSW Planning Guide lines for Wind Farms [12]. Although the guidelines were released follow the issue of the DGR's for the Paling Yards Wind Farm, GL GH considers that the approach used in this report meets the requirements of the new NSW Draft Guidelines.

4 SHADOW FLICKER AND BLADE GLINT ASSESSMENT

4.1 Shadow Flicker Overview

Shadow flicker may occur under certain combinations of geographical position and time of day, when the sun passes behind the rotating blades of a wind turbine and casts a moving shadow over neighbouring areas. When viewed from a stationary position the moving shadows cause periodic flickering of the light from the sun, giving rise to the phenomenon of 'shadow flicker'.

The effect is most noticeable inside buildings, where the flicker appears through a window opening. The likelihood and duration of the effect depends upon a number of factors, including:

- Direction of the property relative to the turbine.
- Distance from the turbine (the further the observer is from the turbine, the less pronounced the effect will be);
- Wind direction (the shape of the shadow will be determined by the position of the sun relative to the blades which will be oriented to face the wind);
- Turbine height and rotor diameter;
- Time of year and day (the position of the sun in the sky);
- Weather conditions (cloud cover reduces the occurrence of shadow flicker)

4.2 Theoretical Modelled Shadow Flicker Duration

The theoretical number of hours of shadow flicker experienced annually at a given location can be calculated using a geometrical model which incorporates the sun path, topographic variation over the wind farm site and wind turbine details such as rotor diameter and hub height.

The wind turbines have been modelled assuming they are spherical objects, which is equivalent to assuming the turbines are always oriented perpendicular to the sun-turbine vector. This assumption will mean the model calculates the maximum duration for which there is potential for shadow flicker to occur.

In line with the methodology proposed in the Draft National Guidelines, GL GH has assessed the shadow flicker at the surveyed house locations and has determined the highest shadow flicker duration within 50 m of the centre of each house location.

Shadow flicker has been calculated at dwellings at heights of 2 m, to represent ground floor windows, and 6m, to represent second floor windows. The shadow receptors are simulated as fixed points, representing the worst case scenario, as real windows would be facing a particular direction.

Additional simulations have been performed at actual window locations, obtained by GBD using a hand held GPS device [6]. Where the Shadow flicker durations have been calculated for window locations, the tilt, orientation and height of the window has been taken into account.

All simulations have been carried out with a temporal resolution of 1 minute; if shadow flicker occurs in any 1 minute period, the model records this as 1 minute of shadow flicker.

An assumption has been made regarding the maximum length of a shadow cast by a wind turbine that is likely to cause annoyance due to shadow flicker. The UK wind industry considers that 10 rotor diameters is appropriate [11], while the Draft National Guidelines suggest a distance equivalent to 265 maximum blade chords as an appropriate limit, corresponding to approximately 800 to 1050 m for modern wind turbines. For each turbine option, the maximum length of the shadow cast by the wind turbine is 10 times the maximum rotor diameters. i.e. For Option 1 and 2 it is 1120 m and for option 3, 1170 m is appropriate.

The model makes the following assumptions and simplifications:

- There are clear skies every day of the year;
- The turbines are always rotating;
- The blades of the turbines are always perpendicular to the direction of the line of sight from the specified location to the sun.

These simplifications mean that the results generated by the model are likely to be conservative.

The settings used to execute the model can be seen in Table 4.

To illustrate typical results, an indicative shadow flicker map for a turbine located in a relatively flat area is shown in Figure 2. The geometry of the shadow flicker map can be characterised as a butterfly shape, with the four protruding lobes corresponding to slowing of solar north-south travel around the summer and winter solstices for morning and evening. The lobes to the north of the indicative turbine location result from the summer solstice and conversely the lobes to the south result from the winter solstice. The lobes to the west result from morning sun while the lobes to the east result from evening sun. When the sun is low in the sky, the length of shadows cast by the turbine increases, increasing the areas around the turbine affected by shadow flicker.

4.3 Factors Affecting Shadow Flicker Duration

Shadow flicker duration calculated in this manner overestimates the annual number of hours of shadow flicker experienced at a specified location for several reasons.

1. The wind turbine will not always be yawed such that its rotor is in the worst case orientation (i.e. perpendicular to the sun-turbine vector). Any other rotor orientation will reduce the area of the projected shadow, and hence the shadow flicker duration.

   The wind speed frequency distribution or wind rose at the site can be used to determine probable turbine orientation, and to calculate the resulting reduction in shadow flicker duration.

2. The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker.

   Cloud cover measurements recorded at nearby meteorological stations may be used to estimate probable levels of cloud cover, and to provide an indication of the resulting reduction in shadow flicker duration.

3. Aerosols (moisture, dust, smoke, etc.) in the atmosphere have the ability to influence shadows cast by a wind turbine.

   The length of the shadow cast by a wind turbine is dependent on the degree that direct sunlight is diffused, which is in turn dependent on the amount of dispersants (humidity, smoke and other aerosols) in the path between the light source (sun) and the receiver.

4. The modelling of the wind turbine rotor as a disk rather than individual blades results in an overestimate of shadow flicker duration.

   Turbine blades are of non-uniform thickness with the thickest part of the blade (maximum chord) close to the hub and the thinnest part (minimum chord) at the tip. Diffusion of sunlight, as discussed above, results in a limit to the maximum distance that a shadow can be perceived. This maximum distance will also be dependent on the thickness of the turbine blade, and the human threshold for perception of light intensity variation. As such, a shadow cast by the blade tip will be shorter than the shadow cast by the thickest part of the blade.

5. The analysis does not consider that when the sun is positioned directly behind the wind turbine hub, there is no variation in light intensity at the receiver location and therefore no shadow flicker.

6. The presence of vegetation or other physical barriers around a shadow receptor location may shield the view of the wind turbine, and therefore reduce the incidence of shadow flicker.

7. Periods where the wind turbine is not in operation due to low winds, high winds, or for operational and maintenance reasons will also reduce the shadow flicker duration.

4.4 Predicted Actual Shadow Flicker Duration

As discussed above, there are a number of effects which may reduce the incidence of shadow flicker, such as cloud cover and variation in turbine orientation, that are not taken into account in the calculation of the theoretical shadow flicker duration. Exclusion of these effects means that the theoretical calculation is conservative. An attempt has been made to quantify the likely reduction in shadow flicker duration due to these effects, and therefore produce a prediction of the actual shadow flicker duration likely to be experienced at a dwelling.

Cloud cover is typically measured in oktas or eighths of the sky covered with cloud. GL GH has obtained data from 2 Bureau of Meteorology (BoM) stations located in proximity to the site. These stations are:

- 063063 Oberon (Located approximately 10 km from the site) [13];
- 070080 Taralga Post Office (Located approximately 12 km from the site) [14];

The reduction in shadow flicker duration caused by cloud cover was calculated using an average across both stations.

The results show that the average annual cloud cover values obtained from readings at 9 am and 3 pm are approximately 4.1 and 4.5 okta's, respectively. This means that on an average day, 4.3 / 8 or approximately 54% of the sky in the vicinity of the wind farm is covered with clouds at these times. Although it is not possible to definitively calculate the effect of cloud cover on shadow flicker duration, a reduction in the shadow flicker duration proportional to the amount of cloud cover is a reasonable assumption. An assessment of the likely reduction in shadow flicker duration due to cloud cover was conducted on a monthly basis, which indicated that monthly reductions of 51% to 57% are expected.

Similarly, turbine orientation can have an impact on the shadow flicker duration. The shadow flicker impact is greatest when the turbine rotor plane is approximately perpendicular to a line joining the sun and an observer, and a minimum when the rotor plane is approximately parallel to a line joining the sun and an observer. Wind direction data recorded at a site mast has been supplied to GL GH from the site Mast PY1 covering a short period from July 2003 to September 2003, and a second longer period from March 2005 to December 2007. [15]. The provided annual wind rose is shown overlaid on the indicative shadow flicker map in Figure 2. An assessment of the likely reduction in shadow flicker duration due to variation in turbine orientation was conducted on a monthly basis, which indicated that reductions of approximately 22% to 35% can be expected at this site.

No attempt has been made to account for vegetation or other shielding effects around each shadow receptor in calculating the shadow flicker duration. Similarly, turbine shutdown has not been considered. It is therefore likely that the adjusted actual shadow flicker durations presented here can still be regarded as a conservative assessment.

4.5 Blade Glint

Blade glint involves the regular reflection of sun off rotating turbine blades. Its occurrence depends on a combination of circumstances arising from the orientation of the nacelle, angle of the blade, and the angle of the sun. The reflectiveness of the surface of the blades is also important. As discussed, blade glint is not generally a problem for modern wind turbines, provided the blades are coated with a non-reflective paint, and it is not considered further here.

5 RESULTS OF THE ANALYSIS

The theoretical maximum predicted shadow flicker durations at receptors within the vicinity of the proposed Paling Yards Wind Farm are presented in Table 5 and Table 6. The maximum predicted theoretical shadow flicker durations within 50 m of receptors are also presented in Table 5 and Table 6. The results are presented in the form of a shadow flicker maps at 2 m and 6 m above ground in Figure 4 through to Figure 7.

These results indicate that seven dwellings are predicted to experience some shadow flicker. All of these dwellings are expected to experience theoretical shadow flicker durations of more than 30 hours per year. However, these dwelling are owned by landholders whom UFWA will negotiate an agreement with. Additionally, some of these dwellings may not be permanent residences.

An assessment of the level of conservatism associated with the worst-case results has been conducted by calculating the possible reduction in shadow flicker duration due to turbine orientation (based on the wind rose measured at the site) and cloud cover. These adjusted results are presented as the predicted actual shadow flicker duration in Table 5 and Table 6. Consideration of turbine orientation and cloud cover reduces the predicted shadow flicker duration by 64% to 74%.

After the application of these factors, the predicted actual shadow flicker durations at all seven of the dwellings mentioned above remain above the limit of 10 hours recommended in the Draft National Guidelines. As before, these dwellings are inhabited by a landholder whom UFWA will negotiate an agreement with.

Often shadow flicker durations in excess of those permitted under the relevant guidelines are deemed acceptable by landowners who have an agreement with the wind farm developer. According to information supplied by UFWA, the dwellings where the draft guideline recommendations are not met are owned by an involved landholder. This suggests that the current layout is acceptable under the Victorian Guidelines and Draft National Guidelines. However it should be noted that the shadow flicker durations predicted at many of the dwellings would be considered as high, with theoretical shadow flicker durations of up to an hour per day for a significant portion of the year predicted at some dwellings.

Shadow Flicker durations at various window locations at the key properties are shown in Table 7 through to Table 8, and time of day shadow flicker durations are shown in Figure 8 though to Figure 15. The shadow flicker durations at each window location takes into account the tilt, orientation and height of that window.

It should be noted that the method prescribed by the Draft National Guidelines for assessing actual shadow flicker duration recommends that only cloud cover, and not turbine orientation, be considered when assessing the actual shadow flicker duration. However, GL GH considers that this additional reduction due to turbine orientation is justified, as the projected area of the turbine, and therefore the expected shadow flicker duration, is reduced when the turbine rotor is not perpendicular to the line joining the sun and dwelling. It should also be noted that some additional potential sources of conservatism, such as screening due to vegetation and turbine shutdown, have not been accounted for in the assessment.

5.1 Mitigation Options

If shadow flicker presents a problem, its effects can be reduced through a number of measures. These include the installation of screening structures or planting of trees to block shadows cast by the turbines, the use of turbine control strategies which shut down turbines when shadow flicker has the potential to occur, or relocation of turbines.

6 CONCLUSION

An analysis has been conducted to determine the duration of shadow flicker experienced at shadow receptors in the vicinity of the proposed Paling Yards Wind Farm, based on the methodology proposed in the Draft National Guidelines. The results of the assessment are presented in the form of a shadow flicker map in Figure 4 to Figure 7. The shadow flicker results for each receptor identified to GL GH are also listed in Table 5 and Table 6. The assessment of theoretical shadow flicker hours shows that all except seven of the dwellings identified by UFWA comply with the recommended limit of 30 shadow flicker hours per year.

Approximation of the degree of conservatism associated with the worst-case results has been conducted by calculating the possible reduction in shadow flicker duration due to turbine orientation and cloud cover.

The results of this analysis, also presented in Table 5 and Table 6 show that the seven dwellings that are predicted to experience theoretical shadow flicker duration in excess of 30 hours per year are also likely to experience more than the recommended limit of 10 actual shadow flicker hours per year.

