# APPENDIX 8

## Landscape and Visual Impact Assessment

## Cumulative Landscape and Visual Impact Assessment

## Green Bean Design

# UPDATES TO THE ENVIRONMENTAL IMPACT STATEMENT

During the preparation of this Environmental Impact Statement, a number of changes occurred.

Please consider these changes while reviewing this Appendix.

- The Assessment Type of the Bango Wind Farm has transitioned from Part 3A, after its repeal, and is now being assessed as a State Significant Development under Part 4 of the EP&A Act. Any reference to a Part 3A assessment in attached technical assessments may be disregarded, and considered as State Significant Development;

- Rugby Wind Farm, a wind farm that was proposed to the north of the Project has been withdrawn. Where references are made to cumulative impacts with the Rugby Wind Farm, please disregard these;

- Slight changes have occurred to the Rye Park Wind Farm layout, a wind farm under development to the east of the Project. The changes made to the layout are not significant and therefore sit within the cumulative impact assessment undertaken for this EIS. The revised layout has been considered in the Environmental Noise Assessment and Landscape Visual Impact Assessment. Where further references are made to the Rye Park Wind Farm layout, these will be incorporated into future documentation where required;

- Four turbines at the south east extent of the Project, situated in the Mt Buffalo cluster have been removed through consultation with landowners. This change has been highlighted in maps and a review of all technical assessments has deemed that the removal of the four turbines has resulted in a reduced. This change will be incorporated into future documentation. These wind turbines are identified as “removed wind turbines” in the Project maps in Volume 2; and

- A number of changes were made to the residence information for the Project, as a result of construction of houses and change in occupancy status of existing buildings. These changes have been incorporated into the EIS.

GREEN BEAN DESIGN landscape architects

Siobhan Isherwood
CWP Renewables Pty Ltd
PO Box 1708, 45 Hunter Street
NEWCASTLE NSW2300

1st September 2016

Dear Siobhan

**Re Bango Wind Farm Landscape and Visual Impact Assessment – turbine modification for an 8m increase to tip of blade height**

Further to the preparation of our Landscape and Visual Impact Assessment (LVIA) and Supplementary Cumulative Visual Impact Assessment for the Bango Wind Farm Project, we understand that CWP Renewables Pty Ltd (the Proponent) propose to consider a wind turbine model extending to a tip height of 200 metres (m) for the Project.

The Bango Wind Farm LVIA originally determined levels of impact for a 192m wind turbine tip height. The parameters for the 192m tip of blade wind turbine and the proposed 200m tip of blade wind turbine are outlined in the following table and the diagram below.

| Element | 192m tip of blade | 200m tip of blade | Difference (%) |
|---|---|---|---|
| Rotor Diameter | 144m | 144m | Nil |
| Overall height to tip of blade | 192m | 200m | +4% |
| **Total number of turbines** | **122** | **122** | **Nil** |

The maximum rotor diameter of 144m will not increase and the final tower and rotor dimensions will sit within the 200m blade tip height envelope.

We understand that the proposed '200m tip height' wind turbines would be located in the same position as the previously assessed '192m tip height' wind turbines and include up to a maximum of 122 wind turbines.

As requested we have reviewed the Bango Wind Farm LVIA (V5 – Final Issue 14 May 2016) to identify any additional level of landscape or visual impact that might result from an 8m increase to the wind turbine tip of blade height. Our review included as assessment of potential changes:

- in wind turbine visibility within the Bango Wind Farm 10km viewshed;
- to levels of visual impact determined for residential and public view locations;
- to the shadow flicker assessment; and
- to the extent of cumulative impact.

Our review of the Bango Wind Farm LVIA has determined that:

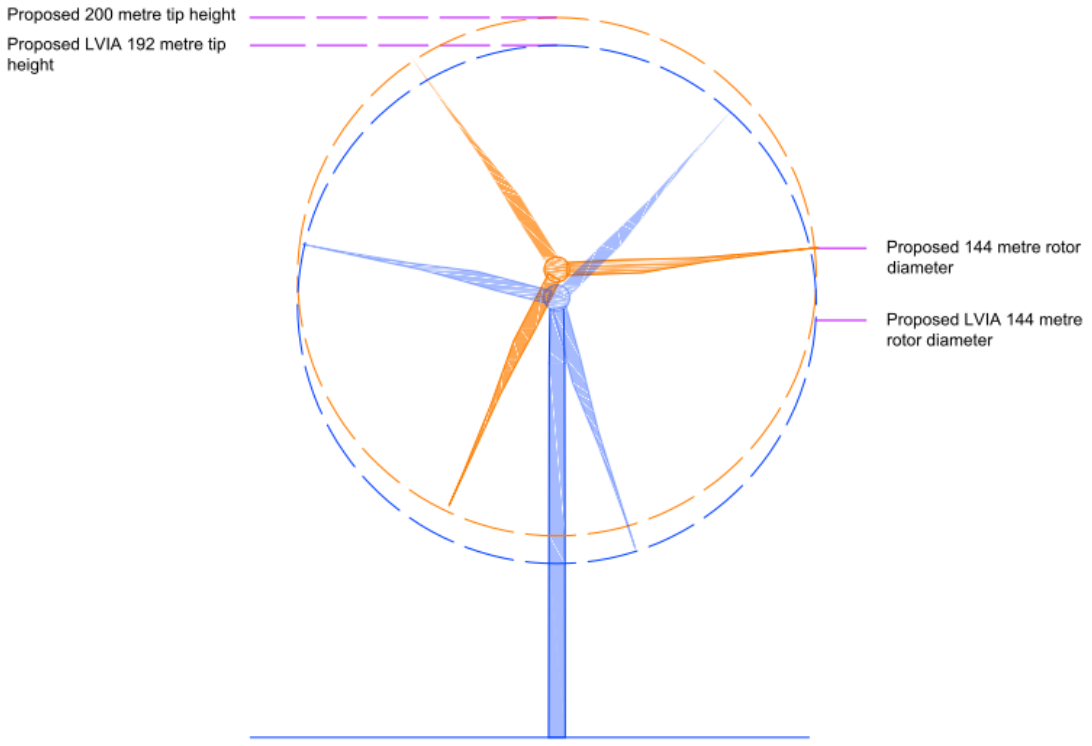
- An 8m increase in wind turbine tip height would not result in any significant increase in the level of visibility of wind turbines over and above that originally determined in the Bango Wind Farm LVIA for the 192m tip of blade wind turbine. There would be no significant or discernable difference to the ZVI Diagrams prepared for the 192m tip height wind turbine (Figures 22, 23 and 24 ZVI Diagrams 1, 2 and 3 within the LVIA).

- An 8m increase in wind turbine tip height would not result in overall changes to the level of visual impact

determined for residential dwellings or public view locations identified and assessed in the Bango Wind Farm LVIA Table 18.

- An 8m increase in tip height would be unlikely to result in any associated or non associated residential dwelling experiencing shadow flicker in excess of the hours per year identified in the Bango Wind Farm LVIA (Table 19).

- An 8m increase in tip height would not result in any additional level of cumulative impact over and above that determined in the Bango Wind Farm LVIA.




Yours sincerely,

**GREEN BEAN DESIGN**
*landscape architects*

Andy Homewood, BSc (Dual Hons), Grad DipLM, DipHort, AILA
*Registered Landscape Architect*

GREEN BEAN DESIGN landscape architects

# Bango Wind Farm

## LANDSCAPE & VISUAL IMPACT ASSESSMENT

*Prepared for:*

WIND PROSPECT CWP PTY LTD

*Prepared by:*

**GREEN BEAN DESIGN**
*landscape architects*

GREEN BEAN DESIGN PTY LTD
PO Box 3178 Austral NSW 2179
Principal: Andy Homewood BSc (Dual Hons), DipLM, DipHort, Registered Landscape Architect, AILA
(ABN: 86 603 575 702)

May 2016

## DOUCMENT CONTROL

| ITEM | DETAIL |
|---|---|
| **Project Name:** | **Bango Wind Farm** |
| **Report Title:** | **Landscape and Visual Impact Assessment** |
| **Project Number:** | **12-164** |
| **Version Number:** | **v5** |
| **Status:** | **Final** |
| **Author:** | **Andrew Homewood**, Registered Landscape Architect, AILA<br>*Graduate Diploma Landscape Management, Bachelor Science (Dual Honours) Landscape Design and Archaeology, National Diploma Horticulture* |
| **Date:** | **14 May 2016** |

## Contents Page

## Contents Page

## Contents Page

## Contents Page

## Contents Page

## Tables

## Figures

## Figures

## Figures

## Figures

## Glossary

This Landscape and Visual Impact Assessment has adopted and adapted the following definitions from *Guidelines for Landscape and Visual Impact Assessment* (2013).

**Table 1** Glossary

| Term | Definition |
|---|---|
| **Cumulative effects** | The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions. |
| **Magnitude** | A combination of the scale, extent and duration of an effect. |
| **Mitigation** | Measures, including any processes, activity or design to avoid, reduce, remedy or compensate for adverse landscape and visual effects of a development project. |
| **Sensitivity** | Susceptibility of a receiver to a specific type of change. |
| **Visibility** | A relative determination at which the proposal can be clearly discerned and described. |
| **Visual amenity** | The value of a particular area or view in terms of what is seen. |
| **Visual envelope** | Extent of potential visibility to or from a specific area or feature. |
| **Visual Impact Assessment** | A process of applied professional and methodical techniques to assess and determine the extent and nature of change to the composition of existing views that may result from a development. |
| **View location** | A place or situation from which a proposed development may be visible. |
| **Visual receiver** | Individual and/or defined groups of people who have the potential to be affected by a proposal. |
| **Visual significance** | A measure of the importance or gravity of the visual effect culminating from the degree of magnitude and receiver sensitivity. |

## Executive summary

Green Bean Design (GBD) has been commissioned by Bango Wind Farm Pty Ltd (the Proponent), a wholly owned subsidiary of Wind Prospect CWP Pty Ltd, to undertake a Landscape and Visual Impact Assessment (LVIA) for the Bango wind farm development (the project).

The project comprises a wind farm development with two potential layouts. Layout Option 1 proposes up to 122 wind turbines, and Layout Option 2 proposes up to 96 wind turbines. For the purpose of this LVIA, an assessment (including ZVI and photomontages) has been prepared for Layout Option 1 as it contains the greater number of proposed wind turbines.

The proposed wind turbines have been assessed with a maximum blade tip height of 192 m from ground level to tip of blade, and a maximum blade length of up to 72 m. Associated electrical works include a proposed overhead powerline (rated up to 132 kV) connection to an existing 132 kV overhead powerline which spans north to south across the western portion of the project site. The proposed overhead powerline would connect to the grid via a collector substation and switching station.

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/medium to high sensitivity to change. The existing landscape character 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/medium to high sensitivity to change, some recognisable characteristics of the landscape character will be altered by the proposed project, and result in the introduction of visually prominent elements that will alter the perceived characteristics of the landscape; however, the degree of alteration 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 Bango wind farm visibility was determined within a 10 km viewshed from the Bango wind turbines, and illustrated within a series of panoramic photographs and 3 Zone of Visual Influence (ZVI) diagrams (up to a

distance of 10 km). The ZVI diagrams demonstrate the influence of topography on visibility and identify theoretical areas from which the wind farm turbines would, and would not, be visible.

A total of twenty one involved, neighbouring and uninvolved dwellings have been identified within 2 km of the proposed Bango wind turbines. Three dwellings have been determined to have a low to medium visual significance and 5 with a medium visual significance. Three dwellings within the 2 km viewshed have been determined to have a medium to high visual significance, and 10 dwellings would have a high visual significance.

A total of 98 involved and uninvolved dwellings have been identified between 2 km and 5 km of the proposed Bango wind turbines. Twenty three of the dwellings between 2 km and 5 km of the Bango wind farm turbines would have a Nil to Low visual significance. Sixty one dwelling locations between the 2 km and 5 km viewshed have been determined to have a low visual significance and 10 with a low to medium visual significance. Two dwellings between the 2 km and 5 km viewshed have been determined to have a medium visual significance.

This LVIA assessed the potential visual impact associated with the proposed sections of an overhead 132 kV powerline, including the three optional collector substation and switching station locations and associated electrical infrastructure. The LVIA determined that the overall visual significance of the electrical elements would be very low to low due to the potential screening influence of landform and tree cover relative to dwelling locations.

A cumulative assessment identified two proposed wind farm developments (the Rye Park and Rugby wind farm projects) in local vicinity of the Bango wind farm 10 km viewshed. This LVIA determined that there would be some potential for wind turbine intervisibility between the Bango wind farm and other wind farm developments, although the potential for direct cumulative impacts for the majority of residents within the Boorowa Township and Rye Park Village would be limited by the arrangement of wind turbine arrays within separate wind farm development, as well as the nature of local topography and exiting tree cover.

Night time obstacle lighting, if implemented, would have the potential to create a visual impact on residential dwelling locations surrounding the Bango wind farm. This LVIA notes that further to the withdrawal of the

CASA Advisory Circular there are no guidelines by which to define criteria for wind farm night time obstacle lighting. 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 east of Yass.

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 can 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 Bango wind farm Environmental Assessment (EA) to be submitted and assessed under Part 3A of the Environmental Planning & Assessment Act 1979 (EP&A Act).

This LVIA methodology adopted by GBD has been applied to a number of similar LVIA for large scale infrastructure projects prepared by GBD, which have been assessed and approved by the New South Wales Department of Planning under Part 3A of the EP&A Act, and peer reviewed by independent landscape architectural experts.

This LVIA addresses and responds to the Director General's Requirements (DGR's) dated 31 March 2011, 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 | Report 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 an assessment of the significance of landscape values and character in a local and regional context. 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. | Refer LVIA **Sections 6** and **15** |
| • assess the impact of shadow "flicker", blade "glint" and night lighting from the wind farm. | Refer LVIA **Sections 9** and **12**, |
| • identify the zone of visual influence including consideration of night lighting (no less than 10 kilometres) and assess the visual impact of all project components on this landscape. | Refer LVIA **Sections 7** and **12**. |
| • Include an assessment of any cumulative visual impacts from powerline infrastructure. | Refer LVIA **Section 10**. |
| • 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 | Refer LVIA **Sections 11** and **16**. |

**Table 1** Director General's Requirements

| DGR's | Report Reference |
|---|---|
| proposed visual amenity mitigation and management measures for both the wind farm and the powerline. The photomontages must include representative views of turbine night lighting if proposed. | |
| • 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**. |
| • Include consideration of alternative powerline pole designs to minimise visual impact. | Refer LVIA **Section 13**. |

The Bango wind farm project site would be located within two Local Government Areas (LGA) including the:

- Boorowa Shire Council; and
- Yass Valley Shire Council.

The Upper Lachlan Shire Council LGA is located to the east of the Bango wind farm project site; however, portions of the Upper Lachlan Shire Council LGA are located within the Bango wind farm 10 km viewshed. GBD has reviewed the Upper Lachlan Shire Council's Development Control Plans (DCP) for Wind Power Generation and confirm that this LVIA addresses a number of key DCP requirements with regard to consideration of visual assessment, and includes provision for:

- the assessment of visual impact and scenic value;
- the assessment of cumulative impact;
- shadow flicker assessment;
- viewshed mapping; and
- photomontages.

The assessment of potential visual impact associated with shadow flicker has been assessed and included in **Section 9** of this LVIA.

GBD is not aware of any landscape areas within the immediate wind farm viewshed that are subject to any Local, State or Federal statutory designations for high landscape values or scenic quality and/or scenic protection.

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, June 2007, and have encompassed the general assessment framework outlined in the National Assessment Framework within the LVIA methodology. In addition to the National Assessment Framework, the preparation of this LVIA has also included a review of the Draft NSW Planning Guidelines: Wind Farms (December 2011).

This LVIA involved a comprehensive evaluation of the landscape character in which the Bango wind farm 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 A** 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 | Photomontages have been prepared from all non host dwellings within 2 km of a proposed wind turbine, as well as 6 residential dwellings subject to negotiations for neighbour agreements (Refer LVIA **Section 11**). |
| 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 7, 8** and **15**). |
| Consider cumulative impacts on landscape and views. | This LVIA has considered potential cumulative landscape and visual impacts (Refer LVIA **Section 10**). |
| 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. **Table 3** outlines the relevant requirements 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**<br>**1A Preliminary Landscape Assessment** | This LVIA has been prepared through a comparable methodology to that outlined in the NAF and has included a |

**Table 3** NAF Recommendations

| NAF Tasks (through Steps 1 to 4) | LVIA Reference/Response |
|---|---|
| • 1A.1 Desktop Review<br>• 1A.2 Seek information from Local Authority<br>• 1A.3 Identify potential community and stakeholder interests<br>• 1A.4 Site survey<br>• 1A.5 Preliminary assessment of landscape values<br>**1B Full Landscape Assessment**<br>• 1B.1 Define the study area for assessment, including the zone of visual influence<br>• 1B.2 Landscape Character Analysis<br>• 1B.3 Natural and cultural values analysis<br>• 1B.4 Involve communities and stakeholders in identifying landscape values<br>• 1B.5 Document values and analyse significance | desktop review (pre site inspection) to determine potential view locations as well as establishing the extent and types of landscape characteristics within the 10km viewshed.<br><br>Discussions with the relevant Local Authorities determined that no additional wind farm developments were current other than those notified on the DoP&I website: (http://majorprojects.planning.nsw.gov.au/page/project-sectors/transport--communications--energy---water/generation-of-electricity-or-heat-or-co-generation/)<br><br>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**.<br><br>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 DoP&I DGR's.<br><br>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**<br>• 2.1 Describe the development<br>• 2.2 Model the development<br>• 2.3 Prepare a visual assessment report | This LVIA has described and modelled the Bango wind farm development and selected view points from a range of view locations including uninvolved residential dwellings and road corridors within the 10km viewshed. |
| **Step 3 Assess the Impacts of the Wind Farm on Landscape Values**<br>• 3.1 Seek community input to potential impacts<br>• 3.2 Identify and describe impacts<br>• 3.3 Identify potential cumulative 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**. |

**Table 3** NAF Recommendations

| NAF Tasks (through Steps 1 to 4) | LVIA Reference/Response |
|---|---|
| • 3.4 Identify other relevant factors<br>• 3.5 Evaluate impacts | This LVIA has identified and described potential landscape and visual impacts associated with the Bango wind farm 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**<br>• 4.1 Changes to location or siting of the wind farm or ancillary infrastructure<br>• 4.2 Layout and design considerations<br>• 4.3 Minor changes and mitigation measures<br>• 4.4 Recommend changes to the development | The development of the Bango wind farm 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.<br><br>Layout changes have occurred throughout the development of the preferred design layouts including the removal and repositioning of turbines within site boundary. |

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 of significance of visual impact; and
- preparation of photomontages and illustrative figures.

## 1.6 Desktop study

A desktop study was carried out to identify an indicative viewshed for the Bango wind farm. 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 10km 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

The Proponent prepared ZVI Diagrams to illustrate the potential visibility of the wind turbines within the Project 10km viewshed. ZVI Diagrams included visibility from tip of blade, hub height and whole turbine. The ZVI are illustrated in **Figures 23, 24** and **25** and detailed in **Section 7** of this LVIA. The Proponent has also prepared cumulative ZVI Diagrams which are illustrated in **Figures 30**, **31** and **32** and detailed in **Section 10** of this LVIA.

### 1.8 Fieldwork and photography

GBD undertook a total three days fieldwork associated with the Bango 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 around the proposed electrical works; and
- one day of site photography for the public photomontages locations.

The Proponent undertook separate fieldwork to capture panorama photographs from uninvolved and neighbouring dwellings within 2 km of the proposed Bango wind farm turbine 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 such as:

- 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

Twenty three photomontages have been prepared from nineteen locations (10 from public road corridors and 9 from potential dwellings) to illustrate the potential visibility of the Bango wind farm following construction. The photomontages locations include uninvolved and neighbouring residential dwellings within 2 km of the Bango wind turbines, in accordance with the requirements of the NSW Draft Guidelines.

The public photomontages locations were selected to provide representative views from the vicinity of residential dwellings as well as publically accessible areas and road corridors. The photomontages locations are illustrated in **Figure 33** and the public photomontages in **Figures 34** to **53**. The photomontages prepared for uninvolved and neighbouring residential dwellings within 2 km of the Bango wind turbines are illustrated in **Figures 54** to **79**.

### 1.12 Shadow flicker & blade glint

The Proponent undertook and shadow flicker assessment and prepared a shadow flicker diagram (**Figure 27**) for the Bango wind farm project. The results of the shadow flicker assessment and a consideration of potential blade glint impacts are included in **Section 9** of this LVIA.

# Location

Section 2

## 2.1 Location

The project would be located on the edge of the Southern Tablelands and the South West Slopes in the NSW/ACT Border Region Renewable Energy Precinct.

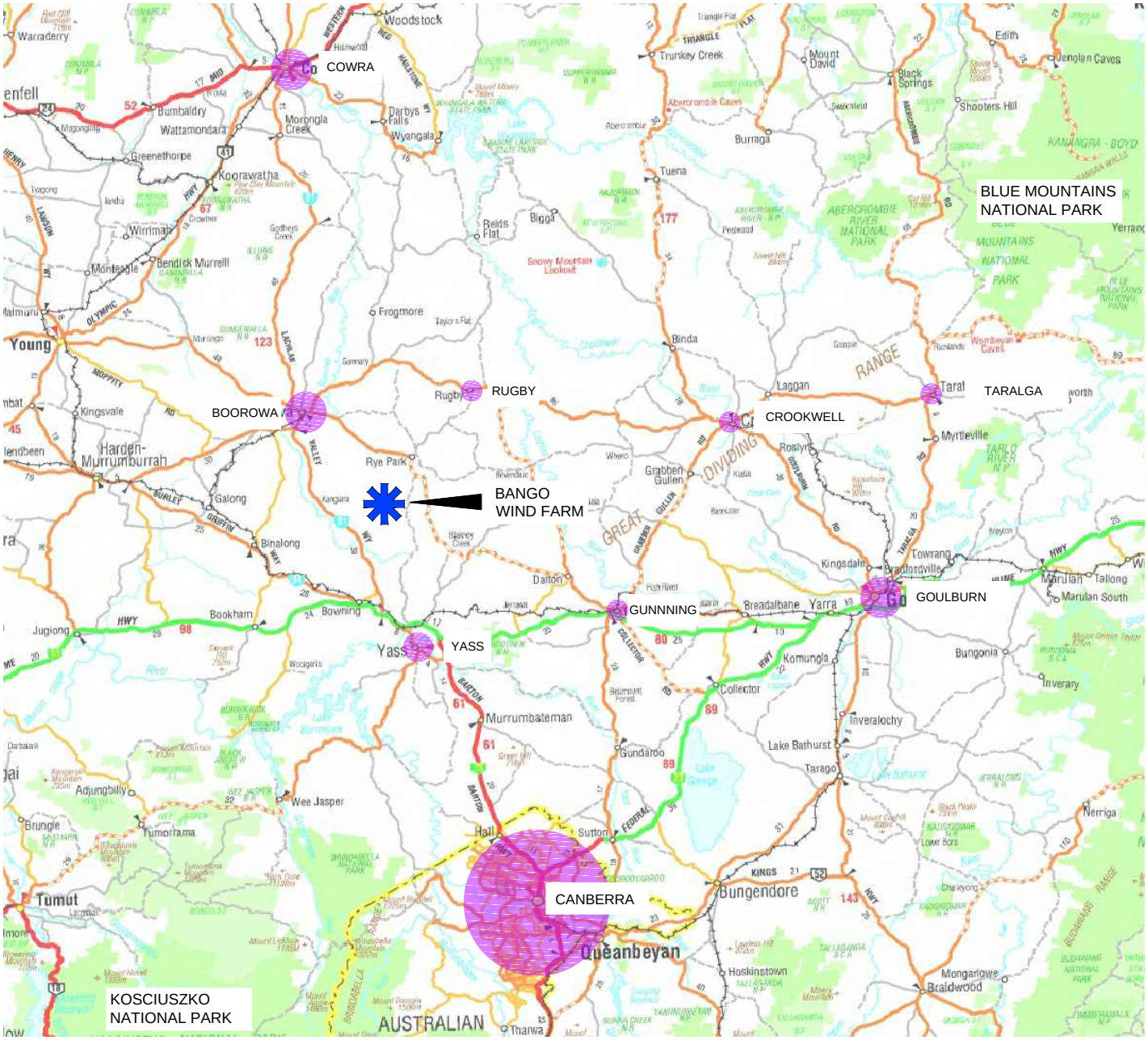
The project would extend in an approximate north south alignment along a series of hills and ridgelines at 430 m to 760 m in elevation. The project site would incorporate around 15 participating rural residential and farming properties covering an area around 7,683 hectares across portions of the Yass Valley Shire and Boorowa Shire Local Government Areas.

