Willogoleche Stage 2 Wind Farm

Visual Impact Assessment

Prepared for International Power (Australia) Pty Ltd (ENGIE) 17 December 2025

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No indications were found during our investigations that information contained in this report as provided to GBD was false.
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DOCUMENT CONTROL

Project Name

Willogoleche Stage 2 Wind Farm

Report Title

Visual Impact Assessment

Project Number

24-323

Version Number:

v3

Status

Final Issue

Author

Andrew Homewood
Registered Landscape Architect AILA, MEIANZ
Graduate Diploma Landscape Management,
BSc. (Dual Honours) Landscape Design and Archaeology,
National Diploma Amenity Horticulture

Date

17 December 2025

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Table 1 Glossary

Term	Definition
Battery Energy Storage System	Battery Energy Storage Systems are devices that enable energy from renewables, such as wind farms, to be stored and then released when power is needed.
Cumulative effects	The summation of effects that result from changes caused by a development in conjunction with other past, present or reasonably foreseeable actions.
Human scale indicators	Natural landscape features or constructed elements that form relatable scaled visual characteristics based on human sensory capabilities.
Landscape	A visible area of the earth’s surface defined by natural or human induced change with discernible characteristic of landform, land use and human cultural overlays.
Landscape character	A distinct and consistent pattern of elements in the landscape that create an area of landscape visually different from other areas.
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.
Photomontage (Visualisation)	Computer simulation or other technique to illustrate the appearance of a development.
Sensitivity	Susceptibility of a receiver to a specific type of change.
Skyline	An outline of the land as defined against the sky.
Stacking	The visual effect of multiple wind turbine rotors overlapping within a view
Topographical variety	A various arrangement of forms and features of land surfaces.
Viewshed	The total landscape area seen from a location or path of travel
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 effect	The change in character of an available view that results from a development or the changes in visual amenity of people living beyond the project.

Table 1 Glossary

Visual 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.

Section 1. Executive summary

1.1 Introduction

This Visual Impact Assessment (VIA) has been prepared to support an Environmental Impact Report and considers potential landscape and visual effects associated with the proposed Willogoleche Stage 2 Wind Farm project (the project). This VIA addresses various 'landscape' and 'scenic amenity' statutory requirements of the Government of South Australia Department for Energy and Mining (DEM) as set out in the in the *Hydrogen and Renewable Energy Act 2023* (the Act). This VIA has also been prepared with regard to relevant sections of DEM's Environmental Impact Assessment Criteria October 2024.

1.2 Professional judgement in landscape and visual impact assessment

The process of landscape and visual assessment incorporates both qualitative and quantitative analysis; however, a determination of visual effect is ultimately based on an interpretation informed by professional judgement. The application of professional judgement is outlined in the Guidelines for Landscape and Visual Impact Assessment, 3rd Edition 2013, which notes that professional judgement is a very important part of landscape and visual assessment. The Guideline notes that professional judgement is applied to several other environmental topics (e.g., ecology and cultural heritage) and that judgements made should be:

- Reasonable and based on clear and transparent methods
- Based on training and experience and
- Made, in general, by suitably qualified and experienced landscape professionals.

The Guideline notes that qualified and experienced landscape professionals may not agree on various aspects of a landscape and visual assessment which may arise from the application of different approaches or criteria; however, the core principals of receiver sensitivity and visual magnitude should provide some consistency in determinations of effects.

1.3 Landscape characteristics

This VIA has determined that landscape characteristics within and immediately surrounding the project site, as well as characteristics within the wider landscape, are visually robust and defined by strong lineal forms and broadscale, consistent landscape patterns within the rural and agricultural landscape.

Whilst recognising sensitivities and values applied to the landscape surrounding the project site, the overall landscape characteristics within and surrounding the project site are considered to exhibit characteristics which tend to result in a low to moderate sensitivity to accommodate change.

Landscapes with a moderate low sensitivity include those associated with broad, simple patterns and consistent colour and texture. These landscape characteristics are also generally common within the perspective of the broader sub-regional landscape which supports several renewable energy projects including wind farms.

Landscapes beyond the project site display characteristics of moderate scenic value with occasional steeper rising landforms providing a higher degree of scenic values.

Landscape characteristics and the overall potential visibility of the project have been illustrated in a series of panoramic photographs and in the Zone of Theoretical Visibility (ZTV) diagram. The ZTV diagram demonstrates the screening influence of undulating landforms and ridgelines surrounding the project site.

The project would incorporate new built features into the landscape and create a visual landmark from proximate and elevated view locations; however, the project is not considered to significantly conflict with existing landscape characteristics.

1.4 Visual effects

Views toward the project from the Hallett township (from dwellings and public spaces) would be partially screened by vegetation and tree cover within the township and result in low to moderate visual effects where visible. This VIA notes that the setback distance between the closest project wind turbine and the Hallett township zone is compliant with setback policies defined by the Planning and Design Code under the Planning, Development and Infrastructure Act 2016 (PDI Act). This VIA also notes that setback distances have been determined against an assumed 300m wind turbine tip height; however, a preferred and constructed wind turbine may be less than this assumed height resulting in a shorter set back requirement.

The assessment of visual effects determined that most non-host dwellings are unlikely to have significant views toward ancillary electrical infrastructure including a proposed Battery Energy Storage System (BESS) and an overhead transmission line (OTL). Views toward the project site from other view locations including lookouts and road corridors would not result in significant visual effects.

1.5 Electrical infrastructure

An assessment of the BESS, the OTL and substation, determined that existing landscape characteristics, including tree cover and a low undulating landform along sections of the proposed OTL easement, would have some capability to absorb smaller scale ancillary electrical infrastructure. Electrical infrastructure would not result in significant visual effects.

1.6 Nighttime obstacle lighting

An Aviation Impact Assessment (AIA) determined that the project is a low risk to aviation activity and does not require night time obstacle lighting with no further mitigation required.

1.7 Cumulative visual effects

A cumulative assessment identified several approved and/or operating wind farms within a 30 kilometre (km) sub-regional locality of the project. This VIA determined that there would be some opportunities for direct and indirect visibility between wind turbines within the project site and other wind farms including the existing Willogoleche Wind Farm, Goyder North Wind Farm and the Hallett Wind Farm group, as well as other wind farms within a broader landscape context. This VIA determined that existing and approved wind farm developments would not result in significant cumulative visual effects due to distances between wind farm developments. This VIA notes the proposed Whyte Yakowie Wind Farm project, to the north and north east of the project site; however, in accordance with standard industry practice, this VIA only considers approved, constructed and operating wind farms in a cumulative impact assessment.

1.8 Mitigation

This VIA considered several strategies to mitigate potential visual effects from sensitive receiver locations. These include applying uniformity in wind turbine design and colour. Visual mitigation would be largely achieved through distance between wind turbines and ancillary project elements and sensitive receiver locations, as well as undulating landforms within and beyond the project site.

1.9 Acceptability of landscape and visual effects

This VIA has assessed the potential landscape and visual effect of the project against relevant policies and guidelines and has determined that, in our professional opinion, the project is compliant with the requirements under Part 4 of the Hydrogen and Renewable Energy Act 2023 as applicable to 'landscape' and 'scenic amenity' and that the level of landscape and visual effects are acceptable.

Section 2. Introduction

2.1 Introduction

This VIA has been prepared to accompany the Environmental Impact Report (EIR) to seek a Renewable Energy Infrastructure Licence (REIL) for the project pursuant to the Act. ENGIE is developing the project as an extension to the operating Willogoleche Wind Farm which is located to the south of the project site and separated by the Wilkins Highway corridor. The operating Willogoleche Wind Farm was opened in July 2019 and includes 32 wind turbines at a 150m tip height. The wind farm connects to the grid via the Willalo substation located south of the Willalo Road.

This VIA informs the assessment of the project site for suitability for a wind farm development within the landscape surrounding the project, as well as considering the potential extent and degree of visual effects on people living in and travelling through, the surrounding landscape and those visiting places around the project site for recreation and tourism.

This VIA has been prepared by Andrew Homewood, Director and Principal Landscape Architect at Green Bean Design Pty Ltd (GBD). Andrew has over 30 years' experience in landscape architectural consulting, and over 18 years' experience in the preparation of VIA reports for wind farm projects, as well as other state significant projects including high voltage transmission lines, substations, and battery energy storage systems. Andrew has been commissioned to undertake visual assessment studies for over 60 large scale renewable energy projects across South Australia, Victoria, New South Wales, Queensland, and Tasmania.

This VIA has been prepared with reference to relevant criteria and the framework established under part 4 of the Act. This VIA notes and confirms that setback requirements (as applicable to the wind turbine assumed 300m tip height) to mitigate impacts to visual amenity are in accordance with the Act and that:

- The Hallett Township Zone is located at least 3.5km from the closest project wind turbine (base of turbine) and
- Non-host dwellings are located beyond 1.5km from the closest project wind turbine (base of turbine).

In addition, this VIA has also considered landscape and visual assessment guidance set out in:

- Guidelines for Landscape and Visual Impact Assessment, Third Edition, Landscape Institute, and Institute of Environmental Management & Assessment, 2013
- Siting and Designing Wind Farms in the Landscape, Version 3a, NatureScot, August 2017 and
- Visual Representation of Wind Farms, Version 2.2, Scottish Natural Heritage, March 2017.

2.2 Previous studies

GBD prepared the Goyder North and Goyder South Hybrid Renewable Energy Facility Landscape and Visual Impact Assessment Reports in 2020 and 2022 which included site inspections surrounding the project site.

Section 3. Methodology and report structure

3.1 Methodology

The VIA methodology adopts existing guidelines identified in the VIA introduction, and also on the assessment of a significant number of wind farms undertaken by GBD across South Australia, Victoria, New South Wales, Queensland and Tasmania.

Key principles of VIA consider a combination of:

- Receiver sensitivity (landscape or people) and
- Potential magnitude of visual effects.

For wind farm projects the magnitude of visual effects is primarily determined through:

- Distance between wind turbines and receiver locations
- Horizontal field of view occupied by wind turbine structures and
- Vertical field of view occupied by wind turbines.

The magnitude of horizontal and vertical fields of view is difficult to quantify against set criteria for potential visual effect and are often considered against the parameters of standard human eyesight. Whilst human eyesight can be objectified against horizontal and vertical field of view, it does not allow for the almost continual movement of receivers in a landscape setting as well as a natural inclination to scan distant horizons. Nevertheless, formulating a professional judgement on the visual scale of a wind turbine within a particular vista is necessary step in the visual assessment process.

It is important to understand the difference between visual assessment and landscape assessment and why both types of assessments are appropriate to include in this VIA. Visual assessments assess effects on viewers (people) caused by developments from selected viewpoints. Examples include a view of the development from a residential area where it will be seen by residents, a view from areas where it will be seen by people engaged in recreational activities or tourists visiting places or landscape features.

A visual assessment will determine the change to the view itself caused by the project. It also determines how change will affect the experience of people who may be at a viewpoint, and how they might respond to the change. The effect of seeing a development on viewer experience depends in part on what the viewers are doing when viewing a particular landscape scene, and their response depends in part on who they are and how much they value the view. Enjoyment of a particular view is dependent on viewers, and in visual assessment, receptors are people, not the landscape.

Landscape assessment considers effects on physical elements and features that make up a landscape and the aesthetic, perceptual, and experiential aspects of that landscape that make it distinctive. These effects affect the “feel,” “character,” or “sense of place” of an area of landscape, rather than the composition of a view from a particular place. Landscape effects, in essence, are a measure of the degree of compatibility of the character of the development, which might be, for example, “industrial,” with the character of the landscape it is in or is visible from, say, “wilderness” or “tranquil.” The impact receptor is the potentially affected landscape.

The final assessment of potential landscape and visual effects combines sensitivity and magnitude of visual effects and is ultimately a process of professional judgement. Professional judgement applies knowledge, assessment skills and relevant experience within the context of existing guidelines and technical supplements. Professional judgements applied in this VIA are based on reasonable and defined criteria.

3.2 Site inspections

Site inspection works and photography were undertaken in June 2024 and were supported by GBD site inspections for other wind farm projects within the same locality and broader regional landscape setting.

3.3 Report structure

This VIA report been structured into 15 parts as follows:

Table 2 Report structure

Report Section	Description
1 Executive summary	This section provides an overview of the main findings of the VIA.
2 Introduction	This section provides an introductory section that describes the intent and purpose of the VIA in the context of planning requirements.
3 Methodology and report structure	This section sets out the structure and methodology employed in the VIA preparation.
4 Project location and description	This section describes the regional and local position of the wind farm development relative to existing landscape features and places and describes the key visible components of the project.
5 Viewshed	This section identifies the area of land surrounding the wind farm project site subject to detailed assessment in this VIA.
6 Panoramic photographs	This section illustrates the VIA with panorama photographs taken during the site inspection. The photographs are provided to illustrate the general appearance of typical landscape characteristics that surround the proposed wind turbines.
7 Landscape character assessment	This section describes the physical characteristics of the landscape surrounding the project site and determines the overall sensitivity of the landscape to the wind farm development.
8 Zone of theoretical visibility and visual factors	This section identifies a theoretical area of the landscape from which the wind turbines may be visible within the

Table 2 Report structure

	viewshed and describes a range of factors which may influence the wind farm visibility within the viewshed.
9 Key views, visual effect and mitigation	This section describes and determines the potential visual effect of the wind turbines on key public viewpoints within the project viewshed.
10 Wind turbine shadow flicker & blade glint assessment summary	This section describes the potential visual effect wind turbine shadow flicker on OTL-host dwellings within the project viewshed.
11 Night lighting	This section describes the potential effect of night lighting associated with the project.
12 Cumulative assessment	This section describes the potential effect of alternate existing and/or known wind farm developments within proximity to the project.
13 Pre-construction and construction	This section describes the activities associated with pre-construction and during construction which may create visual effects.
14 Mitigation	This section outlines potential mitigation measures to minimise visual effects arising from the proposed wind farm development.
15 Summary	Conclusions are drawn on the overall visual effect of the project.

Section 4 Project location and description

4.1 Project location

The project site is in the north portion of the Mount Lofty Ranges and wholly located within the Regional Council of Goyder and within the Mid North Region and the SA Murray-Darling Basin Natural Resource Management (NRM) Area.

From a transport and access perspective, the region is serviced by the Barrier Highway, the Wilkins Highway and the Burra-Morgan Highway (Goyder Highway). This area is generally described as a transitional zone between cropping and pastoral country. It is noted that the project is not located within a prescribed water resources area.

The southern project wind turbines are approximately 4.3km north-east of the centre of Hallett. It extends approximately 6.6km to the north, with the northern tip being approximately 10km north north-west of the centre of Hallett. The land within the development site is privately owned and comprises predominantly dryland cropping and grazing. The regional project locality is illustrated in **Figure 1**.

4.2 General project description

The project would comprise of the following key elements:

- A wind farm of up to 20 wind turbines with a capacity of approximately 110-160MW, a maximum hub height of 209m, a maximum blade length of 91m, and an overall maximum height (tip height) of 300m
- BESS facility within a fenced compound
- Overhead transmission line supported by pole structures connecting the wind turbines to the Willalo substation
- Associated infrastructure for connection to the electricity grid including access tracks, underground connection cabling and transmission lines
- Temporary construction compounds for wind components; and
- Meteorological masts (in addition to the temporary mast already on site) to record wind speed and other meteorological data, both pre- and post- construction.

This VIA notes that the overall maximum wind turbine tip height of 300m is an upper limit height adopted by this VIA for a worst-case scenario for visual impact. The 300m tip height has also been adopted for the zone of theoretical visibility analysis, shadow flicker assessment and photomontage preparation.

4.3 Temporary construction facilities

Temporary construction facilities would include:

- A wind farm construction compound
- A BESS construction compound
- The construction compounds will include office, staff amenities, and carparking facilities

- Temporary batching plant facility
- Temporary overhead transmission line construction compound
- Temporary civil contractor compound
- Other temporary construction areas including storage and laydown areas; and
- Laydown areas will also be required at the base of each turbine.