Often shadow flicker durations in excess of those permitted under the relevant guidelines are deemed acceptable by landowners who have an agreement with the wind farm developer. GL GH understands UFWA will negotiate an agreement with the landholders in question in this case. However it should be noted that the shadow flicker durations predicted at many of the dwellings would be considered as high. To assist UFWA to reach an agreement with these dwellings, detailed time-of-day theoretical shadow flicker durations have been presented along with detail theoretical shadow flicker durations at key window locations for the key effected houses are presented.

It should be noted that the calculation of the predicted actual shadow flicker duration does not take into account any reduction due to low wind speed, vegetation or other shielding effects around each house in calculating the number of shadow flicker hours. Therefore, the adjusted values may still be regarded as a conservative assessment.

Blade glint is not likely to cause a problem for observers in the vicinity of the wind farm provided non-reflective coatings are used on the blades of the turbines.

7 REFERENCES

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House ID	Easting [m][1]	Northing [m][1]	Distance from nearest turbine [km]	Nearest turbine
3	758065	6222550	2.6	P51
4	757528	6222283	2.0	P51
5	757652	6222233	2.1	P51
6	758725	6221219	2.4	P52
6A	759168	6220843	2.4	P52
7	755733	6219927	0.5	P50
7A	754852	6219783	0.4	P46
8	752720	6217349	0.5	P30
8A	752775	6217645	0.6	P36
9	752455	6215508	0.6	P18
9A	752297	6215538	0.5	P20
9B	752581	6215711	0.5	P25
10	745869	6215678	2.1	P1
126	755608	6213611	2.9	P22
128	753128	6211506	2.9	P21
135	755459	6213072	3.0	P22
n	754842	6215362	1.7	P24

[1] The house coordinates are in MGA Zone 55 (GDA94 datum).

Table 1. House locations in the vicinity of the proposed Paling Yards Wind Farm turbines.

Window ID	Easting[1] [m]	Northing[1] [m]	Height [m]	Description / Facing
R7_ave	755755	6219920	-	Average coordinate of all house GPS points
R7_W10	755758	6219932	1.8	northeast
R7_W12	755766	6219925	1.8	northeast
R7_W5	755745	6219924	1.8	northwest
R7_W6	755747	6219927	1.8	northeast
R7A_ave	754867	6219775	-	Average coordinate of all house GPS points
R7A_W1	754864	6219766	1.8	southeast
R7A_W3	754855	6219771	1.8	southeast
R7A_W5	754867	6219782	1.8	northeast
R7A_W7	754873	6219777	2.5	northeast
R8_ave	752731	6217370	-	Average coordinate of all house GPS points
R8_W10	752734	6217371	1.8	northwest
R8_W3	752743	6217358	3.0	east
R8_W6	752722	6217351	3.5	west
R8_W9	752723	6217377	2.0	west
R9_ave	752476	6215503	-	Average coordinate of all house GPS points
R9_W11	752484	6215493	1.8	South southwest
R9_W14	752468	6215497	1.7	West southwest
R9_W15	752464	6215505	1.7	West southwest
R9_W3	752483	6215513	1.8	northwest

[1] MGA Zone 55 (GDA94 datum)

Table 2. Approximate window locations at key House locations in the vicinity of the proposed Paling Yards Wind Farm turbines

Turbine ID	Easting[1] (m)	Northing[1] (m)	Turbine ID	Easting[1] (m)	Northing[1] (m)
P1	747801	6214761	P32	751654	6217234
P2	748312	6214437	P33	751942	6217474
P3	748520	6214803	P34	752209	6217766
P4	748804	6214973	P35	751953	6218025
P5	749055	6215129	P36	753234	6217980
P6	749245	6213667	P37	753414	6218296
P7	749278	6214044	P38	753670	6217768
P8	749638	6214879	P39	753790	6218102
P9	750046	6215203	P40	753716	6219273
P10	750488	6215520	P41	753756	6218710
P11	750673	6216153	P42	753851	6219051
P12	750521	6215025	P43	753990	6219495
P13	750856	6215277	P44	754258	6219703
P14	751065	6215503	P45	754453	6219950
P15	750791	6214083	P46	754724	6220154
P16	751181	6214433	P47	754673	6220559
P17	751425	6214787	P48	755149	6220270
P18	751942	6215115	P49	755527	6220446
P19	751765	6215480	P50	756080	6220346
P20	751924	6215913	P51	756446	6220552
P21	752759	6214377	P52	757360	6219305
P22	752945	6214652	P53	757575	6219025
P23	753154	6215077	P54	757656	6218768
P24	753359	6216136	P55	757565	6218414
P25	752937	6216108	P56	757293	6218235
P27	752654	6216325	P57	757117	6217957
P28	752167	6216399	P58	756711	6217870
P29	752969	6216601	P59	757016	6217565
P30	752971	6216909	P60	757375	6217237
P31	751295	6216935			

[1] Coordinate system used is Zone 55 H, GDA94 datum

Table 3. Proposed turbine layout for the Paling Yards Wind Farm site.

Model Setting	Value
Maximum shadow length	10 x (Maximum) Rotor Diameter
Year of calculation	2024
Minimum elevation of the sun	3°
Time step	1 min (10 min for map)
Rotor modelled as	Sphere
Sun modelled as	Disc
Offset between rotor and tower	None
Receptor height (single storey)	2 m
Receptor height (double storey)	6 m
Grid size for determining maximum shadow flicker within 50 m of centre of dwelling	20 m

Table 4. Shadow flicker model settings for theoretical shadow flicker calculation.

			Theoretical				Predicted Actual[3]			
			At Dwelling[2] [hr/yr]		Max Within 50m of Dwelling[2] [hr/yr]		At Dwelling[2] [hr/yr]		Max Within 50m of Dwelling[2] [hr/yr]	
House ID	Easting[1] [m]	Northing[1] [m]	At 2 m	At 6 m	At 2 m	At 6 m	At 2 m	At 6 m	At 2 m	At 6 m
7	755733	6219927	36	34	90	83	13	12	25	23
7A	754852	6219783	124	124	152	154	42	43	54	54
8	752720	6217349	51	50	71	70	18	17	25	25
8A	752775	6217645	172	173	175	177	52	53	54	55
9	752455	6215508	68	66	79	79	23	23	27	27
9A	752297	6215538	69	68	125	123	22	21	39	38
9B	752581	6215711	89	86	130	126	25	24	36	35
Limits			**30**	**30**	**30**	**30**	**10**	**10**	**10**	**10**

[1] MGA Zone 55 (GDA94 datum)

[2] Dwellings with zero hours shadow flicker have been omitted from this table

[3] Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation

Table 5. Theoretical and predicted actual shadow flicker durations for Turbine Option 1.
(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

			Theoretical				Predicted Actual[3]			
			At Dwelling[2] [hr/yr]		Max Within 50m of Dwelling[2] [hr/yr]		At Dwelling[2] [hr/yr]		Max Within 50m of Dwelling[2] [hr/yr]	
House ID	Easting[1] [m]	Northing[1] [m]	At 2 m	At 6 m	At 2 m	At 6 m	At 2 m	At 6 m	At 2 m	At 6 m
7	755733	6219927	36	34	83	83	13	12	23	23
7A	754852	6219783	151	153	180	180	55	55	63	63
8	752720	6217349	51	50	70	70	18	17	25	25
8A	752775	6217645	186	187	197	197	56	57	58	58
9	752455	6215508	68	66	81	81	23	23	28	28
9A	752297	6215538	84	82	141	141	24	24	43	43
9B	752581	6215711	120	117	156	156	31	31	41	41
Limits			**30**	**30**	**30**	**30**	**10**	**10**	**10**	**10**

[1] MGA Zone 55 (GDA94 datum)

[2] Dwellings with zero hours shadow flicker have been omitted from this table

[3] Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation

Table 6. Theoretical and predicted actual shadow flicker durations for Turbine Option 2.
(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

Window ID	Easting[1] [m]	Northing[1] [m]	Theoretical [hr/yr]	Predicted Actual[3] [hr/yr]
R7_ave	755755	6219920	34	12
R7_W10	755758	6219932	0	0
R7_W12	755766	6219925	0	0
R7_W5	755745	6219924	35	12
R7_W6	755747	6219927	35	12
R7A_ave	754867	6219775	0	0
R7A_W1	754864	6219766	111	39
R7A_W3	754855	6219771	110	39
R7A_W5	754867	6219782	117	41
R7A_W7	754873	6219777	0	0
R8_ave	752731	6217370	0	0
R8_W10	752734	6217371	61	21
R8_W3	752743	6217358	61	21
R8_W6	752722	6217351	0	0
R8_W9	752723	6217377	52	18
R9_ave	752476	6215503	64	22
R9_W11	752484	6215493	66	23
R9_W14	752468	6215497	0	0
R9_W15	752464	6215505	64	22
R9_W3	752483	6215513	66	23

[1] MGA Zone 55 (GDA94 datum)

[2] Dwellings with zero hours shadow flicker have been omitted from this table
[3] Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation

Table 7. Theoretical and predicted actual shadow flicker durations for Turbine Option 1 at window locations identified by GBD.
(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

Window ID	Easting[1] [m]	Northing[1] [m]	Theoretical [hr/yr]	Predicted Actual[3] [hr/yr]
R7_ave	755755	6219920	34	12
R7_W10	755758	6219932	0	0
R7_W12	755766	6219925	0	0
R7_W5	755745	6219924	35	12
R7_W6	755747	6219927	35	12
R7A_ave	754867	6219775	0	0
R7A_W1	754864	6219766	148	53
R7A_W3	754855	6219771	150	53
R7A_W5	754867	6219782	153	54
R7A_W7	754873	6219777	0	0
R8_ave	752731	6217370	0	0
R8_W10	752734	6217371	61	21
R8_W3	752743	6217358	61	21
R8_W6	752722	6217351	0	0
R8_W9	752723	6217377	52	18
R9_ave	752476	6215503	64	22
R9_W11	752484	6215493	66	23
R9_W14	752468	6215497	0	0
R9_W15	752464	6215505	64	22
R9_W3	752483	6215513	66	23

[1] MGA Zone 55 (GDA94 datum)

[2] Dwellings with zero hours shadow flicker have been omitted from this table

[3] Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation

Table 8. Theoretical and predicted actual shadow flicker durations for Turbine Option 2 at window locations identified by GBD.

(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

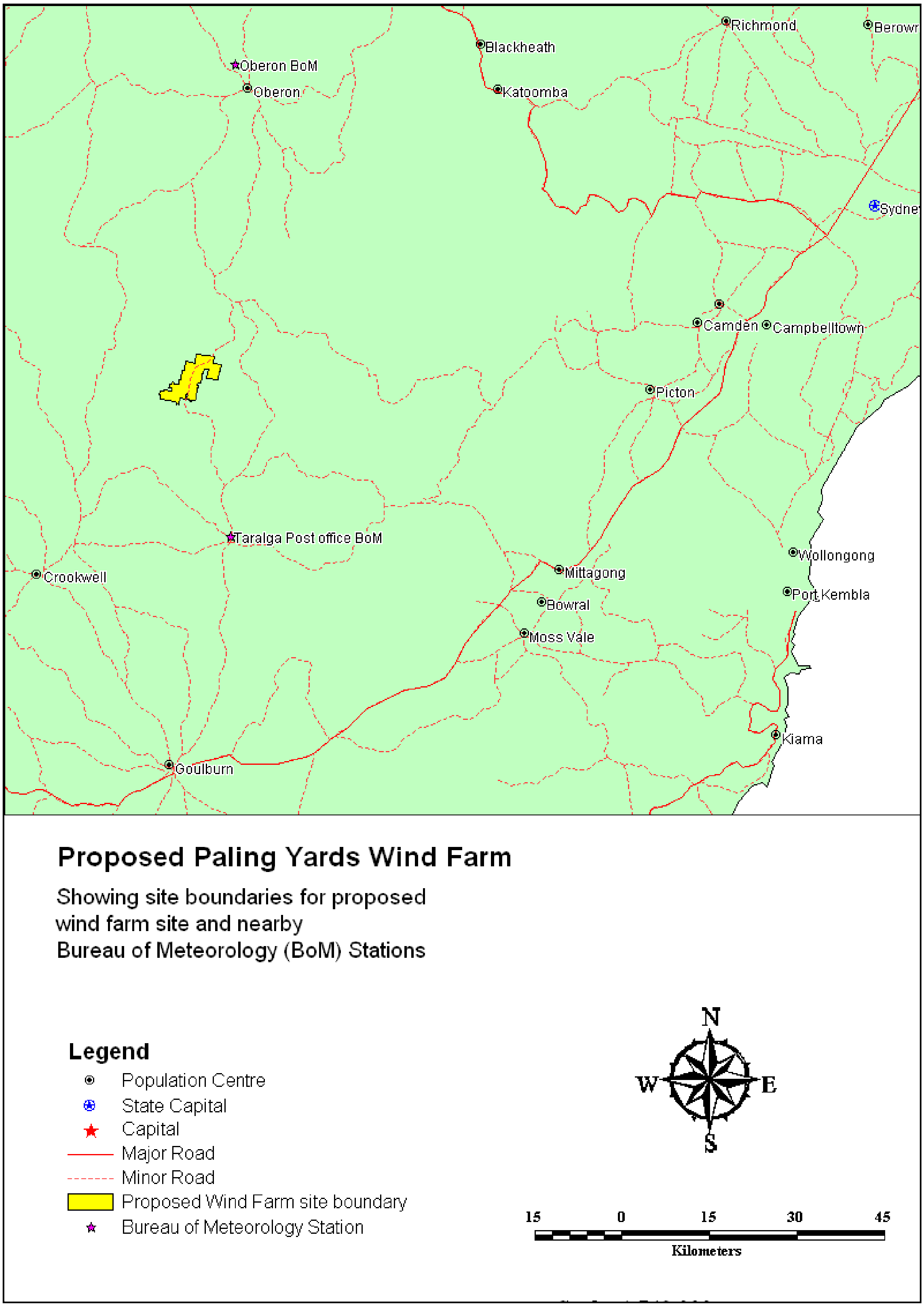

Figure 1. Location of the proposed Paling Yards Wind Farm site and nearby BoM stations