There are a small number of Townships and gazetted localities that occur within and immediately beyond the Bango wind farm 10 km viewshed. These include localities such as:

- Boorowa (approximately 7 km to the north west of the Langs Creek cluster);
- Rye Park (approximately 4 km to the north east of the Mt Buffalo cluster);
- Rugby (approximately 20 km to the north east of the Mt Buffalo cluster);
- Bowning (approximately 13.5 km to the south of the Mt Buffalo cluster); and
- Yass (approximately 22 km to the south of the Mt Buffalo cluster).

The Main Southern Railway and Hume Highway transport corridors extend approximately east to west around 14 km south of the project site boundary.

The location of the Bango wind farm is illustrated in **Figure 1**.




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


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

**Figure 1**
**Location Plan**

# BANGO WIND FARM

# Project description

Section 3

## 3.1 Project description

The key visual components of the Bango wind farm (Layout Option 1) would comprise:

- up to 122 wind turbines;
- up to 122 individual 33kV external kiosk transformers and switchgear with associated control systems to be located in the vicinity of the wind turbine towers (in some turbine models transformer equipment will be integrated within the tower or nacelle);
- underground and overhead electrical and communication cable network linking turbines to each other within the project boundary;
- a collector substation located adjacent to the existing TransGrid 132 kV powerline;
- a switching station located adjacent to the existing TransGrid 132 kV powerline that spans the western portion of the project site;
- up to 6 permanent wind monitoring masts up to 120 m high. The permanent monitoring masts may be either static guyed or un-guyed structures and will be to a minimum height of the wind turbine hubs;
- up to 4 site access tracks for construction traffic as well as operation and ongoing maintenance; and
- appropriate Bango wind farm signage and maintenance facilities.

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

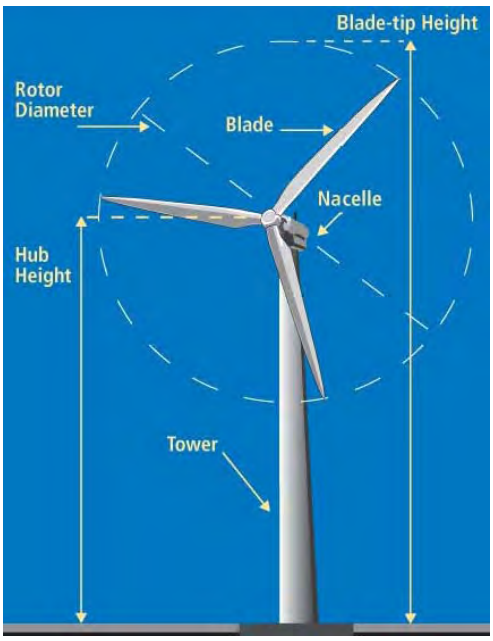
- approximately 4 material lay down areas;
- construction site office and compound;
- crane hardstand areas; and
- mobile concrete batching plant and rock crushing facilities.

## 3.2 Wind turbines

The specific elements of the wind turbine structures comprise:

- concrete foundations;
- tubular tapering steel or concrete towers;
- nacelles at the top of the tower housing the gearbox and electrical generator;
- rotors comprising a hub (attached to the nacelle) with three blades; and
- three fibreglass / carbon fibre blades attached to each hub.

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




*Configuration and components of a typical wind turbine*

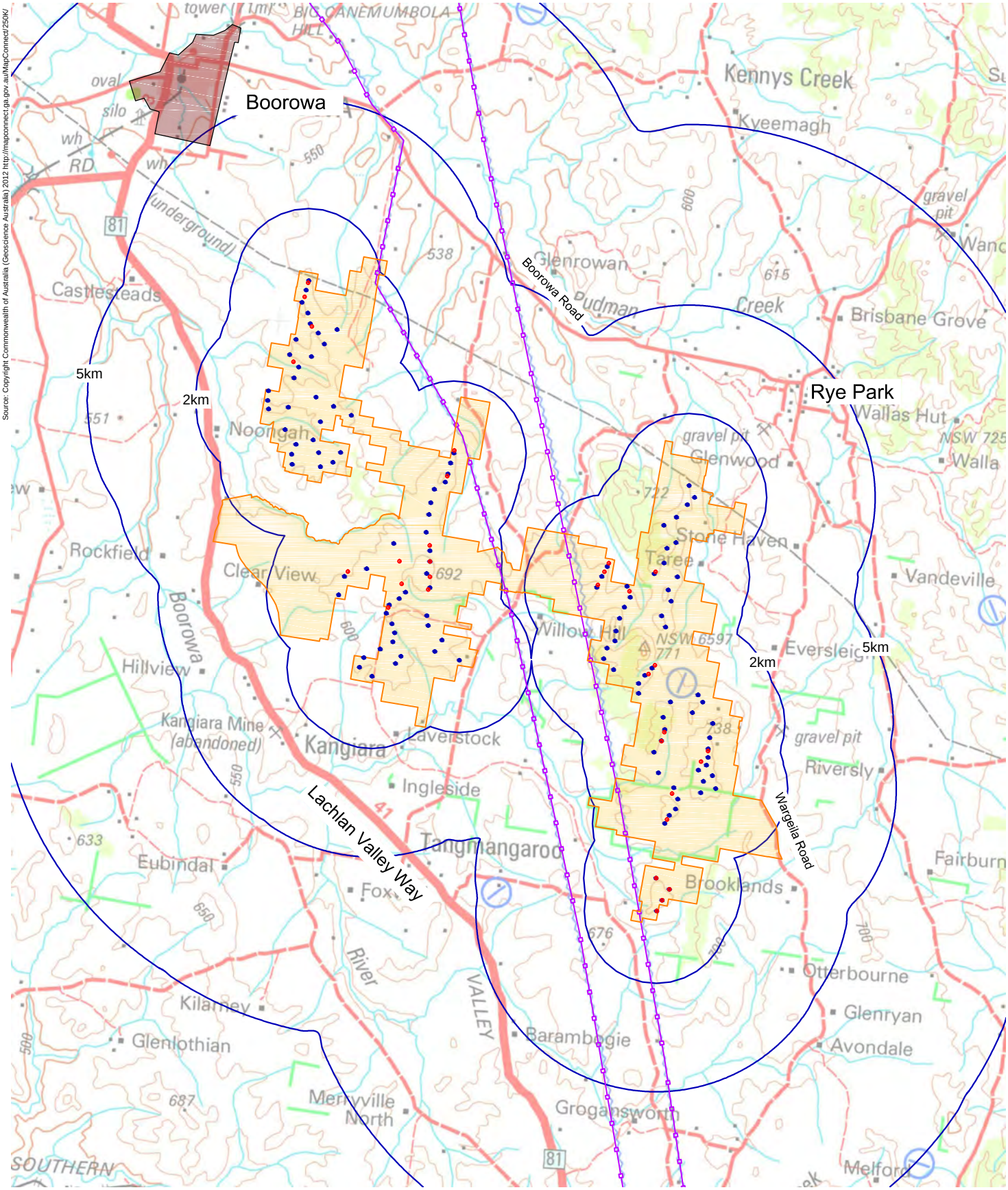
**Table 4** outlines the main design parameters for the proposed Bango wind turbine for Layout Option 1.

**Table 4** Bango wind turbine details:

| Element | Description |
|---|---|
| Tower height | 120 m |
| Rotor Diameter | 144 m |
| Overall height from ground level to tip of blade | 192 m |
| **Proposed number of Bango wind turbines** | **122 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 Bango wind farm layout (for Options 1 and 2) is illustrated in **Figure 2.**

The wind farm is likely to be constructed in stages and comprise 3 main clusters of wind turbines. This LVIA refers to these clusters as:




**Legend**

- Bango wind farm project area
- Proposed Bango wind turbine (Layout Option 1)
- Proposed Bango wind turbine (Layout Option 2)
- Distance from proposed Bango wind turbine (Layout Option1)
- Existing 132 kV overhead powerline

**Figure 2**
**Wind turbine Option 1 & Option 2 Layout**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

- The Mt Buffalo cluster;
- The Kangiara cluster; and
- The Langs Creek cluster.

Details for each wind turbine cluster are provided in **Table 5** and illustrated in **Figure 3**.

**Table 5** Wind turbine clusters

| Wind turbine cluster | Maximum number of wind turbines (Layout Option 1) | General location |
|---|---|---|
| Mt Buffalo cluster | 58 | Eastern cluster |
| Kangiara cluster | 34 | Central cluster |
| Langs Creek cluster | 30 | North western cluster |

### 3.3 Wind monitoring masts

Up to 6 permanent wind monitoring masts would be installed on-site, extending to a minimum height of the wind turbine hubs (around 120 m in height for Option Layout 1). The wind monitoring masts would be of a guyed or un-guyed, narrow lattice or tubular steel design. The wind monitoring masts 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 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 6 m wide (wider at bends) to allow for over sized vehicle manoeuvring. 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;

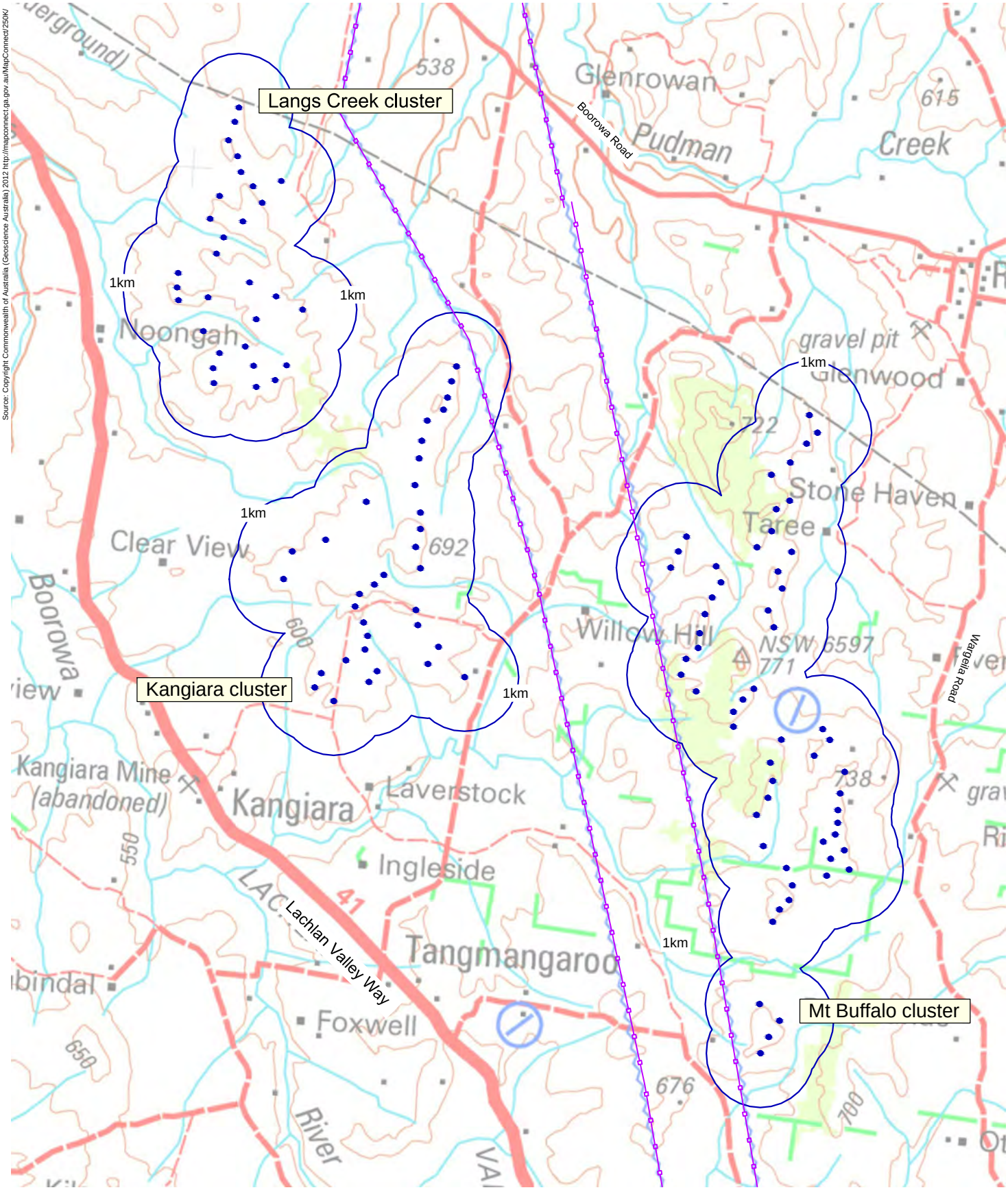
- extent of cut and fill; and
- potential to maximise rehabilitation at the completion of the construction phase.

## 3.5 Electrical works

The majority of cabling works, including the installation of control cables linking the turbines to the control building would be installed underground. For electrical reasons some cabling may be required to be installed on medium voltage (up to 132 kV) overhead powerline supported by single low profile tubular poles.

Grid connection would be achieved via a connection to an existing 132 kV powerline which spans north to south across the western portion of the project site between the Mt Buffalo and Kangiara wind turbine clusters. The wind farm turbines would be connected to a collector substation and switching station for grid connection.

The proposed electrical works are described in **Section 13** and illustrated in **Figure 83**. Typical photographs of existing 132 kV double circuit powerlines (at Glen Innes, NSW) are illustrated in **Figure 84**.




**Legend**

- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV overhead powerline

0 km 2 km

**Figure 3 Bango wind farm turbine clusters**

WIND PROSPECT CWP

GREEN BEAN DESIGN landscape architects

# BANGO WIND FARM

# Local environmental factors



## 4.1 Climatic and atmospheric conditions

Local climatic and atmospheric conditions have the potential to influence the visibility of the Bango wind farm 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.

Meteorological data collected over the past 113 years at Yass (Linton Hostel) indicates that there are:

- 92 clear days (annual mean average);
- 109 cloudy days (annual mean average); and
- 74 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.

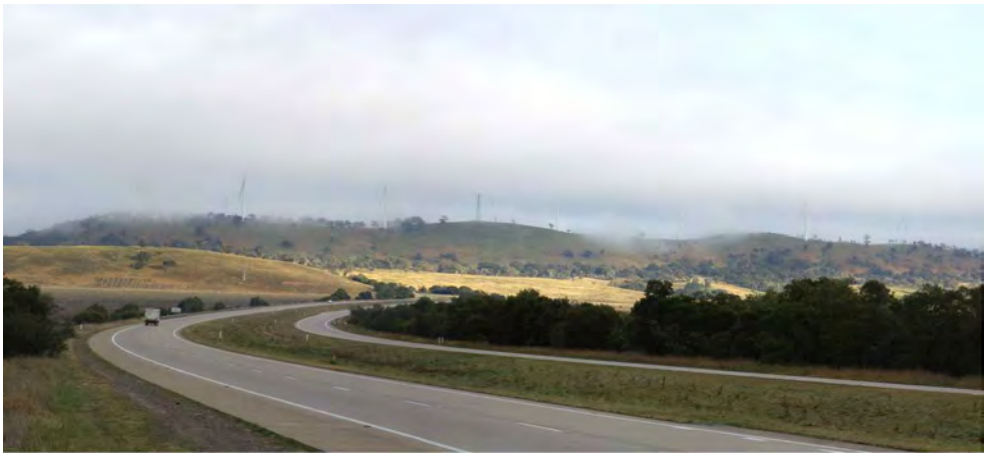
The extent to which local weather conditions can influence visibility toward turbine structures is illustrated in **Figure 4**.

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

PHOTOGRAPH 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.

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

PHOTOGRAPH 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.



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

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

**Figure 4 Visibility & weather**

## 4.2 Topography and drainage

The topography of the landscape within the New South Wales Southern 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 and low rolling hills cut by drainage lines. The elevation of the wind farm site falls gently from the south east to the north west. A number of ephemeral drainage lines occur across the project site, draining to broader valleys north and west of the wind farm project site.

Landform elevation within and surrounding the project site is illustrated in **Figure 5**.

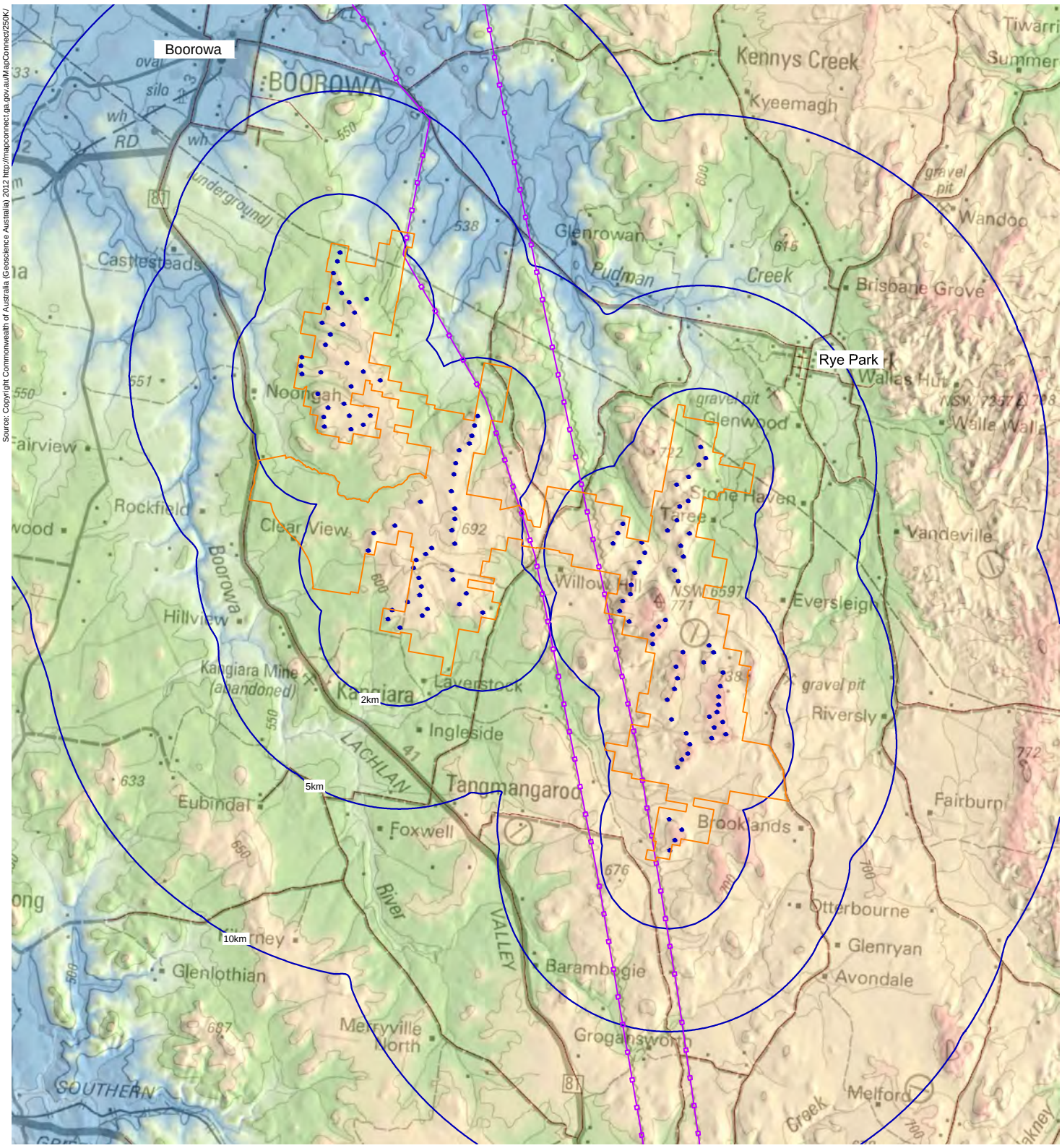
## 4.3 Vegetation

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 **Section 10** of 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.

Timbered areas have some potential to provide partial or full screening toward the project area from surrounding public and residential view locations. The screening potential tends to increase when combined with the local topography of hills and undulating landform.