4.4 Wind turbines

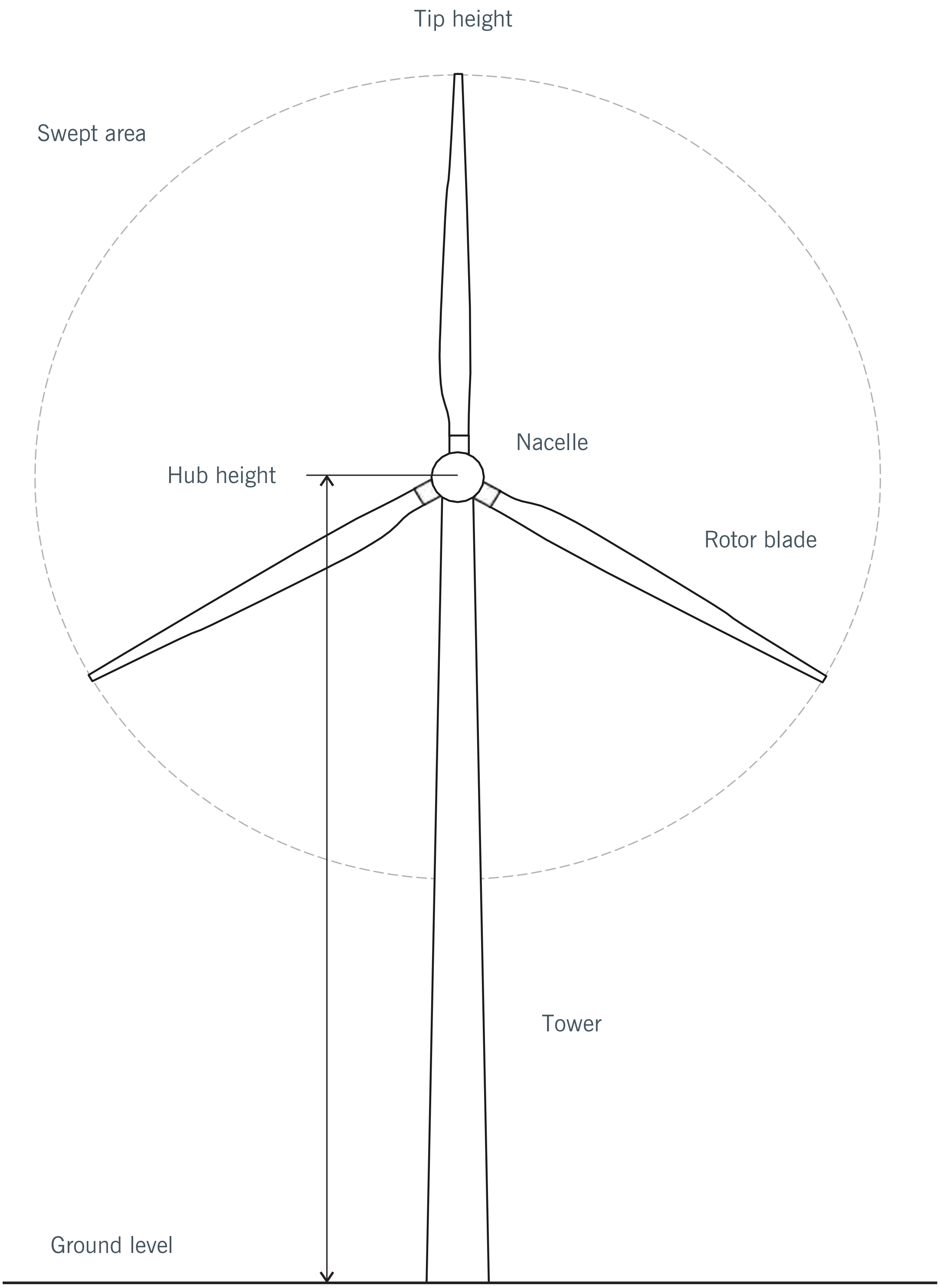
The specific elements of the wind turbines typically comprise:

- Concrete foundations
- A hybrid tubular tapering concrete and steel tower (with the same external colour finish)
- Nacelles at the top of the tower housing the gearbox and electrical generator
- Rotors comprising a hub (attached to the nacelle up to 209m above ground level) with three blades and
- Three composite material blades attached to each hub with a swept area around 26,000m^2.

Diagram 1 illustrates a typical wind turbine structure and names the key components most relevant to this VIA. **Diagram 1** is schematic only and is not drawn to scale or representative of the project wind turbine.

Diagram 1 – Typical wind turbine components and terminology (Image: ©GBD Pty Ltd 2022)

Not to scale



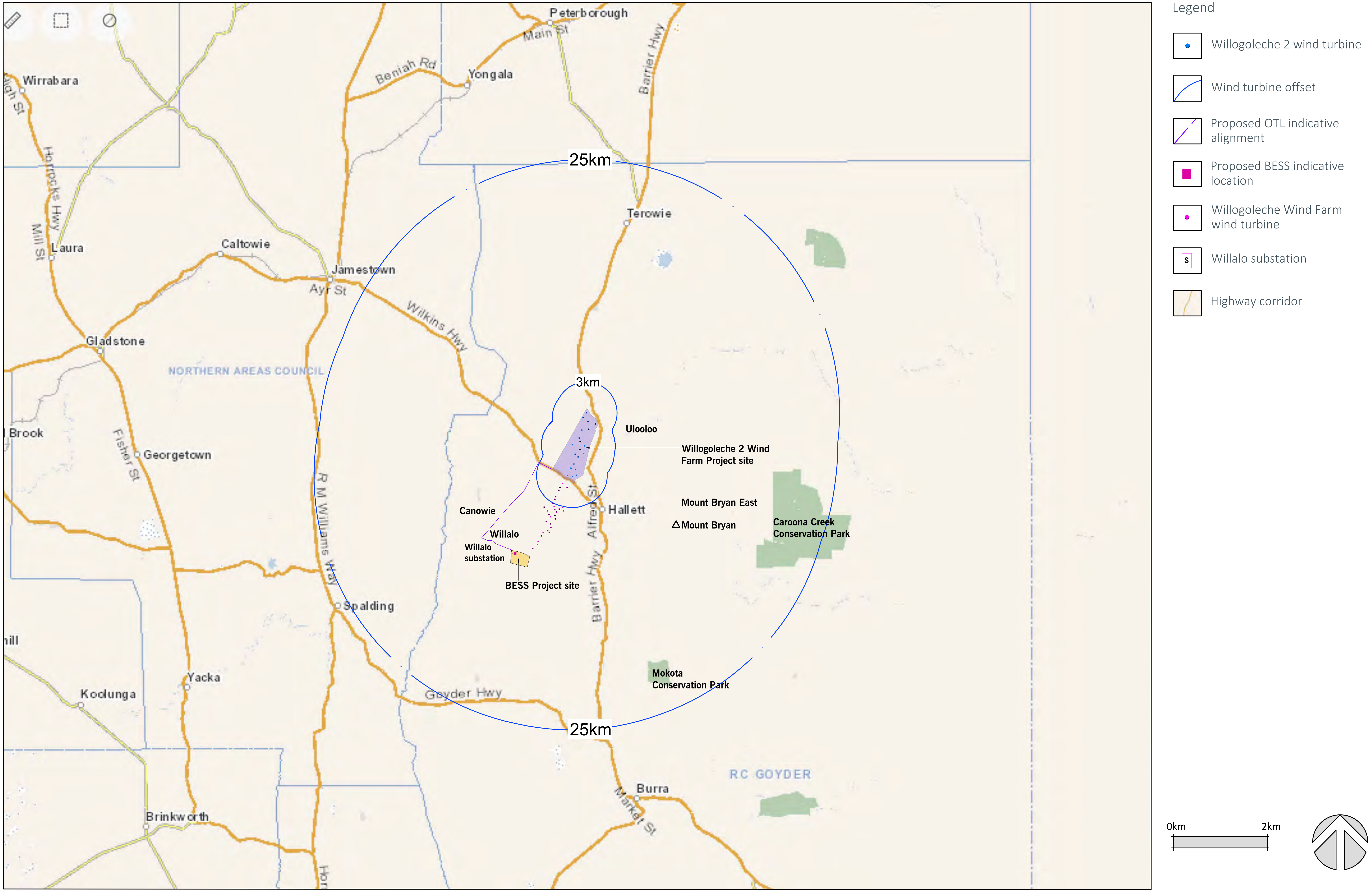


Figure 1
Project location
Willogoleche 2 Wind Farm : Visual Impact Assessment

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4.5 Wind monitoring mast

One temporary wind monitoring mast, up to 150m in height has been installed on the project site. The temporary wind monitoring mast would be replaced with one or two permanent wind monitoring masts, and are expected to be of a guyed, narrow lattice or tubular steel design like the example as shown in Plate 1.

Plate 1 – Typical wind monitoring mast (Image: ©GBD 2021)

4.6 On-site access tracks

New on-site access tracks would be constructed where existing access tracks are not present or not suitable for use and to provide access to wind turbine locations within the project site during construction and operation. On-site access tracks may be reduced in width for the project operational stage or rehabilitated where no longer required.

Final on-site access track design would be subject to the detailed design of the wind farm and will be developed in consideration of site constraints, including minimising the potential for visual effect by considering the:

- Use of existing farm access tracks
- Overall length and extent
- Need for vegetation clearing
- Potential for erosion
- Extent of cut and fill and
- Potential to maximise rehabilitation at the completion of the construction phase.

4.7 Aviation Obstacle Lighting

The Proponent commissioned an Aviation Impact Assessment (AIA). The AIA included a detailed consideration regarding obstacle lighting needs and requirements for the installation and operation of obstacle lighting. The AIA concluded that there will be a low level of aviation safety risk associated with the potential for an aircraft collision without obstacle lighting on the wind turbines. The AIA concluded that no obstacle lighting is required for wind turbines.

4.8 Electrical reticulation

The project would require new electrical reticulation that involves the construction of underground and overhead cabling throughout the wind farm site and a new OTL to connect the project to the existing transmission network is also proposed.

4.9 Proposed BESS

The project includes a proposed BESS located around 9.5km south of the Willogoleche Stage 2 wind turbines. The BESS would be adjacent and to the east of the existing Willalo substation south of Willalo Road. BESS projects may typically include:

- shipping container style units that house individual battery cells and inverters plus additional electrical and civil balance-of-plant
- on-site substation to facilitate the connection to the grid
- an operations and maintenance building
- site office
- control and switching rooms
- water tanks for firefighting purposes.

Constructed elements associated with a BESS facility are generally small scale and largely unobtrusive within the context of larger scale infrastructure associated with a wind farm development. Container style units are nominally 3m to 4m in height.

Plate 3 – Typical 150MW BESS, Hornsdale SA (Image supplied: Neoen Australia Pty Ltd 2017)

4.10 OTL, Substation and Operations and Maintenance Facility

Ancillary and support infrastructure will be selected and located subject to detailed engineering and civil/electrical design works. However, similar structures and built elements associated with existing wind farms, including the operational Willogoleche Wind Farm, can be found within the surrounding landscape. These elements generally demonstrate a lower level of overall visibility as well as a restricted viewshed due to screening through landform and vegetation surrounding dwellings. Subject to detailed design, it is considered unlikely that these elements would result in significant visual impacts from sensitive view locations.

Plate 4 – Willalo substation and operations centre, Willogoleche Wind Farm, Willalo SA (Image: ©GBD 2024)

4.11 Construction

There are potential visual effects that could occur during the project construction phase. The wind farm construction phase is likely to occur over an extended period, although the extent and nature of pre-construction and construction activities will vary at different locations within the project site.

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

- Various civil works to upgrade local roads and access points
- Construction compound buildings and facilities
- Construction facilities, including portable structures and laydown areas
- Various construction and directional signage
- Mobilisation of rock crushing equipment and concrete batching plants (if required)
- Excavation and earthworks and
- Various construction activities including erection of wind turbines, wind monitoring masts with associated electrical infrastructure works.

Construction activities, some of which will result in physical changes to the landscape, are generally temporary in nature and for the most part restricted to various discrete areas within or beyond the immediate wind farm project site.

Plate 5 – Typical wind farm under construction (Image: ©GBD 2017)

Plate 6 – Site entry signage, Willalo substation SA (Image: ©GBD 2024)

4.12 Decommissioning

The proposed technology is expected to have an economic life of approximately 30-35 years. At the end of the lease term, a decision would be made whether to:

- decommission the project permanently or
- to remove the old infrastructure and seek to replace it with new, upgraded technology.

If the project is to be upgraded, then a new development application would be lodged at that time. If the project is permanently decommissioned, the owner would take full responsibility for decommissioning and rehabilitation works. A decommissioning plan would be prepared and submitted to the relevant authority for approval.

Decommissioning would include the following:

- De-energising plant and equipment
- Dismantling and removal wind turbines, battery energy storage units and transmission lines, as well as all other aboveground buildings, foundations and equipment
- Rehabilitation of disturbed land; and
- Recycling of recyclable materials (including batteries).

Decommissioning of some elements may be subject to the landowner's discretion (such as access tracks).

The project site and ancillary infrastructure locations are illustrated in **Figure 2**.

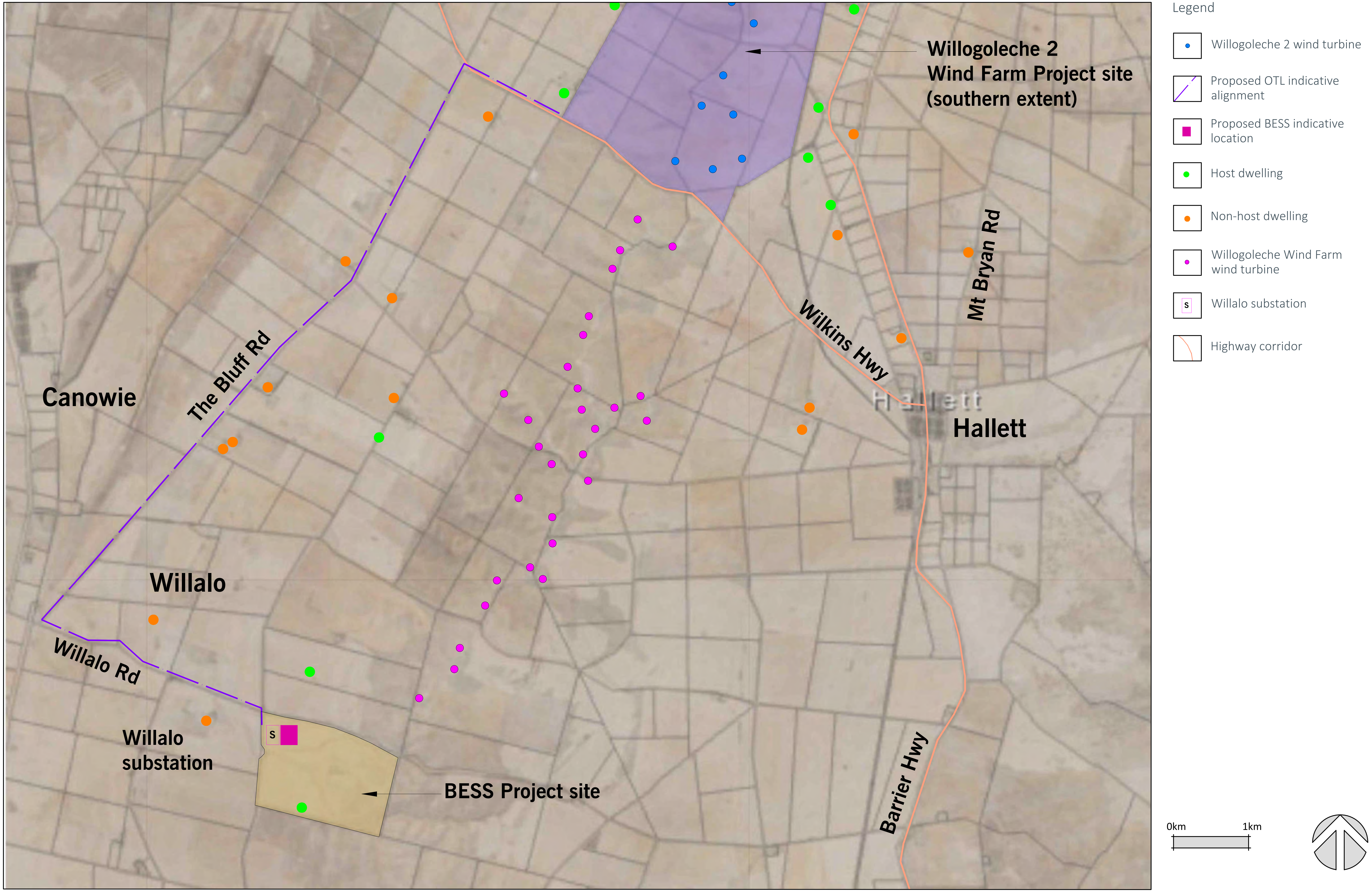

Figure 2
BESS and ancillary elements

Section 5. Viewshed

5.1 Viewshed

This VIA defines the viewshed as a geographic area surrounding the project site where key elements such as wind turbines, OTL and BESS may be visible. Viewsheds can extend for long distances beyond wind farm sites, across mixed use areas including large tracts of unoccupied agricultural or natural landscapes. Viewsheds may include a range of key view locations subject to high, moderate or low visual effects.