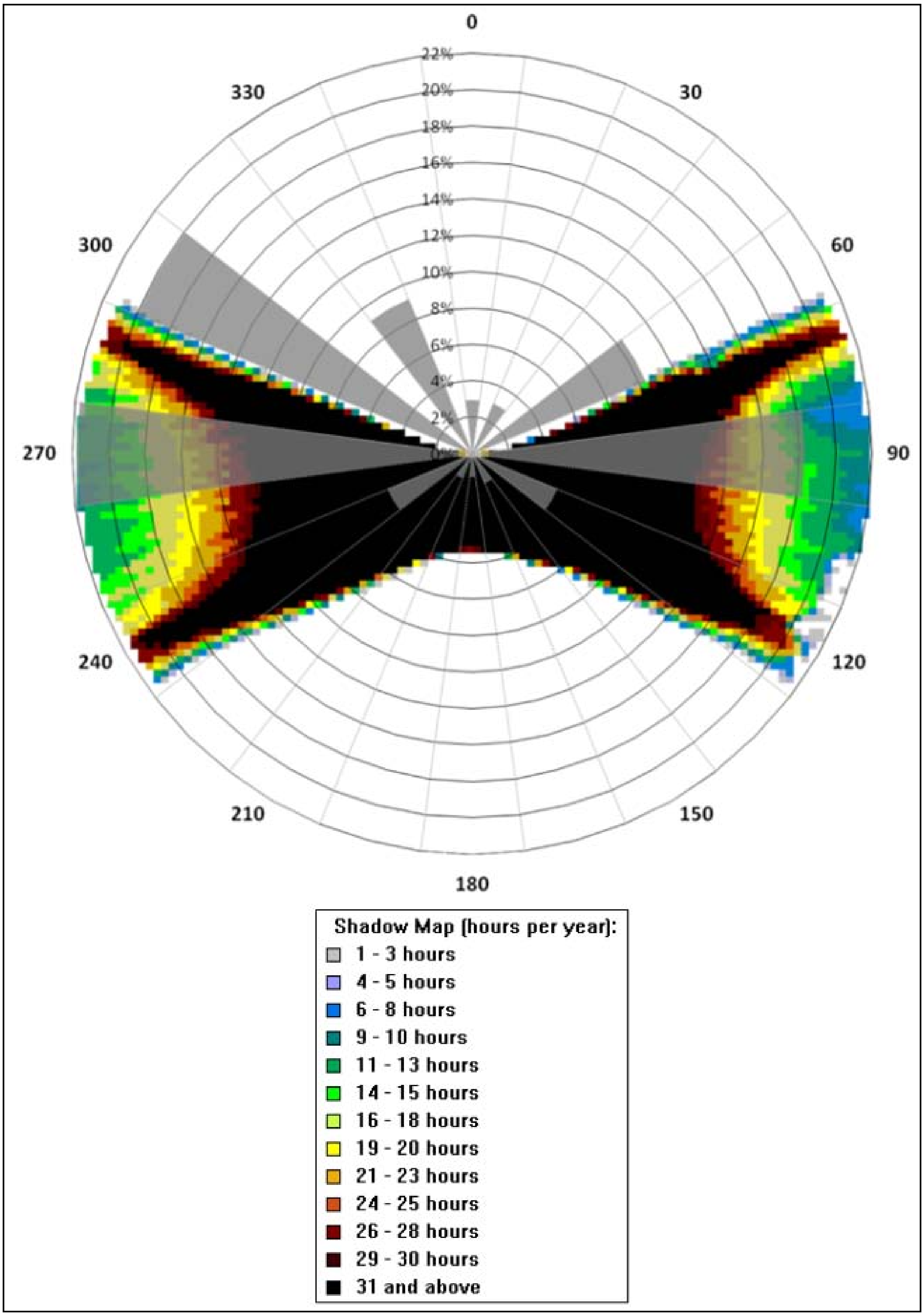

Figure 2. Indicative shadow flicker map showing modelled hours of shadow flicker per year and wind direction frequency distribution.

GL Garrad Hassan

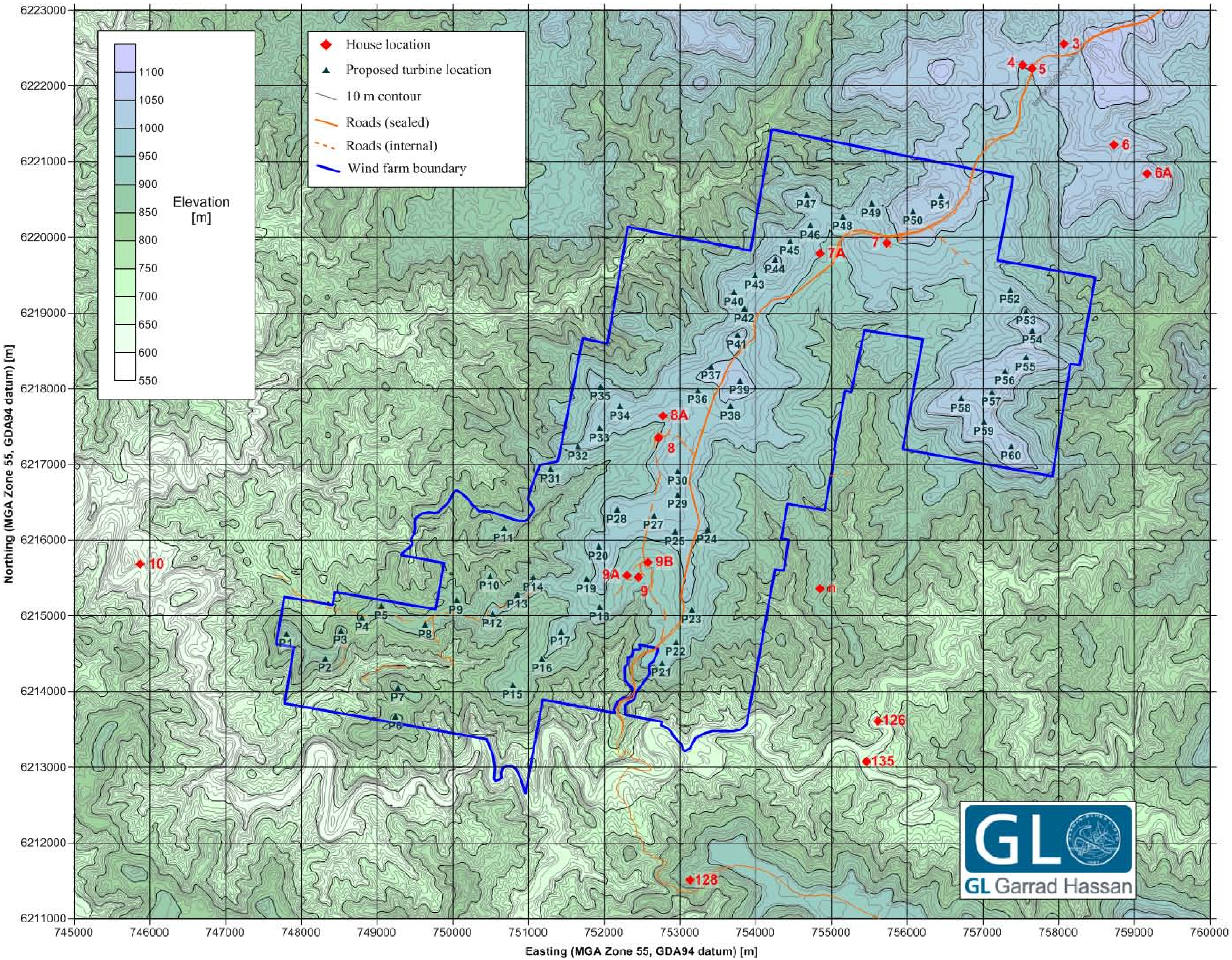

Figure 3. Map of the proposed Paling Yards Wind Farm layout, showing the terrain and house locations.

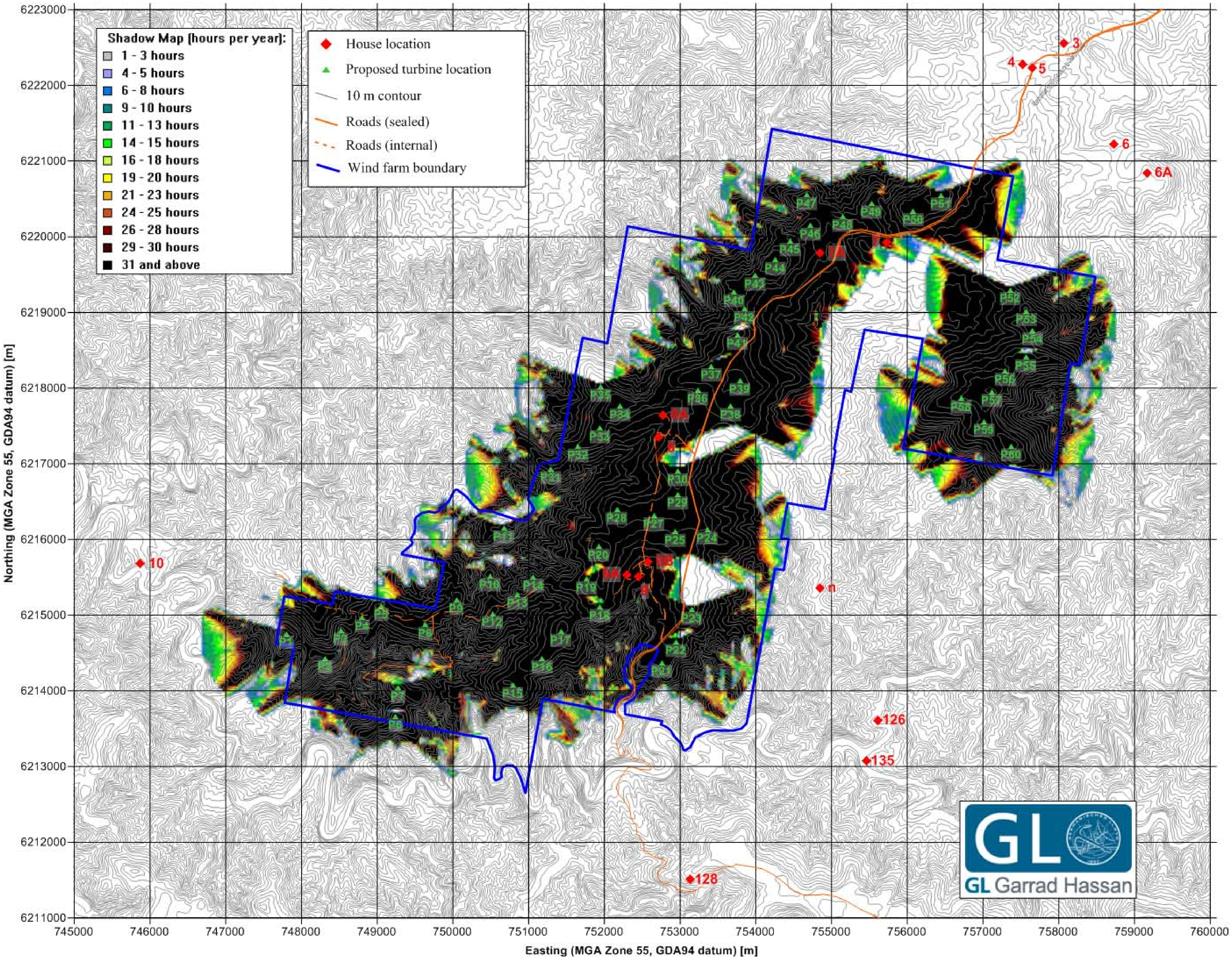

Figure 4. Map of proposed Paling Yards Wind Farm showing turbines, house locations and theoretical shadow flicker duration at 2 m for Turbine Option 1.
(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