The landscape within and surrounding the project site is illustrated in the panorama photographs presented in **Figures 7** to **19.**






**Legend**

- Bango wind farm project area
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing powerline

**Elevation**

- **700 m - 800 m**
- **600 m - 700 m**
- **500 m - 600 m**
- **< 500 m**

0km 2.5km

**Figure 5**
**Topography**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

# Panoramic photographs

Section 5

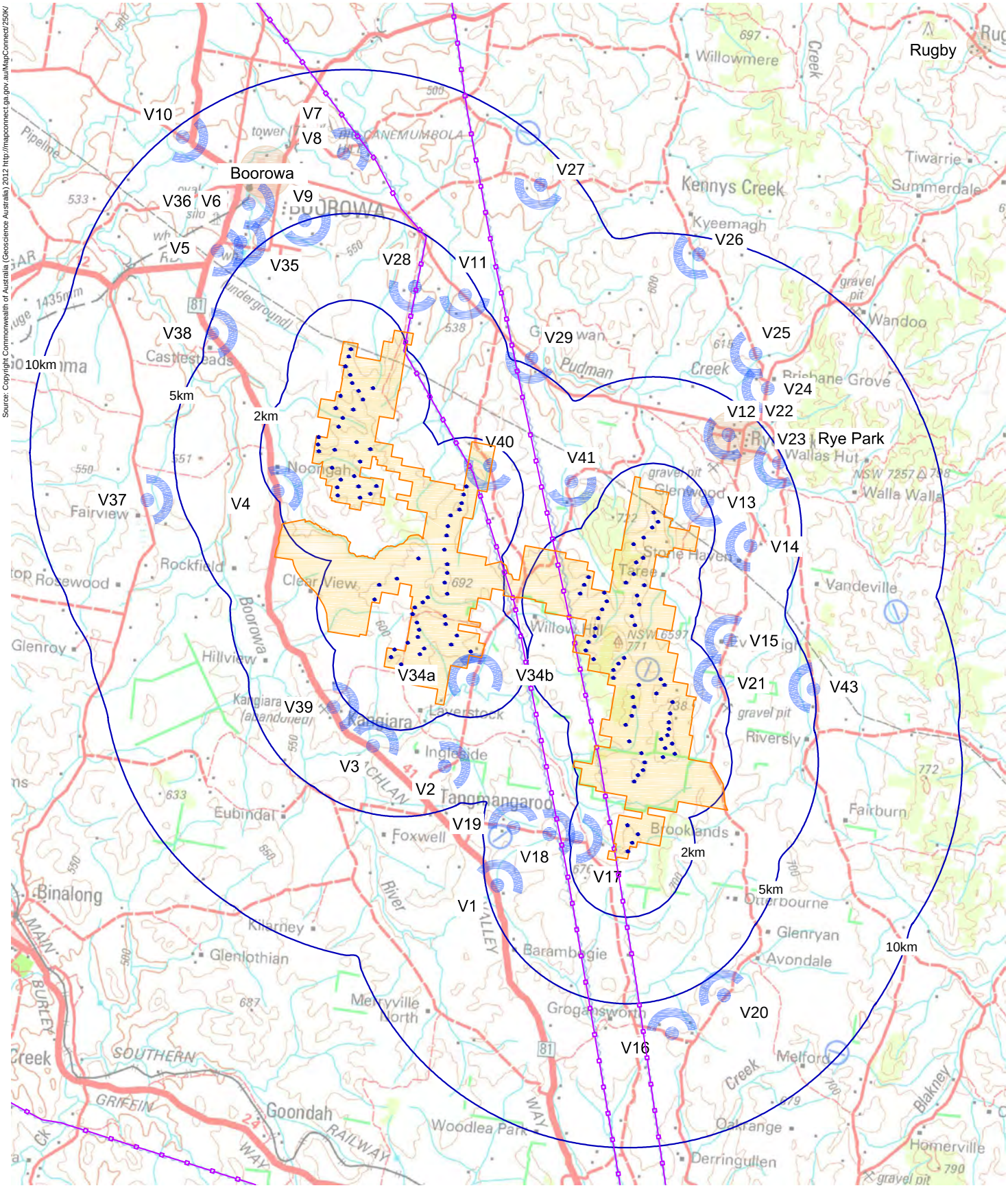
## 5.1 Panoramic Photographs

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.

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 6**, and the panoramic photographs illustrated in **Figures 7** to **19**.

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 11** of this LVIA, and are illustrated in **Figures 34** to **79**.




**Legend**

- Bango wind farm project area
- Public photograph location
- Proposed Bango wind turbine (Layout Option 1)
- Existing powerline route
- Distance from proposed Bango wind turbine

0km 2.5km

**Figure 6 Public photograph locations**

# BANGO WIND FARM

WIND PROSPECT CWP

GREEN BEAN DESIGN landscape architects

Long distance views toward proposed Bagno wind turbines within the Kangiara cluster

(Image source GBD 2013)

Photo Location V1 - View north to north east from residential access track adjoining Lachlan Valley Way (Approximate distance to closest wind turbine 4.7 km)
Photo coordinate Easting: 667999 Northing: 6158794

Long distance views toward proposed Bango wind turbines within the Kangiara and Mt Buffalo clusters

(Image source GBD 2013)


Photo Location V2 - View north to east from Tangmangaroo Road (Approximate distance to closest wind turbine 4 km)
Photo coordinate Easting: 664864 Northing: 6167599

Long distance views toward proposed Bango wind turbines within the Kangiara and Mt Buffalo clusters

(Image source GBD 2013)

Photo Location V3 - View north to east from access track adjoining Lachlan Valley Way (Approximate distance to closest wind turbine 3 km)
Photo coordinate Easting: 662679 Northing: 6167747

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 7 - Photo Sheet 1**

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

# BANGO WIND FARM


Photo Location V4 - View north to east from Lachlan Valley Way (Approximate distance to closest wind turbine 2 km)
Photo coordinate Easting: 658868 Northing: 6177164


Photo Location V5 - View east to south east from Lachlan Valley Way (Boorowa Township south) (Approximate distance to closest wind turbine 5.8 km)
Photo coordinate Easting: 656662 Northing: 6185158


Photo Location V6 - View east to south east from Boorowa Township (south) Trucking Yards Road (Approximate distance to closest wind turbine 6.1 km)
Photo coordinates Easting: 657466 Northing: 6186878

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 8 - Photo Sheet 2**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Boorowa Road

(Image source GBD 2013)

Photo Location V7 - View south from dwelling access road off Brial Road (Boorowa), contextual view toward general locality of proposed Rugby wind farm (no view toward Bango wind farm turbines)
Photo coordinate Easting: 661301 Northing: 6188888

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

Big Canemumbola Hill

(Image source GBD 2013)

Photo Location V8 - View north to east from dwelling access road off Brial Road (Boorowa), contextual view toward general locality of proposed Rugby wind farm (no view toward Bango wind farm turbines)
Photo coordinate Easting: 661775 Northing: 6188514

Views toward wind turbines within the Langs Creek cluster screened by tree cover

Lachlan Valley Way

(Image source GBD 2013)

Photo Location V9 - View south from road to recycling facility (Boorowa) (Approximate distance to closest wind turbine 4.8 km)
Photo coordainte Easting: 659281 Northing: 6187233

**Figure 9 - Photo Sheet 3**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

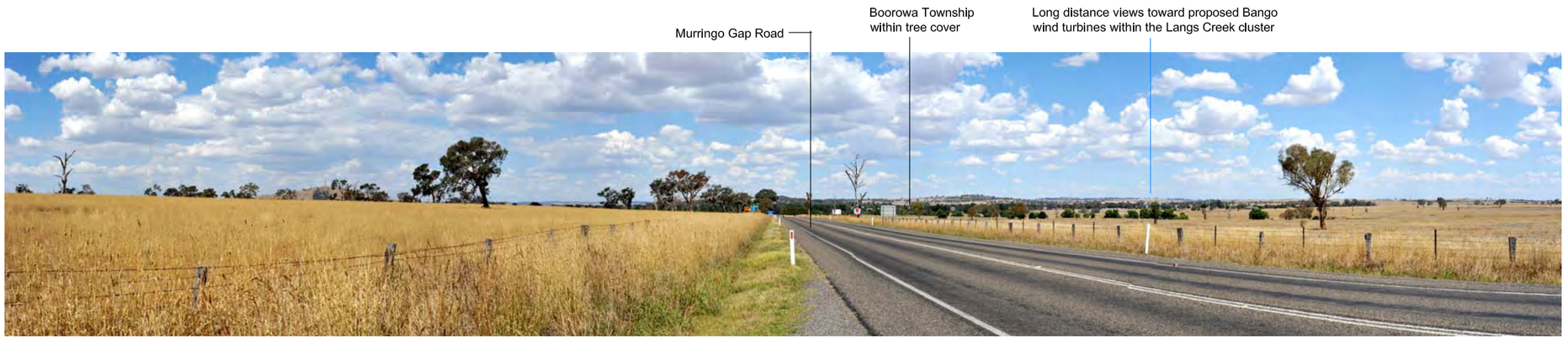



Photo Location V10 - View east to south east from Murringo Gap Road (Approximate distance to closest wind turbine 9.4 km)
Photo coordinate Easting: 655864 Northing: 6189276

Views toward Bango wind turbines are largely screened by landform rising to the south of Boorowa Road

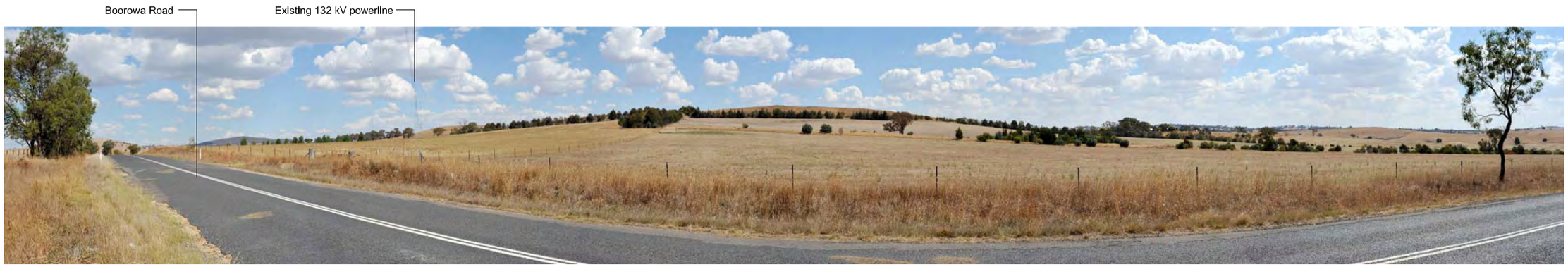



Photo Location V11 - View south from Boorowa Road (Approximate distance to closest wind turbine 4.5 km)
Photo coordinate Easting: 667106 Northing: 6182280


Photo Location V12 - View south to west from Cook Street (Rye Park) (Approximate distance to closest wind turbine 3.75 km)
Photo coordinate Easting: 674704 Northing: 6178978

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 10 - Photo Sheet 4**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Views toward Bango wind turbines within the north portion of the Mt Buffalo cluster

(Image source GBD 2013)

Photo Location V13 - View south to south west from Hill View Lane (Rye Park south) (Approximate distance to closest wind turbine 1.85 km)
Photo coordinate Easting: 674136 Northing: 6176999

Wargeila Road

Views toward Bango wind turbines within the north portion of the Mt Buffalo cluster will be largely screened by landform rising to the west of Wargeila Road

(Image source GBD 2013)

Photo Location V14 - View south to west from Wargeila Road (Approximate distance to closest wind turbine 3.5 km)
Photo coordinate Easting: 675452 Northing: 6175198

Short distance views toward Bango wind turbines within the central portion of the Mt Buffalo cluster

(Image source GBD 2013)

Photo Location V15 - View south west to west from Wargeila Road (Approximate distance to closest wind turbine 2.7 km)
Photo coordinate Easting: 674776 Northing: 6172266

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 11 - Photo Sheet 5**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Long distance views toward Bango wind turbines
within the southern portion of the Mt Buffalo cluster

(Image source GBD 2013)

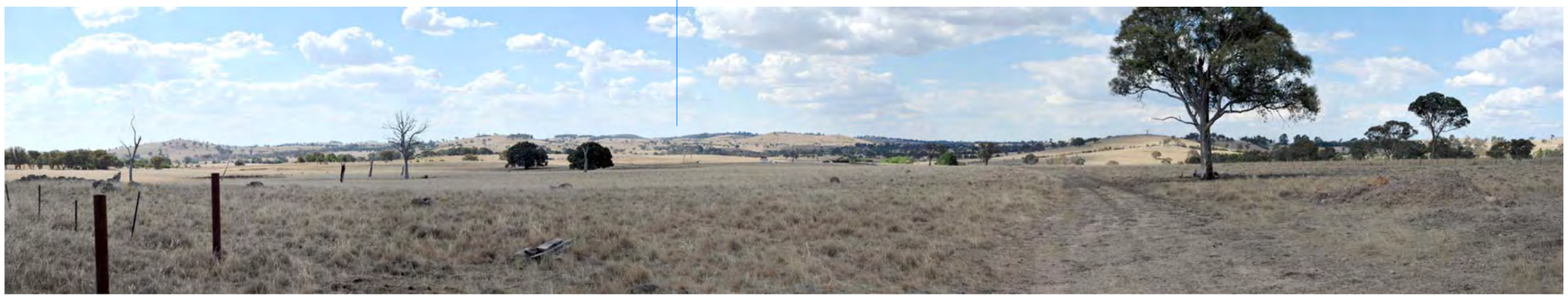


Photo Location V16 - View north from Davis Lane (Approximate distance to closest wind turbine 6.5 km)
Photo coordinate Easting: 672767 Northing: 6158149

Short distance views toward Bango wind turbines within the southern and central portion of the Mt Buffalo cluster

(Image source GBD 2013)

Photo Location V17 - View north to east from Moorby's Lane (Approximate distance to closest wind turbine 1.8 km)
Photo coordinate Easting: 669438 Northing: 6164993

Short distance views toward Bango wind turbines within
the southern and central portion of the Mt Buffalo cluster

Moorby's Lane

(Image source GBD 2013)

Photo Location V18 - View north to north east from Moorby's Lane (Approximate distance to closest wind turbine 2.8 km)
Photo coordinate Easting: 668667 Northing: 6165173

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 12 - Photo Sheet 6**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP


Photo Location V19 - View west to north east from Moorby's Lane (Approximate distance to closest wind turbine 6.3 km)
Photo coordinate Easting: 667163 Northing: 6165521

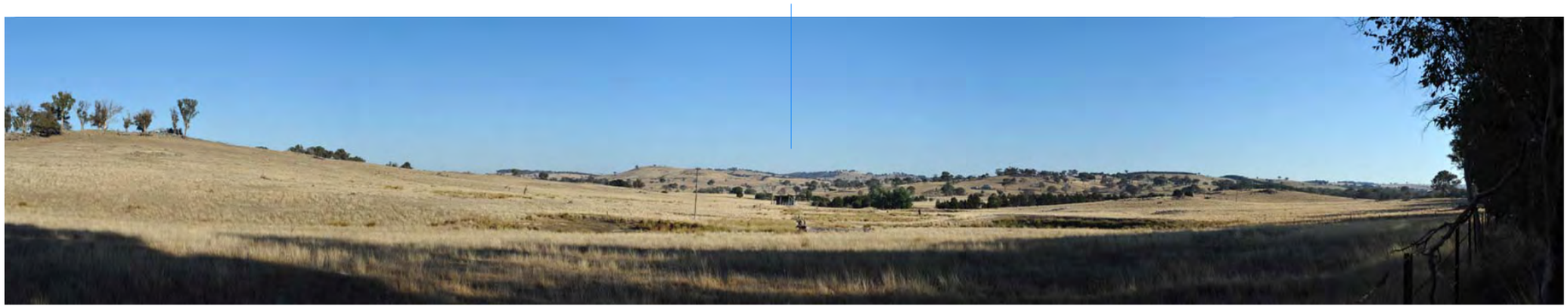



Photo Location V20 - View west to north from Wargeila Road (Approximate distance to closest wind turbine 6 km)
Photo coordinate Easting: 674192 Northing: 6159341

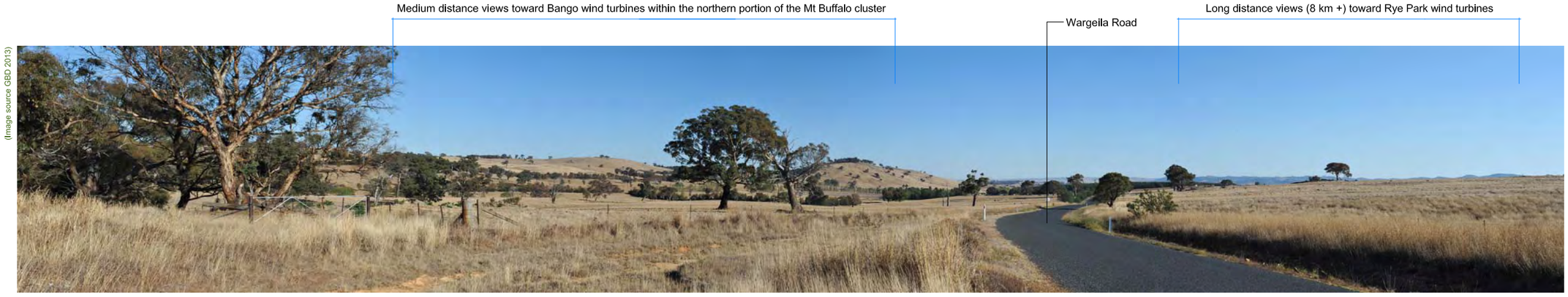



Photo Location V21 - View north west to north east from Wargeila Road (Approximate distance to closest wind turbine 3.5 km)
Photo coordinate Easting: 674010 Northing: 6167621

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 13 - Photo Sheet 7**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP


Photo Location V12 - View south west to west from Cook Street (Rye Park) (Approximate distance to closest wind turbine 3.75 km)
Photo coordinate Easting: 674704 Northing: 6178978


Photo Location V23 - View south west to west from Rye Park Cemetery Road (Approximate distance to closest wind turbine 4.7 km)
Photo coordinate Easting: 676399 Northing: 6178098

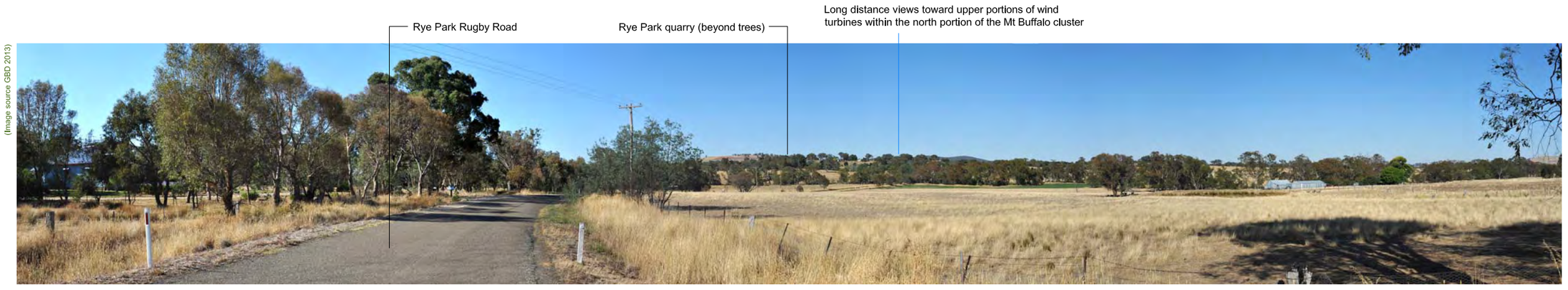



Photo Location V24 - View south east to south west from Rye Park Rugby Road (north of Rye Park Village) (Approximate distance toward closest wind farm turbine 5.8 km)
Photo coordinate Easting: 675763 Northing: 6179791

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 14 - Photo Sheet 8**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

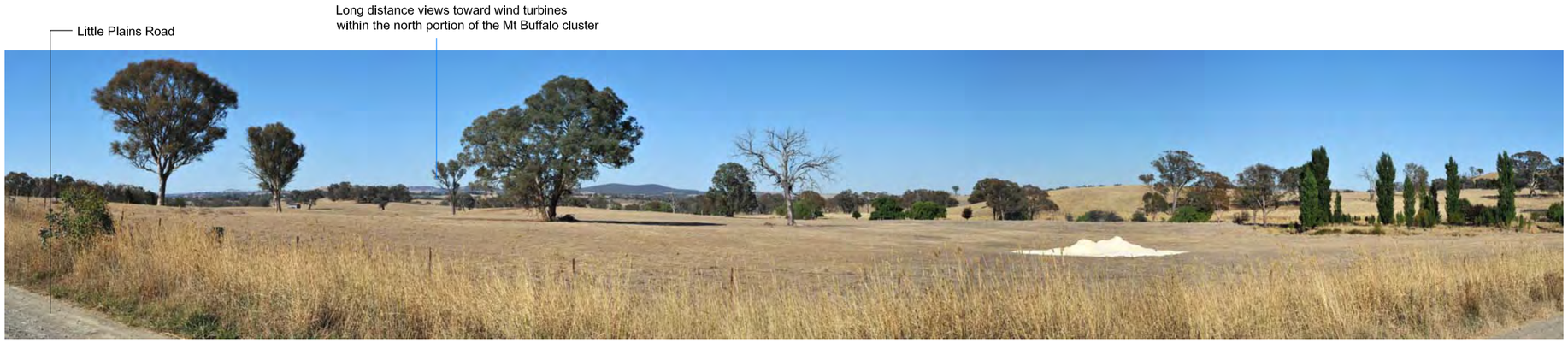



Photo Location V25 - View south to west from Little Plains Road (Approximate distance to closest wind farm turbine 6.5 km)
Photo coordinate Easting: 675693 Northing: 6181544

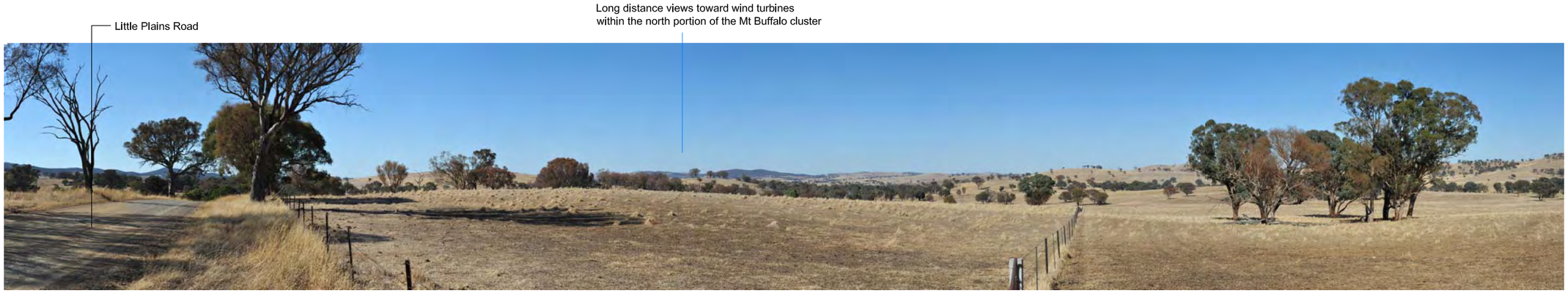



Photo Location V26 - View south east to west from Little Plains Road (Approximate distance to closest wind turbine 9 km)
Photo coordinate Easting: 674496 Northing: 6184105


Photo Location V27 - View south from Kenny's Creek Road (Approximate distance to closest wind turbine 8.7 km)
Photo coordinate Easting: 667866 Northing: 6187889

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 15 - Photo Sheet 9**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Medium distance views toward wind turbines within the Langs Creek and Kangiara clusters

Hopefield Lane

(Image source GBD 2013)

Photo Location V28 - View south east to south west from Hopefield Lane (Approximate distance to closest wind turbine 3 km)
Photo coordinate Easting: 663516 Northing: 6183393

Boorowa Road

Long distance view toward Bango wind turbines
within the central portion of the Mt Buffalo cluster

Views toward turbines within the Kangiara cluster
screened by landform rising to the south of Boorowa Road

(Image source GBD 2013)

Photo Location V29 - View east/south to south west from Boorowa Road (Approximate distance to closest wind turbine 4.9 km)
Photo coordinate Easting: 668504 Northing: 6180858

Very short distance views toward wind turbines within the south portion of the Kangiara cluster

Tangmangaroo Road

(Image source GBD 2013)

Photo Location V34a - View west to north from Tangmangaroo Road (Approximate distance to closest wind turbine 985 m)
Photo coordinate Easting: 665502 Northing: 6169307

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 16 - Photo Sheet 10**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Medium distance views toward wind turbines within the Mt Buffalo cluster


Photo Location V34b - View north to east from Tangmangaroo Road (Approximate distance to closest wind turbine 4 km)
Photo coordinate Easting: 665502 Northing: 6169307


Photo Location V35 - View north to south east from Meads Lane (Boorowa Township south) (Approximate distance to closest wind turbine 5.3 km)
Photo coordinate Easting: 657182 Northing: 6185762


Photo Location V36 - View east to south east from Boorowa Township (south) Trucking Yards Road (Approximate distance to closest wind turbine 6.1 km)
Photo coordinate Easting: 657466 Northing: 6186878

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 17- Photo Sheet 11**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Long distance views toward proposed Bango wind turbines within the Langs Creek and Kangiara clusters

Big Canemumbola Hill

Boorowa Township (9 km beyond trees)

Binalong Road

(Image source GBD 2013)

Photo Location V37 - View north to south east from Binalong Road (Approximate distance to closest wind turbine 6.2 km)
Photo coordinate Easting: 654231 Northing: 6177062

Long distance views toward proposed Bango wind turbines within the Langs Creek cluster

Lachlan Valley Way

(Image source GBD 2013)

Photo Location V38 - View south east to south west from Lachlan Valley Way (Approximate distance to closest wind turbine 5 km)
Photo coordinate Easting: 657051 Northing: 6182202

Short distance views toward proposed Bango wind turbines within the Kangiara cluster

Long distance views toward proposed Bango wind turbines within the Mt Buffalo cluster

Lachlan Valley Way

(Image source GBD 2013)

Photo Location V39 - View east to south west from Lachlan Valley Way (Approximate distance to closest wind turbines 2.6 km - with Kangiara cluster)
Photo coordinate Easting: 661909 Northing: 6168475

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 18- Photo Sheet 12**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

Short distance views toward wind turbines within the north portion of the Kangiara cluster

Harry's Creek Road

(Image source GBD 2013)

Photo Location V40 - View south from Harry's Creek Road (Approximate distance to closest wind turbine 1 km)
Photo coordinate Easting: 666492 Northing: 6177100

Medium distance views toward wind turbines within the central portion of the Mt Buffalo cluster

(Image source GBD 2013)

Photo Location V41 - View south to south east from Tangmangaroo Road (Approximate distance to closest visible wind turbine 4 km)
Photo coordinate Easting: 669103 Northing: 6177509

Medium distance views toward wind turbines within the central and southern portion of the Mt Buffalo cluster

Rye Park Dalton Road

(Image source GBD 2013)

Photo Location V42 - View north to south west from Rye Park Dalton Road (Approximate distance to closest wind turbine 4.9 km)
Photo coordinate Easting: 677690 Northing: 6170040

## Notes

Individual photographs taken with a Nikon D700 camera with a 50 mm 1:1.4D prime lens. Composite digital stitching results in a panorama with an approximate view angle between 110° and 130°.