The extent of viewshed will vary between wind farm projects and are influenced and informed by several criteria including the height of the wind turbines together with the nature, location and height of landform or vegetation that may limit and influence the extent of wind farm visibility.

The landform surrounding the project offers some variability in height (offering various degrees of screening) as illustrated in the ZTV diagram. When combined with areas of tree cover, the potential for significant visual effects to occur beyond 6km is considered low.

It is important to note that wind turbines may be visible from landscape areas far beyond 8km and potentially up to 50km in ideal and extreme viewing conditions (Wind Turbine Visibility and Visual Impact Threshold Distances in Western Landscapes, Sullivan and Richmond May 2012). However, within the general parameters of normal human vision, a wind turbine at a maximum height of 300m to tip of rotor blade would occupy a relatively small proportion of a person's field of view from distances more than 6km and result in a relatively lower level of perceived visual effects, and more so when tree cover is located within foreground to middle ground locations between a viewer and wind turbines.

Section 6. Panoramic photographs

6.1 Panoramic photographs

A series of individual and panorama digital photographs were taken during the site inspection to illustrate existing views near the project and to give a sense of the overall site in its broader landscape setting and characteristics. Photo locations were selected to illustrate the variety of landforms and vegetation types found within the viewshed. The panorama photographs were digitally stitched together forming a segmented panorama image to provide a visual illustration of the existing view from each photo location. Photographs presented in this section are informative only and do not illustrate the appearance of the project wind turbines; however, the general extent of potential wind turbine visibility has been illustrated on each of the panorama photographs.

The panorama photographs were taken with a Nikon D850 digital SLR camera with a full frame sensor and a prime 50mm focal length lens. The photographs were taken as a combination of hand held and tripod mounted images.

The panoramic photographs presented in this VIA have been annotated to identify local features within and beyond the project site. The panorama photograph locations are illustrated in **Figure 3** and the photographs illustrated in **Figures 4** to **7**.

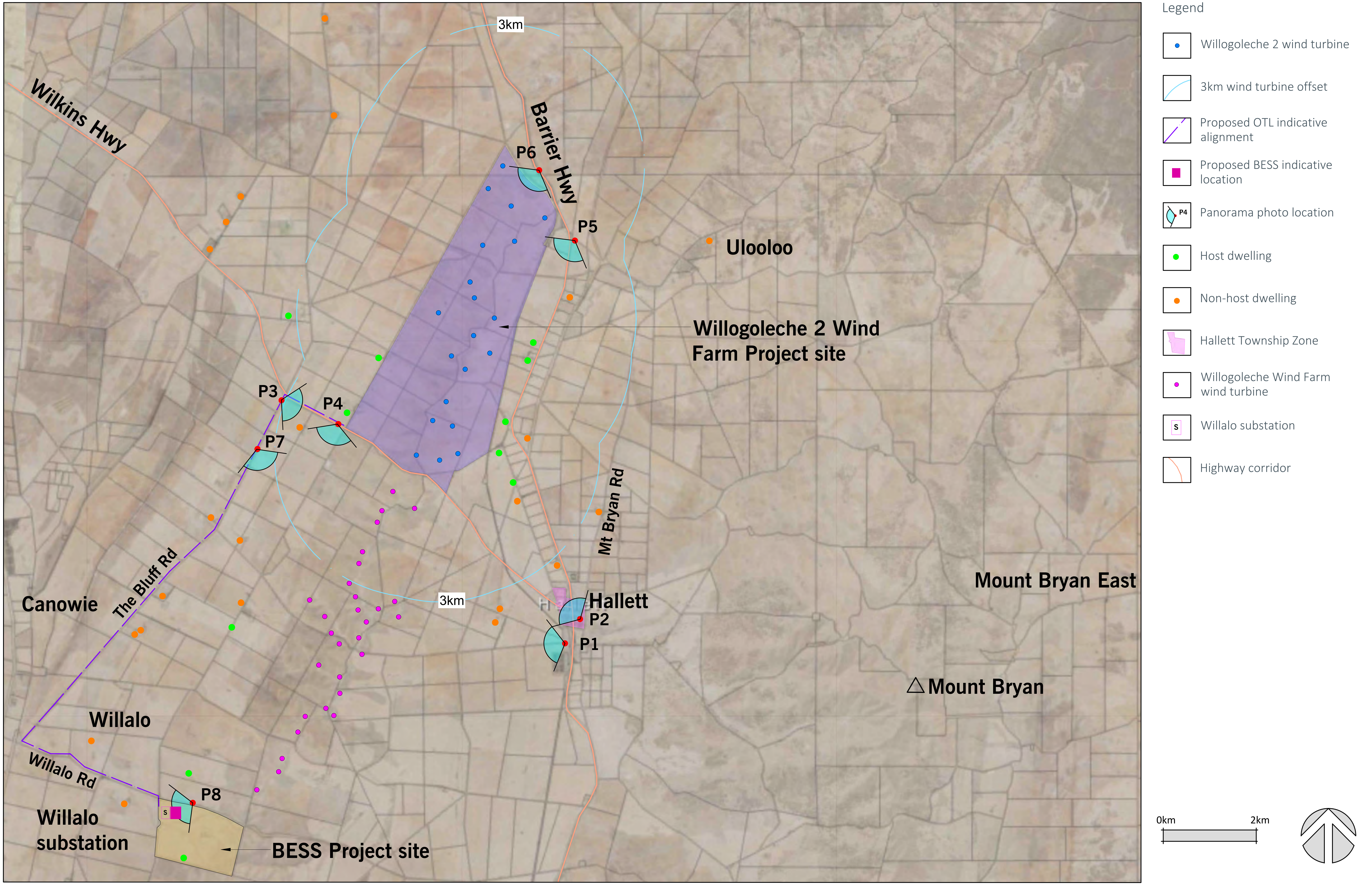

Figure 3
Project site and panorama photo locations

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Panorama photo 1 - Existing view south west to north west from The Government Silos Road.

Panorama photo 2 - Existing view west to north west from East Terrace, Hallett Township Zone.

Panorama photo 3 - Existing view east from The Bluff Road toward the Wilkins Highway and Willogoleche 2 Wind Farm project site.

Photomontage PM1 - Existing view south west from The Bluff Road toward wind farms south west of the Willogoleche 2 Wind Farm project site.

Figure 5
Panorama photo sheet 2

Panorama photo 5 - Existing view south from adjacent to Barrier Highway corridor, Ulooloo Road junction.

Panorama photo 6 - Existing view west to south west from the Barrier Highway corridor.

Panorama photo 7 - Existing view south to south east from The Bluff Road toward the Willogoleche Wind Farm,

Panorama photo 8 - Existing view south to south west toward the Willalo substation from Willalo Road.

Section 7. Landscape Character Assessment

7.1 Landscape Character Area

As part of the VIA process it is important to understand the nature and sensitivity of different components of landscape character, and to identify them in a clear and consistent process. For this VIA, 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). The pattern of elements includes characteristics such as landform, vegetation, land use and settlement.

This VIA has identified a singular Landscape Character Area (LCA), which generally occurs within the project viewshed. The LCA represents an area that is relatively consistent and recognisable in terms of its key landscape elements and physical attributes, which includes a combination of topography/landform, vegetation/landcover, land use and built structures (including settlements and local road corridors).

The LCA is not defined as a discrete area, and characteristics within one section of the LCA may well occur within adjoining landscape surrounding the project site.

7.2 Landscape character assessment

Understanding a particular landscape's key characteristics and principle visual features is important in defining regional distinctiveness and sense of place and to determine a region's sensitivity to change. The criteria applied in the determination of landscape character assessment and the ability of a landscape to accommodate change are outlined in **Table 3**. These criteria are based on established industry practice employed in the assessment of wind farm developments and have been adopted for numerous wind farm assessments across Australia and within South Australia.

The criteria are broadly outlined in the National Wind Farm Development Guidelines (Draft v2.4), Section 6.1 Landscape Character Units, and covered in more detail within the Guidelines for Landscape and Visual Impact Assessment, Third Edition, Landscape Institute and Institute of Environmental Management & Assessment, 2013 – Chapter 5 Assessment of landscape effects.

Whilst landscape character assessment is largely based on a systematic description and analysis of landscape characteristics, this VIA acknowledges that some individuals and other members of the local community may place different values on the local landscape.

Table 3 Criteria for the assessment of landscape character

Landscape Character Assessment Criteria

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

7.3 Landscape sensitivity

The scale of sensitivity for the landscape character area is described below and considered against each characteristic identified in **Table 3**.

The overall sensitivity for the landscape character area has been determined against the following ratings of Negligible through to High:

Negligible – where the characteristics of the landscape character area will not be impacted or visibly altered by the project.

Low – where most of the landscape character area characteristics are generally robust and will be less affected by the project. The degree to which the landscape may accommodate the project will not significantly alter existing landscape character.

Moderate – where distinguishable characteristics of the landscape character area may be altered by the project, although the landscape character area may have the capability to absorb some change. The degree to which the landscape character area may accommodate the project will potentially result in the introduction of prominent elements to the landscape character area, which may be accommodated to some degree.

High – where key characteristics of the landscape may be impacted by the project and could result in major and visually dominant alterations to perceived characteristics of the landscape character area, which may not be fully mitigated by existing landscape elements and features. The degree to which the landscape may accommodate the project will result in several perceived uncharacteristic and significant changes.

7.4 Landscape sensitivity assessment

The following section of this VIA provides an analysis of landscape sensitivity within the viewshed.

Table 4 – Landscape Sensitivity

<table>
<tr><td></td><td colspan="2">Lower Sensitivity</td><td>↔</td><td colspan="2">Higher Sensitivity</td></tr>
<tr><td></td><td>Low</td><td>Low to Mod</td><td>Moderate</td><td>Mod to High</td><td>High</td></tr>
<tr><td rowspan="2">Landform and Scale</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The landform and morphology of the landscape within and immediately surrounding the project site is relatively consistent with areas of gentle to moderately inclined landform extending around the project site. There is an overall large scale to the broader landscape defined by patterns being more moderate in scale. Landscape features and stronger topographical elements beyond the project site create a greater degree of complexity and more visually compartmentalised areas because of tree covered hills and gullies.</td></tr>
<tr><td rowspan="2">Landcover</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Landcover within the project site is relatively simple and predictable, together with that of the immediate and surrounding landscape. Tree cover is generally limited within the viewshed, occurring within steeper gullies beyond the project site or along drainage lines and intermittently along road corridors. European settlement established an agricultural presence which defines some of the contemporary farming areas within and beyond the project site.</td></tr>
<tr><td rowspan="2">Settlement and human influence</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Settlement is generally dispersed within the rural landscape immediately beyond the project site incorporating farmsteads and individual rural dwellings. There are small to moderate scale, historic or vernacular structures within the landscape including those associated with the Hallett township. Most historic built elements or features resultant from human interactions are visually contained by the proximate landform surrounding and screening the Hallett township from extensive and distant views.</td></tr>
<tr><td rowspan="2">Movement</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Movement occurs within the townships and along local roads within urban areas and main roads leading to and away from Hallett. Low to moderate frequency vehicular movements occur along sections of the Barrier and Wilkins Highways. Movement within the project site is limited to occasional vehicles and farm traffic along local access tracks.</td></tr>
<tr><td rowspan="2">Rarity</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">The project site and adjoining landscape are a relatively common landscape type (Rural Zone) within a regional context and do not tend to exhibit landscape features or elements which would only occur within the project site.</td></tr>
</table>

	Lower Sensitivity		↔		Higher Sensitivity
	Low	**Low to Mod**	**Moderate**	**Mod to High**	**High**
Intervisibility			■		
	Areas of landscape surrounding the project Site can allow for far distant and regional scale views. Whilst views can, depending on prevailing climatic conditions, extend toward portions of landscapes with a moderate to high visual sensitivity, the level of distant visibility is generally restricted to landform silhouettes. Whilst the wind turbines would be visible from some elevated areas, the distance between wind farm and distant elevated receiver locations would tend to render the project wind turbines as generally noticeable, but not dominant features which occupy a relatively small portion of the overall available view.				
Overall Sensitivity Rating	Moderate Low				

7.5 Landscape sensitivity summary

As a landscape with a Moderate Low sensitivity the landscape character area characteristics are generally robust and will be less affected by the project. The degree to which the landscape may accommodate the project will not significantly alter existing landscape character.

However, where distinguishable characteristics of the landscape character area may be altered by the project, although the landscape character area may have the capability to absorb some change. The degree to which the landscape character area may accommodate the project will potentially result in the introduction of prominent elements to the landscape character area, which may be accommodated to some degree.

Section 8. Zone of Theoretical Visibility

8.1 Zone of Theoretical Visibility

ZTV diagrams are used to identify theoretical areas of the landscape from which wind turbines, or portions of turbines, may be visible from areas within and surrounding the project site. They are useful for providing an overview as to the extent to which the project wind turbines may be visible from surrounding areas.

8.2 ZTV Methodology

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

Calculations have been made to determine the visibility of the wind turbines from blade tips essentially a view toward any part of the wind turbine rotor, including views toward the tips.

The ZTV assessment methodology is very conservative as:

- the screening effects of any structures and vegetation above ground level are not considered in any way. Therefore, the project may not be visible at many locations indicated on the ZTV diagram due to the local presence of trees, buildings or other screening materials.
- additionally, the number of turbines visible from any location is also influenced by prevailing weather conditions. Inclement or cloudy weather would tend to mask the visibility of the wind turbines.

Accordingly, while a ZTV diagram is a useful visualisation tool, it is very conservative in nature and the level of visibility as illustrated in the ZTV diagram is unlikely to occur from all view locations within the viewshed.

A diagram illustrating the tip of blade and hub height visibility is illustrated in **Figure 8** and the ZTV diagram is shown in **Figure 9**.

The ZTV diagram illustrates the extent of similar areas of potential visibility and highlight the extent and influence of landform surrounding the project site; however, the ZTV do not illustrate screening provided by tree cover.

8.3 Visibility

The level of wind turbine visibility of the project would result from several factors including, but not limited to:

- Distance between view location and wind turbine
- Directional movement (travelling toward or away from wind turbines)
- Relative position and backdrops and
- Climatic and atmospheric conditions.

8.3.1 Distance

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, would decline. **Figure 10** illustrates the effect increasing view distance on the scale and visibility of wind turbines.

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.

8.3.2 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 may be relatively wide as a person would tend to scan back and forth across the landscape where panoramic views are available.

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

8.3.3 Relative position

In situations where the view location is at a lower elevation than the wind turbine structure most of it 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. Dark grey clouds would contrast more strongly with white turbines than a background of white clouds.

The level of contrast is also influenced by the position of the sun relative to the individual wind turbines and the view location. Where the sun is in front of the viewer, the visible portion of the wind turbine would be seen in shadow. Where the background to the wind turbine is dark toned the visual contrast would be reduced.

Where the sun is located behind the view location then the visible portion of the wind turbine would be in full sun. If the background is also light toned, such as white clouds, then the contrast is less when compared to a dark background.

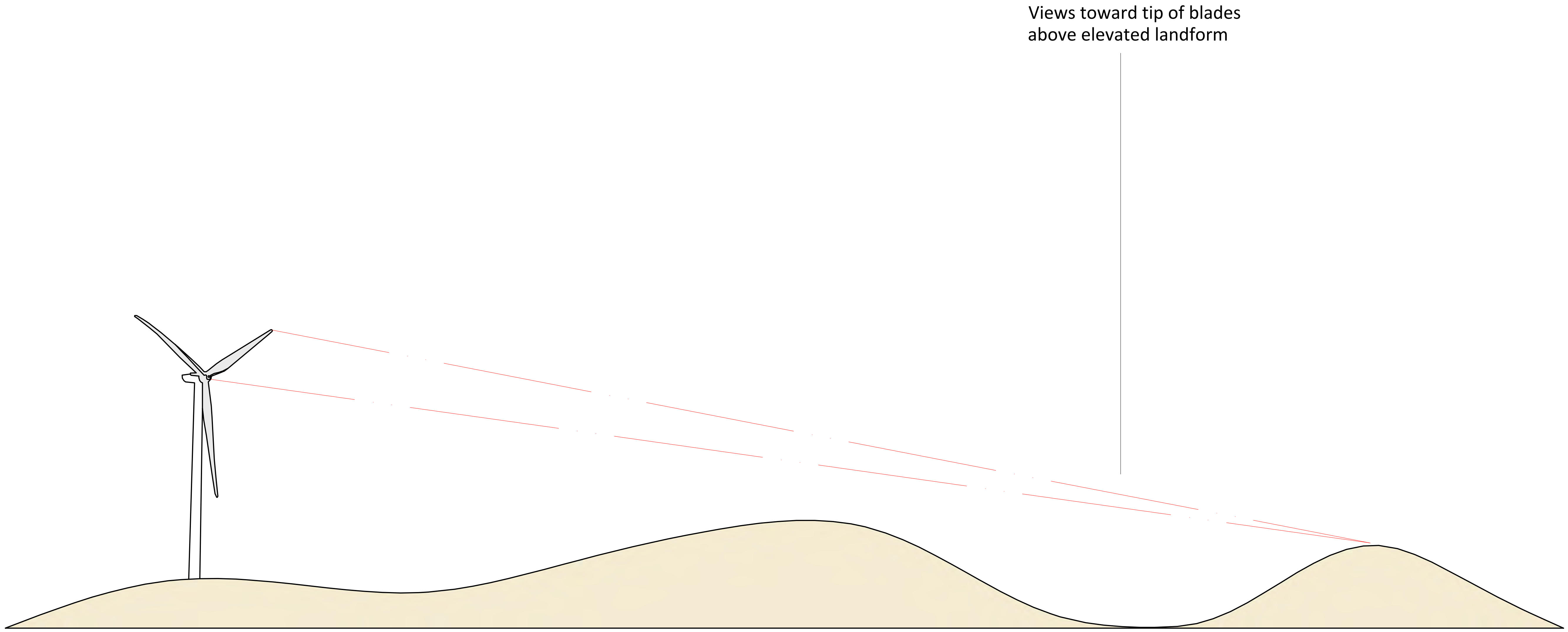
8.3.4 Climatic and Atmospheric Conditions

Local climatic and atmospheric conditions have the potential to influence the visibility of the project from surrounding view locations, and more significantly, from middle ground and distant view locations.