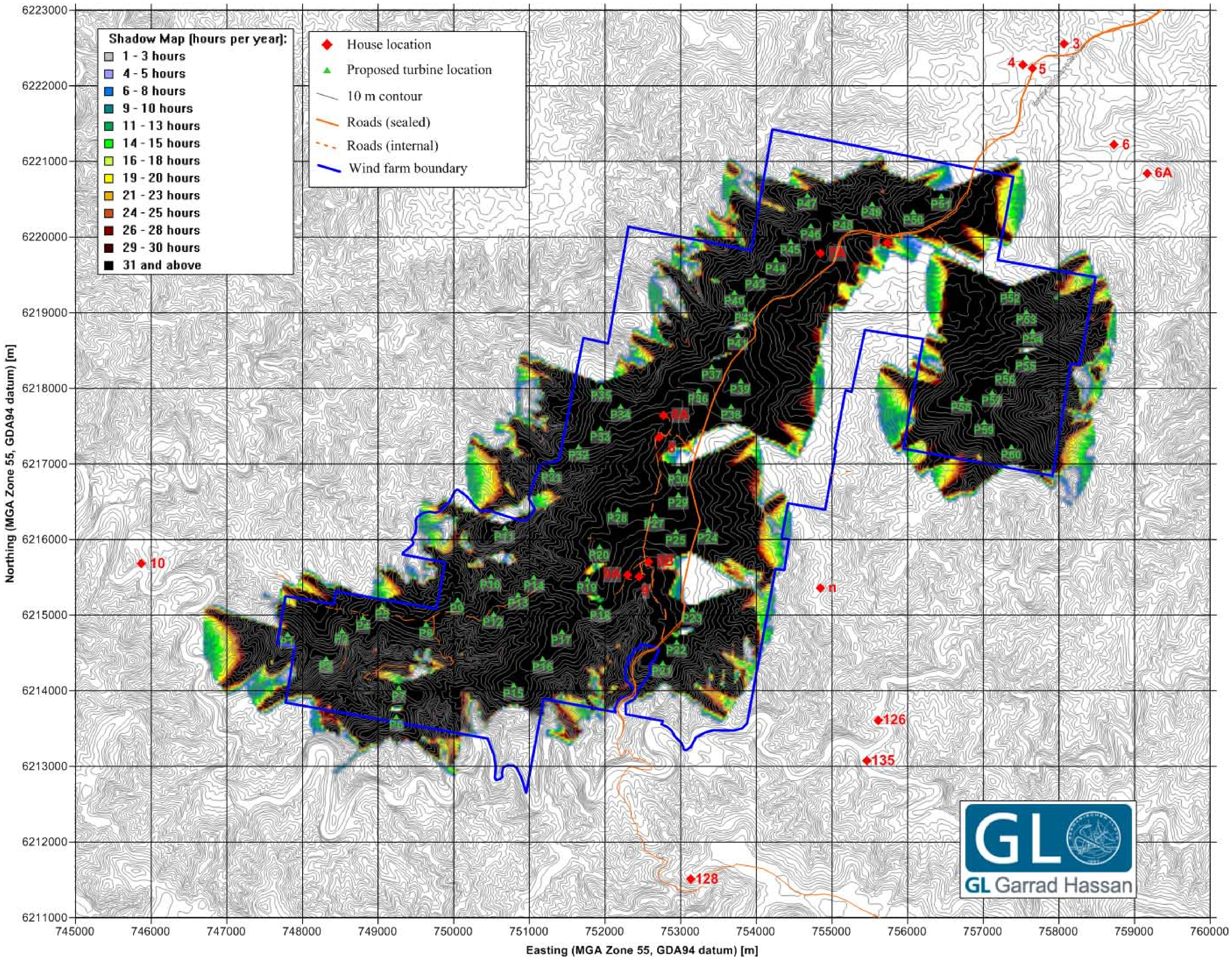

Figure 5. Map of proposed Paling Yards Wind Farm showing turbines, house locations and theoretical shadow flicker duration at 6 m for Turbine Option 1.
(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

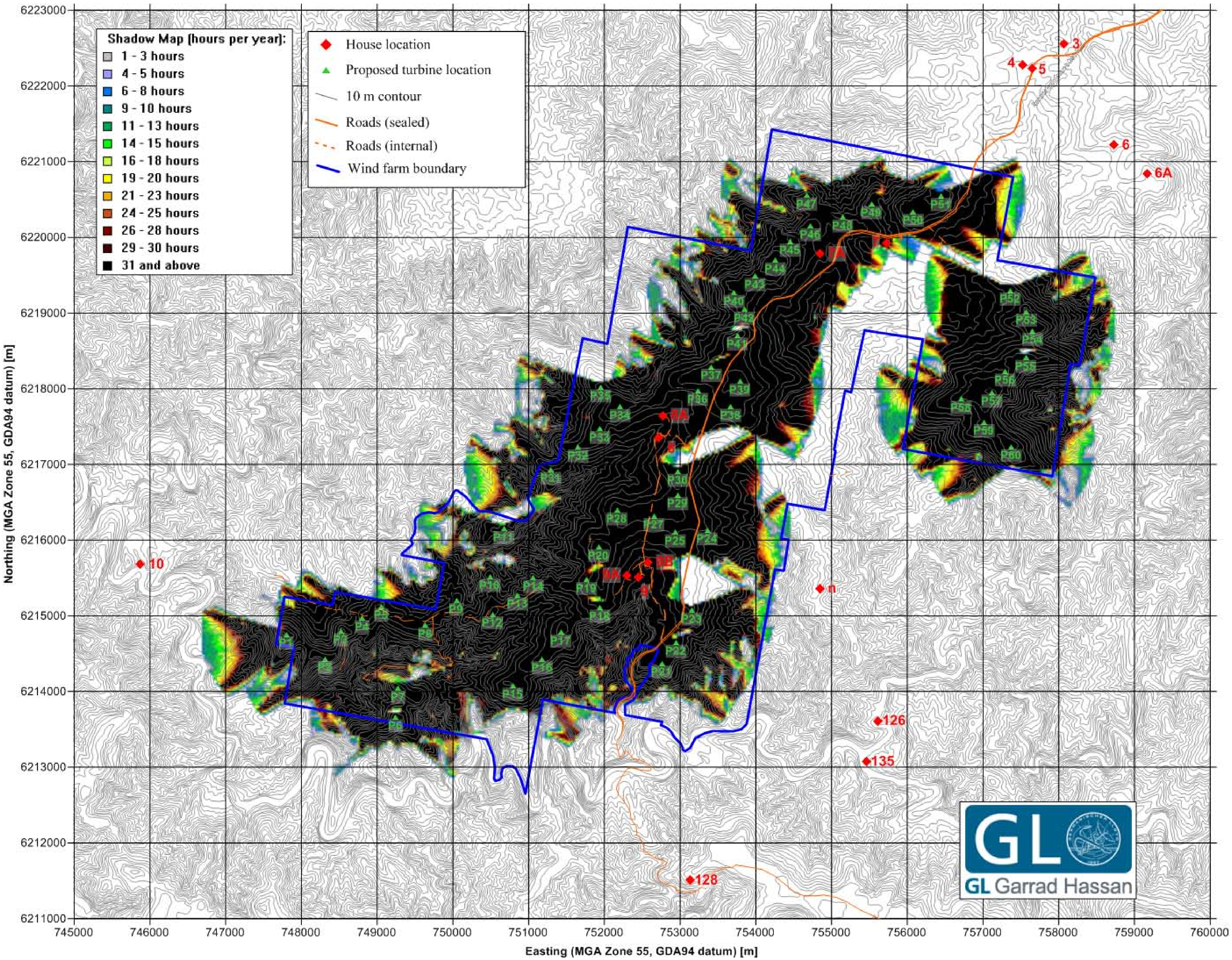

Figure 6. Map of proposed Paling Yards Wind Farm showing turbines, house locations and theoretical shadow flicker duration at 2 m for Turbine Option 2.
(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

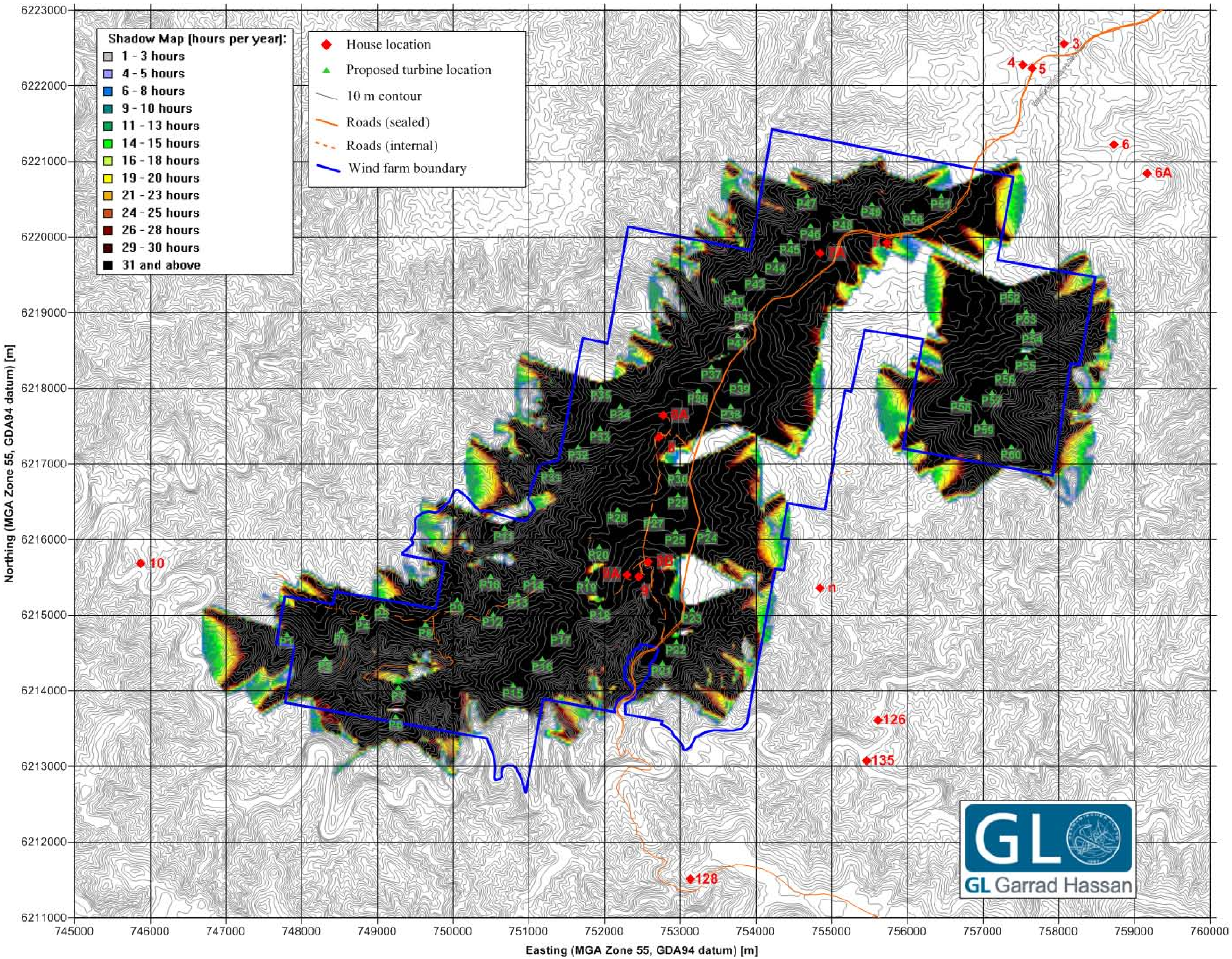

Figure 7. Map of proposed Paling Yards Wind Farm showing turbines, house locations and theoretical shadow flicker duration at 6 m for Turbine Option 2.
(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