Individual panorama photo coordinate map datum is in GDA94 to ± 5 m accuracy.

Extent of potential wind turbine visibility and illustrated on each panorama photograph is indicative only.

**Figure 19- Photo Sheet 13**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

# Landscape character areas

Section 6

## 6.1 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 20**. The LCA's are not considered to be 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/agricultural landscape;
- LCA 2 – Drainage lines;
- LCA 3 – Hills and ridgelines;
- LCA 4 – Timbered areas; and
- LCA 5 – Rural dwellings.

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

## 6.2 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


**Legend**

- Bango wind farm project area
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing powerline
- Involved residential dwelling
- Uninvolved residential dwelling within 2 km of wind turbine
- Uninvolved residential dwelling within 2 km of wind turbine subject to neighbour agreement
- Uninvolved residential dwelling between 2 km and 5 km of wind turbine
- Uninvolved residential dwelling between 5 km and 10 km of wind turbine
- LCA 1 - Undulating pastoral & agricultural landscape
- LCA 2 - Drainage lines
- LCA 3 - Hills and ridgelines
- LCA 4 - Timbered areas
- LCA 5 - Urban/rural settlement

0 km 2.5 km

**Figure 20 Landscape Character Areas**

# BANGO WIND FARM

WIND PROSPECT CWP

GREEN BEAN DESIGN landscape architects

extent to which it could accommodate the wind farm development. The criteria used to determine landscape sensitivity are outlined in **Table 6** and based on current good practice employed in the assessment of wind farm developments. This LVIA draws on the Land Use Consultants report on landscape sensitivity for wind farm developments on the Shetland Islands (March 2009) as well as the Western Australian Planning Commission manual for Visual Landscape Planning (2007). 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 Southern Tablelands region.

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 values on the local landscape. These values could transcend preferences (likes and dislikes) and include personal, cultural as well as other parameters.

**Table 6** – Landscape Sensitivity Criteria

| 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<br>• Simple<br>• Featureless<br>• Absence of strong topographical variety | ↔ | • Small scale landform<br>• Distinctive and complex<br>• Human scale indicators<br>• Presence of strong topographical variety |
| Landcover: patterns, complexity and consistency | • Simple<br>• Predictable<br>• Smooth, regular and uniform | ↔ | • Complex<br>• Unpredictable<br>• Rugged and irregular |
| Settlement and human influence | • Concentrated settlement pattern<br>• Presence of contemporary structures (e.g. utility, infrastructure or industrial elements) | ↔ | • Dispersed settlement pattern<br>• 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 |

**Table 6** – Landscape Sensitivity Criteria

| Landscape Sensitivity Assessment Criteria | | | |
|---|---|---|---|
| **Characteristic** | **Aspects indicating lower sensitivity to the wind farm development** | ↔ | **Aspects indicating higher sensitivity to the wind farm development** |
| Intervisibility with adjacent landscapes | • Limited views into or out of landscape<br>• Neighbouring landscapes of low sensitivity<br>• Weak connections, self contained area and views<br>• Simple large scale backdrops | ↔ | • Prospects into and out from high ground or open landscape<br>• Neighbouring landscapes of high sensitivity<br>• Contributes to wider landscape<br>• Complex or distinctive backdrops |

The landscape sensitivity assessment criteria set out in **Table 6** 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 7** to **11** and is set out against each characteristic identified in **Table 6**.

The overall landscape sensitivity for each LCA is a summation of the scale for each characteristic identified in **Tables 7** to **11**. 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.

### 6.3 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.

### 6.3.1 LCA 1 Undulating pastoral/agricultural landscape

**Plate 1** – Typical view across undulating pastoral/agricultural landscape

**Table 7** – LCA 1 - Undulating pastoral/agricultural landscape -Landscape Sensitivity

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Landform and Scale | | **2** | | | |
| | The undulating pastoral/agricultural landscape is a medium to large scale open landscape with a gently undulating landform. The structure of the landform is simple containing few distinct features and has a general absence of any strong topographical elements. | | | | |
| Landcover | | **2** | | | |
| | Landcover is predominantly simple and predictable within the context of widespread pasture areas across the regional area of the Southern Tablelands. The overall landscape pattern created by the grass pasture is smooth, regular and uniform. Areas of cultural planting surround many rural dwellings in the form of evergreen windbreaks. | | | | |
| Settlement and human influence | | | **3** | | |
| | A dispersed settlement pattern occurs across the landscape and comprises rural farm homesteads including documented local historical structures. There is a general absence of modern development throughout this landscape, excluding agricultural structures and local roads and access tracks. | | | | |
| Movement | | | **3** | | |
| | Movement is generally restricted to occasional passing traffic, livestock as well as agricultural machinery. | | | | |
| Rarity | | **2** | | | |
| | Undulating grassland is generally well represented and a common feature across the regional area of the Southern Tablelands. | | | | |

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Intervisibility | | | 3 | | |
| | Undulating grassland areas appear as a simple backdrop in views from surrounding elevated areas. Undulating landform can retain and constrict views within the landscape, but generally contributes to the wider landscape. | | | | |
| Overall Sensitivity Rating | Medium (Score 15 out of 30) | | | | |

### 6.3.2 LCA 2 Drainage Lines

**Plate 2** – Typical view across drainage lines landscape

**Table 8** – LCA 2 - Drainage Lines - Landscape Sensitivity

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Landform and Scale | | 2 | | | |
| | Drainage line areas are generally contained by the gently sloping landform resulting in a small to moderate scale landform. The landform is simple containing few distinct features and has an absence of any strong topographical elements. | | | | |
| Landcover | | 2 | | | |
| | Landcover is predominantly simple and predictable within the context of widespread drainage areas across the broader regional area of the Southern Tablelands. The overall landscape pattern created by grass pasture within this landscape is smooth, regular and uniform, although mosaics of timbered stands on adjoining slopes and hillsides create some diversity and contrast in pattern. | | | | |
| Settlement and human influence | | | 3 | | |
| | There is a general absence of settlement within this landscape with a small and | | | | |

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| | dispersed number of agricultural structures (some abandoned), minor access tracks and fences occurring throughout. Some modifications to landscape have been carried out to accommodate road access and the former railway line. | | | | |
| Movement | | | 3 | | |
| | Movement within this LCA is largely defined by traffic travelling along local road corridors such as the Lachlan Valley Way and the Boorowa Road. | | | | |
| Rarity | | **2** | | | |
| | Drainage lines and their surrounding landscape are generally well represented and a common feature across the broader regional area of the Southern Tablelands. | | | | |
| Intervisibility | | | **3** | | |
| | Intervisibility is limited as views from within this landscape are often contained by sloping landform rising above drainage lines. Views along drainage lines, as well as views from areas above and across drainage lines provide links with adjoining landscape areas. | | | | |
| Overall Sensitivity Rating | Medium (Score 15 out of 30) | | | | |

### 6.3.3 LCA 3 Hills and ridgelines

**Plate 3** – Typical views along hills and ridgeline landscape

**Table 9** – LCA 3 - Hills and ridgelines - Landscape Sensitivity

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Landform and Scale | | 2 | | | |
| | Hill and ridgeline areas are represented by a generally open and large scale landform with distant views available from elevated areas within this landscape. The landform is simple containing few distinct features and has a general absence of any strong topographical elements. | | | | |
| Landcover | | 2 | | | |
| | Landcover is predominantly simple and predictable within the context of similar areas across the Southern Tablelands. The overall landscape pattern created by grass pasture within this landscape is smooth, regular and uniform, although mosaics of timbered areas on surrounding slopes and cultural planting surrounding dwellings create some diversity and contrast in pattern. | | | | |
| Settlement and human influence | | | 3 | | |
| | Settlement is occasional and dispersed within this landscape and does not generally occur along the top of ridgelines or on elevated and exposed slopes. The main influences of human activity are the effects of agricultural improvement within the landscape. | | | | |
| Movement | | | | 4 | |
| | Movement is generally limited to local roads and access tracks. | | | | |
| Rarity | | 2 | | | |
| | Simple slopes and ridgelines are generally well represented and a common feature across the broader regional area of the Southern Tablelands. | | | | |
| Intervisibility | | | 3 | | |

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| | Intervisibility is limited as views from within this landscape are often contained by undulating or sloping landform rising to ridgelines, however, potential distant views do occur from elevated landform to provide links to adjoining landscape areas. | | | | |
| Overall Sensitivity Rating | Medium to High (Score 16 out of 30) | | | | |

### 6.3.4 LCA 4 Timbered Areas

**Plate 4** – Typical views across timbered areas

**Table 10** – LCA 4 - Timbered Areas- Landscape Sensitivity

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Landform and Scale | | **2** | | | |
| | Timbered areas occur across a range of landform types that are generally defined by gently sloping or undulating landform resulting in a moderate scale landform. The landform is simple containing few distinct features and has an absence of any strong topographical elements. | | | | |
| Landcover | | **2** | | | |
| | Landcover is predominantly simple and predictable within the context of similar timbered areas across the Southern Tablelands. The overall landscape pattern created by timbered areas creates diversity and contrast to the smooth, regular and uniform grass pasture and cultivated areas within this landscape. The darker coloured foliage of timbered areas contrast against the surrounding backdrop of lighter toned pasture and cultivated areas. | | | | |
| Settlement and human | | | **3** | | |

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| influence | Settlement is occasional and dispersed within timbered areas with the majority of dwellings visually screened from surrounding landscape areas. The main influences of human activity are the effects of agricultural improvement within the landscape. | | | | |
| Movement | | | | **4** | |
| | Movement is generally limited to local roads and access tracks. | | | | |
| Rarity | | **2** | | | |
| | Timbered areas are reasonably well represented and an established feature across broader regional areas of the New South Wales Southern Tablelands. | | | | |
| Intervisibility | | | **3** | | |
| | The level of intervisibility between this landscape and adjoining areas is generally determined by the location and extent of timbered area relative to view locations, but on the whole is limited as views from within this landscape are constrained by vegetation, combined with sloping landform. Views from scattered or lightly timbered areas provide links to adjoining landscape areas. | | | | |
| Overall Sensitivity Rating | Medium to High (Score 16 out of 30) | | | | |

### 6.3.5 LCA 5 Urban/Rural settlement

**Plate 5** – Typical view across urban settlement area

**Table 11** – LCA 5 – Urban/rural settlement - Landscape Sensitivity

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Landform and Scale | | | | 4 | |
| | Urban and rural settlement is generally surrounded and contained by gently sloping and low undulating landform resulting in an overall small scale rural urban environment. | | | | |
| Landcover | | 2 | | | |
| | The overall landscape pattern is defined by human scale indicators including houses, shops and roads together with a variety of urban structures which create some diversity and contrast in pattern. There are generally no elements that result in the presence of strong topographical variety within developed areas. | | | | |
| Settlement and human influence | | | 3 | | |
| | Dwellings are dispersed beyond village settlement and urban areas (such as Rye Park and Boorowa) and are generally associated with individual farms and rural structures. | | | | |
| Movement | | 2 | | | |
| | Movement is generally limited to local roads and access tracks. | | | | |
| Rarity | | 2 | | | |
| | Small scale urban settlements are dispersed across the landscape, as well as the broader regional area of the Southern Tablelands. | | | | |
| Intervisibility | | | 3 | | |
| | Intervisibility is limited where views are partially contained by buildings and structures, although views from elevated areas of the settlement extend beyond and across adjoining landscape areas. | | | | |

| | Lower Sensitivity | | ↔ | | Higher Sensitivity |
|---|---|---|---|---|---|
| | Low | Low to Med | Medium | Med to High | High |
| Rating | 1 | 2 | 3 | 4 | 5 |
| Overall Sensitivity Rating | Medium to High (Score 16 out of 30) | | | | |

## 6.4 Landscape values (local and regional)

### 6.4.1 What are landscape values?

For the purpose of this LVIA landscape values have been considered as a set of professional judgements on the importance to society of the local and regional landscape surrounding the proposed wind farm development. Societal landscape values may extend across a range of specific interests such as historic, ecological or cultural issues. The purpose of identifying local and regional landscape values is to consider what, if any, losses to landscape features or characteristics may result from the construction and operation of the wind farm development, and how this may impact upon local and regional landscape values.

### 6.4.2 Historical landscape values

Both the local and regional landscape has a strong association with early European settlement and agricultural production and specifically the establishment of pastoral properties. The European historical and cultural association with settlement and agrarian transition is set against a backdrop of indigenous populations being relocated and ultimately removed from the landscape. The removal of the indigenous population resulted in long held landscape cultural values and practices being replaced by those employed by early settlers in the mid to early 19$^{th}$ century. Landscape change resulting from the abrupt replacement of landscape values (from subsistence to industrial agriculture) has wrought significant alteration to the landscape; however the existing landscape pattern is one that most people at the local and regional scale would recognise as typical and representative of a rural agricultural landscape. A detailed consideration and assessment of the relationship between landscape and indigenous populations is described in the Heritage Assessment Report within the **EA**.

### 6.4.3 Existing landscape values

Whilst the landscape is likely to hold more significant value at a local level, for those who both work and reside within the landscape surrounding the proposed wind farm development, there are no specific references to designations or policies which indicate or recognise a 'high value' landscape. There are no 'iconic' landscape elements (including constructed or natural features) that occur within the local or regional landscape which have a broader public value or that are recognised at a national level. The majority of land within and surrounding the wind farm development is privately owned and, at a local and regional scale, opportunities for the broader public to access and explore the landscape and obtain distant and panoramic views are largely limited to existing rights of way such as road corridors. The proposed wind farm development is not considered to have the potential to have a significant impact on existing landscape values.

## 6.5 Summary

In terms of overall landscape sensitivity and value, this LVIA has determined that the landscape within the viewshed of the proposed Bango wind farm has a medium/medium to high sensitivity to accommodate change, and represents a landscape that is reasonably typical of landscape types found in surrounding areas of the Southern Tablelands.

As a landscape with an overall medium/medium to high sensitivity to accommodate change, some characteristics are likely to be altered by the wind farm; however, the landscape will have some capability to accommodate change. This capability is largely derived from the presence of predominantly large scale and open landscape across portions of the wind farm, together with the relatively low settlement density within the Bango 10km viewshed.

This LVIA has determined that the wind farm would not be an unacceptable development within the Bango wind farm viewshed, which in a broader context also contains built elements such as roads, agricultural industry, aircraft landing strips, communication towers, powerlines as well as operating and approved wind farms within the regional location of the Bango wind farm site.

Despite being 'naturalistic' in appearance large portions of the Southern Tablelands landscape have been heavily modified by agricultural improvement for pasture and arable production post European settlement. 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.

# Viewshed, zone of visual influence and visibility

Section 7

## 7.1 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 12**.

**Table 12** – 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.

## 7.2 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

192 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 distances.

### 7.3 Zone of Visual Influence

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 to include:

- ZVI Diagram 1 from tip of blade;
- ZVI Diagram 2 from hub height; and
- ZVI Diagram 3 toward the whole turbine.

The extents to which the wind turbines may be visible are illustrated in **Figure 21**, and the ZVI Diagrams in **Figures 22, 23** and **24**.

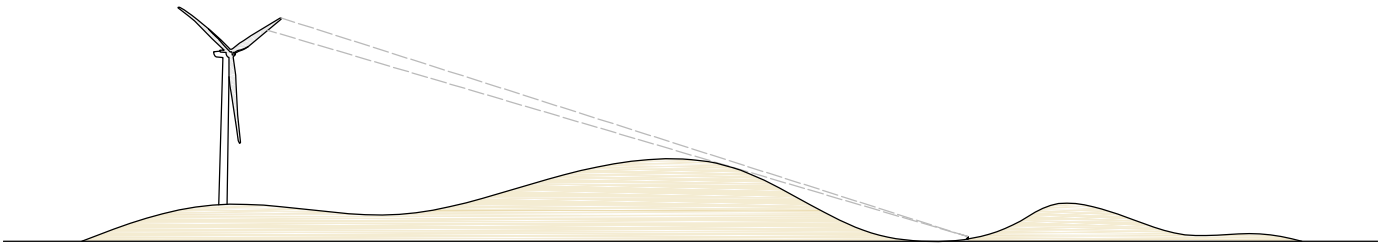
### 7.4 ZVI methodology

The methodology adopted for the ZVI 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:

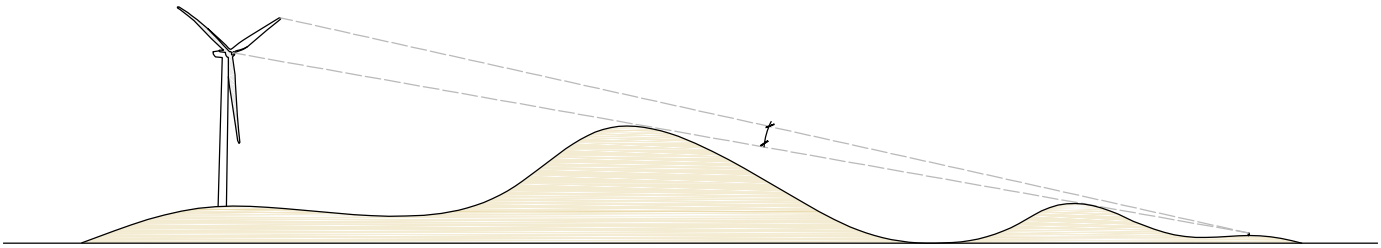
- to blade tips (essentially a view toward any part of the wind turbine rotor, including views toward the tips of blades above ridgelines);
- to hub height (essentially a view toward half the swept path of the wind turbine blades); and
- to the whole turbine (essentially a view toward the whole turbine).

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



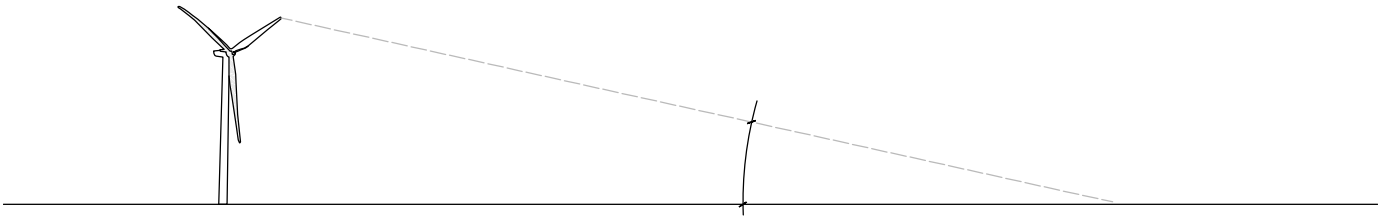
'Tip of blade'

View toward 'tip of blade' - where views extend toward the tip of blades above hill and ridgelines.



'Hub height'

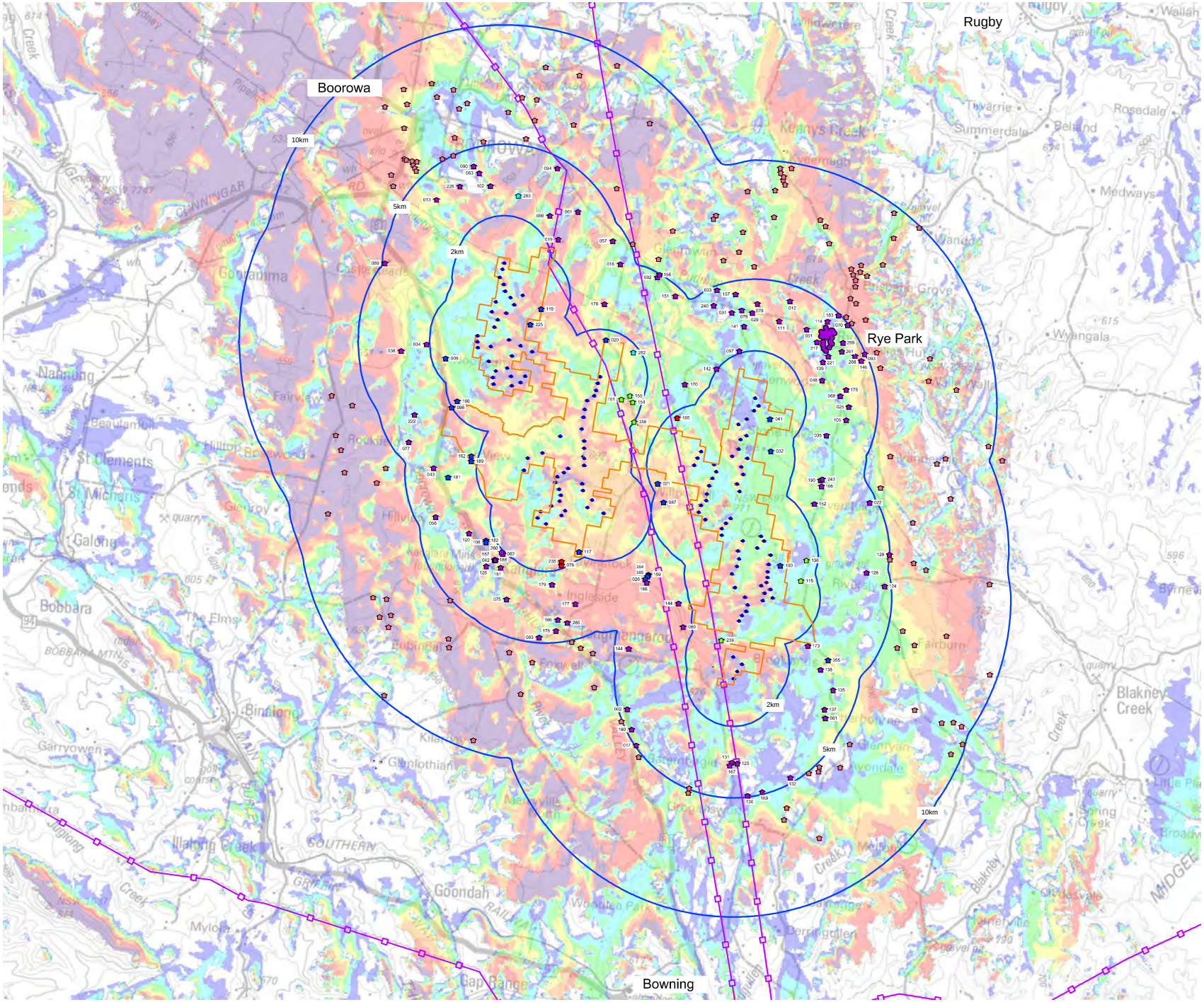
View toward 'hub height' - where views extend toward the upper half of the wind turbine rotor with views toward the lower half of the rotor face and tower screened by landform.