Rainfall would tend to reduce the level of visibility toward the project from several surrounding view locations, with the degree of visibility tending to decrease over distance. Rain periods may also reduce the number of visitors travelling through the areas from which the project may 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 may be visible.

On clear or partly cloudy days, the position of the sun would also influence the degree of visibility of the project. The degree of effect 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.



'Tip of blade'

View toward 'tip of blade' - where views extend toward any part of the turbine
including views toward the tip of blades above elevated landform and ridgelines.

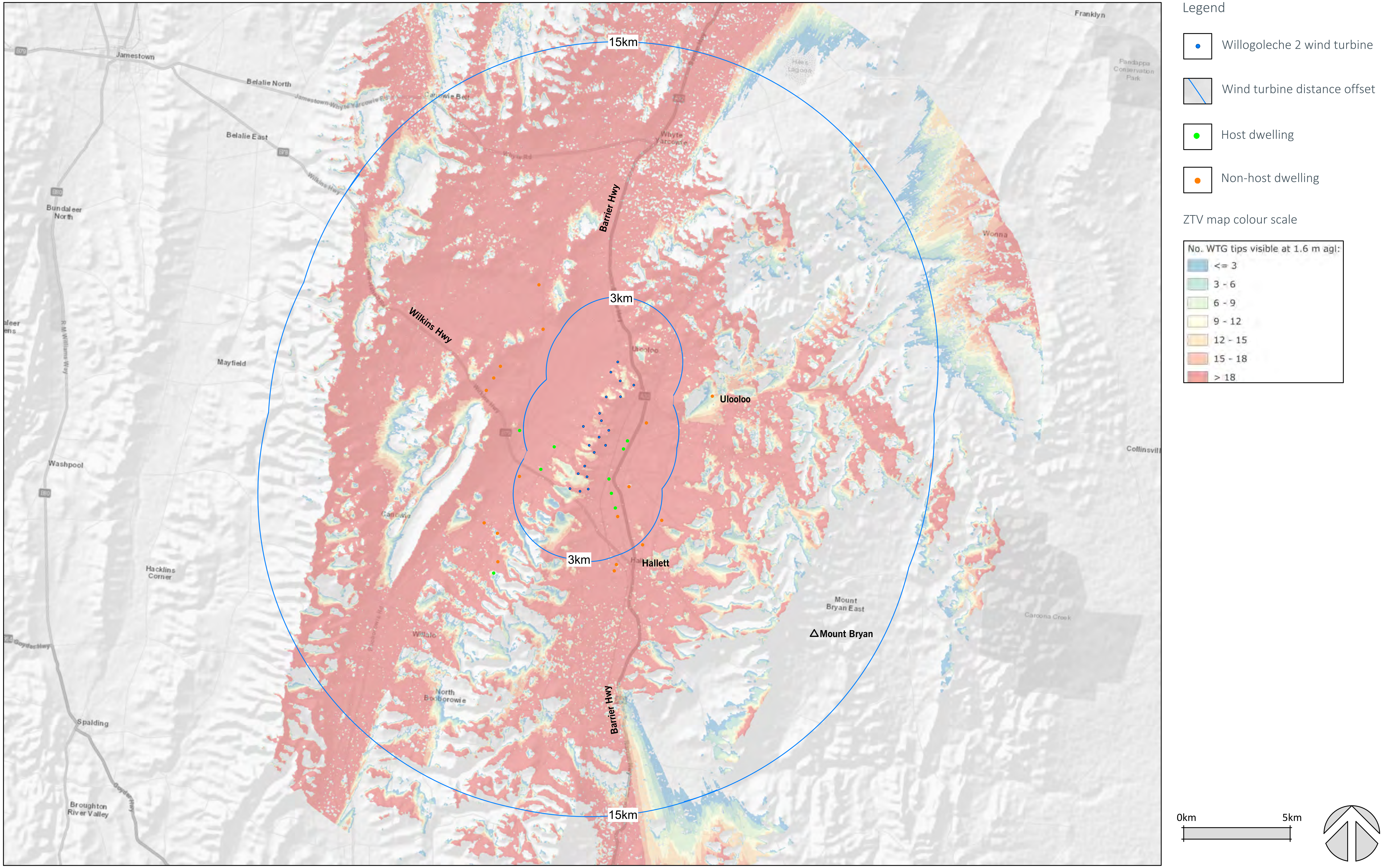


Figure 9
ZTV Diagram - tip of blade 300m

Willogoleche 2 Wind Farm : Visual Impact Assessment

GBD
Landscape architecture

Image 1 Modelled wind turbine 300m tip height - view distance 2 km

Image 2 Modelled wind turbine 300m tip height - view distance 3 km

Image 3 Modelled wind turbine 300m tip height- view distance 4 km

Image 4 Modelled wind turbine 300m tip height - view distance 5 km

Camera: Nikon D700, 50mm prime lens

Approximate wind turbine swept area

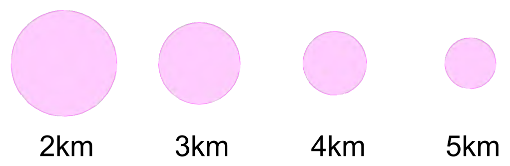


Figure 10
Wind turbine visibility

Section 9. Key views and visual effects

9.1 Introduction

The overall determination of visual effects resulting from the project would result primarily from a combination of receptor sensitivity and the magnitude of visual effects.

A determination of visual effects from the combination of receptor sensitivity and the magnitude of visual effect is a well-established methodology and has been applied extensively on proposed wind farms in South Australia and across Australia. The standard methodology is set out in industry and best practice guidelines including the Guidelines for Landscape and Visual Impact Assessment, Third Edition, Landscape Institute, and Institute of Environmental Management & Assessment, 2013 – Chapter 6 Assessment of visual effects.

9.2 Sensitivity of visual receivers

Judging the sensitivity of visual receivers surrounding the project site needs to consider the occupation or activity of people experiencing the view at particular locations and the extent to which their attention or interest is focussed on views toward the wind turbines or electrical infrastructure within and surrounding the project site.

9.3 Magnitude of visual effects

Judging the magnitude of visual effects has considered the:

- Distance and resultant scale of the change in the view with respect to the loss or addition of features in the view
- Changes in landscape composition, including the proportion of the view occupied by the project
- Degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line height, colour, and texture
- Nature of the view of the proposed development, in terms of the relative amount of time over which it would be experienced and
- Whether views from receiver locations would be screened to any degree by existing vegetation or other above ground structures.

View distance and the resultant change in wind turbine scale are illustrated in **Figure 10.** Wind turbines at around a 6km view distance are clearly visible; however, the overall wind turbine scale presents a less dominant visual element within the available field of view. As the overall scale of wind turbine structures diminish with distance the greater the potential for screening where trees are located between the receiver and the wind turbine. The overall height of planting required to screen wind turbines decreases as it moves nearer to the receiver. The consideration of distance magnitude criteria has determined that wind turbines occupying around 2% or less of a person's vertical field of view are unlikely to result in a significant visual effect.

The combination of sensitivity and magnitude would provide the rating of visual effect for viewpoints. **Table 5** sets out the relative visual impact grading values which combines issues of sensitivity and magnitude for the project.

An overall determination of potential visual effect at each key view location has been assessed and determined against the visual impact grading matrix in **Table 5** below. The levels of sensitivity and magnitude of visual effects outlined in **Table 5** are **used as a guide** to determine levels of visual effect and are not absolute. For example, views may extend toward the project from 'high' sensitive view locations; however, a 'medium' magnitude may be adjusted to 'low' as a result of restricted views or existing screening, resulting in 'moderate' visual effects rather than 'high moderate' visual effects.

Key view locations up to 6km from the wind turbines are illustrated in **Figure 11**. Non-dwelling structures, such as agricultural sheds, within 6km of the proposed wind turbines have not been assessed.

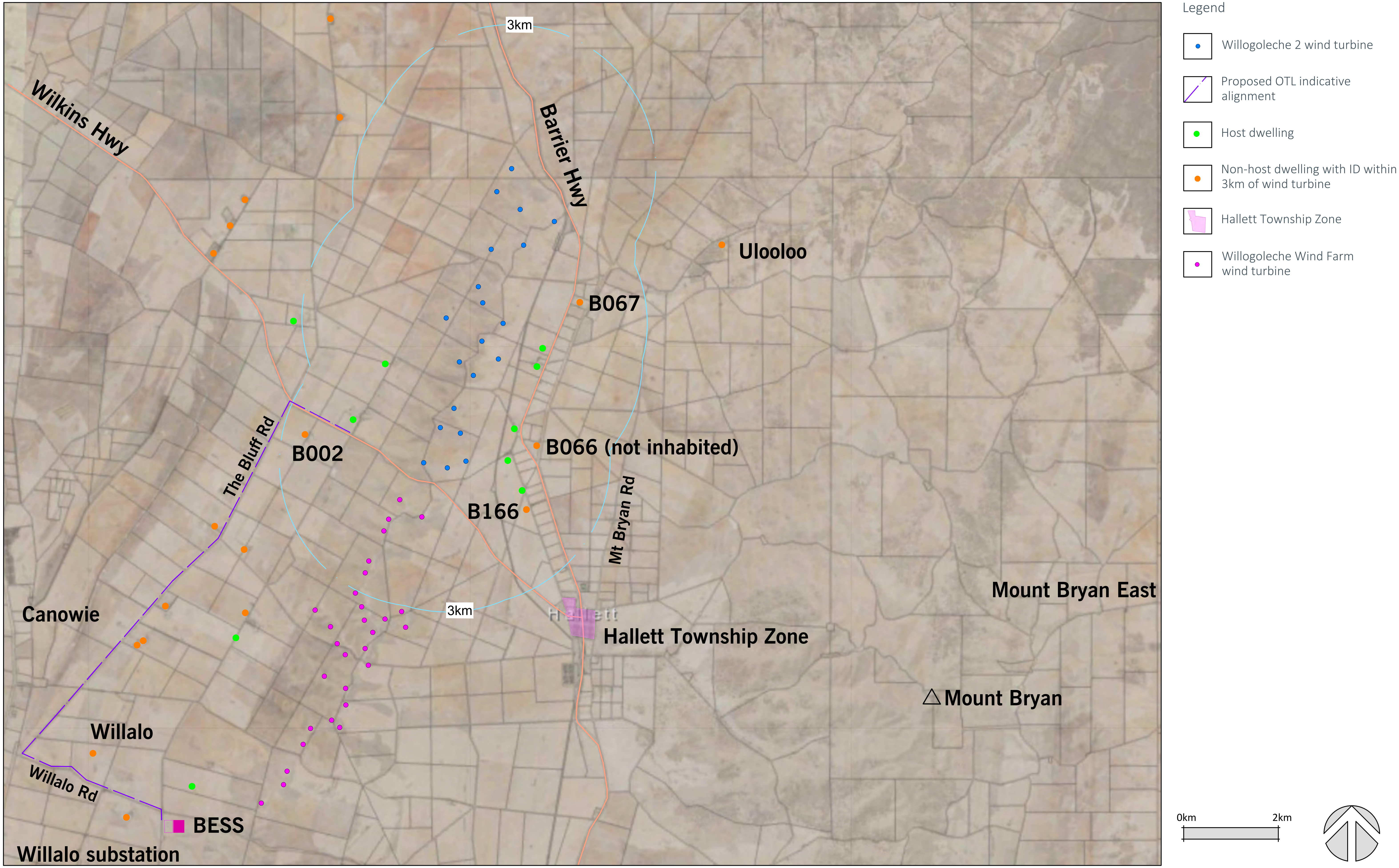


Figure 11
Key view locations

Table 5 Visual effect grading matrix

			Scale or magnitude of visual effects			
			High	Moderate	Low	Negligible
			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. Total loss or major change to pre-development view or introduction of elements which are uncharacteristic to the existing landscape features.	Short to moderate distance views over a moderate duration of time. A moderate extent of wind turbine visibility would have the potential to dominate available views with visibility recessing over increasing distance. Partial alteration to pre-development view or introduction of elements that may be prominent but not uncharacteristic with the existing landscape.	Moderate to long distance views over a low to moderate 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. Minor alteration to pre-development view or introduction of elements that may not be uncharacteristic with the existing landscape.	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. Very minor loss or alteration to pre-development view or introduction of elements which are not uncharacteristic with the existing landscape features.
Sensitivity of visual receptor	High	**Indicator** People with a proprietary interest and prolonged viewing opportunities such as those in dwellings or visitors to attractive and/or well-used recreational facilities. Views from a regionally important location whose interest is specifically focussed on the landscape e.g., from lookouts or areas/campgrounds within National Parks.	High	High-moderate	Moderate	Negligible
	Moderate	People with an interest in their environment e.g., visitors to environmental areas, bush walkers, and horse riders etc…those travelling with an interest in their surroundings	High-moderate	Moderate	Moderate-low	Negligible
	Low	People with a passing interest in their surroundings e.g., those travelling along local roads between townships, or people whose interest is not specifically focussed on the wider landscape e.g., service providers or commuters.	Moderate	Moderate-low	Low	Negligible
	Negligible	People with no specific interest in their surroundings or those with occasional and transient views travelling at speed along highways or from a place of work where attention may not be focussed on surrounding views.	Negligible	Negligible	Negligible	Negligible

9.4 Key viewpoints

This VIA acknowledges that the practicalities of preparing an assessment does not extend to assessing every public viewpoint in the landscape from which the project may be visible. However, every effort has been made to include significant and key viewpoints where wind turbines, or other project infrastructure visibility, may result in a change to scenic amenity from sensitive or established viewpoints where people are likely to visit. This assessment, based on the current project layout, has determined the potential visual effect on views from:

- Hallett township/public spaces
- Hallet township dwellings
- Rural non-host dwellings
- Highways (Barrier and Wilkins)
- Local road corridors and
- Agricultural land.

This VIA notes the Mount Bryan lookout located around 11km south east of the closest wind turbine within the project site. The lookout, and direction of view from 'God's Chair' (a landmark on the Heysen Trail), is primarily focused on views from east to south and opposite to the project site.

9.5 Key Viewpoint Assessment

An assessment of potential visual effects has been prepared against the methodology and criteria outlined above and as described in the following sections.

9.6 Hallett township/public spaces

Views toward the proposed wind turbines from most public spaces within the Hallett township would be partially screened by buildings and/or vegetation and tree cover within surrounding streetscapes, as well as trees located within parks and gardens. Partial views would extend toward the project from the Hallett Oval, tennis courts and bowls club in the north portion of the Township Zone; however, tree cover around these facilities would provide some degree of screening. More direct and open views towards the project would occur from the golf course to the east of the Oval. Most streetscapes within the Township Zone would not have views toward the project site where screened by tree planting. Partial views and gradually more open views toward the project site would occur from outlying streets and roads within the north and north east of the Township including the Mount Bryan East Road heading north past the Hallett Cemetery.

Ancillary electrical infrastructure, including the BESS facility, the OTL and substation would not be visible from open space within the Hallett Township Zone.

This VIA notes that the offset between the proposed wind turbines and the Hallet Township Zone is in accordance with the relevant Act requirement for a 3.5km setback distance from the closest wind turbine at a 300m tip height.