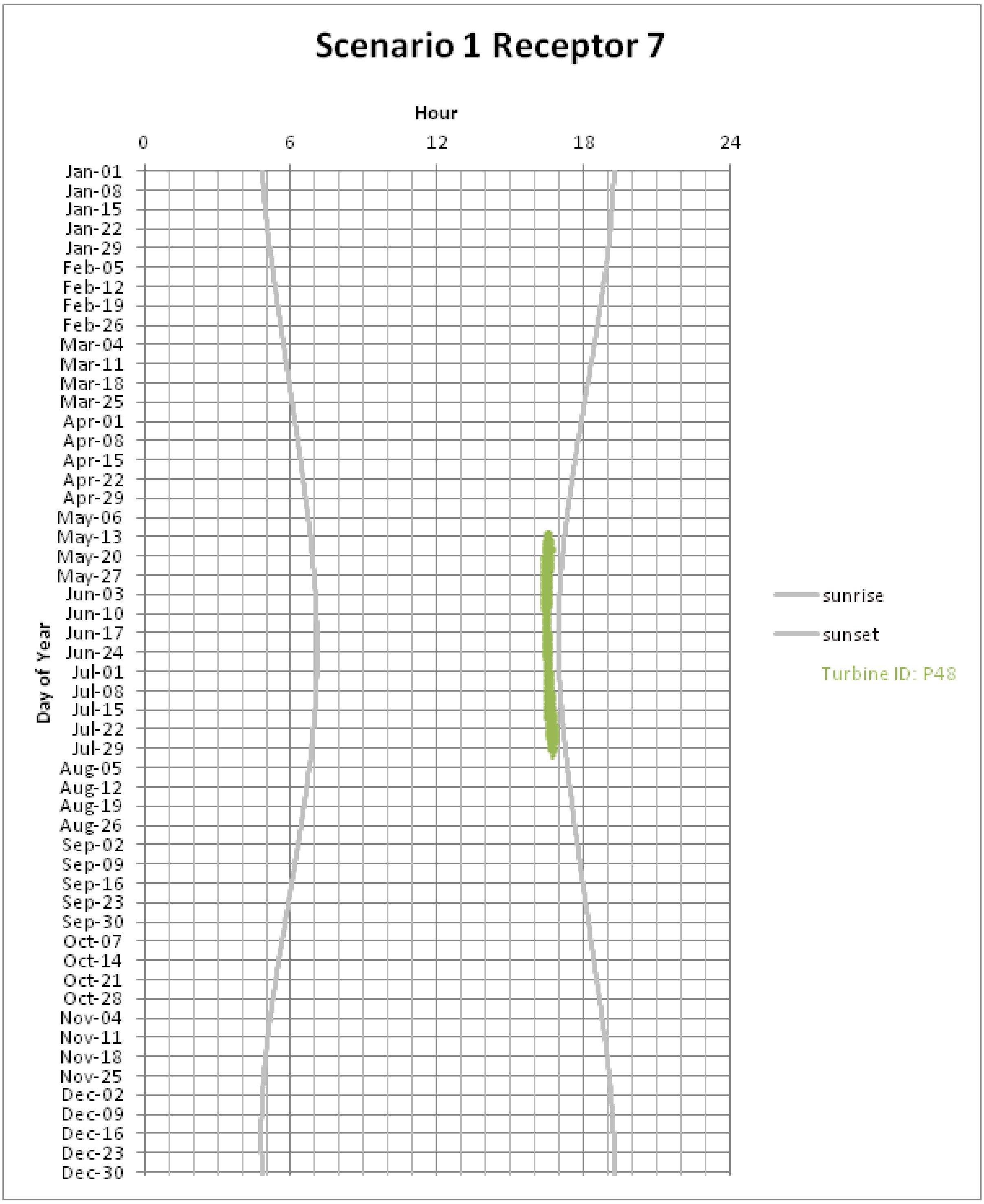

Figure 8 Theoretical time of day Shadow flicker durations at House 7 for turbine Option 1.

(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

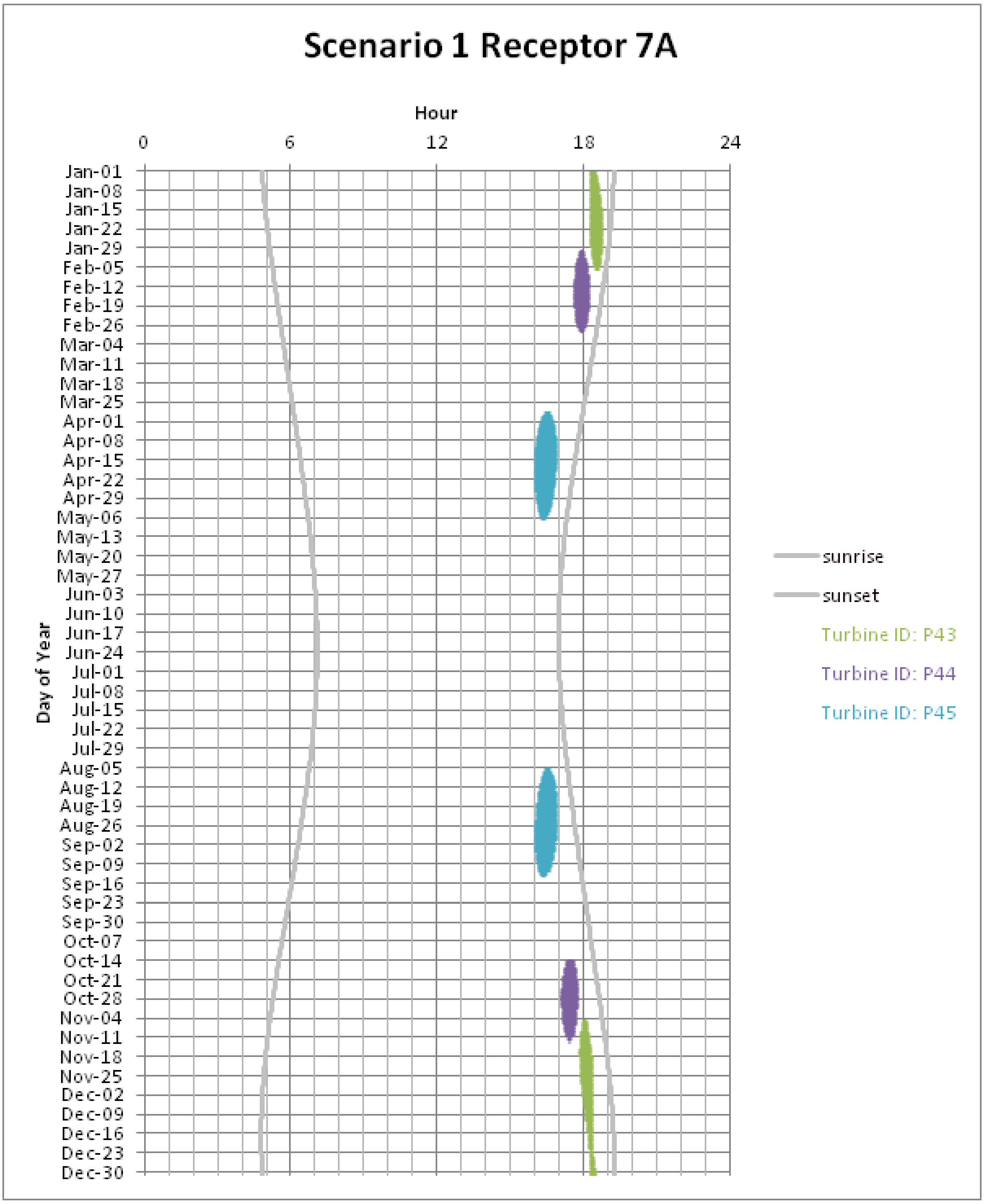

Figure 9 Theoretical time of day Shadow flicker durations at House 7A for turbine Option 1.

(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

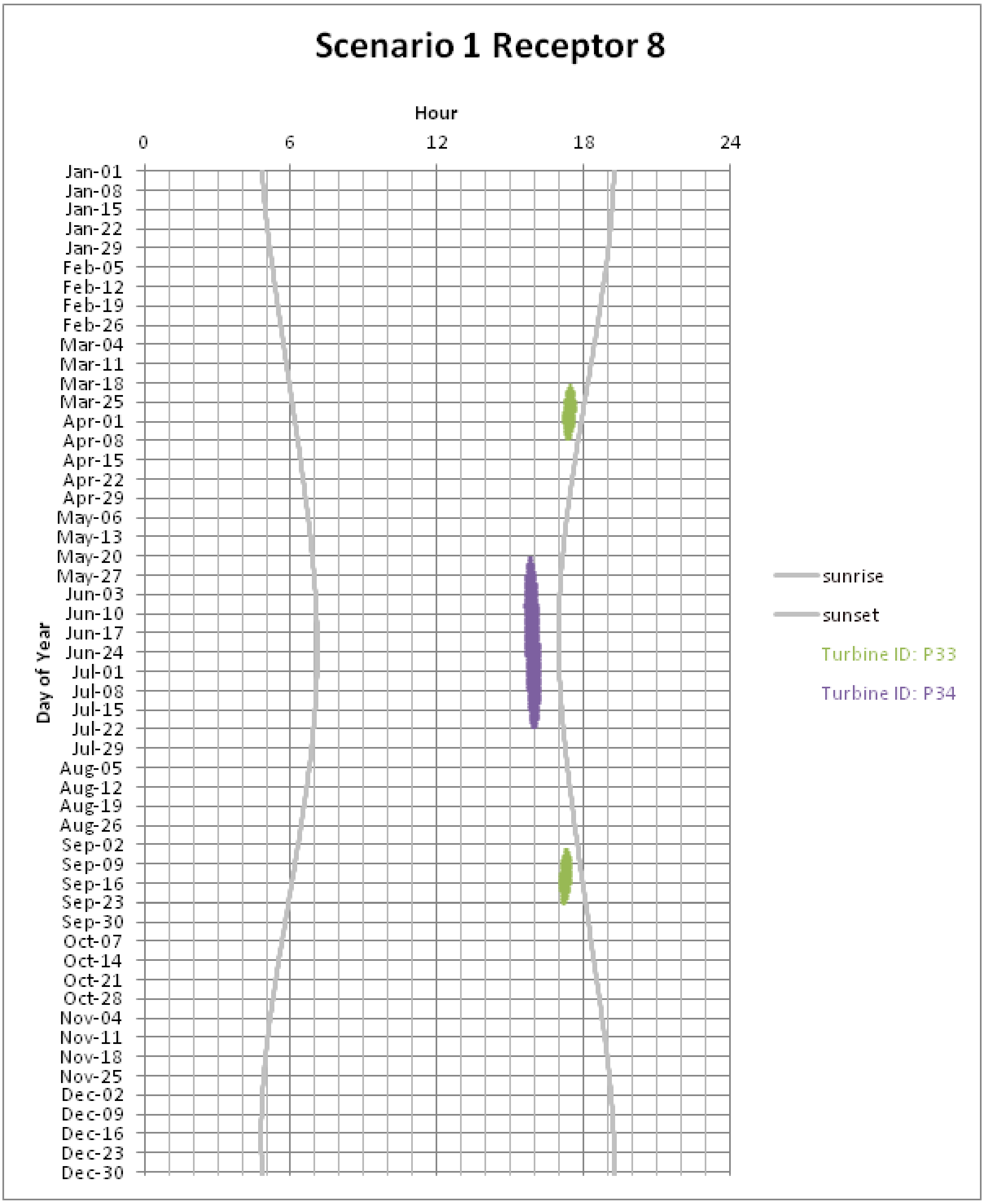

Figure 10 Theoretical time of day Shadow flicker durations at House 8 for turbine Option 1.