'Whole turbine'

View toward 'whole turbine' - where views extend from the base of the tower to the tip of the rotor blade.

**Figure 21**
**ZVI visibility zones**




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.
This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.
Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:
Number of wind turbine tip of blade visible

- 0
- 1-20
- 21-40
- 41-60
- 61-80
- 81-100
- 101-120
- 121-122

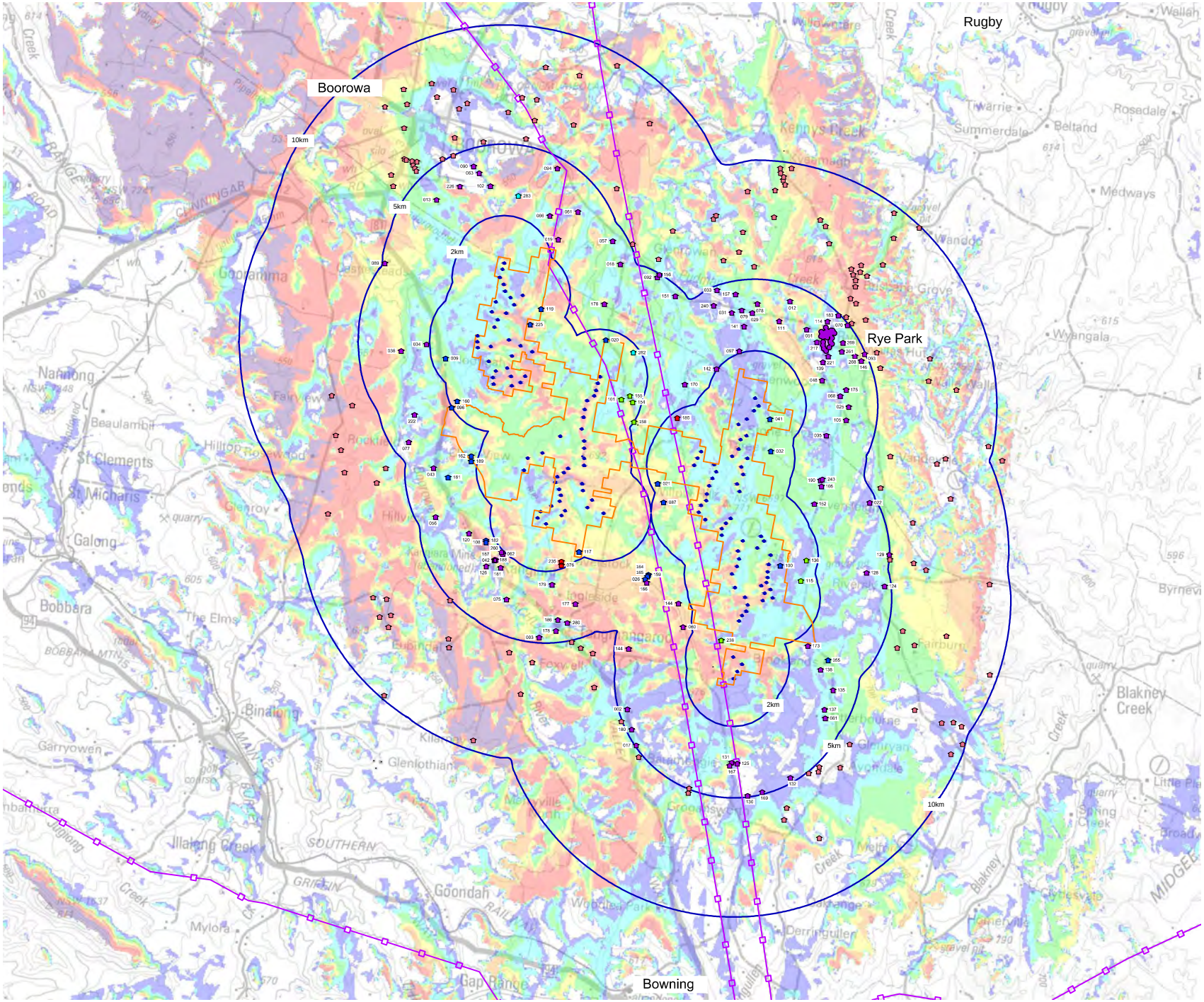
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV overhead powerline

**Figure 22**
**ZVI Diagram 1**
**Tip of blade**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature. Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

Number of wind turbine s visible from hub height

- 0
- 1-20
- 21-40
- 41-60
- 61-80
- 81-100
- 101-120
- 121-122

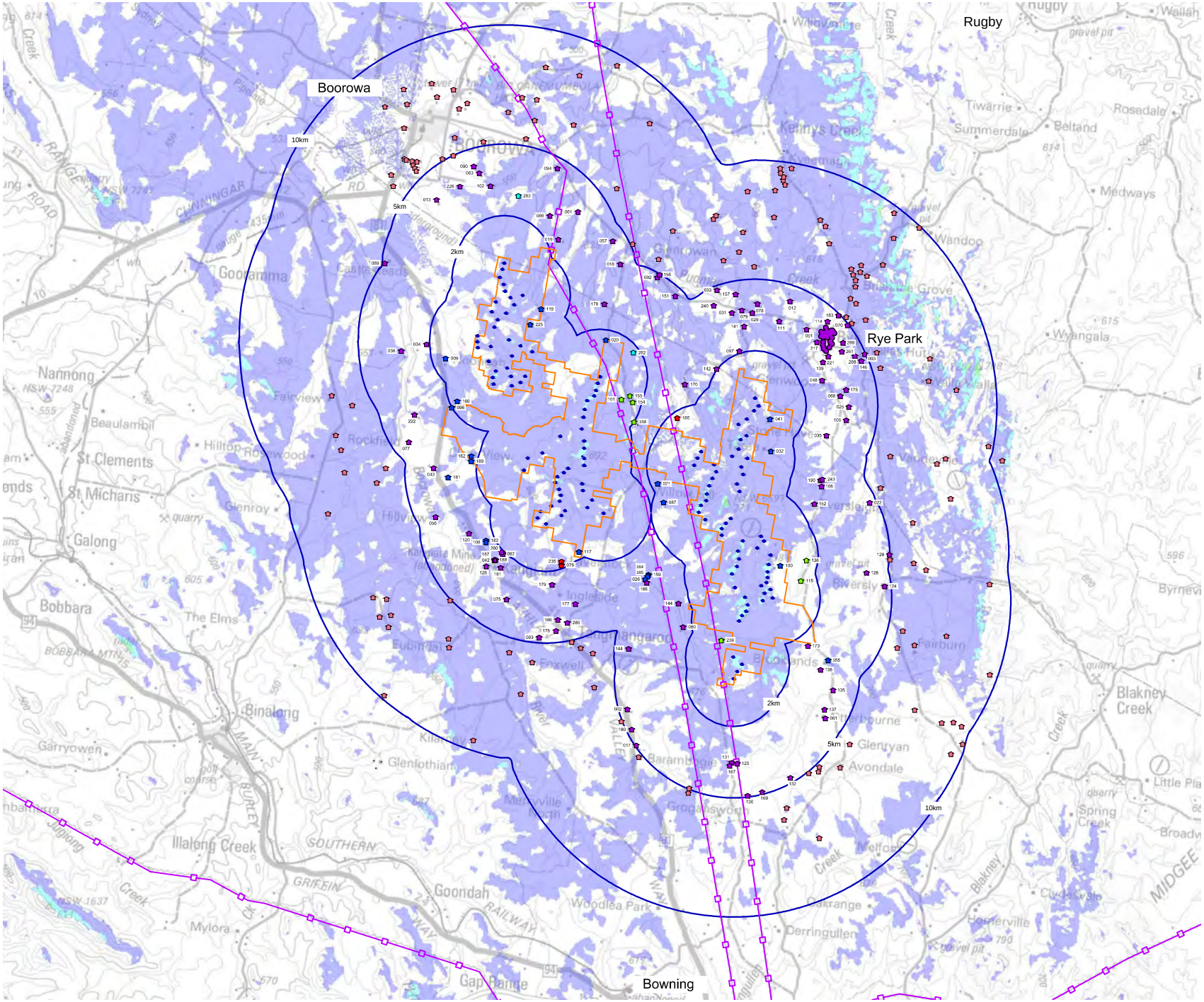
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV overhead powerline

**Figure 23**
**ZVI Diagram 2**
**Hub height**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain. This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature. Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

Number of whole wind turbines visible

- 0
- 1-20
- 21-40
- 41-60
- 61-80
- 81-100
- 101-120
- 121-122

- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV overhead powerline

**Figure 24**
**ZVI Diagram 3**
**Whole turbine**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

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.

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

### 7.5 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.

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.

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.

## 7.6 Visibility

The level of wind turbine visibility within the Bango wind farm 10 km viewshed can result from a number of factors such as:

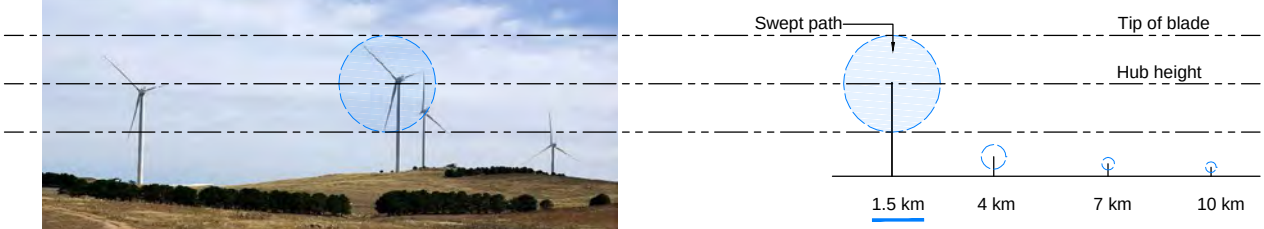
- distance effect;
- movement;
- relative position; and
- weather.

### 7.6.1 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 25**, 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.

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 13** 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.




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 25 Distance effect**

**Table 13 –** 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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>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.<br><br>Turbines dominant and significant within viewshed (potentially resulting in **High** level visibility). |

### 7.6.2 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.

### 7.6.3 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.

# Significance of visual effect

Section 8

## 8.1 Introduction

The significance of visual effect resulting from the construction and operation of the Bango 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 effect.

**Table 14** – View Location Sensitivity

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

**Table 15** – Numbers of viewers

| Criteria | Definition |
|---|---|
| **Number of viewers** | |
| High | > 500 people per day |
| Medium to high | 100 - 499 people per day |

| Criteria | Definition |
|---|---|
| Medium | 26 - 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:

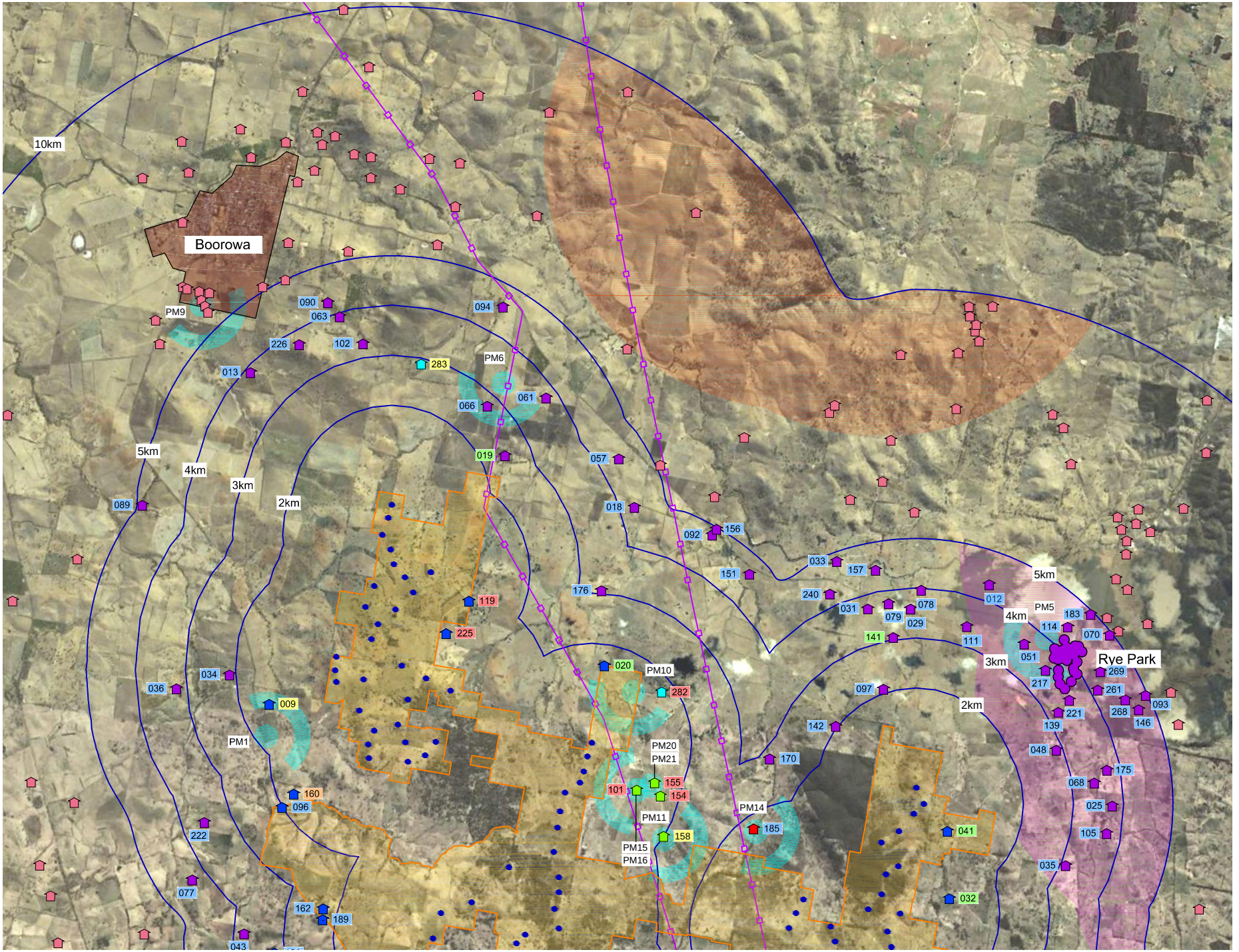
- the distance between the view location and the wind farm turbines;
- the duration of effect;
- the extent of the area over which the wind farm could be theoretically visible (ZVI hub height)
- the degree of visibility subject to existing landscape elements (such as forested areas or tree cover).

An overall determination of visual effect at each view location has also been assessed and determined against the criteria outlined in **Table 16** below:

**Table 16 –** 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 | 81 -122 wind turbines visible |
| Medium | 41 – 80 wind turbines visible |
| Low | 21 – 40 wind turbines |
| Very low | 1 – 20 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 Bango wind farm are illustrated in **Figures 26a** and **26b**.




## Legend

- Bango wind farm project area
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing powerline
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine

Visual significance

- 003 Low - Nil/Low
- 164 Low - Medium
- 060 Medium
- 117 Medium - High
- 155 High

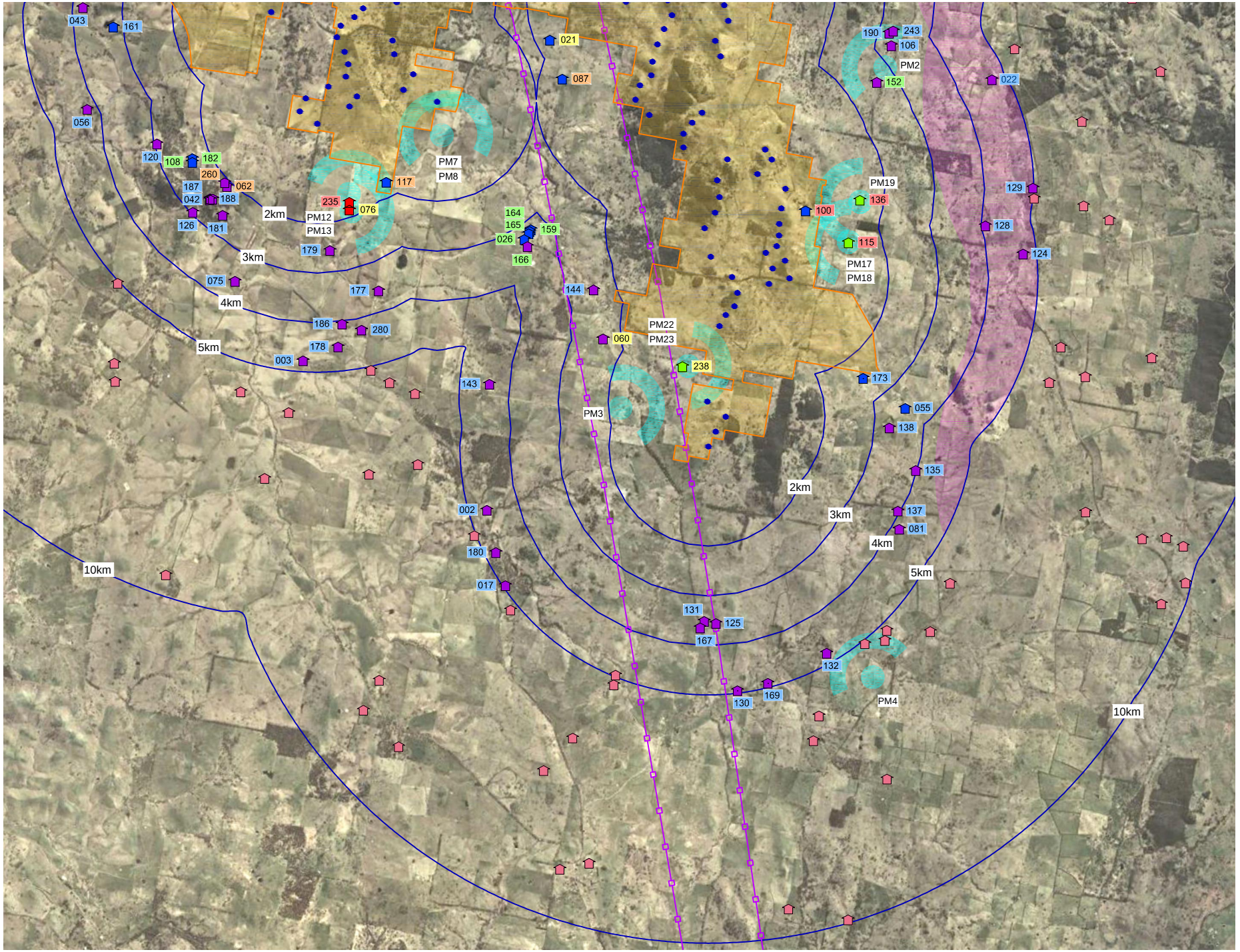
- Boorowa Township
- Landscape area between 2 km and 5 km of the Bango and Rye Park wind turbines
- Landscape area between 2 km and 5 km of the Rugby wind farm turbines (within the Bango 10 km viewshed)
- Photomontage location. Refer Section 11and Figures 34 to 79

**Figure 26a Residential dwellings (detail north)**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




## Legend

- Bango wind farm project area
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing powerline
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine

Visual significance

- 003 Low - Nil/Low
- 164 Low - Medium
- 060 Medium
- 117 Medium - High
- 155 High

- Boorowa Township
- Landscape area between 2 km and 5 km of the Bango and Rye Park wind turbines
- Landscape area between 2 km and 5 km of the Rugby wind farm turbines (within the Bango 10 km viewshed)
- Photomontage location. Refer Section 11and Figures 34 to 79

**Figure 26b Residential dwellings (detail south)**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

**Table 17** 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 | **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 effects.