Table 6

Visual effect grading – Hallett township public spaces

Sensitivity of visual receiver	High
Magnitude of visual effects	Low
Visual Effect	Moderate Low where wind turbines are visible

9.7 Hallett Township dwellings

Whilst the project wind turbines will be visible from distances beyond 2km, views toward wind turbines from dwellings within the Hallett Township would be partially restricted by surrounding buildings and more extensively by tree planting. A generous amount of tree planting extends throughout the township within property boundaries and alongside road corridors and surrounding sporting facilities in the north and north west portion of the township.

Whilst there is an opportunity for discrete views from a small number of dwellings to extend toward some portions of the project site, it is unlikely that the proposed wind turbines would have a significant visual impact on most people residing in the Hallett Township.

Ancillary electrical infrastructure, including the BESS facility, the OTL and substation, would not be visible from dwellings within the Hallett Township.

This VIA notes that the offset between the wind turbines and the Hallet Township Zone is in accordance with the relevant Act requirements for setback distances.

Table 7

Visual effect grading – Hallett Township dwellings

Sensitivity of visual receiver	High
Magnitude of visual effects	Moderate Low
Visual Effect	Moderate Low where wind turbines are visible

9.8 Non-host rural dwellings

Most non-host rural dwellings located within 3km of the wind turbines are unlikely to be significantly impacted by the project. Rural dwellings include varying extents of tree screen/shelter planting within proximity to dwellings which has the potential to offer a greater degree of screening significance as the viewing distance from the wind turbines increases and visual scale of the wind turbines decreases.

This VIA notes that the setback between the wind turbines and non-host rural dwellings is in accordance with the relevant Act requirements.

Electrical infrastructure, including the BESS facility would not be out of character with other moderate to large scale agricultural structures and existing electrical infrastructure located within the broader landscape beyond the project site. Most ancillary electrical infrastructure would be located away from non-host dwellings and would not result in significant visual effects.

Table 8

Visual effect grading – Non-host rural dwellings

Sensitivity of visual receiver	High
Magnitude of visual effects	Moderate Low
Visual Effect	Moderate

9.9 Highways

View toward the project wind turbines would occur from sections of the Barrier and Wilkins Highway. Views would be partially restricted to upper portions of the wind turbine structures where screened by undulating landform; however, views would be dynamic and constantly changing in nature and extent (through direction and distance) from vehicles travelling along Highways. Views would also tend to be transitory in nature and generally short term from moving vehicles.

Ancillary electrical infrastructure, including the BESS facility, the OTL and substation would not be visible from the Barrier Highway. A short section of the OTL, around 1.5km, would extend along the Wilkins Highway between the Ashby Road and The Bluff Road intersections before extending south west along The Bluff Road corridor. Given the relatively short distance of OTL alongside the Wilkins Highway, and a posted speed limit of 110km/hr, the OTL is unlikely to be a significant element of the project within views from the Highway.

Table 9

Visual effect grading – Highways

Sensitivity of visual receiver	Low
Magnitude of visual effects	Moderate
Visual Effect	Moderate Low

9.10 Local road corridors

Views toward wind turbines and ancillary infrastructure would occur from sections of several local road corridors, either proximate to, or passing adjacent to the project site. Views would be partially restricted to upper portions of the wind turbine structures where screened by undulating landform, with greater extent of wind turbine visibility blocked by low hills beyond local road corridors. The dynamic and constantly changing nature of views (through direction and distance) from vehicles travelling along local roads will tend to be transitory in nature and generally short term.

Table 10

Visual effect grading – local road corridors

Sensitivity of visual receiver	Low
Magnitude of visual effects	Moderate
Visual Effect	Moderate Low

9.11 Agricultural land

The project site, wind turbines and ancillary infrastructure would be visible to people engaged in predominantly farming activities surrounding the project site. Ultimately the level of visual effect would depend on the type of activities engaged in as well as the location of the activities together with the degree of screening provided by local vegetation within the landscape.

Table 11

Visual effect grading – agricultural land

Sensitivity of visual receiver	Low
Magnitude of visual effects	Moderate
Visual Effect	Moderate Low

9.12 BESS Facility

Industry standards adopted for the visual assessment of BESS have established a study area of approximately 2km surrounding BESS project sites. This report notes that the BESS would be approximately 900m to the east of the nearest visual receptor, dwelling B34. Views from the dwelling toward the BESS would be partially screened by tree cover beyond the dwelling as well as infrastructure within the existing Willalo substation. There would be limited visibility toward the BESS facility due to distance and scattered tree cover within the landscape.

The BESS facility would present a low to negligible visual effect from surrounding, and distant view locations.

Section 10 Wind turbine shadow flicker & blade glint assessment

10.1 Shadow flicker

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 detailed Shadow Flicker and Blade Glint Assessment has been prepared by DNV Energy Systems (DNV), to determine and illustrate the potential impact of shadow flicker and blade glint on surrounding view locations. The shadow flicker assessment has assessed expected annual shadow flicker durations specified in the Draft National Wind Farm Development Guidelines (Draft National Guidelines) which recommend a limits of 30 hours per year on the theoretical shadow flicker duration, and 10 hours per year on the actual shadow flicker duration.

The detailed Shadow Flicker Assessment considered three variations in hub height options at 130m, 150m and up to 209m. For the purpose of this VIA, the option for a 209m hub height, 91m rotor length and up to 300m wind turbine tip height is the relevant design for consideration of potential shadow flicker impacts.

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

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

10.2 Shadow flicker summary results

The following summary of shadow flicker results has been extracted from the detailed Shadow Flicker Assessment included in this VIA at Appendix A.

A total of 10 dwellings are expected to experience shadow flicker at or above a moderate level of intensity within 50 m of the dwelling. For the purposes of this assessment, shadow flicker above a moderate level of intensity is assumed to occur up to a distance of 10 rotor diameters from the wind turbines. Of these 10 dwellings, seven are host dwellings.

Out of the 10 dwellings predicted to experience shadow flicker at or above a moderate level of intensity due to Project turbines, 8 are predicted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50 m of the dwelling (host dwellings B156, B157, B158, B168, B169, B170 and non-host dwellings B066 and B166).

This VIA notes that non-host dwellings B066 and B166 are partially dilapidated and are not inhabited. Therefore, both non-host dwellings noted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50m of the dwelling will have no receivers present. The only receivers to experience theoretical shadow flicker durations will be within host dwellings. This VIA also notes that whilst uninhabited, non-host dwellings B066 and B166 have mature tree planting close to the dwelling structures that would disrupt some degree of shadow flicker at the dwelling locations.

A cumulative shadow flicker assessment was also carried out for the Project considering the combined impacts of the Project turbines for a hub height of 209 m and those of the neighbouring Willogoleche Wind Farm. When considering shadow flicker at or above a moderate level of intensity, there are no dwellings where the shadow flicker impacts from both the Willogoleche Stage 2 Wind Farm and existing Willogoleche Wind Farm turbines are acting cumulatively.

Please refer to Appendix A for further details on the Shadow Flicker Assessment.

10.3 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 very low to 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.

Section 11 Night lighting – ancillary structures

11.1 Existing light sources

Some existing night time light sources occur within the project viewshed and include residential, general amenity and road lighting associated within township areas; however, the project site has minimal illumination and presents a dark sky environment.

Local and domestic lighting is associated with rural dwellings within 6km of the wind turbines, but lighting is unlikely to be visually prominent and does not emit any significant illumination beyond immediate areas surrounding residential and agricultural buildings.

Vehicle headlights and tail lights visible along local roads and highways provide dynamic and temporary sources of light.

11.2 Potential light sources – ancillary structures

Potential light sources associated with the wind farm ancillary structures would include low intensity night lights for the BESS facility adjacent to the existing Willalo substation, control room and auxiliary buildings. Most lighting would be temporary and in use for emergency maintenance, safety, and security purposes. Lighting associated with the project would not include flood or broad area lighting installations.

11.3 Potential receiver locations and impact

Potential receiver locations that may be impacted by night time lighting include residents and motorists. Night time lighting would not be visible from sensitive visual locations surrounding the project.

Night time lighting associated with the wind farm is unlikely to have a significant visual impact on public receiver locations.

Irrespective of the total number of visible lights, lighting is more likely to be noticeable from exterior areas surrounding dwellings rather than from rooms within dwellings, where internal lighting tends to reflect and mirror views in windows, or where exterior views would be obscured when curtains and blinds are closed.

11.4 Night lighting mitigation

Impacts of ancillary lighting may be mitigated by ensuring that installed lighting meets the requirements of Australian Standard AS 4282:2019: Control of the obtrusive effects of outdoor lighting. To assist in the mitigation of night lighting associated with ancillary structures the following should be considered:

- Security lighting throughout the wind farm, BESS facility, the Operations and Maintenance Facility and the substation, should be minimised to decrease the contrast between the wind farm and the surrounding night time environment
- Motion detectors should be used to activate night time security lighting when required
- Ancillary lighting is to be designed to ensure it does not spill onto nearby roads or dwellings

Section 12 Cumulative assessment

12.1 What is Cumulative Assessment?

A cumulative effect may result from a wind farm being constructed in conjunction with other existing or proposed wind farm developments or other large-scale infrastructure projects and may be either associated or separate to it.

Separate wind farm or other developments may occur within the viewshed of the proposed wind farm or may be located within a regional context where visibility is dependent on a journey between different wind farms.

'Direct' cumulative visual effects may occur where two or more winds farms, or other infrastructure developments have been constructed within the same locality and may be viewed from the same view location simultaneously.

'Indirect' cumulative visual effects may occur where two or more wind farms or other infrastructure developments have been constructed within the same locality and may be viewed from the same view location but not within the same field of view (i.e., the viewer must turn their head in order to view both wind farms).

'Sequential' cumulative visual effects may arise because of multiple wind farms or other infrastructure developments being observed at different locations during a journey (e.g., from a vehicle travelling along a highway or from a network of local roads), which may form an impression of greater magnitude within the construct of short term memory.

12.2 Other wind farm developments (regional locality)

An assessment of cumulative visual effect identified several wind farm developments within the project broader viewshed, or regional locality. These include the approved Goyder North Renewable Energy Facility, Goyder South Hybrid Renewable Energy Facility (under construction), the operational Waterloo Wind Farm, Willogoleche Wind Farm, the Hornsdale Wind Farm and Hallet group of Wind Farms to the north north west the project site.

Table 12 – Other Wind Farm Developments

Other Wind Farms	Turbine tip height	Status	Number of turbines	Approximate distance from project site (between turbines)
Goyder North Renewable Energy Facility	240m	Approved	135	15.5km
Goyder South Hybrid Renewable Energy Facility	150-270m	Construction	75	39km
Hallett 1 Brown Hill	124m	Operating	45	14km
Hallett 2 Hallett Hill	124m	Operating	34	14km
Hallett 4 Brown Hill North	124m	Operating	63	14km
Hallett 5 The Bluff	124m	Operating	25	4.65km

Table 12 – Other Wind Farm Developments

Other Wind Farms	Turbine tip height	Status	Number of turbines	Approximate distance from project site (between turbines)
Hornsdale (1,2 and 3)	150m	Operating	99	34km
Willogoleche	150m	Operating	32	950m
Waterloo	124m	Operating	43	58km

Overall, the project would not significantly increase the magnitude of cumulative visual effect for most dwelling locations surrounding the project site due to the relatively small number of wind turbines within the project. The potential for the occurrence of 'direct' and 'indirect' cumulative visual effect is partially mitigated by the screening or filtering of views toward approved and existing wind farms.

Sequential views from local roads would be mitigated to some extent by undulating landform and tree cover alongside road corridors and the transitory nature of short-term dynamic views, and the fact that most wind farm developments are not located along a single highway or thoroughfare.

Section 13 Pre-construction and construction

13.1 Potential visual effect

There are potential visual effects that could occur during both pre-construction and construction phases of the project. The project construction phase is likely to occur over 24 months, although the extent and nature of pre-construction and construction activities would vary at different locations within the project area.

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

- Ongoing detailed site assessment including sub surface geotechnical investigations
- Various civil works to upgrade local roads and access point
- Temporary construction compound buildings and facilities
- Temporary construction facilities, including portable structures and laydown areas
- Various temporary construction and directional signage
- Mobilisation of rock crushing equipment and concrete batching plant (if required)
- Excavation and earthworks and
- Various construction activities including erection of wind turbines, monitoring mast and electrical infrastructure works.

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

Plates 7 to **11** illustrate typical construction activities during preparation and installation of wind turbines:

Plate 7 Cable laying equipment (Image: ©GBD 2023)

Plate 8 Typical crane plant utilised in wind turbine construction (Image: ©GBD 2023)

Plate 9 Typical storage and laydown area (Image: ©GBD 2023)

Plate 10 Typical contractors site office and amenities compound (Image: ©GBD 2023)

Plate 11 Typical view toward wind turbines under construction (Image: ©GBD 2023)

Section 14 Mitigation

14.1 Introduction

The application of mitigation measures is a standard approach to minimise visual effects for proposed wind farm developments. The British Landscape Institute states 'the purpose of mitigation is to avoid, reduce, or where possible remedy or offset any significant negative (adverse) effects on the environment arising from the proposed development' (2012).

14.2 Mitigation limitations

There are several limitations to mitigation strategies applicable to wind energy facilities and this VIA recognises that large scale wind energy facilities are likely to result in unavoidable visual impacts in the current landscape and project context. Wind turbines are large scale constructed elements with a form and line that will contrast with the relatively simple landscape forms and lines that adjoin and extend beyond the project site.

The efficiency of the project is dependent on a range of technical factors, and the potential for visual impacts must be balanced against other requirements. A level of acceptance for unavoidable low to moderate visual impacts should be considered appropriate without the need for mitigation as has been applied to several preceding wind farm developments including the Goyder North and South wind farm developments.

14.3 Mitigation strategies

Mitigation strategies considered applicable to wind farm projects include:

- *using turbine colour to reduce visual impacts from key public viewpoints*

  Wind turbines are commonly installed in a white to off white colour across Australia as well as most other countries around the world. This industry standardised colour has likely been adopted for several reasons. White is a neutral colour and whilst visible against blue sky backdrops it will tend to blend readily on cloudy or partly cloudy days. The white colour also assists with protecting wind turbine infrastructure by reflecting ultraviolet rays rather than absorbing them which helps to protect the generator from overheating. Wind turbines are also painted white to provide contrast between the wind turbine structures and the ground when viewed from aircraft flying above the wind farm.

Plate 12 illustrates 'white' wind turbines with apparent colour differences (grey and white). This demonstrates the effect of partial cloud cover and shading on visible wind turbine colour. **Plate 13** illustrates wind turbines at the Windy Hill Wind Farm in Far North Queensland. The wind turbines have been painted with concentric bands of green paint, from dark green at the base to light green for approximately one third of the tower height. The success of painting the wind turbine tower is dependent on the viewpoint location, elevation and backdrop against which the wind turbine is visible.

Plate 12 – Wind turbines at Crookwell 2 Wind Farm NSW (Image: ©GBD 2018)

Plate 13 – Wind turbines with coloured base Windy Hill Wind Farm QLD (Image: ©GBD 2017)

- *selecting turbines that are consistent in height, appearance and rotate the same way*

  Selected wind turbines would be consistent in visual form and design, comprising similar basic components of towers, hubs and blades. Most current wind turbines rotate in a clockwise direction. Adopting wind turbines that rotate in different directions would result in engineering challenges with the creation of turbulent airflow.

- *spacing turbines to respond to landscape characteristics*

  The wind farm design and wind turbine layout responds to a range of technical and environmental requirements, as well as landuse/farming operations and regulatory requirements. Where possible, wind turbine spacing, and the overall layout, has considered strategies to minimise impacts on the characteristics of the landscape surrounding the project site including establishing offsets from sensitive locations as nominated in the Act.

- *minimising removal of vegetation*

  The project will minimise the removal of vegetation from the project site where possible; however, vegetation within the project site does not offer significant screening potential toward the wind turbines.

- *avoiding additional clutter on turbines, such as unrelated advertising and telecommunications apparatus*

  The wind turbines would not include unrelated advertising and/or telecommunications apparatus.

The landscape plan mitigation measures generally involve reducing the extent of visual contrast between the visible portions of the proposed structures and the surrounding landscape and are discussed below.

14.4 Detail design

Mitigation measures during the detail design process should consider:

- further refinement in the design and layout where possible, which may assist in the mitigation of bulk and height of proposed structures and
- a review of materials and colour finishes for selected components including the use of non-reflective finishes to structures where possible.

14.5 Construction

Mitigation measures during the construction period should consider actions to:

- minimise tree removal where possible
- avoidance of temporary light spill beyond the construction site where temporary lighting is required
- progressively rehabilitate disturbed areas and
- protect mature trees within the project site where possible.