(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

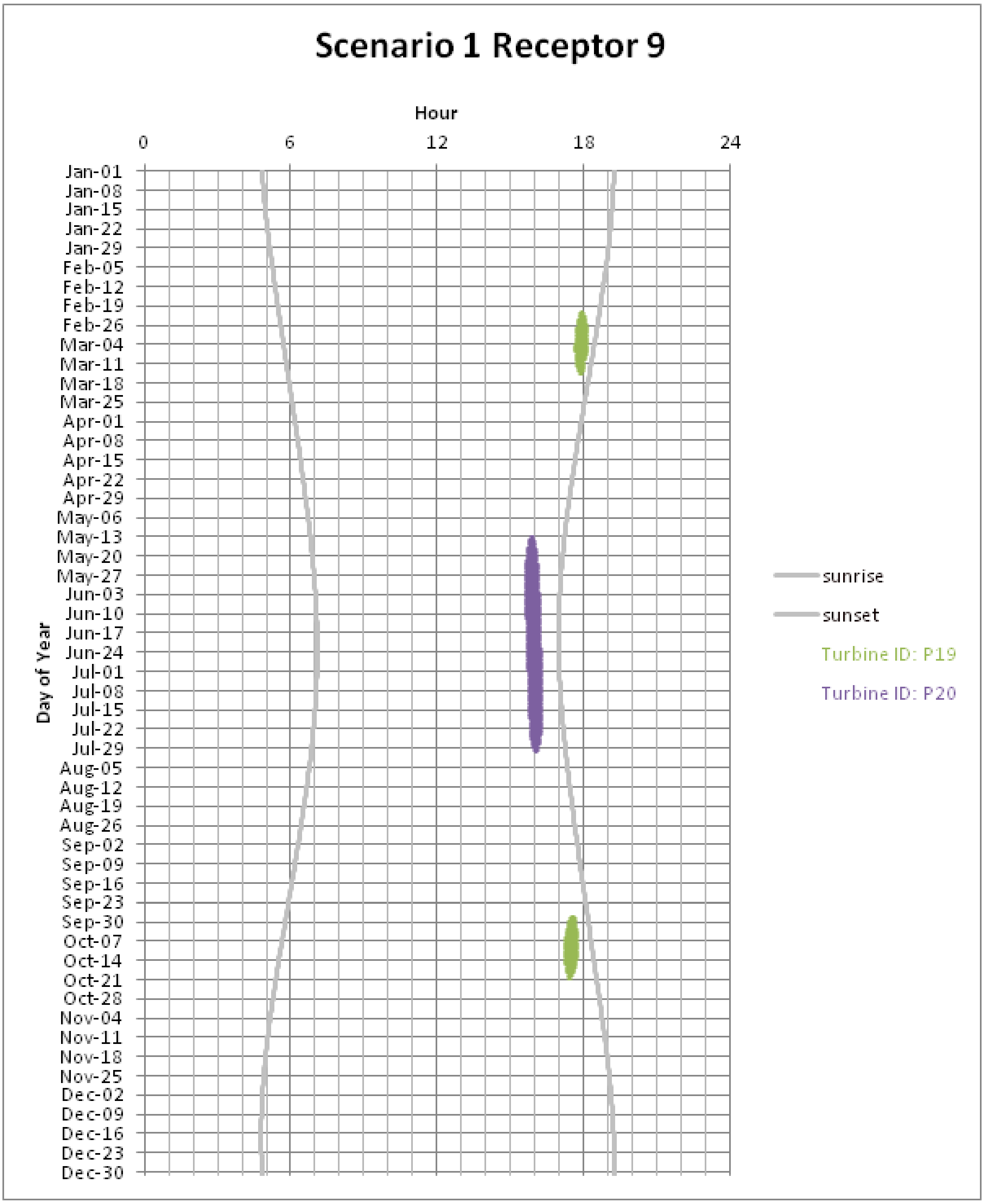

Figure 11 Theoretical time of day Shadow flicker durations at House 9 for turbine Option 1.

(13 turbines with an 100 m rotor diameter and an 80 m hub height, and 46 turbines with an 117 m rotor diameter and a hub height of 91 m)

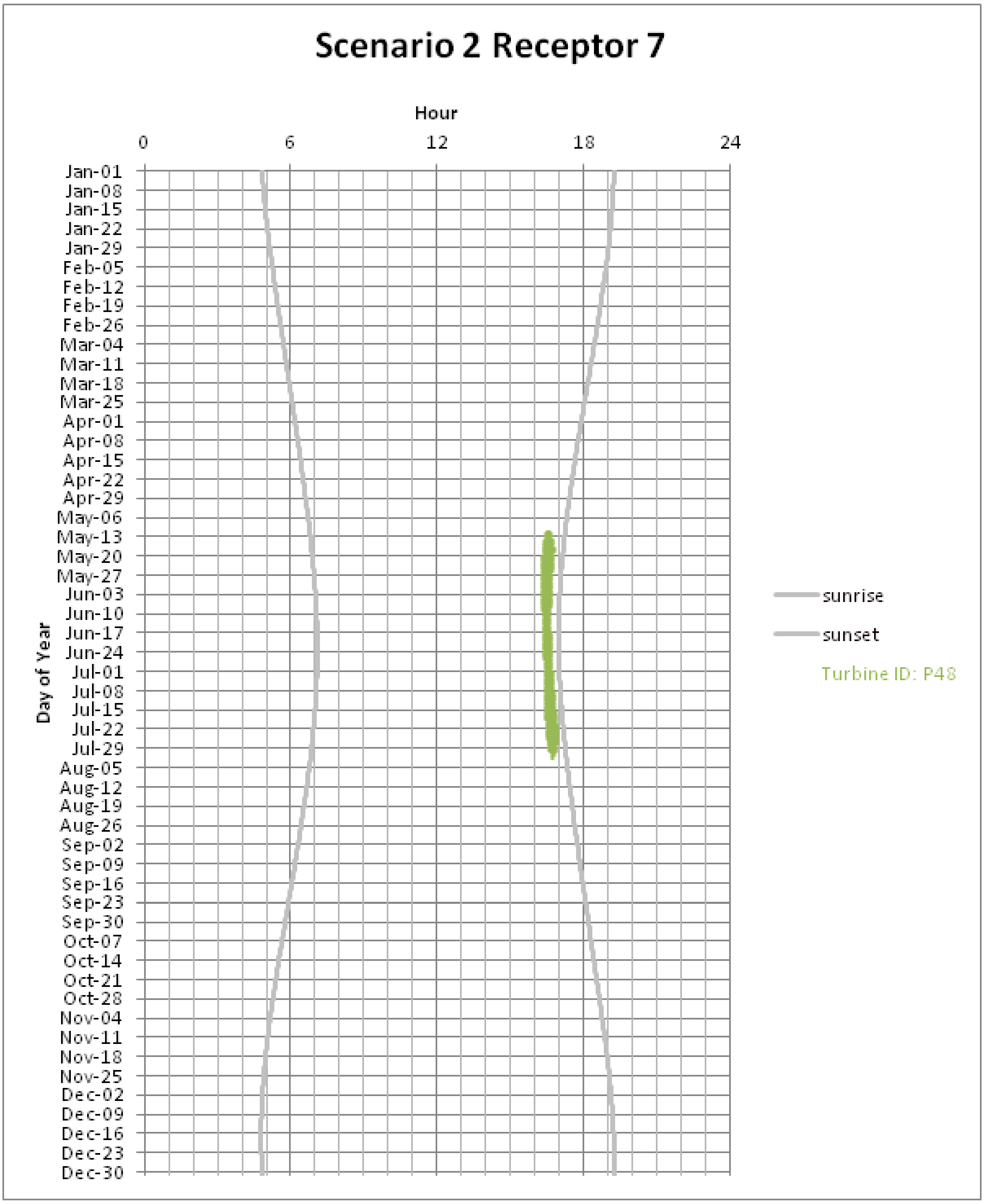

Figure 12 Theoretical time of day Shadow flicker durations at House 7 for turbine Option 2.

(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

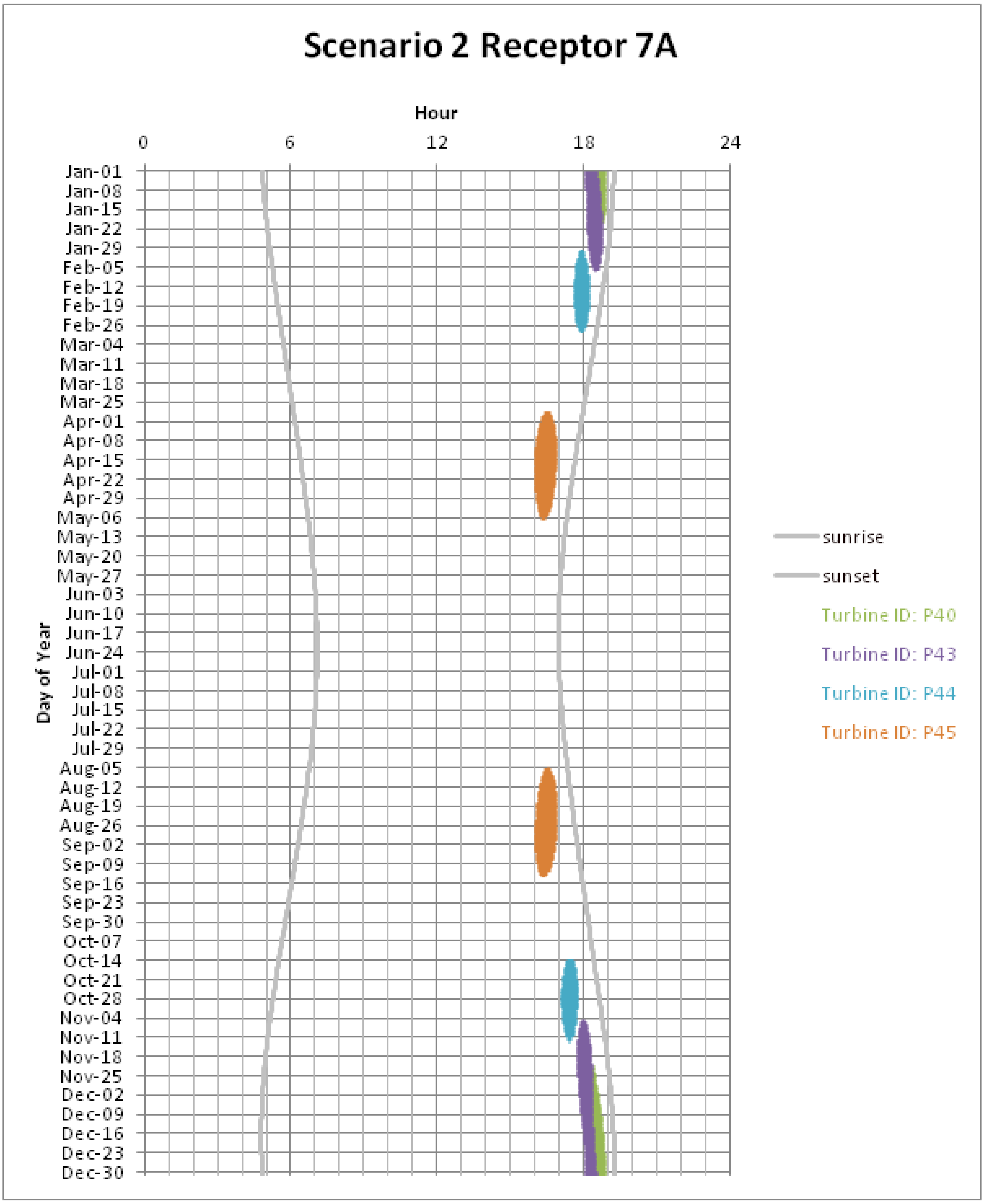

Figure 13 Theoretical time of day Shadow flicker durations at House 7A for turbine Option 2.