## 8.2 Visual significance matrix

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| **Assessment of dwelling locations within 0 to 2 km of the proposed Bango wind turbines (Refer Figure 26a and 26b for locations)** | | | | | | | |
| 009<br>Photomontage location PM1 (in general vicinity) | Involved residential dwelling<br>High | Very low | 1.4 km | High | Medium | Short distance views east to north east toward wind turbines within the Langs Creek cluster. Views toward wind turbines within the Kangiara and Mt Buffalo clusters are more likely to be screened by landform and tree cover. | Medium |
| 020<br>Photomontage location PM10 (in general vicinity) | Involved residential dwelling<br>High | Very low | 1.5 km | High | Medium | Short distance views south toward the Kangiara cluster and west toward the Langs Creek cluster will be partially filtered by tree planting surrounding the residential dwelling. Views toward wind turbines within the Mt Buffalo cluster are more likely to be screened by undulating landform to the south east of the dwelling. | Low to Medium |
| 021 | Involved residential dwelling<br>High | Very low | 1.7 km | High | Medium | Short distance views will extend east and west toward wind turbines within the Mt Buffalo and Kangiara clusters. Views toward wind turbines within the Langs Creek cluster are likely to be screened by undulating and ridgeline landform to the north west of the dwelling. | Medium |
| 032 | Involved residential dwelling<br>High | Very low | 1.0 km | High | Low to medium | Short distance views will extend west toward wind turbines within the north portion of the Mt Buffalo cluster. Views toward wind turbines in the Kangiara and Langs Creek clusters will be largely screened by rising landform to the west of the dwelling. | Low to Medium |
| 041 | Involved residential | Very low | 0.7 km | High | Medium | Very short distance views will extend west toward wind turbines | Low to Medium |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | dwelling<br>High | | | | | within the north portion of the Mt Buffalo cluster. Views toward wind turbines in the Kangiara and Langs Creek clusters will be largely screened by rising landform to the west of the dwelling. | |
| 076<br>Photomontage location PM12 | Uninvolved residential dwelling<br>High | Very low | 1.9 km<br>(wind turbine within south portion of Kangiara cluster) | High | High | Short distance views will extend north toward wind turbines within the southern portion of the Kangiara cluster. Views toward turbines within the northern portion of the Kangiara cluster, as well as turbines within the Langs Creek cluster will be largely distant, and/or screened by landform and tree cover. Long distance views (between 6 km and 7 km) will extend east toward turbines within the Mt Buffalo cluster. | Medium |
| 087 | Involved residential dwelling<br>(weekender)<br>High | Very low | 1.5 km | High | High | Short distance views will extend north east to south east toward wind turbines within the Mt Buffalo cluster. Views toward wind turbines within the Kangiara and Langs Creek clusters will be largely screened by landform and tree cover. | Medium to High |
| 100<br>Photomontage location PM17 and PM18 (in general vicinity) | Involved residential dwelling<br>(uninhabited)<br>High | Very low | 0.5 km | High | Low | Views will extend toward a small number of turbines within the south east portion of Mt Buffalo cluster. The wind turbines will located on a hill to the west of the dwelling. Views toward the majority of wind turbines within the Mt Buffalo cluster, as well as wind turbines within the Langs Creek and Kangiara clusters, will be screened by landform and tree cover. | High |
| 101<br>Photomontage location PM15 and | Neighbour<br>residential dwelling | Very low | 1.1 km | High | Low to medium | Short distance views will extend west and north west toward wind turbines within the northern portion of the Kangiara cluster. Views toward wind turbines within the Mt Buffalo and Langs Creek cluster | High |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| PM16 | High | | | | | will be largely screened by landform and tree cover. | |
| 115<br>Photomontage location PM17 and PM18 | Neighbour<br>residential dwelling<br>High | Very low | 1.3 km | High | Low | Short distance views will extend toward a small number of turbines within the south east portion of Mt Buffalo cluster. The wind turbines will be located on a hill to the west of the dwelling. Views toward the majority of wind turbines within the Mt Buffalo cluster, as well as wind turbines within the Langs Creek and Kangiara clusters, will be screened by landform and tree cover. | High |
| 117<br>Photomontage location PM12 (in general vicinity) | Involved residential dwelling<br>High | Very low | 1.7 km | High | Medium to high | Short distance views will extend north toward wind turbines within the southern portion of the Kangiara cluster, with some partial filtering of views provided by tree planting surrounding dwelling. Potential views may also extend east (in excess of 5 km) toward turbines within the Mt Buffalo cluster. Views toward wind turbines within the Langs Creek cluster, as well as wind turbines within the northern portion of the Kangiara and Mt Buffalo clusters are likely to be screened by landform and tree cover. | Medium to High |
| 119<br>Photomontage location PM10 (in general vicinity) | Involved residential dwelling<br>High | Very low | 1.0 km | High | Medium to high | Very short distance views will extend west to north west toward wind turbines within the central and north portion of the Langs Creek cluster. Views toward wind turbines within the Kangiara and Mt Buffalo clusters will be largely screened by tree cover and landform. | High |
| 136<br>Photomontage location PM19 | Neighbour<br>residential dwelling<br>High | Very low | 1.5 km | High | Low | Short distance views will extend toward a small number of turbines within the south east portion of Mt Buffalo cluster. The wind turbines will be located on a hill to the west of the dwelling. Views toward the majority of wind turbines within the Mt Buffalo cluster, as well as | High |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | wind turbines within the Langs Creek and Kangiara clusters, will be screened by landform and tree cover. | |
| 154<br>Photomontage location PM20 and PM21 (in general vicinity) | Neighbour<br>weekender<br>High | Very low | 1.9 km | Varies | Low | Short distance views west will extend toward a small number of wind turbines within the northern portion of the Kangiara cluster. Views toward wind turbines within the Langs Creek and Mt Buffalo clusters will be largely screened by landform. | High |
| 155<br>Photomontage location PM20 and PM21 | Neighbour<br>weekender<br>High | Very low | 1.4 km | Varies | Low | Short distance views west will extend toward a small number of wind turbines within the northern portion of the Kangiara cluster. Views toward wind turbines within the Langs Creek and Mt Buffalo clusters will be largely screened by landform. | High |
| 160<br>Photomontage location PM1 (in general vicinity) | Involved residential dwelling<br>High | Very low | 1.7 km | High | Medium to high | Short distance views will extend north east toward wind turbines within the central and southern portion of the Langs Creek cluster. Views toward wind turbines within the Mt Buffalo cluster will be screened by landform and tree cover. | Medium to High |
| 172<br>Photomontage location PM22 and PM23 | Neighbour - Shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 185<br>Photomontage location PM11 | Uninhabited dwelling (derelict)<br>High | Very low | 1.7 km | High | Low | Short distance views east to south east toward wind turbines within the Mt Buffalo cluster will be largely screened by tree cover and landform. | N/A |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 225 | Involved residential dwelling<br>High | Very low | 1.0 km | High | High | Very short distance views will extend west to north west toward wind turbines within the central and north portion of the Langs Creek cluster. Views toward wind turbines within the Kangiara and Mt Buffalo clusters will be largely screened by tree cover and landform. | High |
| 235<br>Photomontage location PM13 | Uninvolved residential dwelling<br>High | Very low | 1.7 km | High | | Short distance views will extend north toward wind turbines within the southern portion of the Kangiara cluster. Views toward turbines within the northern portion of the Kangiara cluster, as well as turbines within the Langs Creek and Mt Buffalo clusters will be largely distant, and/or screened by landform and tree cover. | High |
| 238<br>Photomontage location PM22 and PM23 | Neighbour | Very low | 1.0 km | Varies | Low | Very short distance views north east and south east will extend toward a small number of wind turbines within the southern portion of the Mt Buffalo cluster. Views toward wind turbines within the central and northern portion of the Mt Buffalo cluster, as well as wind turbines within the Kangiara and Langs Creek clusters, will be largely screened by landform and tree cover. | Medium |
| 282 | Approved DA (no house) | Very Low | 1.7 km | High | Medium | Short distance views will extend west to south west toward wind turbines within the Kangiara cluster. Whilst existing tree cover will provide some filtering of views, the distance between the approved dwelling locality and the wind turbines will result in opportunities for proximate and direct views toward wind turbines. | High |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| **Assessment of dwelling locations between 2 km and 3 km of the proposed Bango wind turbines (Refer Figures 26a** and **26b for locations)** | | | | | | | |
| 019 | Uninvolved residential dwelling<br>High | Very low | 2.5 km | High | High | Short distance views will extend toward wind turbines within the northern portion of the Langs Creek cluster, with some filtering effect provided by scattered tree cover beyond the residential dwelling. | Low to Medium |
| 034<br>Photomontage location PM1 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 2.1 km | High | Medium | Short distance views will extend east toward wind turbines within the Langs Creek cluster, with some partial screening by scattered tree cover beyond the residential dwelling. | Low |
| 042 | Uninvolved residential dwelling<br>High | Very low | 2.5 km | High | Low to medium | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be largely screened by scattered tree cover to the north east of the residential dwelling. | Nil/Low |
| 048 | Uninvolved residential dwelling<br>High | Very low | 2.9 km | High | Medium to high | Short distance views south west toward wind turbines within the northern portion of the Mt Buffalo cluster will be partially screened by tree planting beyond the residential dwelling. | Low |
| 060<br>Photomontage location PM3 (in general vicinity) | Uninvolved<br>Residential dwelling<br>High | Very low | 2.4 km | High | High | Short distance views will extend toward wind turbines within the southern and central portions of the Mt Buffalo cluster. | Medium |
| 062 | Uninvolved residential dwelling<br>High | Very low | 2.1 km | High | High | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be partially screened by tree cover and agricultural building surrounding and beyond the | Medium/High |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | residential dwelling. | |
| 066<br>Photomontage location PM6 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 2.8 km | High | Medium to High | Short distance views will extend toward wind turbines within the northern portion of the Langs Creek cluster, with some filtering effect provided by scattered tree cover beyond the residential dwelling. | Low |
| 096<br>Photomontage location PM1 (in general vicinity) | Involved residential dwelling<br>High | Very low | 2.0 km | High | High | Short distance views toward wind turbines within the southern portion of the Langs Creek cluster will be partially screened by tree cover and agricultural buildings beyond the residential dwelling. | Low |
| 097 | Uninvolved residential dwelling<br>(weekender)<br>High | Very low | 2.1 km | High | Low | Short distance views toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low |
| 108 | Involved residential dwelling<br>High | Very low | 2.4 km | High | High | Short distance views will extend north east toward wind turbines within the southern portion of the Kangiara cluster. Views will be partially filtered by tree cover surrounding and beyond the dwelling. Views toward wind turbines within the Langs Creek and Mt Buffalo clusters will be largely screened by landform and tree cover. | Low to Medium |
| 142 | Uninvolved residential dwelling<br>High | Very low | 2.0 km | High | Low | Short distance views south east toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 144 | Uninhabited residential dwelling<br>High | Very low | 2.5 km | High | Medium | Short distance views will extend east toward wind turbines within the southern portion of the Mt Buffalo cluster with some partial screening by tree cover surrounding the dwelling. | Low |
| 152<br>Photomontage location PM2 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 2.6 km | High | Low | Short distance views west toward wind turbines within the Mt Buffalo cluster will be partially screened by landform and scattered tree cover beyond the residential dwelling. | Low to Medium |
| 158<br>Photomontage location PM11 (in general vicinity) | Neighbour<br>caravan<br>High | Very low | 2.1 km | Varies | Medium | Short distance view will extend toward wind turbines within the north portion of the Kangiara cluster. Views toward wind turbines within the Mt Buffalo and Langs Creek clusters will be largely screened by ridgeline landforms. | Medium |
| 162 | Involved residential dwelling<br>High | Very low | 2.3 km | High | Medium to high | Medium distance views north toward wind turbines within the southern portion of the Lang Creek cluster, and east toward wind turbines within the Kangiara cluster will be largely screened by landform and tree cover surrounding and beyond the residential dwelling. | Low |
| 170<br>Photomontage location PM14 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 2.8 km | High | Low | Medium distance views toward wind turbines within the Mt Buffalo and Kangiara clusters will be largely screened by landform and tree cover. Views toward wind turbines within the Langs Creek cluster will be screened by landform. | Nil/Low |
| 173 | Involved residential dwelling | Very low | 2.5 km | High | Low | Short distance views toward wind turbines within the south eastern portion of the Mt Buffalo cluster will be partially screened by gently | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | High | | | | | rising landform to the north west of the residential dwelling. | |
| 179<br>Photomontage location PM12 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 2.6 km | High | Low | Short distance views north toward wind turbines within the southern portion of the Kangiara cluster will be partially screened by landform beyond the residential dwelling. Potential distant (in excess of 7 km) view east to south east toward wind turbines within the southern portion of the Mt Buffalo cluster. | Low |
| 181 | Uninvolved residential dwelling<br>High | Very low | 2.6 km | High | Low to medium | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be screened by tree cover and landform. | Nil/Low |
| 182 | Involved residential dwelling<br>High | Very low | 2.4 km | High | High | Short distance views will extend north east toward wind turbines within the southern portion of the Kangiara cluster. Views toward wind turbines within the Langs Creek and Mt Buffalo clusters will be largely screened by landform and tree cover. | Low to Medium |
| 187 | Uninhabited residential dwelling<br>High | Very low | 2.5 km | High | Low to medium | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be largely screened by scattered tree cover to the north east of the residential dwelling. | Nil/Low |
| 188 | Uninhabited residential dwelling<br>High | Very low | 2.5 km | High | Low to medium | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be largely screened by scattered tree cover to the north east of the residential dwelling. | Nil/Low |
| 189 | Involved residential | Very low | 2.2 km | High | Medium | Short distance views north toward wind turbines within the southern portion of the Lang Creek cluster, and east toward wind turbines | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | dwelling<br>High | | | | | within the Kangiara cluster will be largely screened by landform and tree cover surrounding and beyond the residential dwelling. | |
| 260 | Uninvolved Empty dwelling<br>High | Very low | 2.0 km | High | High | Short distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be partially filtered by tree cover beyond the residential dwelling. | Medium/High |
| 283 | Approved DA (no house) | Very Low | 2.7 km | High | Medium | Short distance views extend south from the general locality of the proposed dwelling toward wind turbines within the north portion of the Langs Creek cluster. Some partial screening or filtering may be provided by scattered tree cover, but will be dependent on the location and orientation of the dwelling. | Medium |
| **Assessment of dwelling locations between 3 km and 4 km of the proposed Bango wind turbines (Refer Figures 26a and 26b for locations)** | | | | | | | |
| 013<br>Photomontage location PM9 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.9 km | High | Medium | Medium distance views extend south east toward the northern portion of the Langs Creek cluster with some potential for partial screening through undulating landform and scattered tree cover beyond the residential dwelling. | Low |
| 025 | Uninvolved residential dwelling<br>High | Very low | 3.8 km | High | Medium | Medium distance views will extend west toward wind turbines within the northern portion of the Mt Buffalo cluster. Some partial filtering of views may be provided by tree cover beyond the residential dwelling. | Low |
| 026 | Involved residential dwelling<br>High | Very low | 3.3 km | High | High | Medium distance views will extend east to north east toward wind turbines within the central portion of the Mt Buffalo cluster. | Low to Medium |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 029 | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Low | Medium distance views toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low |
| 031 | Uninvolved residential dwelling<br>High | Very low | 3.7 km | High | Low | Medium distance views toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low |
| 035 | Uninvolved residential dwelling<br>High | Very low | 3.1 km | High | Low | Medium distance views west to north west toward wind turbines within the southern and central portion of the Mt Buffalo cluster will be partially screened by tree cover beyond the residential dwelling. | Low |
| 036 | Uninvolved residential dwelling<br>High | Very low | 3.2 km | High | Medium | Medium distance views will extend east toward wind turbines within the Langs Creek cluster, with some partial screening by scattered tree cover beyond and to the east of the residential dwelling. | Low |
| 043 | Uninvolved residential dwelling<br>High | Very low | 3.8 km | High | Low to medium | Medium distance views north east toward wind turbines within the Langs Creek cluster and east toward the Kangiara cluster, will be largely screened by landform and tree cover beyond the residential dwelling. | Nil/Low |
| 051<br>Photomontage location PM5 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Low | Medium distance views south west toward wind turbines within the northern portion of the Mt Buffalo cluster will be partially screened by gently rising landform beyond the dwelling. | Low |
| 055 | Involved | Very low | 3.5 km | High | Medium | Medium distance views west to north west toward wind turbines | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | residential dwelling<br>High | | | | | within the southern and central portion of the Mt Buffalo cluster will be partially screened by scattered tree cover beyond the residential dwelling. | |
| 061<br>Photomontage location PM6 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.8 km | High | Low | Medium distance views toward wind turbines will be largely restricted by gently rising landform to the south and south west of the residential dwelling as well as some filtering through tree cover beyond the residential dwelling. | Low |
| 063 | Uninvolved residential dwelling<br>High | Very low | 3.9 km | High | Low | Medium distance views toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Nil/Low |
| 064 | Rye Park School<br>High | Low | 3.6 km | High | Low | Medium distance views south west to south will generally be screened by ridgeline landform and tree cover alongside road corridors to the south of the school. | Nil/Low |
| 068 | Agricultural shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 075 | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Medium to high | Medium distance views will extend north to north east toward wind turbines within the southern portion of the Kangiara cluster and potentially distant (in excess of 9 km) views east toward wind turbines within the southern portion of the Mt Buffalo cluster. | Low |
| 079 | Uninvolved residential dwelling | Very low | 3.7 km | High | Low | Medium distance views toward wind turbines will be largely screened by landform rising gently to the south of the residential dwelling. | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | High | | | | | | |
| 102 | Uninvolved residential dwelling<br>High | Very low | 3.3 km | High | Low | Medium distance views toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Nil/Low |
| 105 | Uninvolved residential dwelling<br>High | Very low | 3.7 km | High | Medium | Medium distance views west to north west toward wind turbines within the northern portion of the Mt Buffalo cluster will be partially screened by tree cover beyond the residential dwelling. | Low |
| 106<br>Photomontage location PM2 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.3. km | High | Low | Medium distance views west and south west toward wind turbines within the Mt Buffalo cluster will be partially screened by gently rising landform beyond the residential dwelling. | Low |
| 111<br>Photomontage location PM5 (in general vicinity) | Uninhabited residential dwelling<br>High | Very low | 3.4 km | High | High | Medium distance views extend south toward wind turbines within the northern portion of the Mt Buffalo cluster with some partial filtering created by scattered tree cover beyond the residential dwelling. | Low |
| 125 | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Low | Medium distance views north toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened and tree cover. | Nil/Low |
| 126 | Uninvolved residential dwelling<br>High | Very low | 3.0 km | High | Low to medium | Medium distance views north east toward wind turbines within the southern portion of the Kangiara cluster will be largely screened by scattered tree cover to the north east of the residential dwelling. Views toward wind turbines within the Langs Creek and Mt Buffalo | Nil/Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | clusters will be screened by landform and tree cover. | |
| 131 | Uninvolved residential dwelling<br>High | Very low | 3.5 km | High | Low to medium | Medium distance views north toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened by landform and scattered tree cover beyond the residential dwelling. | Nil/Low |
| 138 | Involved residential dwelling<br>High | Very low | 3.3 km | High | Medium | Medium distance views west toward wind turbines within the southern portion of the Mt Buffalo cluster will be partially screened by landform rising to the west of the dwelling as well as tree cover surrounding the dwelling. | Low |
| 139<br>Photomontage location PM5 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.2 km | High | Low | Medium distance views south west toward wind turbines within the northern portion of the Mt Buffalo cluster are largely screened by ridgeline landform to the south west of the residential dwelling. | Nil/Low |
| 141<br>Photomontage location PM5 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.0 km | High | Low | Medium distance views south and south west toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low to Medium |
| 159 | Involved residential dwelling<br>High | Very low | 3.2 km | High | Medium to high | Medium distance views will extend east to north east toward wind turbines within the central portion of the Mt Buffalo cluster. | Low to Medium |
| 161 | Involved residential dwelling | Very low | 3.2 km | High | Low | Medium distance views will extend east toward wind turbines within the western portion of the Kangiara cluster with partial screening provided by a gently undulating and rising landform to the east of the | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | High | | | | | residential dwelling. | |
| 164 | Involved residential dwelling<br>High | Very low | 3.2 km | High | High | Medium distance views will extend east to north east toward wind turbines within the central portion of the Mt Buffalo cluster. | Low to Medium |
| 165 | Involved residential dwelling<br>High | Very low | 3.2 km | High | High | Medium distance views will extend east to north east toward wind turbines within the central portion of the Mt Buffalo cluster. | Low to Medium |
| 166 | Uninvolved residential dwelling<br>High | Very low | 3.4 km | High | High | Medium distance views will extend east to north east toward wind turbines within the southern and central portion of the Mt Buffalo cluster. | Low to Medium |
| 167 | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Medium | Medium distance views north toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened by landform and scattered tree cover beyond the residential dwelling. | Nil/Low |
| 175 | Uninvolved residential dwelling<br>High | Very low | 3.7 km | High | Low | Medium distance views west toward wind turbines within the northern portion of the Mt Buffalo cluster will be partially screened by landform and tree cover to the west of the residential dwelling. | Low |
| 176 | Uninvolved residential dwelling<br>High | Very low | 3.0 km | High | Medium | Medium distance views will extend south toward wind turbines within the north portion of the Kangiara cluster and wind turbines within the Langs Creek cluster. Wind turbines within the Mt Buffalo cluster will be largely screened by ridgeline landform and tree cover south east | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | of the residential dwelling. | |
| 177 | Uninvolved residential dwelling<br>High | Very low | 3.6 km | High | Low | Medium distance views will extend north toward wind turbines within the southern portion of the Kangiara cluster. Potential distant (in excess of 6.5 km) view east to south east toward wind turbines within the southern portion of the Mt Buffalo cluster. | Low |
| 178 | Agricultural shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 180 | Agricultural shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 190<br>Photomontage location PM2 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.2 km | High | Low | Medium distance views west toward wind turbines within the Mt Buffalo cluster will be partially screened by landform and tree cover beyond the residential dwelling. | Low |
| 217 | Agricultural shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 221 | Agricultural shed | N/A | N/A | N/A | N/A | N/A | N/A |
| 222<br>Photomontage location PM1 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.5 km | High | Low | Medium distance views east to north east toward the southern portion of the Langs Creek cluster are partially screened by landform rising to the east of the dwelling. | Low |
| 226<br>Photomontage location PM9 (in | Uninvolved residential dwelling | Very low | 3.7 km | High | Low | Medium distance views south east toward the north portion of the Langs Creek cluster will be generally screened by a low ridgeline to | Nil/Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| general vicinity) | High | | | | | the south of the residential dwelling. | |
| 243<br>Photomontage location PM12 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 3.2 km | High | Low | Medium distance views west toward wind turbines within the Mt Buffalo cluster will be partially screened by landform and tree cover to the west of the residential dwelling. | Low |
| **Assessment of dwelling locations between 4 km and 5 km of the proposed Bango wind turbines (Refer Figures 26a** and **26b for locations)** | | | | | | | |
| 002 | Uninvolved residential dwelling<br>High | Very low | 4.6 km | High | Low | Medium distance views toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened by landform and tree cover. | Low |
| 003 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Low to medium | Medium distance views extend north toward the southern portion of the Kangiara cluster, with some partial screening through rising landform to the north of the Lachlan Valley Way road corridor. | Low |
| 017 | Uninvolved residential dwelling<br>High | Very low | 4.8 km | High | Low | Medium distance views toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened by landform and tree cover beyond the residential dwelling. | Low |
| 018 | Uninvolved residential dwelling<br>High | Very low | 4.3 km | High | Low to medium | Medium distance views will extend south toward wind turbines within the north portion of the Kangiara cluster and wind turbines within the Langs Creek cluster. Wind turbines within the Mt Buffalo cluster will be largely screened by ridgeline landform and tree cover south east of the residential dwelling. | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 022 | Uninvolved residential dwelling<br>High | Very low | 4.7 km | High | Low | Medium distance views west toward wind turbines within the Mt Buffalo cluster will be partially screened by landform rising to the west of the dwelling together with scattered tree cover. | Low |
| 033 | Uninvolved residential dwelling<br>High | Very low | 4.8 km | High | Low | Medium distance views south and south west toward the northern portion of the Mt Buffalo and Kangiara clusters will be largely screened by landform. Views toward wind turbines within the Langs Creek cluster will be screened by landform. | Low |
| 056 | Uninvolved residential dwelling<br>High | Very low | 4.2 km | High | Low | Medium distance views east to north east toward wind turbines within the western portion of the Kangiara cluster will be partially screened landform and scattered tree cover beyond the residential dwelling. | Low |
| 057 | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | Low | Medium distance views toward wind turbines will be largely restricted by gently rising landform to the south and south west of the residential dwelling. | Low |
| 070 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Medium | Medium distance views south west toward wind turbines within the northern portion of the Mt Buffalo cluster will be largely screened by tree cover beyond the residential dwelling. | Nil/Low |
| 077 | Uninvolved residential dwelling<br>High | Very low | 4.3 km | High | Medium | Medium distance views north east toward the southern portion of the Langs Creek cluster are partially screened by landform rising to the east of the dwelling. Views toward wind turbines within the Kangiara and Mt Buffalo clusters will be largely screened by landform and tree | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | cover. | |
| 078 | Uninvolved residential dwelling<br>High | Very low | 4.0 km | High | Medium | Medium distance views will extend south to south west toward turbines within the northern portion of the Mt Buffalo and Kangiara clusters with some partial screening by tree cover beyond dwelling. Views toward the Langs Creek cluster will be largely screened by landform. | Low |
| 081 | Uninvolved residential dwelling<br>High | Very low | 4.2 km | High | Low | Medium distance views north west toward wind turbines within the southern portion of the Mt Buffalo cluster will be partially screened by landform rising to the west and north west of the dwelling. | Low |
| 089 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Medium | Medium distance views east to south east toward wind turbines within the Langs Creek cluster will be generally screened by a gently rising landform and tree/vegetation cover beyond the residential dwelling. | Low |
| 092 | Uninvolved residential dwelling<br>High | Very low | 4.7 km | High | Low | Medium distance views south, south east and south west toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Nil/Low |
| 093 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Medium to High | Medium distance views south west toward wind turbines within the Mt Buffalo cluster will be partially screened by tree cover beyond the residential dwelling. | Low |
| 094<br>Photomontage | Uninvolved residential | Very low | 4.5 km | High | High | Medium distance views will extend south to south west toward wind turbines within the northern portion of the Langs Creek cluster. | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| location P6 (in general vicinity) | dwelling<br>High | | | | | Views will be partially screened by tree cover and agricultural buildings beyond the dwelling. Views toward wind turbines within the southern portion of the Langs Creek cluster, as well as the Kangiara and Mt Buffalo clusters will be screened by landform and tree cover. | |
| 114 | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | Low | Medium distance views south west toward wind turbines in the northern portion of the Mt Buffalo cluster will be largely screened by landform beyond the residential dwelling. | Nil/Low |
| 120 | Derelict building | N/A | N/A | N/A | N/A | N/A | N/A |
| 124 | Derelict building | N/A | N/A | N/A | N/A | N/A | N/A |
| 128 | Uninvolved residential dwelling<br>High | Very low | 4.1 km | High | Low | Medium distance views west toward wind turbines within the Mt Buffalo cluster will be largely screened by landform beyond the dwelling. | Nil/Low |
| 129 | Uninvolved residential dwelling<br>High | Very low | 5.0 km | High | Medium | Medium distance views west toward wind turbines within the Mt Buffalo cluster will be partially screened by landform and tree cover, as well as outbuildings to the west of the residential dwelling. | Low |
| 130 | Uninvolved residential dwelling<br>High | Very low | 5.0 km | High | Low | Medium distance views toward the wind turbines within the southern portion of the Mt Buffalo cluster are largely screened by landform. | Nil/Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 132 | Uninvolved residential dwelling<br>High | Very low | 4.8 km | High | Low | Medium distance views north toward wind turbines within the southern portion of the Mt Buffalo cluster and largely screened by landform and scattered tree cover beyond the residential dwelling. | Nil/Low |
| 135 | Uninvolved residential dwelling<br>High | Very low | 4.1 km | High | Low to medium | Medium distance views west to north west toward wind turbines within the southern portion of the Mt Buffalo cluster will be partially screened by landform rising to the west of the dwelling as well as tree cover along ridgelines. | Low |
| 137 | Uninvolved residential dwelling<br>High | Very low | 4.2 km | High | Low | Medium distance views north west toward wind turbines within the southern portion of the Mt Buffalo cluster will be partially screened by landform rising to the west and north west of the dwelling as well as tree cover surrounding the residential dwelling. | Low |
| 143<br>Photomontage location PM3 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | High | Medium distance views will extend east toward wind turbines within the southern portion of the Mt Buffalo cluster. Views toward wind turbines within the Langs Creek and Kangiara clusters will be largely screened | Low |
| 146 | Uninvolved residential dwelling<br>High | Very low | 4.7 km | High | Medium | Medium distance views south west toward wind turbines within the Mt Buffalo cluster will be partially screened by tree cover surrounding the residential dwelling. | Low |
| 151 | Uninvolved residential dwelling<br>High | Very low | 4.6 km | High | Low | Medium distance views south and south west toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| 156 | Uninvolved residential dwelling<br>High | Very low | 5.0 km | High | Low | Medium distance views south, south east and south west toward wind turbines will be largely screened by topography and tree cover beyond the residential dwelling. | Nil/Low |
| 157 | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | Low | Medium distance views south and south west toward the northern portion of the Mt Buffalo and Kangiara clusters will be largely screened by landform. Views toward wind turbines within the Langs Creek cluster will be screened by landform. | Low |
| 169 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Low | Medium distance views north toward wind turbines within the southern portion of the Mt Buffalo cluster will be largely screened by landform and tree cover beyond the residential dwelling. | Low |
| 183 | Uninvolved residential dwelling<br>High | Very low | 4.9 km | High | Low | Medium distance views south west toward wind turbines within the northern portion of the Mt Buffalo cluster will be largely screened by landform and tree cover. | Low |
| 186 | Uninvolved residential dwelling<br>High | Very low | 4.1 km | High | Low to medium | Medium distance views north toward wind turbines within the southern portion of the Kangiara cluster will be partially screened by landform beyond the residential dwelling. Potential distant (in excess of 7 km) view east to south east toward wind turbines within the southern portion of the Mt Buffalo cluster. | Low |
| 261 | Uninvolved residential dwelling<br>High | Very low | 4.1 km | High | Low | Medium distance views west to south west toward wind turbines within the Mount Buffalo cluster would be partially screened by scattered tree cover beyond the dwelling and more significantly by a | Low |