14.6 Operation

Mitigation measures during the operational period should consider:

- ongoing maintenance and repair of constructed elements
- replacement of damaged or missing constructed elements and

- long term maintenance (and replacement as necessary) of vegetation within the project site to maintain visual filtering and screening of external views where appropriate.

Section 15. Summary

15.1 Relevant guidelines

The VIA has considered and responded to relevant sections of the Hydrogen and Renewable Energy Act 2023 and to support the Environmental Impact Report (EIR). The VIA has been prepared with regard to well established and accepted industry standards including the DEM's Environmental Impact Assessment Criteria October 2024, PlanSA Assessment Requirements Library AEQ4 Visual Amenity, Landscape and Open Space and the United Kingdom Landscape Institute Guidelines for Landscape and Visual Impact Assessment 3rd Edition.

15.2 Landscape Character

Existing landscape characteristics, identified and described in this VIA, are generally well represented throughout the broader regional landscape surrounding the project site. The VIA noted a number of existing and operational renewable energy projects within the landscape surrounding the project site. An assessment of landscape characteristics has identified that a renewable energy (wind farm) zone, has been established as a landscape character subset within the broader regional area.

Whilst distinguishable characteristics of the existing landscape character may be altered by the project, the landscape character area would have some capability to absorb some change.

15.3 Key view locations

The project and proposed wind turbines would not have a significant visual effect on the character of surrounding townships and localities, where views toward the wind turbines would be partially screened by built structures and tree cover within urban areas. Where wind turbines would be visible from areas within the Hallett Township, the overall number of visible wind turbines, and distance between wind turbines and view locations would generally result in Low Moderate visual effects.

Views from most non-host dwellings located within 6km of a wind turbine would not result in significant levels of visual effect with most dwellings likely experience no more than a Moderate level of visual effect. A small number of dwellings proximate to the project site and wind turbines would likely experience a Moderate High level of visual effect where views from dwellings or land immediately around dwellings would extend directly toward wind turbines.

Views toward the project from the Barrier Highway, Wilkins Highway and local roads would offer a range of transitory and short term views which would be subject to direction of travel and potential screening influence of vegetation alongside road corridors. Views from local roads and highways would not result in a significant level of visual effect.

This VIA notes that non-host dwellings B066 and B166 are partially dilapidated and are not inhabited. Therefore, both non-host dwellings noted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50m of the dwelling will have no receivers present.

15.4 Electrical infrastructure

Proposed electrical infrastructure including the BESS facility and some sections of the OTL extending south from the project site to the existing Willalo substation, would be partially screened from dwelling view locations by tree cover and, as relatively small scale structures, the OTL would be screened from several dwellings by windbreak/screen planting around the dwellings.

15.5 Lighting

Temporary and safety night lighting associated with project electrical infrastructure and office/maintenance buildings would be largely filtered or screened from most surrounding view locations and not considered significant enough to directly impact upon the dark sky night time experience within or beyond the project site.

An obstacle lighting review determined that wind monitoring towers be appropriately marked in accordance with applicable guidelines (excluding strobe lighting) noted in the lighting review. The lighting review further determined that the project is a low risk to aviation activity and therefore does not require obstacle lighting with no further mitigation required.

The overall visual effect on views from temporary and safety night lighting would be low.

15.6 Construction

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

15.7 Cumulative impacts

The project would not result in a significant increase in cumulative visual effect for many non-host dwelling locations surrounding the project site. The potential for the occurrence of 'direct' and 'indirect' cumulative visual effect is partially mitigated by natural landform screening between approved and existing wind farms and the distance between them.

Sequential views from local roads and highways would be mitigated to some extent by undulating landform and tree cover alongside road corridors and the transitory nature of short-term dynamic views, and the fact that most wind farm developments are not located along a single highway.

15.8 Mitigation

The VIA has considered a range of mitigation measures which may be adopted to minimise potential visual effects associated with the project. Overall, the extent and level of potential visual effect is moderate to low at most view locations resulting in minimal application of mitigation measures to screen views. Screening views may also be detrimental to various locations where foreshortening or restricting existing views may not be desirable.

15.9 Conclusion

In conclusion, the proposed development of a wind farm project requires a responsible authority to determine whether the visual effects of a wind energy facility in the landscape are acceptable. The VIA has assessed the potential visual effect of the project against relevant policies and guidelines, and has determined that, in our professional opinion, the level of landscape and visual effects are acceptable.

Appendix A – Shadow Flicker Assessment

WILLOGOLECHE STAGE 2 WIND FARM

Shadow Flicker and Blade Glint Assessment

Green Bean Design Pty Ltd

Report No.: 10565193-AUMEL-R-01, Rev. B
Document No.: 10565193-AUMEL-R-01-B
Date: 3 October 2025
Status: Draft

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DNV

Project name:	Willogoleche Stage 2 Wind Farm	DNV Energy Systems
Report title:	Shadow Flicker and Blade Glint Assessment	Level 12, 350 Queen Street
Customer:	Green Bean Design Pty Ltd	Melbourne Vic 3000
	PO BOX 3178	Australia
	Austral NSW 2179, Australia	Tel: +61 3 8615 1515
Customer contact:	Andy Homewood	ABN 19 094 520 760
Date of issue:	3 October 2025	
Project No.:	10565193	
Organisation unit:	E-KA-ST	
Report No.:	10565193-AUMEL-R-01, Rev. B	
Document No.:	10565193-AUMEL-R-01-B	

Applicable contract(s) governing the provision of this Report:
DNV proposal OPP-00401198-AUMEL-SFA-01 Issue A, dated 24 April 2025

Objective: Willogoleche Stage 2 Wind Farm Shadow Flicker and Blade Glint Assessment

Prepared by:	Verified by:	Approved by:
David Price Senior Engineer Energy Analytics & Measurements (ANZ)	John Villalba Engineer Energy Analytics & Measurements (ANZ)	Naomi Brammer Senior Engineer Team Lead - Technical Planning Energy Analytics & Measurements (ANZ)
	Peter Degorski Engineer Energy Analytics & Measurements (ANZ)	Kevin Bleiber Head of Section Energy Analytics & Measurements (ANZ)

Document classification:

Customer's discretion

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Keywords:
Willogoleche Stage 2 Wind Farm Shadow Flicker and Blade Glint Assessment

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
A	2025-05-30	First issue – DRAFT	D Price	J Villalba	N Brammer
B	2025-10-03	Revised SF assessment for updated wind farm layout, and including hub heights 130 m, 150 m, and 209 m.	D Price	P Degorski	K Bleiber

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EXECUTIVE SUMMARY

DNV has been commissioned by Green Bean Design Pty Ltd ("GBD" or "the Customer") to independently assess the expected annual shadow flicker durations in the vicinity of the proposed Willogoleche Stage 2 Wind Farm ("W2WF" or "the Project") in South Australia. The results of the shadow flicker assessment are described in this document.

Background and methodology

DNV has assessed the expected annual shadow flicker durations for the Project against limits specified in the Draft National Wind Farm Development Guidelines (Draft National Guidelines). The methodology used in this assessment has been informed by these guidelines and various standard industry practices.

The Draft National Guidelines recommend limits of 30 hours per year on the theoretical shadow flicker duration, and 10 hours per year on the actual shadow flicker duration.

A Project layout consisting of 20 wind turbines, with a maximum rotor diameter of 182 m, and three hub height options (130 m, 150 m, and 209 m) have been considered in this assessment. It is understood that these turbine dimensions represent the range of turbine dimensions currently under consideration for the Project.

The locations of 41 dwellings in the vicinity of the Project have been provided by the Customer, of which up to 11 may potentially be affected by shadow flicker.

The theoretical shadow flicker durations at dwellings in the vicinity of the Project have been determined using a purely geometric analysis. The actual shadow flicker duration likely to be experienced at each dwelling has also been predicted by estimating the possible reduction in shadow flicker due to turbine orientation and cloud cover.

Outcomes of the assessment

Based on the assessment across the three different hub heights, 10 dwellings are expected to experience shadow flicker at or above a moderate level of intensity within 50 m of the dwelling. For the purposes of this assessment, shadow flicker above a moderate level of intensity is assumed to occur up to a distance of 10 rotor diameters from the wind turbines. Of these 10 dwellings, seven are host dwellings.

The maximum shadow flicker durations for all hub heights options considered together has been used to assess the level of compliance with shadow flicker thresholds for the Project as follows. Out of the 10 dwellings predicted to experience shadow flicker at or above a moderate level of intensity due to Project turbines, 8 are predicted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50 m of the dwelling (host dwellings B156, B157, B158, B168, B169, B170 and non-host dwellings B066 and B166). When considering the likely reduction in shadow flicker due to cloud cover and rotor orientation, for 7 of these dwellings (host dwellings B156, B157, B158, B168, B169 and B170 and non-host dwelling B066) the predicted actual shadow flicker durations within 50 m of the dwelling are also above the recommended limit of 10 hours per year. The predicted shadow flicker durations at some of the dwellings (host dwellings B156, B157, B158 and B169) significantly exceed the recommended limits.

Note that when considering the shadow flicker results for the hub height options individually, then the preceding shadow flicker impact conclusions are similar, except for the 130 and 150 m hub height results at non-host dwelling B066, where the predicted theoretical shadow flicker duration is below the recommended limit of 30 hours per year within 50 m of the dwelling. However the predicted actual shadow flicker duration within 50 m of the dwelling is still above the recommended limit of 10 hours per year for all hub height options.

The calculation of the predicted actual shadow flicker duration does not take into account other potential reductions due to low wind speed, vegetation, or other shielding effects around each house.

A cumulative shadow flicker assessment was also carried out for the Project considering the combined impacts of the Project turbines for a hub height of 209 m and those of the neighbouring W1WF. When considering shadow flicker at or above a moderate level of intensity, there are no dwellings where the shadow flicker impacts from both the W2WF and W1WF turbines are acting cumulatively. It is considered that the cumulative impact conclusions calculated for the 209 m hub height option are also applicable for the 130 m and 150 m hub height turbine options considered for the Project.

If required, the effects of shadow flicker may be reduced through a number of mitigation measures such as the removal or relocation of turbines, the use of smaller turbines, installation of screening structures or planting of trees to block shadows cast by the turbines, or the use of turbine control strategies to shut down turbines when shadow flicker is likely to occur.

The effects of blade glint have not been quantified in this study as the Draft National Guidelines do not provide any quantification methodology. The guidelines, however, recommend that the Customer ensures that the turbine blades used have a surface finish with a low reflectivity to avoid occurrences of blade glint.

1 INTRODUCTION

Green Bean Design Pty Ltd ("GBD" or "the Customer") has commissioned DNV to independently assess the expected annual shadow flicker durations in the vicinity of the proposed Willogoleche Stage 2 Wind Farm ("W2WF" or "the Project") in South Australia. The results of this work are reported here. This document has been prepared in accordance with OPP-00401198-AUMEL-SFA-01 Issue A, dated 24 April 2025, and is subject to the terms and conditions in that agreement.

This assessment evaluates the shadow flicker durations in the vicinity of the Project for the current proposed turbine layout and configuration in accordance with the Draft National Wind Farm Development Guidelines (Draft National Guidelines) [1]. The methodology used in this study has been informed by these guidelines and various standard industry practices.

2 DESCRIPTION OF THE SITE AND PROJECT

2.1 The site

The Project is located approximately 4 km northwest of Hallett and 29 km east southeast of Jamestown in South Australia.

The terrain at the site is complex, with turbine elevations ranging from approximately 540 m to 640 m above sea level. The surface cover of the site is comprised of areas of open, agricultural land and low scrubland. A digital elevation model of the Project terrain was derived from publicly available NASADEM data [2].

2.2 The Project

2.2.1 Proposed wind farm layout

The Project is proposed to consist of 20 wind turbines [3]. A map of the site showing the turbine layout and terrain elevations considered in this assessment is shown in Figure 3, and the coordinates of the proposed turbine locations are given in Table 1.

DNV has modelled the shadow flicker based on a theoretical turbine model with a rotor diameter of 182 m, and the following three hub height options above ground level (agl):

- 130 m
- 150 m
- 209 m

It is understood that these turbine dimensions represent the range of turbine dimensions currently under consideration for the Project.

2.2.2 Dwelling locations

The locations of 41 dwellings in the vicinity of the Project have been provided by the Customer [4].

For the purposes of this assessment, 11 dwellings have been identified as having the potential to experience shadow flicker, based on their distances from the proposed turbine locations, and these have been considered in this assessment. Of those 11 dwellings, 7 have been identified by the Customer as host dwellings.

The remaining 30 dwellings are at locations that are considered unlikely to be impacted by shadow flicker at intensities typically considered sufficient to cause annoyance, as discussed further in Sections 3.1 and 4.1.2, and have not been considered further in this assessment.

The dwellings considered in this assessment are shown in Figure 3 and presented in Table 2.

It should be noted that the scope of the work reported here does not include a comprehensive survey of dwellings in the vicinity of the Project, and so DNV is relying on dwelling information provided by the Customer.

3 REGULATORY REQUIREMENTS

3.1 Shadow flicker

The South Australian Wind Farms Development Plan Amendment [5] states that:

> *"Wind farms and ancillary development should avoid or minimise… impacts on nearby property owners/occupiers, road users and wildlife [caused by] shadowing, flickering, reflection or glint…".*

In addition, the South Australian Planning and Design Code (SA Planning Code) [6] includes the requirement that:

> *"Development that incorporates moving parts, including windmills and wind farms, are located and operated to not cause unreasonable nuisance to nearby dwellings and tourist accommodation caused by shadow flicker."*

However, the SA Wind Farms Development Plan Amendment and the SA Planning Code do not provide recommended limits for shadow flicker, or a methodology for calculating shadow flicker durations. Therefore DNV has relied on other suitable guidelines to assess the shadow flicker for the Project, as discussed below.

The Environment Protection and Heritage Council (EPHC), in conjunction with Local Governments and the Planning Ministers' Council, released a draft version of the National Wind Farm Development Guidelines in July 2010 (Draft National Guidelines) [1]. The Draft National Guidelines cover a range of issues across the different stages of wind farm development. In relation to shadow flicker, the Draft National Guidelines provide background information, a proposed methodology, recommended limits, and a suite of assumptions for assessing shadow flicker durations in the vicinity of a wind farm.

The Draft National Guidelines recommend that the modelled theoretical shadow flicker duration at any dwelling should not exceed 30 hours per year at any dwelling, and that the actual or measured shadow flicker duration should not exceed 10 hours per year. The Draft National Guidelines also recommend that the shadow flicker duration at a dwelling be assessed by calculating the maximum shadow flicker occurring within 50 m of the centre of the dwelling. These limits are assumed to apply to a single dwelling, and it is noted that there is no requirement under the Draft National Guidelines to assess shadow flicker durations at locations other than in the vicinity of dwellings.

The impact of shadow flicker is typically only significant up to a limited distance from the wind turbines. Beyond this distance limit the shadow is diffused such that the variation in light levels is not likely to be sufficient to cause annoyance. This issue is discussed in the Draft National Guidelines, where it is stated that:

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

The Draft National Guidelines suggest a shadow flicker distance limit equal to 265 times the maximum blade chord length, which would correspond to approximately 1000 to 1600 m for modern wind turbines (which typically have maximum blade chord lengths of 4 to 6 m). However, the UK wind industry considers that a distance limit of around 10 rotor diameters from a turbine [7, 8] or approximately 1200 m to 1900 m for modern wind turbines (which typically have rotor diameters of 120 m to 190 m), is appropriate.

For the purposes of this assessment, DNV has considered the guidance and recommendations given in the Draft National Guidelines in relation to shadow flicker along with the shadow flicker distance limit applied by the UK wind industry, as discussed further in Section 4.1.2.

3.2 Blade glint

Blade glint involves the regular reflection of the sun off rotating turbine blades. Its occurrence depends on a combination of circumstances arising from the orientation of the nacelle, angle of the blade and the angle of the sun. The reflectiveness of the surface of the blades is also important. Blade glint is not generally a problem for modern wind turbines [1].

A methodology for the quantification of blade glint impacts as well as a regulatory limit are not provided by the Draft National Guidelines [1]. However, the Draft National Guidelines suggest that the Customer ensures the blades of the wind turbines have a finish with low reflectivity.

In relation to blade glint, guidance from the Draft National Guidelines [1] states that:

> *"Blade glint can be produced when the sun's light is reflected from the surface of wind turbine blades. Blade glint has potential to annoy people.*
>
> *All major wind turbine blade manufacturers currently finish their blades with a low reflectivity treatment. This prevents a potentially annoying reflective glint from the surface of the blades and the possibility of a strobing reflection when the turbine blades are spinning. Therefore the risk of blade glint from a new development is considered to be very low.*
>
> *Proponents should ensure that blades from their supplier are of low reflectivity."*

4 ASSESSMENT METHODOLOGY

4.1 Shadow flicker

4.1.1 Overview

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

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

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

Example photographs of wind turbines and associated shadows which have the potential to cause flicker are shown in Figure 1 below.