(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

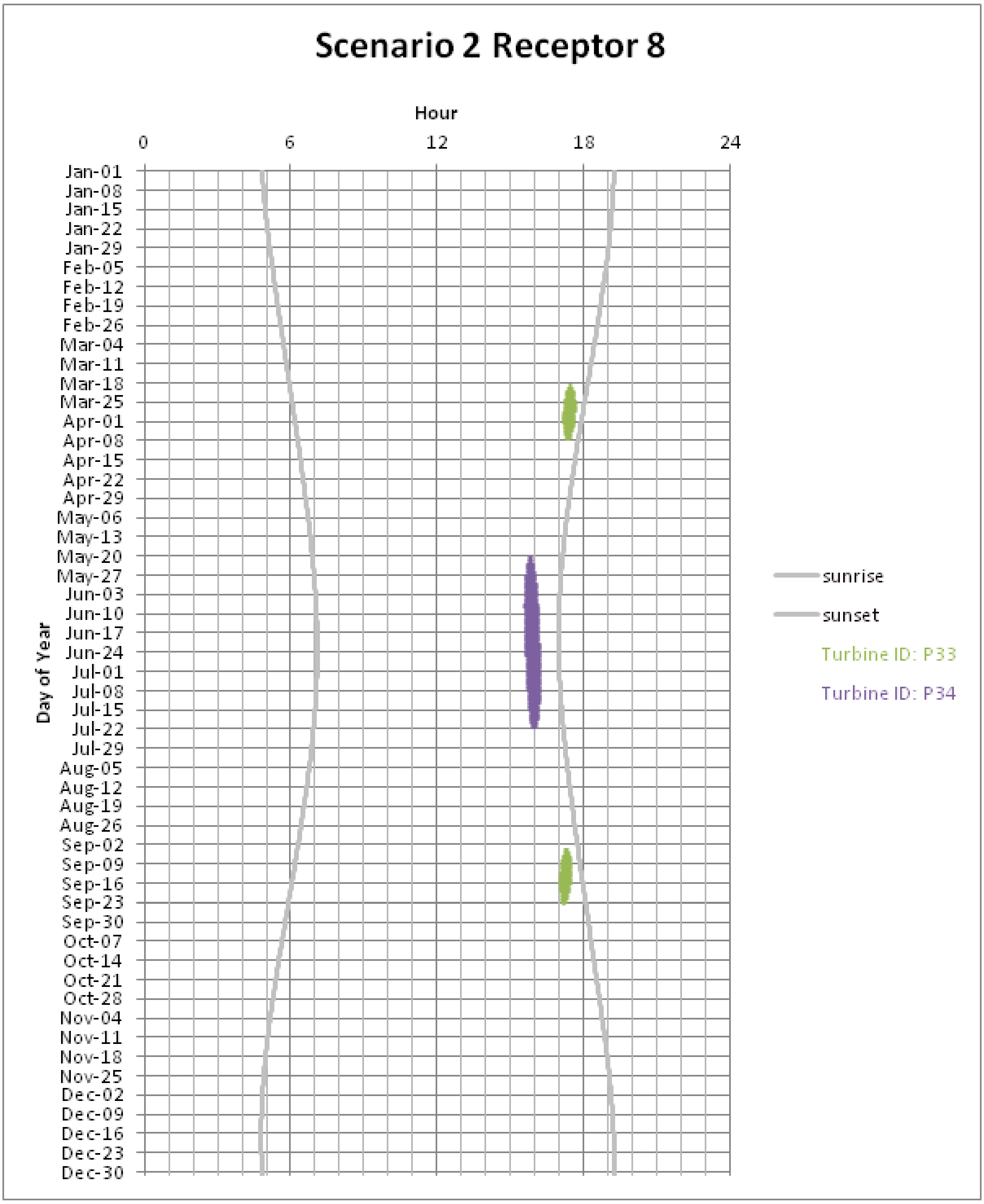

Figure 14 Theoretical time of day Shadow flicker durations at House 8 for turbine Option 2.

(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

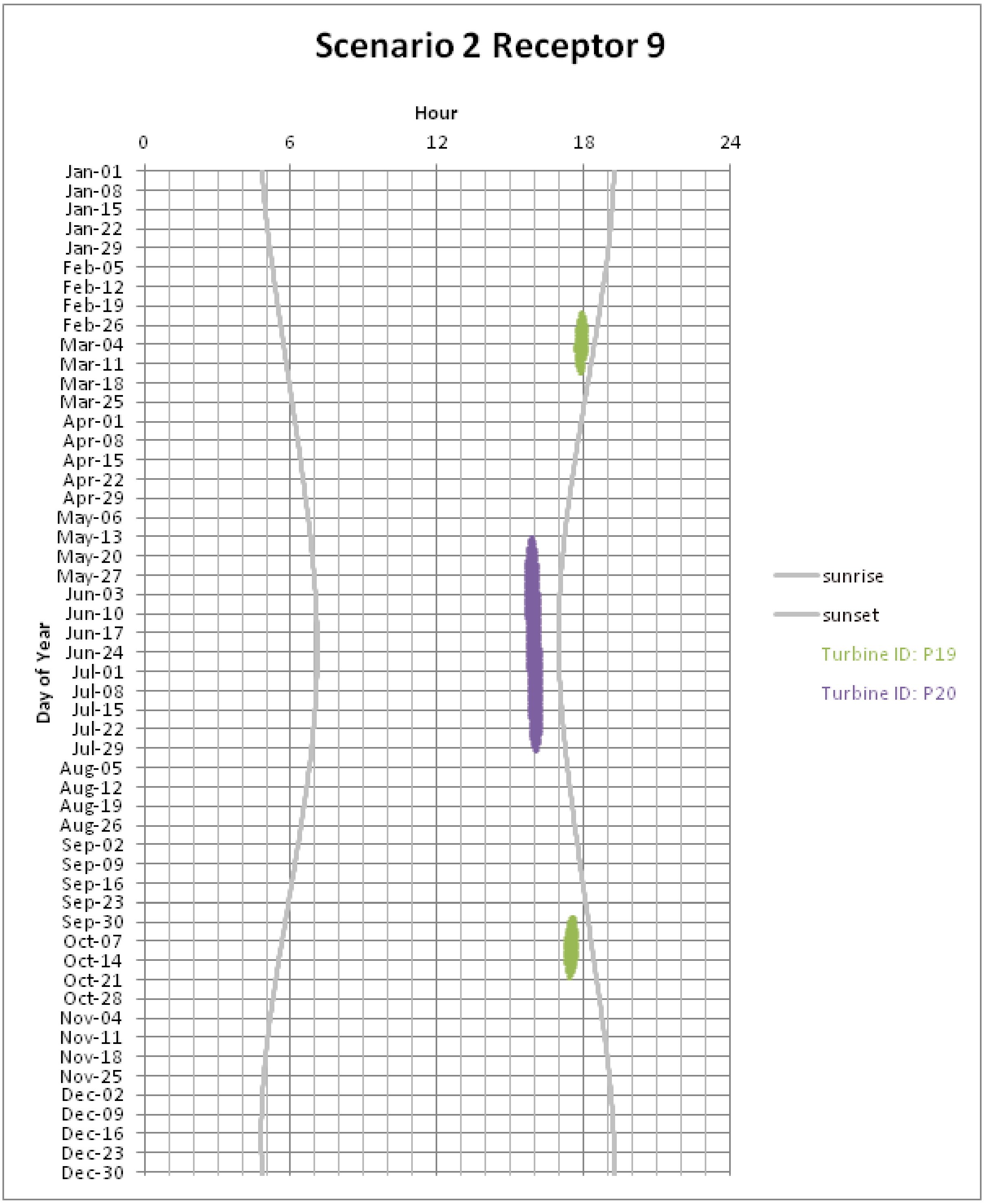

Figure 15 Theoretical time of day Shadow flicker durations at House 9 for turbine Option 2.

(15 turbines with an 100 m rotor diameter and an 80 m hub height, and 44 turbines with an 136 m rotor diameter and a hub height of 107 m)

Appendix B – Civil Aviation Safety Authority Advisory Circular AC139-18(0) July 2007 (Withdrawn)

Australian Government
Civil Aviation Safety Authority

Advisory Circular

AC 139-18(0) SEPTEMBER 2004

OBSTACLE MARKING AND LIGHTING OF WIND FARMS

CONTENTS

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4. General 2
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7. Marking of wind turbines 3
8. Lighting of wind turbines 4

1. REFERENCES

- CASR Part 139, Subpart 139.E, and in particular
  - ◊ 139.365 Structures 110 metres or more above ground level.
  - ◊ 139.370 Hazardous objects etc.
- MOS-Part 139 Chapter 7 – Obstacle Restrictions and Limitations.
- MOS-Part 139 Section 8.10 – Obstacle Marking.
- MOS-Part 139 Section 9.4 – Obstacle Lighting.

2. PURPOSE

This Advisory Circular (AC) provides general information and advice on the obstacle marking and lighting of Wind Farms (including single wind turbines), where CASA has determined that the wind farm is, or will be, a hazardous object to aviation.

3. STATUS OF THIS AC

This is the first AC to be issued on this subject.

Advisory Circulars are intended to provide recommendations and guidance to illustrate a means but not necessarily the only means of complying with the Regulations, or to explain certain regulatory requirements by providing interpretative and explanatory material.

Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material.

ACs should always be read in conjunction with the referenced regulations

4. GENERAL

4.1 This AC applies specifically to horizontal-axis wind turbines, which are the only type installed, or known to be proposed for installation, in Australia, at the date of issue of this document.

4.2 This AC applies to:

(a) a single wind turbine; or

(b) a group of wind turbines, referred to as a wind farm, which may be spread over a relatively large area.

4.3 The height of a wind turbine is defined to be the maximum height reached by the tip of the turbine blades.

4.4 Australian standards and recommended practices for the marking and lighting of obstacles and objects assessed as being hazardous to aviation, are consistent with international standards and recommended practices as published by the International Civil Aviation Organisation (ICAO) in Annex 14 Volume 1 (Aerodrome Design and Operations). The general requirements are:

(a) marking is used to make objects conspicuous to pilots, by day.

(b) lighting is used to make objects conspicuous to pilots, by night;

(c) lights are located as close as practicable to the top of the objects, and at other locations so as to indicate the general definition and extent of the objects.

4.5 Wind turbines pose a particular practical problem in that their highest point is not a fixed structure, and therefore lights can not be appropriately located. The highest fixed part of the turbine where lights can conveniently be located is the top of the generator housing, sometimes known as the nacelle, and this is typically of the order of 2/3 the maximum height of the turbine.

4.6 ICAO has not yet published standards and recommended practices specifically suited to wind turbines. The advice in this document has been derived by allowing some variations to standards and recommended practices to accommodate the specific practical difficulties associated with wind turbines and wind farms, and taking into consideration the practices of some overseas countries.

5. WIND TURBINES IN THE VICINITY OF AN AERODROME

5.1 CASA strongly discourages the siting of wind turbines in the vicinity of an aerodrome.

5.2 A wind turbine located sufficiently close to an aerodrome so that it penetrates an obstacle limitation surface (OLS) of the aerodrome, is defined by MOS-Part 139 Section 7.1, to be an obstacle.

5.3 If the aerodrome is to be used at night, an obstacle that penetrates an OLS should be lighted, in accordance with MOS-Part 139 Section 9.4. The top lights are required to be arranged so as to at least indicate the points or edges of the object highest above the obstacle limitation surface. For a wind turbine, these lights may be located on a separate supporting structure adjacent to the wind turbine, to overcome the difficulty associated with the highest point of the obstacle being the (moving) blades of the turbine.

Note: *Obstacle limitation surfaces are a complex of imaginary surfaces associated with an aerodrome. They vary depending on number and orientation of runways, and the instrument-approach type of the runway(s). Some surfaces can extend to 15 km from an aerodrome. Aerodrome operators can provide details for their particular aerodrome.*

6. WIND TURBINES WITH A HEIGHT OF 110 m OR MORE

6.1 CASR 139.365 requires a person proposing to construct a building or structure, the top of which will be 110 m or more above ground level, to inform CASA of that intention and the proposed height and location of the proposed building or structure.

6.2 CASA will conduct an aeronautical study to determine if the wind turbine will be a hazardous object to aviation, in accordance with CASR 139.370.

6.3 If, as a result of the aeronautical study CASA finds that a proposed wind turbine will penetrate an OLS of an aerodrome, the proposal will be dealt with in accordance with 5 above.

6.4 The aeronautical study may find that even though the proposed wind turbine will not penetrate any OLS of an aerodrome, it will be a hazardous object to aviation.

6.5 The hazard that an object poses to aviation can be reduced by indicating its presence by appropriate marking and/or lighting.

Note: *The marking and/or lighting does not necessarily reduce operating limitations which may be imposed by an obstacle or hazardous object.*

6.6 The advice, in 7 and 8 below, on marking and lighting of wind turbines, should be suitable for wind turbines that do not penetrate an OLS, in most cases. However, because of the variations in configurations and layout of turbines in wind farms, the aeronautical study may indicate that a variation to that advice would be appropriate for a particular wind farm. In such a case, CASA may offer suggestions for variations to the normal advice provided in 7 and 8 below.

7. MARKING OF WIND TURBINES

7.1 Experience with wind turbines installed to date, indicates that they are sufficiently conspicuous by day, due to their shape, size, and colour.