**Table 18 –** Visual significance matrix (Refer **Figures 26a** and **26b** for residential view locations)

| View location (Refer to Figure 26a/b) | Category of view location and sensitivity | Relative number of people | Approximate distance to closest turbine | Duration of effect | Extent of visibility (ZVI hub height) | Degree of visibility | Visual significance |
|---|---|---|---|---|---|---|---|
| | | | | | | gently rising landform to the west of the dwelling. | |
| 268 | Uninvolved residential dwelling<br>High | Very low | 4.5 km | High | Low | Medium distance views west to south west toward wind turbines within the Mount Buffalo cluster would be partially screened by scattered tree cover beyond the dwelling and more significantly by a gently rising landform to the west of the dwelling. | Low |
| 269 | Uninvolved residential dwelling<br>High | Very low | 4.3 km | High | Low | Medium distance views west to south west toward wind turbines within the Mount Buffalo cluster would be partially screened by scattered tree cover surrounding and beyond the dwelling. | Low |
| 240 | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | Very low | Medium distance views west to south toward wind turbine in the north portion of the wind farm will be largely screened by landform rising to the south and south west of dwelling. | Nil/Low |
| 241 | Derelict building | N/A | N/A | N/A | N/A | N/A | N/A |
| 280<br>Photomontage location PM7 and PM8 (in general vicinity) | Uninvolved residential dwelling<br>High | Very low | 4.4 km | High | Medium | Medium distance views north toward wind turbines within the southern portion of the Kangiara cluster will be partially screened by landform beyond the residential dwelling. Potential distant (in excess of 7 km) view east to south east toward wind turbines within the southern portion of the Mt Buffalo cluster. | Low |

## 8.3 Summary of visual significance (within 2 km of wind turbines)

This LVIA identified a total of 22 potential dwelling locations (including 4 weekenders) within 2 km of the Bango wind farm turbines. These potential dwellings have been identified as:

- 11 involved residential dwellings
- 2 uninvolved residential dwellings
- 7 neighbouring properties* (subject to negotiation and agreement);
- 1 proposed dwelling with approved Development Application and
- 1 uninhabited (and derelict) dwelling.

* The 7 neighbouring properties identified in **Table 18** consist of 3 residential dwellings and 4 weekender structures (including 1 caravan).

An assessment of the 21 locations (excluding the derelict dwelling – house 185) within 2 km of the Bango wind turbines determined that:

- 3 of the 21 locations would have a low to medium visual significance
- 5 of the 21 locations would have a medium visual significance
- 3 of the 21 locations would have a medium to high visual significance and
- 10 of the 21 locations would have a high visual significance.

The locations with a potential high visual significance would include:

- 3 involved landowners with residential dwellings
- 1 uninvolved landowner with a residential dwelling
- 3 neighbouring landowners with residential dwellings
- 2 neighbouring landowners with weekenders and
- 1 proposed dwelling with approved Development Application.

## 8.4 Summary of visual significance (between 2 km and 5 km of wind turbines)

This LVIA identified a total of 106 potential dwelling locations between 2 km and 5 km of the wind turbines. Eight structures were determined to be either derelict or agricultural sheds during the fieldwork and have not been assessed in the LVIA. The 98 dwellings between 2 km and 5 km of the wind turbines included:

- 12 involved residential dwellings
- 86 uninvolved residential dwellings
- 1 proposed dwelling with an approved Development Application and
- 5 uninhabited dwellings.

An assessment of the dwelling locations between 2 km and 5 km of the Bango wind turbines determined that:

- 2 of the 98 residential view locations would have a medium to high visual significance
- 2 of the 98 residential view locations would have a medium visual significance
- 10 of the 98 residential view locations would have a low to medium visual significance
- 61 of the 98 residential view locations would have a low visual significance and
- 23 of the 98 residential view locations would have a nil to low visual significance.

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

## 8.5 Summary of visual significance (beyond 5 km of wind turbines)

There are a number of rural residential dwellings located beyond 5 km of the Bango wind farm turbines and within the 10 km viewshed. The rural residential dwellings beyond 5 km of the Bango wind turbines are primarily agricultural homesteads, but also include a small number of weekender dwellings, uninhabited dwellings and derelict structures. Dwelling locations beyond 5 km of the Bango wind farm turbines have a greater potential to be screened by topography, as well as tree cover to the east of the project area. It is

unlikely that residential dwelling locations beyond 5 km of the Bango wind turbines would experience any high or moderate to high visual significance.

## 8.6 Public view locations

A local road network extends roughly parallel to the main ridgelines and hills within the project area and provides a variety of direct and indirect view opportunities toward the wind farm turbines. Tree planting alongside road corridors to the west of the project area tends to restricts views to partial and glimpsed opportunities (including views from the Lachlan Valley Way and the Wargeila Road). A greater range of open views tend to occur along minor roads to the east of the site. This LVIA did not identify any formalised or designated public lookout points within the Bango wind farm 10 km viewshed.

## 8.7 Towns and localities

There are two population centres within the Bango wind farm 10 km viewshed, and include:

- Boorowa Township, population 1,211 (2011 Census). The Boorowa Township is located approximately 7 km to the north west of the Langs Creek cluster and
- Rye Park Village, population 237 (within the Rye Park gazetted locality – 2011 Census). The Rye Park Village is approximately 4 km to the north east of the Mt Buffalo cluster.

The population centres are illustrated in **Figure 26a** and **26b**.

It is unlikely that the Bango wind farm will have any significant visual effect on the Boorowa Township and smaller rural localities, including the Rye Park Village, which are located in the landscape surrounding the project site. This is primarily due to the screening influence of undulating landform as well as the distance between the wind farm and potential view locations within the population centres.

Views toward the wind farm from the main streets of Boorowa (including the Lachlan Valley Way and Pudman Street) are screened by buildings within the town as well as a rising and gently undulating landform to the south and south east of the Township. Similarly, views toward the Bango wind farm turbines from the majority of residential dwellings within the Boorowa Township will also be screened by a combination of built infrastructure, tree planting within and beyond residential dwellings. Distant views toward wind turbines within the north portion of the Langs Creek cluster may occur from a small number of residential dwellings in the south of the Boorowa population centre, as illustrated in **Photomontage 9**, **Figures 50** and **51**.

Views toward the Bango wind farm turbines from Yass Street (the Rye Park main street), and the majority of residential dwellings within Rye Park, will be screened by landform rising to the west, as well as tree cover alongside local roads within the village. Views toward a small number of wind turbines within the northern portion of the Mt Buffalo cluster, and more distant views toward portions of the Langs Creek cluster, will be visible from Cook Street which delineates the western edge of the village. The proposed view toward the Bango wind farm turbines from Cook Street is illustrated in **Photomontage 5**, **Figures 42** and **53**.

### 8.8 Future residential dwellings

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

Potential future planning considerations for residential dwellings would be able to take advantage of any approved layout design for the Bango wind farm 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.

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 effect not only with additional residential structures within the landscape but also a range of domestic infrastructure associated with it.

# Shadow flicker assessment and blade glint

Section 9

## 9.1 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 assessment has been prepared by the Proponent to determine and illustrate the potential effect of shadow flicker on surrounding residential dwellings. 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.

The shadow flicker diagram is illustrated in **Figure 27**.

## 9.2 Residents

The Proponent has adopted the NSW Draft Guidelines which state:

*"The impact of shadow flicker from wind turbines on neighbours' houses within 2 km of a proposed wind turbine should be assessed. The shadow flicker experienced at any dwelling should not exceed 30 hours per year as a result of the operation of the wind farm".*

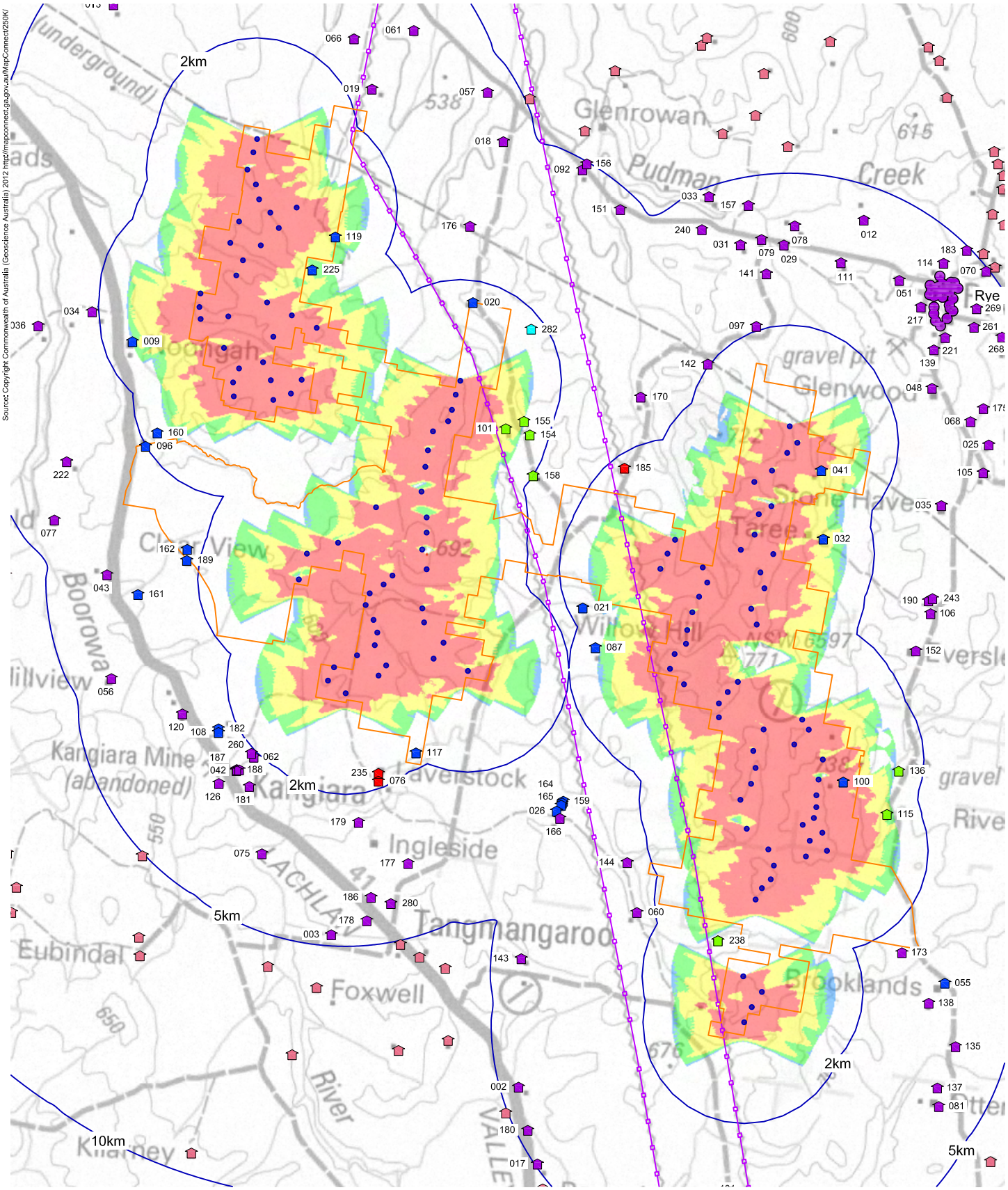



**Figure 27 Shadow flicker diagram**

# BANGO WIND FARM

WIND PROSPECT CWP

GREEN BEAN DESIGN landscape architects

The results of the shadow flicker assessment for the Bango wind farm project determined that nine dwellings (comprising six involved landowners and three neighbouring landowners), may be subject to some levels of shadow flicker. The results of the shadow flicker assessment are outlined in **Table 19**.

**Table 19** – Shadow flicker assessment

| House ID | Status | Turbine cluster | Shadow flicker hours/year |
|---|---|---|---|
| 009 | Involved | Langs Creek | 10.5 |
| 032 | Involved | Mt Buffalo | 75.03 |
| 041 | Involved | Mt Buffalo | 95.59 |
| 100 | Involved | Mt Buffalo | 136.19 |
| 101 | Neighbour | Kangiara | 73.34 |
| 115 | Neighbour | Mt Buffalo | 26.43 |
| 119 | Involved | Langs Creek | 60.4 |
| 155 | Neighbour (weekender) | Kangiara | 0 |
| 225 | Involved | Langs Creek | 28.5 |

Eight of the dwellings have been identified as having some potential to experience shadow flicker. Six of the residential dwellings would be involved landowners, and three neighbouring landowners. Three of the eight dwellings (two involved and one neighbour) would have less than 30 shadow flickers hours per year, including houses 009, 115 and 225. Five of the eight dwellings (four involved and one neighbour) would have more than 30 shadow flicker hours per year, including houses 032, 041, 100, 101 and 119.

## 9.3 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. The Proponent will discuss various mitigation options with involved and neighbouring property owners with potential shadow flicker impacts exceeding 30 hours per year.

## 9.4 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 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 Bango 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 Bango 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 Bango wind turbines would present a risk to people with photosensitive epilepsy.

## 9.5 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 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** – Shadow flicker created by roadside tree planting (Image GBD 2013)

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 Bango 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.

### 9.6 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.

# Cumulative assessment

Section 10

## 10.1 What is cumulative assessment?

A cumulative effect 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.

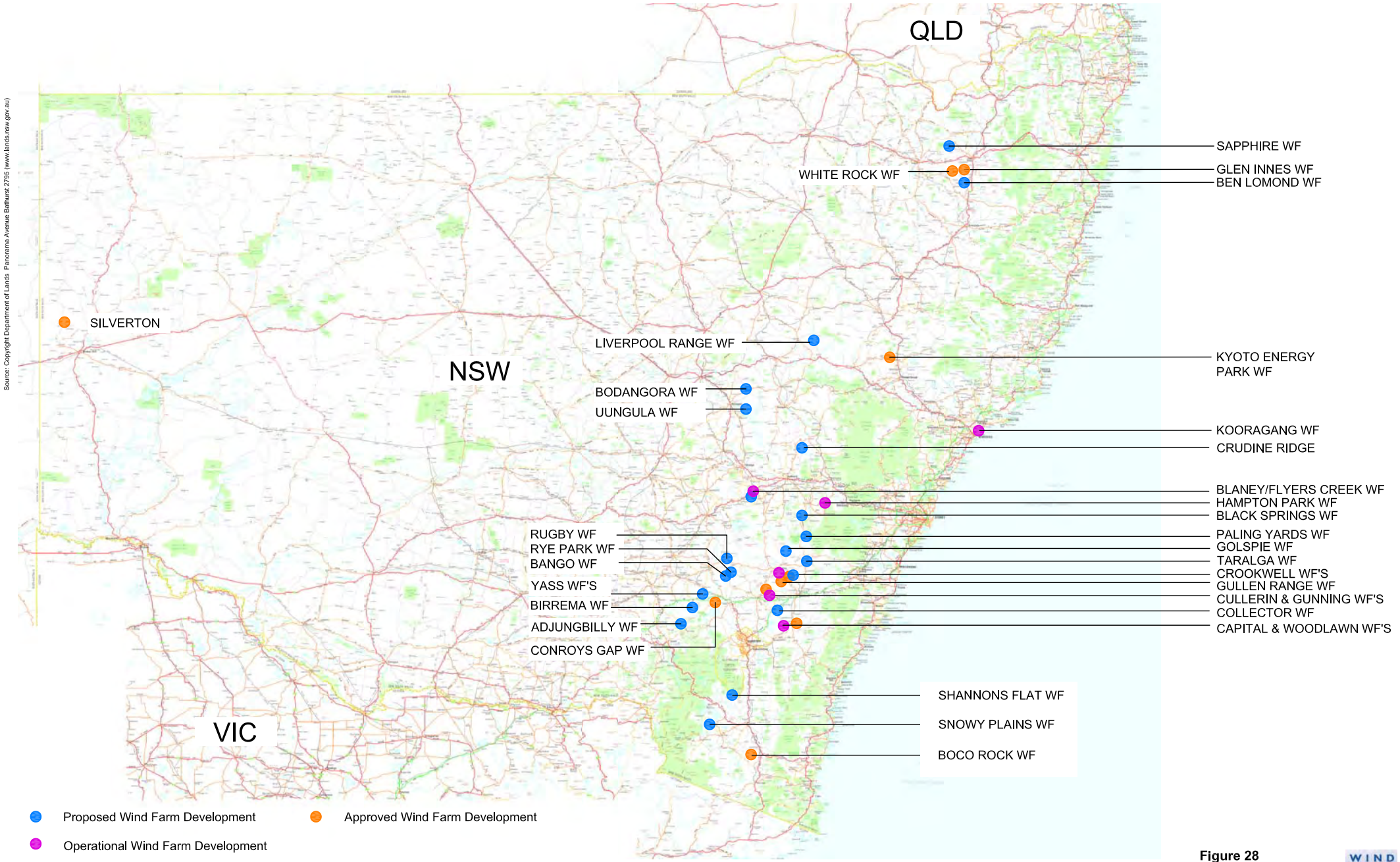
Separate wind farm developments could occur within the established viewshed of the proposed wind farm, or be located within a regional context where visibility is dependent on a journey between each site or an individual project viewshed. Cumulative effects presented by multiple wind farm developments may be presented as 'direct', 'indirect' or 'sequential' effects.

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

## 10.2 Regional wind farm developments

There are a number of proposed, approved and operating wind farm developments within New South Wales which are illustrated in **Figure 28**. The regional locality of wind farms surrounding the Bango wind farm are illustrated in **Figure 29**. 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.