Figure 1 Examples of wind turbine shadows

4.1.2 Theoretical modelled duration

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

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

In line with the methodology proposed in the Draft National Guidelines, DNV has assessed the shadow flicker at the provided dwellings and has determined the highest shadow flicker duration within 50 m of each of these locations.

In the absence of detailed dwelling height information, shadow flicker has been calculated at the dwellings at heights of 2 m, to represent ground floor windows, and 6 m, to represent second floor windows. The shadow receptors are simulated as fixed points, representing the worst-case scenario, as real windows could be facing a particular direction less affected by shadows cast from the turbines. The shadow flicker calculations for dwelling locations have been carried out with a temporal resolution of 1 minute. The shadow flicker map was generated using a temporal resolution of 5 minutes and a spatial resolution of 10 m to reduce computational requirements to acceptable levels.

As part of the shadow flicker assessment, it is necessary to make an assumption regarding the maximum length of a shadow cast by a wind turbine that is likely to cause annoyance due to shadow flicker. As noted in Section 3.1, the UK wind industry considers that 10 rotor diameters is appropriate [7, 8] while the Draft National Guidelines suggest a distance limit equivalent to 265 times the maximum blade chord [1].

For the current assessment, DNV has applied a maximum shadow length of 10 times the rotor diameter (10D), corresponding to a distance limit of 1820 m for the Project, which DNV considers is more appropriate than a limit of 265 times the maximum blade chord. Beyond this distance limit, it is assumed that any shadow flicker experienced will be below a "moderate level of intensity" and unlikely to cause annoyance. However, it is recognised that different people have different levels of sensitivity to shadow flicker and may therefore be affected by shadow flicker intensities below the "moderate level of intensity" assumed by this distance limit. To account for this possibility, DNV has also calculated the shadow flicker to a distance of up to 15 times the rotor diameter (15D), or 2730 m, which should include shadow flicker below a "moderate level of intensity".

In this assessment, shadow flicker of a moderate level of intensity or above is assumed to occur up to a distance of approximately 10D from the wind farm. Conversely, shadow flicker below a moderate level of intensity, also described as "low intensity" shadow flicker in this report, is assumed to occur beyond a distance of 10D and up to a distance of approximately 15D from the wind turbines.

The model also makes the following assumptions and simplifications:

- there are clear skies every day of the year
- the blades of the turbines are always perpendicular to the direction of the line of sight from the location of interest to the sun

- the turbines are always rotating.

The first two of these items are addressed in the calculation of the predicted actual shadow flicker duration as described in Section 4.1.4. The third item is not considered but is unlikely to have a significant impact on the results. The settings used to execute the model can be seen in Table 3.

To illustrate typical results, an indicative shadow flicker map for a turbine located in a flat area is shown in Figure 4. The geometry of the shadow flicker map can be characterised as a butterfly shape, with the four protruding lobes corresponding to slowing of solar north-south travel around the summer and winter solstices for morning and evening. The lobes to the north of the indicative turbine location result from the summer months and conversely the lobes to the south result from the winter months. The lobes to the west result from morning sun while the lobes to the east result from evening sun. When the sun is low in the sky, the length of shadows cast by the turbine increases, increasing the area around the turbine affected by shadow flicker.

4.1.3 Factors affecting duration

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

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

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

2. The occurrence of cloud cover has the potential to significantly reduce the number of hours of shadow flicker. Cloud cover measurements recorded at nearby meteorological stations may be used to estimate probable levels of cloud cover and to provide an indication of the resulting reduction in shadow flicker duration.

3. Aerosols (moisture, dust, smoke, etc.) in the atmosphere have the ability to influence shadows cast by a wind turbine. The length of the shadow cast by a wind turbine is dependent on the degree that direct sunlight is diffused, which is in turn dependent on the amount of dispersants (humidity, smoke, and other aerosols) in the path between the light source (sun) and the receiver.

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

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

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

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

4.1.4 Predicted actual duration

As discussed above in Section 4.1.3, there are a number of factors which may reduce the incidence of shadow flicker that are not taken into account in the calculation of the theoretical shadow flicker duration. An attempt has been made to quantify the likely reduction in shadow flicker duration due to cloud cover and, therefore, produce a prediction of the actual shadow flicker duration likely to be experienced at a dwelling.

Cloud cover is typically measured in 'oktas', effectively eighths of the sky covered with cloud. DNV has obtained data from the following Bureau of Meteorology stations:

- Bundaleer Forest Reserve (021008), located approximately 29 km west of the centre of the Project [9]
- Yongala (019062), located approximately 38 km north-northwest of the centre of the Project [10]
- Clare Post Office (021014), located approximately 58 km south-southwest of the centre of the Project [11]
- Snowtown (021046), located approximately 77 km southwest of the centre of the Project [12]
- Port Pirie Nyrstar Comparison (021043), located approximately 83 km west-northwest of the centre of the Project [13]
- Eudunda (024511), located approximately 93 km south-southwest of the centre of the Project [14].

The number of oktas of cloud cover visible across the sky at these stations is recorded twice daily, at 9 am and 3 pm, and the observations are provided as monthly averages. After averaging the 9 am and 3 pm observations for the stations considered, the results indicate that the average monthly cloud cover in the region ranges between 37% and 60%, and the average annual cloud cover is approximately 49%. This implies that on an average day, 49% of the sky in the vicinity of the wind farm is covered with clouds. Although it is not possible to definitively calculate the effect of cloud cover on shadow flicker duration, a reduction in the shadow flicker duration proportional to the amount of cloud cover is considered to be a reasonable assumption.

Similarly, turbine orientation can have an impact on the shadow flicker duration. The shadow flicker duration is greatest when the turbine rotor plane is approximately perpendicular to a line joining the sun and an observer, and a minimum when the rotor plane is approximately parallel to a line joining the sun and an observer. A wind direction frequency distribution for the site provided by the Customer [15] was used to estimate the reduction in shadow flicker duration due to rotor orientation. The site wind rose is shown overlaid on the indicative shadow flicker map in Figure 4. The assessment of the likely reduction in shadow flicker duration due to variation in turbine orientation was conducted on an annual basis.

It should be noted that the method prescribed by the Draft National Guidelines for assessing actual shadow flicker duration recommends that only reductions due to cloud cover, and not turbine orientation, be included. However, DNV considers that the additional reduction due to turbine orientation is appropriate as the projected area of the turbine, and therefore the expected shadow flicker duration, is reduced when the turbine rotor is not perpendicular to the line joining the sun and dwelling. Due to limitations in the availability of suitable cloud cover data, the methodology used in this assessment also deviates somewhat from the method recommended by the Draft National Guidelines for assessing the reduction in shadow flicker due to cloud cover. However, considering the available cloud cover data, the approach described above is deemed to provide a reasonable estimate of the likely impact of cloud cover on the shadow flicker duration.

While the calculation of the predicted actual shadow flicker duration considers the likely reductions due to cloud cover and rotor orientation, it does not take into account other potential reductions due to low wind speed (or turbine shutdown), vegetation, or other shielding effects around each dwelling.

4.1.5 Cumulative impact assessment

DNV notes that the Project is located in an area of high wind farm development activity, with multiple operational wind farms nearby. Consequently, it is possible that some dwellings near the Project could experience cumulative impacts from the turbines of a neighbouring wind farm.

The only wind farm development that could possibly contribute cumulatively to the shadow flicker at dwellings in the vicinity the Project is the Willogoleche Stage 1 Wind Farm ("W1WF").

Details of the turbines installed at the W1WF site were provided by the Customer [16], with the coordinates of the turbine locations derived using publicly available aerial imagery [17]. The neighbouring W1WF consists of 32 turbines of the type GE 3.4-130 and GE 3.8-130, with a rotor diameter of 130 m and hub height of 85 m agl in each case [18]. The W1WF turbines nearest to the Project are shown in Figure 3.

For the purposes of this assessment, it has been conservatively assumed that the W1WF turbines generate shadow flicker at similar distances to the W2WF turbines. On this basis, the potential for cumulative impacts has been assessed considering dwellings located up to 2780 m (i.e. 15 times the rotor diameter of W2WF turbines + 50 m) from both the W1WF and W2WF turbines.

4.2 Blade glint

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

5 ASSESSMENT RESULTS

5.1 Shadow flicker

5.1.1 Predicted shadow flicker durations

Shadow flicker predictions were generated at the provided dwelling locations, and the results are summarised in Table 4, Table 5 and Table 6 for the 130 m, 150m and 209 m hub height options for the Project respectively. As there were some differences in the shadow flicker results for the different hub height options, to assess the shadow flicker results for all hub height options considered in this assessment, a combined table of the maximum shadow flicker durations for all hub heights options is summarised in Table 7.

The results of the theoretical and predicted actual shadow flicker modelling are also shown in the form of shadow flicker map in Figure 5 and Figure 6 respectively for the 209 m hub height option for the Project, which for most dwellings gave the longest durations of shadow flicker between the hub height options assessed. The shadow flicker values presented in these maps represent the worst case between the results calculated at 2 m and 6 m above ground level for each modelled grid point for this hub height option.

Based on the assessment across the three different hub heights, 10 dwellings are expected to experience shadow flicker at or above a moderate level of intensity within 50 m of the dwelling. For the purposes of this assessment, shadow flicker above a moderate level of intensity is assumed to occur up to a distance of 10 rotor diameters from the wind turbines. Of these 10 dwellings, seven are host dwellings.

The maximum shadow flicker durations for all hub heights options considered together has been used to assess the level of compliance with shadow flicker thresholds for the Project as follows. Out of the 10 dwellings predicted to experience shadow flicker at or above a moderate level of intensity due to Project turbines, 8 are predicted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50 m of the dwelling (host dwellings B156, B157, B158, B168, B169, B170 and non-host dwellings B066 and B166). When considering the likely reduction in shadow flicker due to cloud cover and rotor orientation, for 7 of these dwellings (host dwellings B156, B157, B158, B168, B169 and B170 and non-host dwelling B066) the predicted actual shadow flicker durations within 50 m of the dwelling are also above the recommended limit of 10 hours per year. The predicted shadow flicker durations at some of the dwellings (host dwellings B156, B157, B158 and B169) significantly exceed the recommended limits.

Note that when considering the shadow flicker results for the hub height options individually, then the preceding shadow flicker impact conclusions are similar, except for the 130 and 150 m hub height results at non-host dwelling B066, where the predicted theoretical shadow flicker duration is below the recommended limit of 30 hours per year within 50 m of the dwelling. However the predicted actual shadow flicker duration within 50 m of the dwelling is still above the recommended limit of 10 hours per year for all hub height options.

Beyond the 10D distance limit, it is assumed that any shadow flicker experienced will be below a moderate level of intensity and unlikely to cause annoyance. However, as discussed in Section 4.1.2, it is recognised that different people have different levels of sensitivity to shadow flicker and may therefore be affected by low intensity shadow flicker assumed by this distance limit. To inform the potential for this outcome, although not part of the methodology outlined in the Draft National Guidelines, DNV has also calculated the theoretical shadow flicker impacts for the Project for an increased distance limit of 15D that is intended to include shadow flicker of low intensity. The results of this additional assessment are also included in the map presented in Figure 5.

These results indicate that, in addition to the dwellings expected to be affected by shadow flicker at or above a moderate level of intensity, one dwelling (non-host dwelling B002) may have the potential to be exposed to low intensity shadow flicker. This dwelling is also included in the shadow flicker results tables (i.e. Table 4, Table 5, Table 6 and Table 7).

5.1.2 Cumulative impact assessment

An assessment was also carried out that identified six dwellings which could potentially be affected by cumulative shadow flicker (host dwellings B157, B158, B170, B171 and non-host dwellings B002, B166) due to the neighbouring W1WF turbines. The approximate areas within which shadow flicker could potentially occur and lead to cumulative impacts are shown in Figure 7.

Note that the 209 m hub height option for the W2WF was modelled for the cumulative shadow flicker assessment (along with the W1WF turbines), because for most of the dwellings identified as being at risk of cumulative impacts, the modelled shadow flicker durations for the 209 m hub height option, when considering the W2WF alone (as presented in Section 5.1.1), was similar or greater in magnitude to the other hub height options considered in the assessment. The modelled shadow flicker results for the 150 m hub height option at host dwelling B170 was slightly higher than for the 209 m hub height option, but not enough to be significant for the purposes of the analysis.

The results of the theoretical shadow flicker modelling due to cumulative impacts assuming the 209 m hub height option for the W2WF are shown in the form of a shadow flicker map in Figure 8. The shadow flicker values presented in this map represent the worst case between the results calculated at 2 m and 6 m above ground level for each modelled grid point, and show the predicted shadow flicker at or above a moderate level of intensity. It was found that none of the dwellings near the project will be affected by shadow flicker generated from both W1WF and W2WF turbines if shadow flicker at or above a moderate level of intensity is considered. As a result, there is no change to the shadow flicker results reported for the project in Table 6 due to cumulative impacts.

However, some dwellings (host dwellings B158, B170 and non-host dwelling B166) could potentially be subject to increased shadow flicker within 50 m of the dwelling, as a result of the turbines from both W1WF and W2WF acting cumulatively, if low intensity shadow flicker is also considered.

It is considered that the cumulative impact conclusions calculated for the 209 m hub height are also applicable for the 130 m and 150 m hub height turbine options assessed for the Project.

5.1.3 Mitigation options

If required, the effects of shadow flicker may be reduced through a number of mitigation measures. These include the removal or relocation of turbines, the use of turbines with a smaller rotor diameter, installation of screening structures or planting of trees to block shadows cast by the turbines, or the use of turbine control strategies to shut down turbines when shadow flicker is likely to occur.

5.2 Blade glint

As discussed in Section 4.2, blade glint is not expected to be an issue for the Project provided that a non-reflective paint is applied to the wind turbine blades.

6 CONCLUSIONS

A shadow flicker assessment was carried out for dwelling locations in the vicinity of the Project.

For the purpose of this assessment, DNV has considered a layout consisting of 20 turbines, with a rotor diameter of 182 m, and three hub height options (130 m, 150 m, and 209 m). It is understood that these dimensions represent the range of turbine dimensions currently under consideration for the Project.

Based on the assessment across the three different hub heights, 10 dwellings are expected to experience shadow flicker at or above a moderate level of intensity within 50 m of the dwelling. For the purposes of this assessment, shadow flicker above a moderate level of intensity is assumed to occur up to a distance of 10 rotor diameters from the wind turbines. Of these 10 dwellings, seven are host dwellings.

The maximum shadow flicker durations for all hub heights options considered together has been used to assess the level of compliance with shadow flicker thresholds for the Project as follows. Out of the 10 dwellings predicted to experience shadow flicker at or above a moderate level of intensity due to Project turbines, 8 are predicted to experience theoretical shadow flicker durations above the recommended limit of 30 hours per year within 50 m of the dwelling (host dwellings B156, B157, B158, B168, B169, B170 and non-host dwellings B066 and B166). When considering the likely reduction in shadow flicker due to cloud cover and rotor orientation, for 7 of these dwellings (host dwellings B156, B157, B158, B168, B169 and B170 and non-host dwelling B066) the predicted actual shadow flicker durations within 50 m of the dwelling are also above the recommended limit of 10 hours per year. The predicted shadow flicker durations at some of the dwellings (host dwellings B156, B157, B158 and B169) significantly exceed the recommended limits.

Note that when considering the shadow flicker results for the hub height options individually, then the preceding shadow flicker impact conclusions are similar, except for the 130 and 150 m hub height results at non-host dwelling B066, where the predicted theoretical shadow flicker duration is below the recommended limit of 30 hours per year within 50 m of the dwelling. However the predicted actual shadow flicker duration within 50 m of the dwelling is still above the recommended limit of 10 hours per year for all hub height options.

The calculation of the predicted actual shadow flicker duration does not take into account other potential reductions due to low wind speed, vegetation, or other shielding effects around each house.

A cumulative shadow flicker assessment was also carried out for the Project considering the combined impacts of the Project turbines for a hub height of 209 m and those of the neighbouring W1WF. When considering shadow flicker at or above a moderate level of intensity, there are no dwellings where the shadow flicker impacts from both the W2WF and W1WF turbines are acting cumulatively. It is considered that the cumulative impact conclusions calculated for the 209 m hub height option are also applicable for the 130 m and 150 m hub height turbine options considered for the Project.

It is recommended that the Customer ensures the turbine blades are coated with a non-reflective paint to avoid the occurrence of blade glint from the wind farm.