7.2 Wind turbines that are of basically a single colour, and visually conspicuous against the prevailing background, do not require to be painted in obstacle marking colours and/or patterns.

8. LIGHTING OF WIND TURBINES

8.1 In the case of a single wind turbine:

(a) two flashing red medium intensity obstacle lights should be mounted on top of the generator housing;

(b) the light fixtures should be mounted at a horizontal separation to ensure an unobstructed view of at least one of the lights by a pilot approaching from any direction;

(c) both lights should flash simultaneously; and

(d) the characteristics of the obstacle lights should be in accordance with MOS-Part 139 subsection 9.4.7.

8.2 In the case of a wind farm, sufficient individual wind turbines should be lighted to indicate the extent of the group of turbines:

(a) the interval between obstacle lights should not be less than the current extensive object standard of 900 metres, and at a distance that minimises the number of lighted wind turbine generators without diminishing appropriate aviation safety;

(b) in addition, the most prominent (highest for the terrain) turbine(s) should be lighted, if not included amongst the turbines lighted in accordance with (a) above; and

(c) the lighting of individual turbines should be in accordance with 8.1 above.

Note: *There is an overseas proposal that all lighting provided at a wind farm should flash simultaneously. This proposal is still to be validated and accepted. It is suggested that wind farm operators bear in mind that the simultaneous flashing of all lights at a wind farm could become accepted practice some time in the future.*

8.3 On completion of the project, CASA may choose to conduct a flight check to determine the adequacy of the obstacle lighting. This may result in a change (either more or fewer) to the number of obstacle lights required, to ensure the development remains conspicuous.

8.4 Where obstacle lighting is to be provided, it is recommended a monitoring, reporting and maintenance procedure be put in place to ensure outages are reported through the NOTAM system and repairs are implemented.

Bill McIntyre
Executive Manager
Aviation Safety Standards

Appendix C – Draft NSW Planning Guidelines: Wind Farms. Meeting Assessment requirements, Landscape and visual amenity

Appendix A: Meeting assessment requirements

Where a wind farm application is State significant development (SSD), specific assessment requirements are specified in Director General's Requirements (DGRs). This appendix includes information to assist applicants with assessing particular impacts from a wind farm proposal in cases where DGRs require particular impacts to be assessed. The assessment must be detailed in the proponent's EIS.

Landscape and visual amenity

The visual impact of a wind farm depends on the extent of the change to the landscape caused by the development, taking into account:

- the visibility of the development
- the locations and distances from which the development can be viewed
- landscape values and their significance
- the sensitivity of the landscape features to change

The visual impact of the development relates to:

- the number, height, scale, spacing, colour and surface reflectivity of the wind turbines
- the quantity and characteristics of lighting, including aviation obstacle lighting (subject to CASA requirements and advice)
- potential for visual clutter caused by turbine layout and ability to view through a cluster or array (visually well ordered series) of turbines in an orderly manner
- the removal or planting of vegetation
- the location and scale of other buildings and works including transmission lines and associated access roads
- proximity to sensitive areas
- proximity to an existing or proposed wind farm, having regard to cumulative visual effects.

The features of the landscape include:

- the topography of the land
- the amount and type of vegetation
- natural features such as waterways, cliffs, escarpments, hills, gullies and valleys
- visual boundaries between major landscape types
- the type, pattern, built form, scale and character of development, including roads and walking tracks
- flora and fauna habitat
- cultural heritage sites
- the skyline

Assessing landscape and visual amenity impacts

DGRs typically require a comprehensive assessment of the impact of a proposed wind farm on the landscape character, landscape values, visual amenity and any scenic or significant vistas to be undertaken. There should be a particular focus on any neighbours' houses within 2 km of a proposed wind turbine that do not host the wind farm facility. The assessment should include:

- a description of the assessment methodology and a clear justification of it including discrete justification of the methodology for assessing impacts at neighbours' houses within 2 km of a proposed wind turbine
- a description of all relevant components of the project, including turbine heights and layout – where micro-siting or a range of turbines is proposed, the assessment should be based on the 'worst case' layout and turbine height
- a description of the landscape including key features

- a description of the visibility of the development
- photomontages of the project and associated transmission lines taken from:
  - potentially affected residences (including approved but not yet developed dwellings or subdivisions with residential rights) within 2 km of a proposed wind turbine or other associated infrastructure (note that the number of photomontages may be reduced in less sensitive landscapes such as industrial areas),
  - urban settlements, and
  - significant public view points including roads, lookout points and walkways.
- identification of the zone of visual influence of the wind farm (no less than 10km)
- a description of the significance of the landscape values and character in a local and regional context
- a description of community and stakeholder values of the local and regional visual amenity and quality and perceptions of the project based on surveys and consultation.
- assessment of cumulative impacts on the landscape and any cumulative visual impacts from transmission line infrastructure and any surrounding approved or operational wind farms in the locality

Mitigating landscape and visual amenity impacts

The feasibility, effectiveness and reliability of proposed mitigation measures should be assessed. The extent of any residual impacts left over after mitigation measures have been implemented should also be described. Examples of mitigation measure that proponents can use to reduce the visual impact of a proposed wind farm include:

- where possible, locate turbines:
  - away from areas with high scenic values
  - away from areas with high visibility from local residents
- select turbines that :
  - look the same, have the same height and rotate the same way
  - are off-white or grey colouring
- minimise the removal of vegetation
- plant vegetation to provide a visual screen
- reduce impacts of night and obstacle lighting by
  - limiting lighting on towers to that required for safe operation and aviation safety and
  - use of lighting design which minimises glare
- underground electricity wires where practicable
- use alternative transmission line pole designs to minimise visual impact.

Appendix D – Andrew Homewood, curriculum vitae

GREEN BEAN DESIGN
landscape architects

Areas of Expertise

Landscape and Visual Impact Assessment

Landscape Design and Contract Documentation

Independent Verification & Landscape Management

Education

University of Sheffield, Graduate Diploma Landscape Management, 1996

University of Sheffield, BSc (Dual Hons), Landscape Architecture & Archaeology, 1995

Writtle College, National Diploma Amenity Horticulture, 1989

Registration & Memberships

Registered Landscape Architect , Australian Institute Landscape Architects (AILA)

Member Environmental Institute Australia and New Zealand (MEIANZ)

Member of the Landscape Research Group (UK)

Selected Project Experience

Landscape and Visual Impact Assessment

Wind and Solar Farms

BP Moree Solar Power Station, Status: Approved

LVIA for the Solar Flagship Moree Solar Farm site in northern New South Wales.

Boco Rock Wind Farm EA, (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 125 wind turbine generators in the NSW Southern Tablelands Monaro sub region, including coordination for supply of photomontage, ZVI and flicker assessment.

Sapphire Wind Farm EA (Wind Prospect CWP Pty Ltd) Status: Approved

LVIA for the proposed construction of up to 174 wind turbine generators in the NSW New England region, including coordination for supply of photomontage, ZVI and flicker assessment.

Silverton Wind Farm EA Stages 1 & 2 (Epuron Pty Ltd) Status: Approved

LVIA for a 1000MW wind farm at Silverton in the Unincorporated Area of western NSW, for up to 600 wind turbines including a 25km length of 220kV transmission line between the wind farm and Broken Hill.

Conroy's Gap Wind Farm (Epuron Pty Ltd) Status: Approved

LVIA for a DA modification for additional wind turbines to an approved development located in the southern highlands NSW.

Bango Wind Farm (Wind Prospect CWP Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines located in the southern highlands NSW.

Liverpool Range Wind Farm Stage 1 (Epuron Pty Ltd)

LVIA for the proposed construction of up to 200 wind turbines located in the Warrumbungle and Upper Hunter Shire Councils approximately 370 km north of Sydney, and a 60 km length of 330 kV line connecting to the Ulan mine site.

Rye Park Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 120 wind turbines adjoining multiple wind farm sites in the New South Wales southern highlands.

Deepwater Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines at Deepwater in north NSW.

Port Kembla Wind Farm (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the Port Kembla industrial facility at Wollongong.

Eden Wind Farm, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 7 wind turbines within the SEFE woodchip facility on the south coast of New South Wales.

Paling Yards Wind Farm EA, (Union Fenosa Pty Ltd)

LVIA for the proposed construction of up to 59 wind turbines including night lighting, cumulative impact assessment, detailed field assessment for shadow flicker and preparation of photomontages.

Collector Wind Farm EA, (APP/RATCH)

LVIA for the proposed construction of up to 68 wind turbines adjoining the operation Cullerin wind farm project including a detailed cumulative impact assessment.

Willatook Wind Farm EES Referral, (Wind Prospect WA Pty Ltd)

Preliminary LVIA for the proposed construction of up to 190 wind turbines within Moyne Shire Council (Victoria) including a detailed cumulative impact assessment, photomontage location selection and community consultation.

Birrema Wind Farm EA (Epuron Pty Ltd)

LVIA for the proposed construction of up to 75 wind turbines adjoining the proposed Yass Valley wind farm project development including a detailed cumulative impact assessment, photomontage location selection and community consultation.

White Rock Wind Farm EA, (Epuron Pty Ltd)

LVIA for the proposed construction of up to 100 wind turbines adjoining the proposed Sapphire and approved Glen Innes wind farm projects including a detailed cumulative impact assessment, photomontage location selection and community consultation.

Crookwell 3 Wind Farm EA, (Union Fenosa Wind Australia)

LVIA for the proposed construction of up to 35 wind turbines adjoining the approved Crookwell 2 wind farm development including a detailed cumulative impact and night time lighting assessment.

Electrical Infrastructure

22kV transmission line (Country Energy)

LVIA for a short section of electrical distribution line through central New South Wales.

Wagga North 132kV substation (TransGrid)

LVIA for a proposed 132/66kV substation and installation of transmission line connections at Wagga Wagga New South Wales.

Lismore to Dumaresq 330kV transmission line (TransGrid)

LVIA for a proposed 330kV transmission line through northern New South Wales.

Manildra to Parkes 132kV transmission line (TransGrid)

LVIA for a proposed 132kV transmission line through central New South Wales.

Mount Macquarie Communication Tower (TransGrid)

LVIA and preparation of visual simulations for proposed 80m high microwave communication tower in rural New South Wales, adjacent to the Blayney Wind Farm.

Broken Hill to Red Cliffs 220kV transmission line duplication (Epuron Pty Ltd)

LVIA for approximately 300km of 220kV transmission line duplication for the Silverton Wind Farm Concept Approval application.

Molong to Manildra 132kV transmission line (TransGrid)

View catchment mapping and visual assessment for a 28 km section of 132kV transmission line through rural landscape in central western New South Wales.

Power Generation

Dalton Gas fired Power Plant (AGL Energy)

LVIA for gas turbine peaking power station, valve station and communication tower in rural NSW. Preparation of photomontage and 3D modelling.

Herons Creek Peaking Power Station (International Power)

LVIA for 120MW distillate-fired peaking power station in rural landscape setting. Visual assessment included preparation of visual simulations to model each of the three 40MW generating units in the existing landscape.

Parkes Peaking Power Station (International Power)

LVIA for 120MW distillate-fired peaking power station in central New South Wales, including provision of photomontages.

Buronga Peaking Power Station (International Power)

LVIA for 120MW distillate-fired peaking power station in far west New South Wales.

Leafs Gully Peaking Power Plant (AGL Energy Pty Ltd)

LVIA and landscape master plan for gas turbine peaking power station in south-west Sydney.

Bio Energy Project (SEFE)

LVIA for a 5MW bio fuel power plant located on the south of Two Fold Bay, Eden.

Professional History

Green Bean Design, Principal Landscape Architect 2006 -

URS Australia Pty Ltd, Practice Leader Landscape Architecture 2005 - 2006

URS Australia Pty Ltd, Associate Landscape Architect 2003-2005

URS Australia Pty Ltd, Senior Landscape Architect, 2002 - 2003

URS Australia Pty Ltd, Landscape Planner, 2001-2002

URS, Contract Landscape Architect, 2000-2001

Blacktown City Council, Contract Landscape Planner, 2000-2001

Knox & Partners Pty Ltd, Landscape Architect, 1996-2000

Brown & Associates, Landscape Architect, 1996

Philip Parker & Associates, Graduate Landscape Architect, 1994-1995

Rendel & Branch, Landscape Assistant, 1989-1991

National Trust, Horticulturalist, 1987-1988

English Nature, Species Protection Warden, 1985-1986

Essex Wildlife Trust, Botanist, 1984-1985

Royal Society for the Protection of Birds, Voluntary Warden, 1983-1984