There are currently around 20 existing or proposed wind farm projects at various stages of development within an approximate 70 km radius of the proposed Bango wind farm. Whilst 5 of the 21 wind farms are



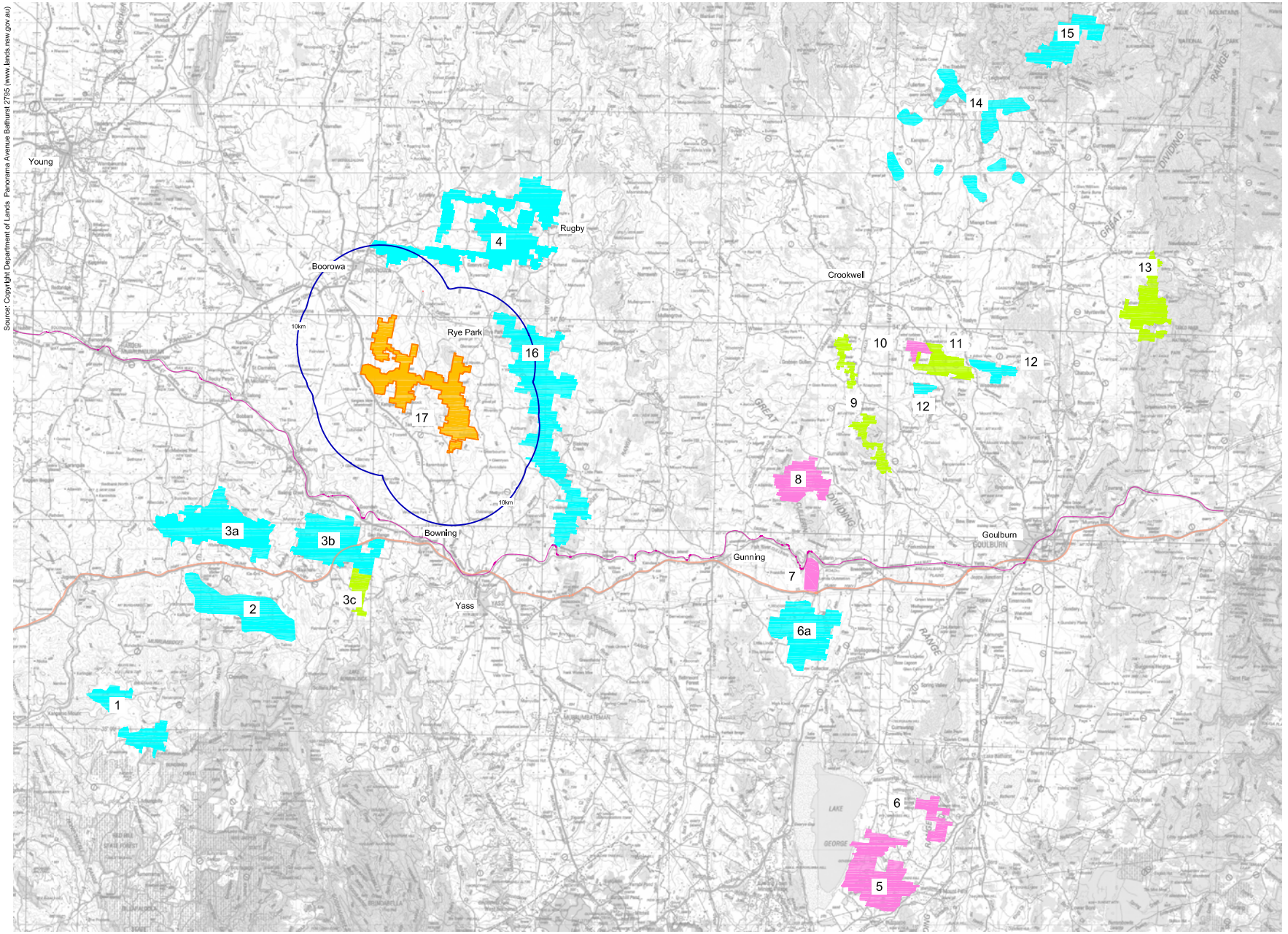

Not to scale

**Figure 28**
**NSW wind farms**
**(as of April 2013)**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




Legend

1 Adjunbilly Wind Farm
2 Birrema Wind Farm
3a Yass Wind Farm (Coppabella)
3b Yass Wind Farm (Marilba)
3c Conroys Gap Wind Farm
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
16 Rye Park Wind Farm
17 Bango Wind Farm

Operational wind farm
Approved wind farm (not constructed)
Proposed wind farm development
Hume Highway
Great Southern Railway

Not to scale

**Figure 29**
**Regional wind farm developments**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP

operational and 4 have progressed to early construction phases, the remaining 11 projects (including those that have been approved) may not necessarily progress to construction.

Long distance views (around 30 km) can be obtained toward the operational Gunning and Cullerin wind farms from elevated areas of the landscape to the south west of the Bango project area. Although visible, these wind farm developments are unlikely to result in any significant additional level of 'direct' and 'indirect' cumulative effect for view locations within the Bango 10 km viewshed due to the distance effect on overall visibility between the wind farm developments. The potential for cumulative effect will be dependent on a number of factors such as the separation distance between turbines and layout of turbines relative to the proposed Bango project.

The existing and proposed wind farm developments within the Bango project 70 km radius and identified and described in **Table 20**.

**Table 20 -** Regional wind farm developments

| Wind Farm | Proponent or Owner | Status | Number of turbines |
|---|---|---|---|
| Adjungbilly | CBD Energy | Planning stage – not yet lodged | Up to 26 |
| Birrema | Epuron | Planning stage – not yet lodged | Up to 68 |
| Capital 1 | Infigen Energy | Operational | 63 |
| Capital 2 | Infigen Energy | Approved – Construction Stage | 41 |
| Cullerin | Origin Energy | Operational | 15 |
| Collector | RATCH | Planning - assessment | 68 |
| Conroy's Gap | Epuron | Approved | 15 |
| Coppabella | Epuron | Planning - assessment | Up to 86 |
| Crookwell 1 | Eraring Energy | Operational | 8 |
| Crookwell 2 | Crookwell Development | Approved – Construction Stage | 46 |

| Wind Farm | Proponent or Owner | Status | Number of turbines |
|---|---|---|---|
| Crookwell 3 | Crookwell Development | Planning – not approved | 30 |
| Golspie | Wind Prospect/ CWP | Planning stage – not yet lodged | up to 100 |
| Gullen Range | Gullen Range Wind Farm Pty Ltd | Approved - Construction Stage | 73 |
| Gunning | Acciona | Operational | 31 |
| Marilba | Epuron | Planning - assessment | Up to 66 |
| Paling Yards | Union Fenosa Wind Australia | Planning stage – not yet lodged | Up to 60 |
| Taralga | RES Australia | Approved – Construction Stage | 62 |
| Woodlawn | Infigen Energy | Operational | 23 |
| Yass Valley Wind Farm | Epuron | Planning - assessment | Up to 148 |

GBD is not aware of any smaller wind farm developments that are currently lodged, or being assessed by the Yass Valley Shire or Boorowa Shire Councils.

**Table 21** Wind farm developments within Bango 10 km viewshed

| Wind Farm | Proponent or Owner | Status | Number of turbines |
|---|---|---|---|
| Rye Park | Epuron Pty Ltd | Planning stage – not yet lodged | Up to 126 |
| ^Rugby | Suzlon Energy and Windlab | Planning stage – not yet lodged | Up to 52 |

^ Whilst the Rugby wind farm turbines would not be located within the Bango wind farm 10 km viewshed, a small number of residential dwellings (around 15) within the Bango wind farm 5 km to 10 km viewshed would also be within the Rugby 2km to 5 km viewshed. These dwellings are illustrated in **Figure 26a**.

### 10.3 Bango, Rye Park and Rugby wind farm intervisibility

The proposed Rye Park and Rugby wind farm developments are currently in the planning stage, and as such the final proposed location and number of wind turbines associated with each development were not known during the preparation of this LVIA. Information on local wind farm developments has been gathered from publically available sources.

The investigative areas included in the Rye Park and Rugby preliminary environmental assessment indicate that some of the Rye Park wind turbines would be located within the Bango wind farm 10 km viewshed. The closest Rye Park wind farm turbines would potentially be located around 6 km east of the Bango wind turbines within the Mt Buffalo cluster. The Rugby wind farm turbines would be potentially located over 11 km north to north east of the Bango wind turbines within the Mt Buffalo cluster.

It is likely that some level of cumulative effect would occur from public and residential view locations to the south east, east, north east and north of the Bango wind farm project area. This may include opportunities for 'direct', 'indirect' and sequential effects, which may result in an increase in the significance of effects, determined for individual view locations in this LVIA. View locations to the west of the Bango wind farm will be afforded a greater degree of screening toward other wind farm projects by undulating landform and tree cover across, and beyond the project site.

Whilst the Cumulative ZVI **Figures 30, 31** and **32**, indicate that there will be some limited potential for 'direct' and 'indirect' views toward the Bango, Rye Park and Rugby wind farm projects from areas within the Boorowa Township, views toward the Bango wind turbines will be largely screened by tree cover and buildings from the majority of the Township.

Given the degree of tree cover within the Rye Park Village, and the screening influence of the local landform between the Village and the Bango wind turbines, the overall opportunity for residential dwellings to experience any significant degree of cumulative effect is considered to be low. A very small number of residential dwellings (up to five) may have an opportunity for indirect views toward some wind turbines within

the Bango and Rye Park wind farm projects. Local tree cover, including vegetation within and around these dwellings will provide a degree of screening potential.

Whilst some degree of intervisibility between all three projects is expected for a small number of rural residential dwellings, the nature and extent of the undulating landform surrounding each of the project sites, would partially limit the overall potential for 'direct' and 'indirect' views for many of the residential dwellings located between them.

Around twenty residential dwellings, as well as dwellings within the Rye Park Village, would be located in an area between 2 km and 5 km of both the proposed Bango and Rye Park wind farm turbines (Refer **Figures 26a** and **26b**). There are no residential dwellings that would occur within 2 km of any more than one wind farm development.

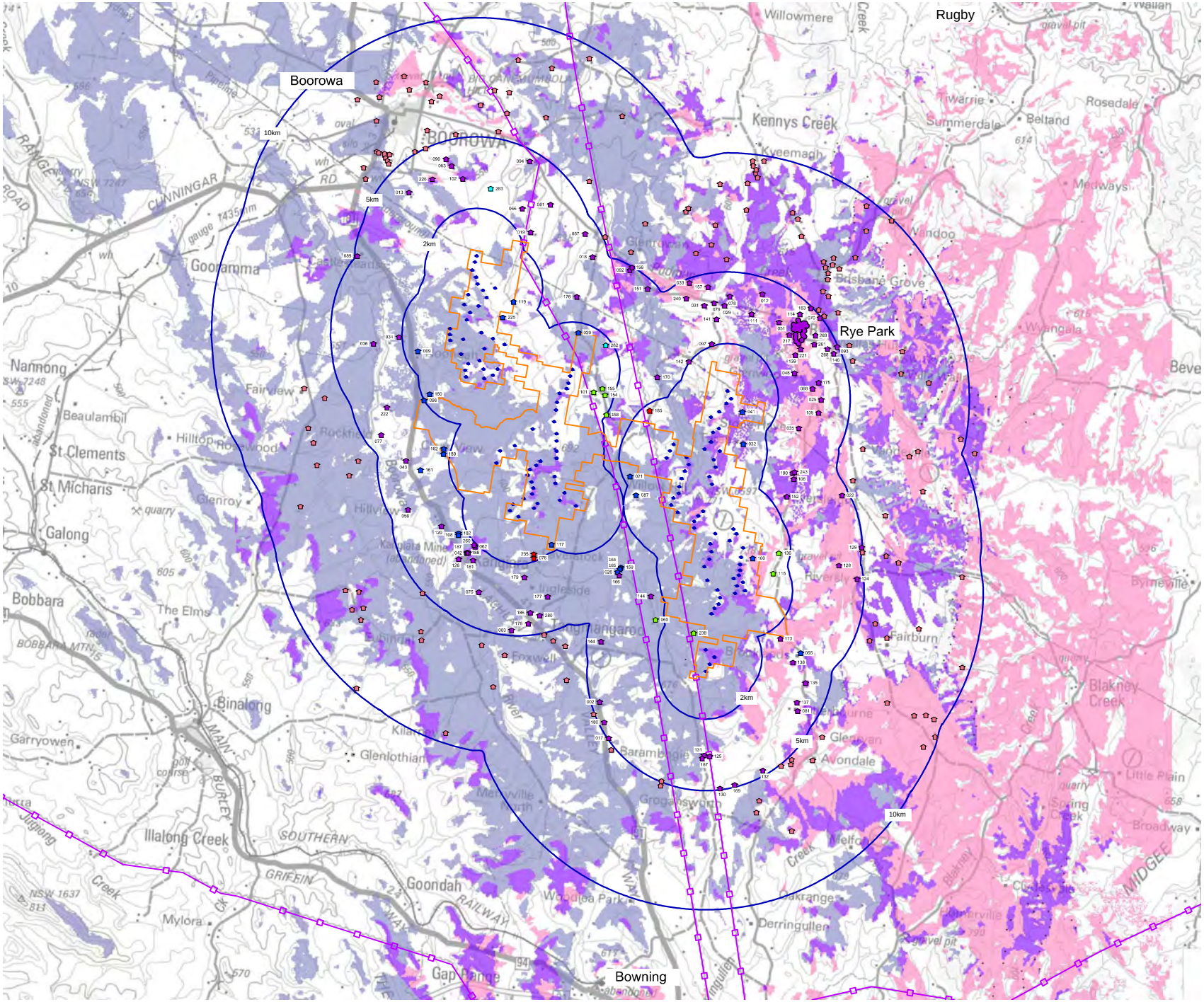
A series of 'sequential' views would also occur from local roads although the journey between the wind farms would include a range of views extending toward and beyond turbines. The extent and overall visibility of turbines would be influenced by the direction of travel relative to the alignment of the wind farm developments as well as the relatively short travel time along the local road network between wind farm developments.

Three cumulative ZVI diagrams (**Figures 30, 31** and **32)** have been prepared to illustrate the potential visibility between the proposed Bango wind turbines, and wind turbines within the proposed Rye Park and Rugby wind farm developments.

The ZVI diagrams include:

- Cumulative ZVI Diagram 1 – Bango and Rye Park Wind Farms;
- Cumulative ZVI Diagram 2 – Bango and Rugby Wind Farms; and
- Cumulative ZVI Diagram 3 – Bango, Rye Park and Rugby Wind Farm.

A supplementary Cumulative Landscape and Visual Impact Assessment has been prepared to assess and determine potential cumulative landscape and visual effects between the Bango and Rye Park Wind Farms. The Cumulative Landscape and Visual Assessment is included in Appendix B.




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

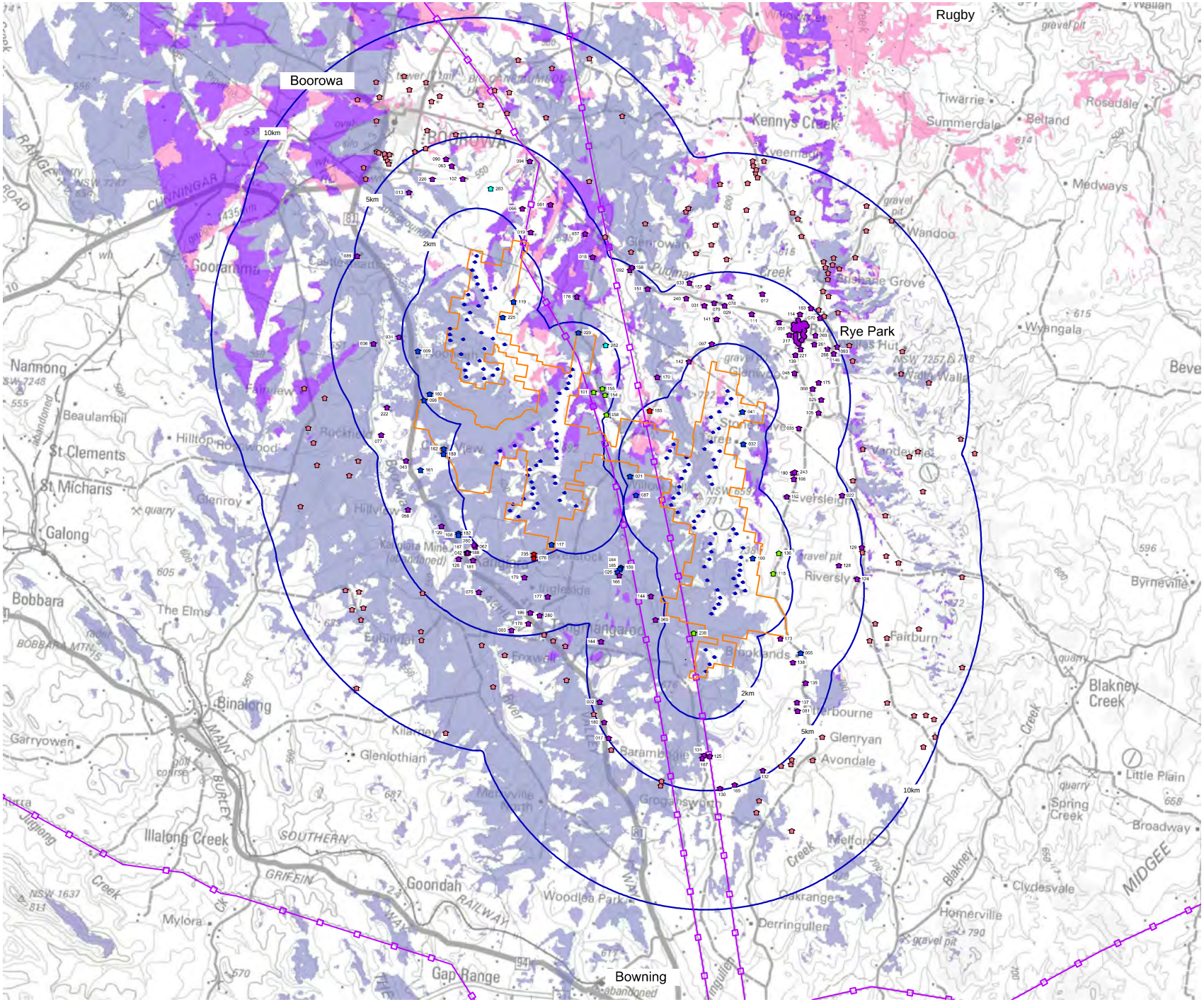
- Bango wind farm turbine visible
- Rye Park wind farm turbine visible
- Bango and Rye Park wind farm turbine visible
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV power line

**Figure 30**
**Cumulative ZVI Diagram 1**
**Bango and Rye Park**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

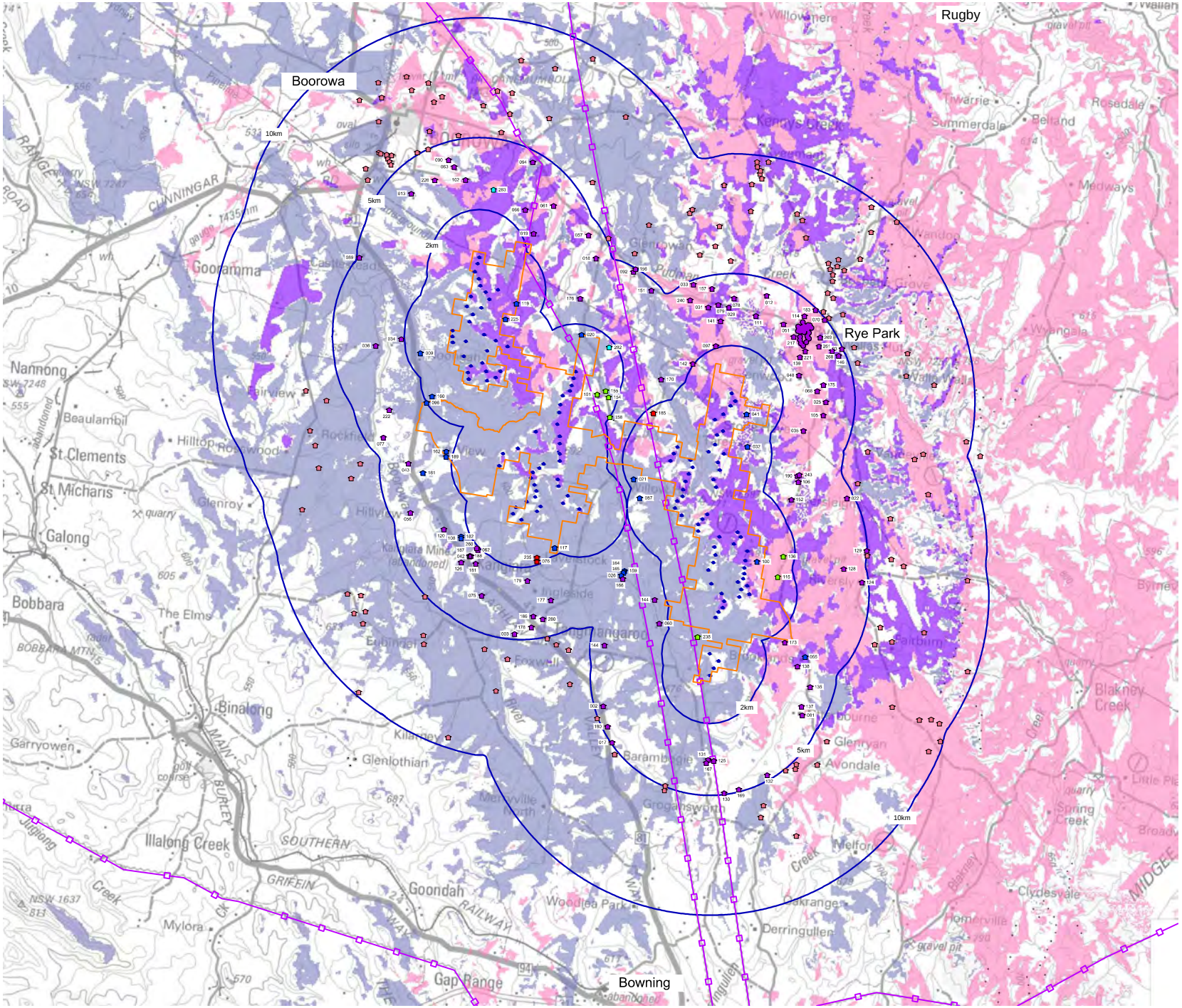
- Bango wind farm turbine visible
- Rugby Park wind farm turbine visible
- Bango and Rugby wind farm turbine visible
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV power line

**Figure 31**
**Cumulative ZVI Diagram 2**
**Bango and Rugby**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP




NOTES:

The ZVI methodology is a purely geometric assessment where the visibility of the proposed Bango wind farm is determined from carrying out calculations based on a digital terrain model of the site and the surrounding terrain.

This assessment methodology is assumed to be conservative as the screening affects of any structures and vegetation above ground level are not considered in any way. Therefore the wind farm may not visible at many of the locations indicated on the ZVI maps due to the local presence of trees, vegetation or other screening potential. While the ZVI maps are a useful visualisation tool, they are very conservative in nature.

Additionally, the number of turbines visible at any one time is also affected by the weather condition at the time. Inclement or cloudy weather tends to mask the visibility of the proposed wind project.

LEGEND:

- Bango wind farm turbine visible
- Rugby and Rye Park wind farm turbine visible
- Bango, Rye Park and Rugby wind farm turbine visible
- Involved residential dwelling
- Neighbour dwelling within 2 km of Bango wind turbine (subject to agreement)
- Uninvolved dwelling within 2 km of Bango wind turbine
- Uninvolved dwelling between 2 km and 5 km of Bango wind turbine
- Proposed dwelling (not built) with approved Development Application
- Uninvolved dwelling between 5 km and 10 km of Bango wind turbine
- Proposed Bango wind turbine (Layout Option 1)
- Distance from proposed Bango wind turbine
- Existing 132 kV power line

**Figure 32**
**Cumulative ZVI Diagram 3**
**Bango, Rye Park and Rugby wind farms**

# BANGO WIND FARM

GREEN BEAN DESIGN
landscape architects

WIND PROSPECT
CWP