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LIST OF TABLES

Table 1 Proposed turbine layout for the Project [3]

Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]	Turbine ID	Easting[1] [m]	Northing[1] [m]	Base elevation [m]
WTG_01	300601	6304533	631	WTG_11	301808	6307965	592
WTG_02	301110	6304423	599	WTG_12	301706	6308323	589
WTG_03	300948	6305289	640	WTG_13	301963	6309128	587
WTG_04	301368	6305191	607	WTG_14	302642	6309226	605
WTG_05	301217	6305703	612	WTG_15	302566	6309971	594
WTG_06	301637	6306411	607	WTG_16	303247	6309846	570
WTG_07	301350	6306718	611	WTG_17	302066	6310366	553
WTG_08	301812	6307162	590	WTG_18	302354	6310896	540
WTG_09	300976	6307614	550	WTG_19	301494	6304580	585
WTG_10	302242	6307532	590	WTG_20	302150	6306779	573

1. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.

Table 2 Locations of dwellings considered in this assessment [4]

Dwelling ID[1]	Easting[2] [m]	Northing[2] [m]	Dwelling status	Nearest turbine	
				Distance [m][3]	Turbine ID
B002	298152	6305013	Non-host	2496	WTG_01
B066	303107	6305041	Non-host	1677	WTG_19
B067	303882	6307932	Non-host	1688	WTG_10
B156	*303050*	*6306601*	*Host*	*917*	*WTG_20*
B157	*302587*	*6305340*	*Host*	*1228*	*WTG_04*
B158	*302427*	*6304726*	*Host*	*945*	*WTG_19*
B166	302947	6303641	Non-host	1730	WTG_19
B168	*299941*	*6306602*	*Host*	*1414*	*WTG_07*
B169	*303148*	*6306972*	*Host*	*1017*	*WTG_20*
B170	*302786*	*6304063*	*Host*	*1391*	*WTG_19*
B171	*299314*	*6305454*	*Host*	*1583*	*WTG_01*

1. Host dwellings are indicated by *underlined italic text*.
2. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
3. The shadow flicker assessment has considered dwellings up to a maximum distance of 15D + 50 m from the Project wind turbines.

Table 3 Shadow flicker model settings for theoretical shadow flicker calculation

Model setting	
Shadow distance limit (10D)	1820 m
Year of calculation	2037
Minimum elevation of the sun	3°
Time step	1 min (5 min for map)
Rotor modelled as	Sphere (disc for turbine orientation reduction calculation)
Sun modelled as	Disc
Offset between rotor and tower	None
Receptor height (single storey)	2 m
Receptor height (double storey)	6 m
Locations used for determining maximum shadow flicker within 50 m of each dwelling	8 points evenly spaced (every 45°) on 25 m and 50 m radius circles centred on the provided dwelling location

Table 4 Theoretical and predicted actual annual shadow flicker duration for 130 m hub height option for Project

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Dwelling status	Contributing turbines[2]	Theoretical annual: At dwelling [hr/yr] 2 m	Theoretical annual: At dwelling [hr/yr] 6 m	Theoretical annual: Max within 50 m [hr/yr] 2 m	Theoretical annual: Max within 50 m [hr/yr] 6 m	Predicted actual annual[3]: At dwelling [hr/yr] 2 m	Predicted actual annual[3]: At dwelling [hr/yr] 6 m	Predicted actual annual[3]: Max within 50 m [hr/yr] 2 m	Predicted actual annual[3]: Max within 50 m [hr/yr] 6 m
B002[4]	298152	6305013	Non-host	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B066	303107	6305041	Non-host	WTG_04 WTG_19	25.1	24.7	27.5	26.9	9.3	9.1	10.2	10.0
B067	303882	6307932	Non-host	WTG_10	13.9	13.6	15.4	15.2	5.2	5.1	5.8	5.7
B156	303050	6306601	Host	WTG_06 WTG_07 WTG_08 WTG_20	93.7	93.4	106.2	105.8	31.0	30.8	34.1	33.9
B157	302587	6305340	Host	WTG_03 WTG_04 WTG_05	50.4	50.5	54.6	54.7	18.1	18.1	19.7	19.7
B158	302427	6304726	Host	WTG_01 WTG_02 WTG_03 WTG_04 WTG_19	88.4	88.1	102.4	102.1	31.5	31.3	36.9	36.7
B166	302947	6303641	Non-host	WTG_19	16.5	15.8	24.2	23.5	4.0	3.8	6.6	6.4
B168	299941	6306602	Host	WTG_06 WTG_07	29.3	29.5	31.2	31.3	10.7	10.7	11.3	11.4
B169	303148	6306972	Host	WTG_06 WTG_07 WTG_08 WTG_10 WTG_11 WTG_20	144.5	142.6	167.9	166.6	48.0	47.5	57.0	56.5
B170	302786	6304063	Host	WTG_02 WTG_19	33.7	33.3	37.9	37.0	10.1	9.9	11.0	10.9
B171	299314	6305454	Host	WTG_03	14.0	13.7	14.9	15.0	5.1	5.0	5.4	5.4
Recommended duration limits (hr/yr)					30	30	30	30	10	10	10	10

1. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Contributing turbines shown are for the theoretical shadow flicker calculated at 2 m above ground level.
3. Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.
4. Dwelling is not predicted to experience any shadow flicker at or above a moderate level of intensity, but may experience low-intensity shadow flicker.

Table 5 Theoretical and predicted actual annual shadow flicker duration for 150 m hub height option for Project

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Dwelling status	Contributing turbines[2]	Theoretical annual At dwelling [hr/yr] 2 m	Theoretical annual At dwelling [hr/yr] 6 m	Theoretical annual Max within 50 m [hr/yr] 2 m	Theoretical annual Max within 50 m [hr/yr] 6 m	Predicted actual annual[3] At dwelling [hr/yr] 2 m	Predicted actual annual[3] At dwelling [hr/yr] 6 m	Predicted actual annual[3] Max within 50 m [hr/yr] 2 m	Predicted actual annual[3] Max within 50 m [hr/yr] 6 m
B002[4]	298152	6305013	Non-host	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B066	303107	6305041	Non-host	WTG_04 WTG_19	27.1	26.9	29.4	29.1	10.1	10.0	10.9	10.8
B067	303882	6307932	Non-host	WTG_10	14.7	14.7	16.2	16.1	5.6	5.5	6.1	6.1
B156	303050	6306601	Host	WTG_06 WTG_07 WTG_08 WTG_20	93.2	93.3	103.8	104.6	31.0	31.0	33.8	33.9
B157	302587	6305340	Host	WTG_03 WTG_04 WTG_05	50.3	50.5	54.7	54.7	18.1	18.1	19.7	19.7
B158	302427	6304726	Host	WTG_01 WTG_02 WTG_03 WTG_04 WTG_19	88.6	88.3	103.8	103.1	31.7	31.6	37.4	37.3
B166	302947	6303641	Non-host	WTG_19	19.6	18.9	27.3	26.9	5.0	4.8	7.5	7.3
B168	299941	6306602	Host	WTG_06 WTG_07	29.3	29.4	31.2	31.3	10.7	10.7	11.4	11.4
B169	303148	6306972	Host	WTG_06 WTG_07 WTG_08 WTG_10 WTG_11 WTG_20	150.2	149.0	169.9	169.8	49.6	49.3	57.9	57.8
B170	302786	6304063	Host	WTG_02 WTG_19	35.2	35.3	39.2	39.1	10.6	10.6	11.4	11.5
B171	299314	6305454	Host	WTG_03	14.0	13.9	15.0	15.0	5.1	5.1	5.5	5.5
Recommended duration limits (hr/yr)					30	30	30	30	10	10	10	10

1. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Contributing turbines shown are for the theoretical shadow flicker calculated at 2 m above ground level.
3. Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.
4. Dwelling is not predicted to experience any shadow flicker at or above a moderate level of intensity, but may experience low-intensity shadow flicker.

Table 6 Theoretical and predicted actual annual shadow flicker duration for 209 m hub height option for Project

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Dwelling status	Contributing turbines[2]	Theoretical annual At dwelling [hr/yr]		Theoretical annual Max within 50 m [hr/yr]		Predicted actual annual[3] At dwelling [hr/yr]		Predicted actual annual[3] Max within 50 m [hr/yr]	
					2 m	6 m	2 m	6 m	2 m	6 m	2 m	6 m
B002[4]	298152	6305013	Non-host	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B066	303107	6305041	Non-host	WTG_04 WTG_19	28.2	28.4	31.2	31.2	10.5	10.5	11.6	11.6
B067	303882	6307932	Non-host	WTG_10	15.4	15.4	17.1	17.0	5.8	5.8	6.5	6.4
B156	303050	6306601	Host	WTG_06 WTG_07 WTG_08 WTG_20	89.9	90.3	98.4	99.0	30.2	30.3	32.8	32.9
B157	302587	6305340	Host	WTG_03 WTG_04 WTG_05	50.7	50.6	55.1	54.9	18.2	18.2	20.0	19.9
B158	302427	6304726	Host	WTG_01 WTG_02 WTG_03 WTG_04 WTG_05 WTG_19	99.0	97.5	122.4	120.9	33.9	33.6	42.7	42.1
B166	302947	6303641	Non-host	WTG_19	26.9	26.6	32.1	31.7	7.4	7.2	8.8	8.7
B168	299941	6306602	Host	WTG_06 WTG_07 WTG_09	29.4	29.4	33.5	32.1	10.6	10.6	11.3	11.3
B169	303148	6306972	Host	WTG_06 WTG_07 WTG_08 WTG_10 WTG_11 WTG_20	157.2	156.7	172.4	171.6	52.6	52.4	58.9	58.7
B170	302786	6304063	Host	WTG_02 WTG_04 WTG_19	33.5	33.7	39.0	38.4	10.3	10.3	11.3	11.2
B171	299314	6305454	Host	WTG_03	14.2	14.3	15.5	15.3	5.2	5.2	5.6	5.6
Recommended duration limits (hr/yr)					30	30	30	30	10	10	10	10

1. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Contributing turbines shown are for the theoretical shadow flicker calculated at 2 m above ground level.
3. Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.
4. Dwelling is not predicted to experience any shadow flicker at or above a moderate level of intensity, but may experience low-intensity shadow flicker.

Table 7 Maximum Theoretical and predicted actual annual shadow flicker duration for all hub height options considered for Project

Dwelling ID	Easting[1] [m]	Northing[1] [m]	Dwelling status	Contributing turbines[2]	Theoretical annual At dwelling [hr/yr]		Theoretical annual Max within 50 m [hr/yr]		Predicted actual annual[3] At dwelling [hr/yr]		Predicted actual annual[3] Max within 50 m [hr/yr]	
					2 m	6 m	2 m	6 m	2 m	6 m	2 m	6 m
B002[4]	298152	6305013	Non-host	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B066	303107	6305041	Non-host	WTG_04 WTG_19	28.2	28.4	31.2	31.2	10.5	10.5	11.6	11.6
B067	303882	6307932	Non-host	WTG_10	15.4	15.4	17.1	17.0	5.8	5.8	6.5	6.4
B156	303050	6306601	Host	WTG_06 WTG_07 WTG_08 WTG_20	93.7	93.4	106.2	105.8	31.0	31.0	34.1	33.9
B157	302587	6305340	Host	WTG_03 WTG_04 WTG_05	50.7	50.6	55.1	54.9	18.2	18.2	20.0	19.9
B158	302427	6304726	Host	WTG_01 WTG_02 WTG_03 WTG_04 WTG_05 WTG_19	99.0	97.5	122.4	120.9	33.9	33.6	42.7	42.1
B166	302947	6303641	Non-host	WTG_19	26.9	26.6	32.1	31.7	7.4	7.2	8.8	8.7
B168	299941	6306602	Host	WTG_06 WTG_07 WTG_09	29.4	29.5	33.5	32.1	10.7	10.7	11.4	11.4
B169	303148	6306972	Host	WTG_06 WTG_07 WTG_08 WTG_10 WTG_11 WTG_20	157.2	156.7	172.4	171.6	52.6	52.4	58.9	58.7
B170	302786	6304063	Host	WTG_02 WTG_04 WTG_19	35.2	35.3	39.2	39.1	10.6	10.6	11.4	11.5
B171	299314	6305454	Host	WTG_03	14.2	14.3	15.5	15.3	5.2	5.2	5.6	5.6
Recommended duration limits (hr/yr)					30	30	30	30	10	10	10	10

1. Coordinate system: UTM zone 54 South, WGS84 datum. Coordinates were provided by the Customer in a different coordinate system and/or datum and have been converted using mapping software, which may result in small discrepancies depending on the software and transformation approach used.
2. Contributing turbines shown are for the theoretical shadow flicker calculated at 2 m above ground level.
3. Considering likely reductions in shadow flicker duration due to cloud cover and turbine orientation.
4. Dwelling is not predicted to experience any shadow flicker at or above a moderate level of intensity, but may experience low-intensity shadow flicker.

LIST OF FIGURES

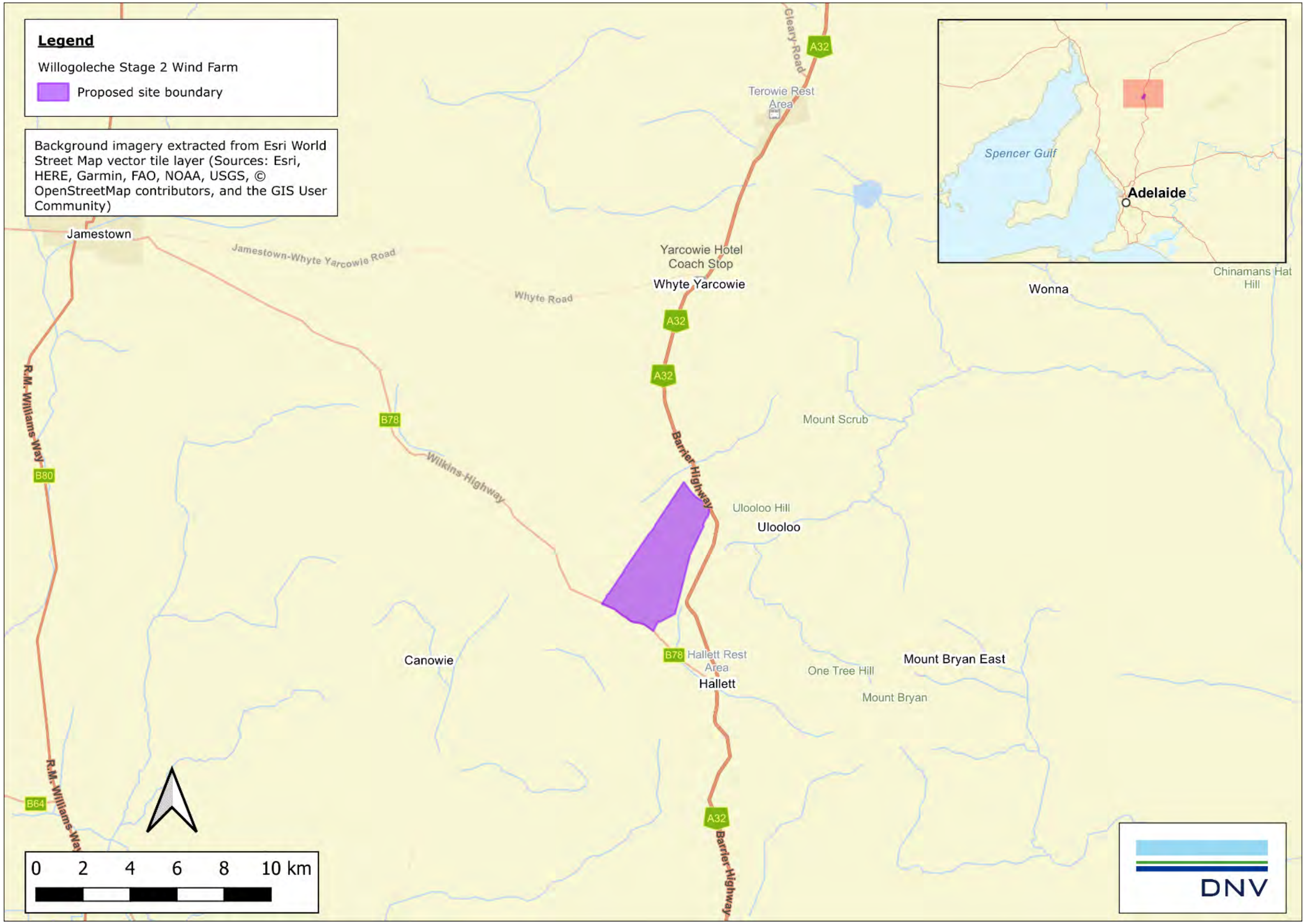


Figure 2 Location of the Project

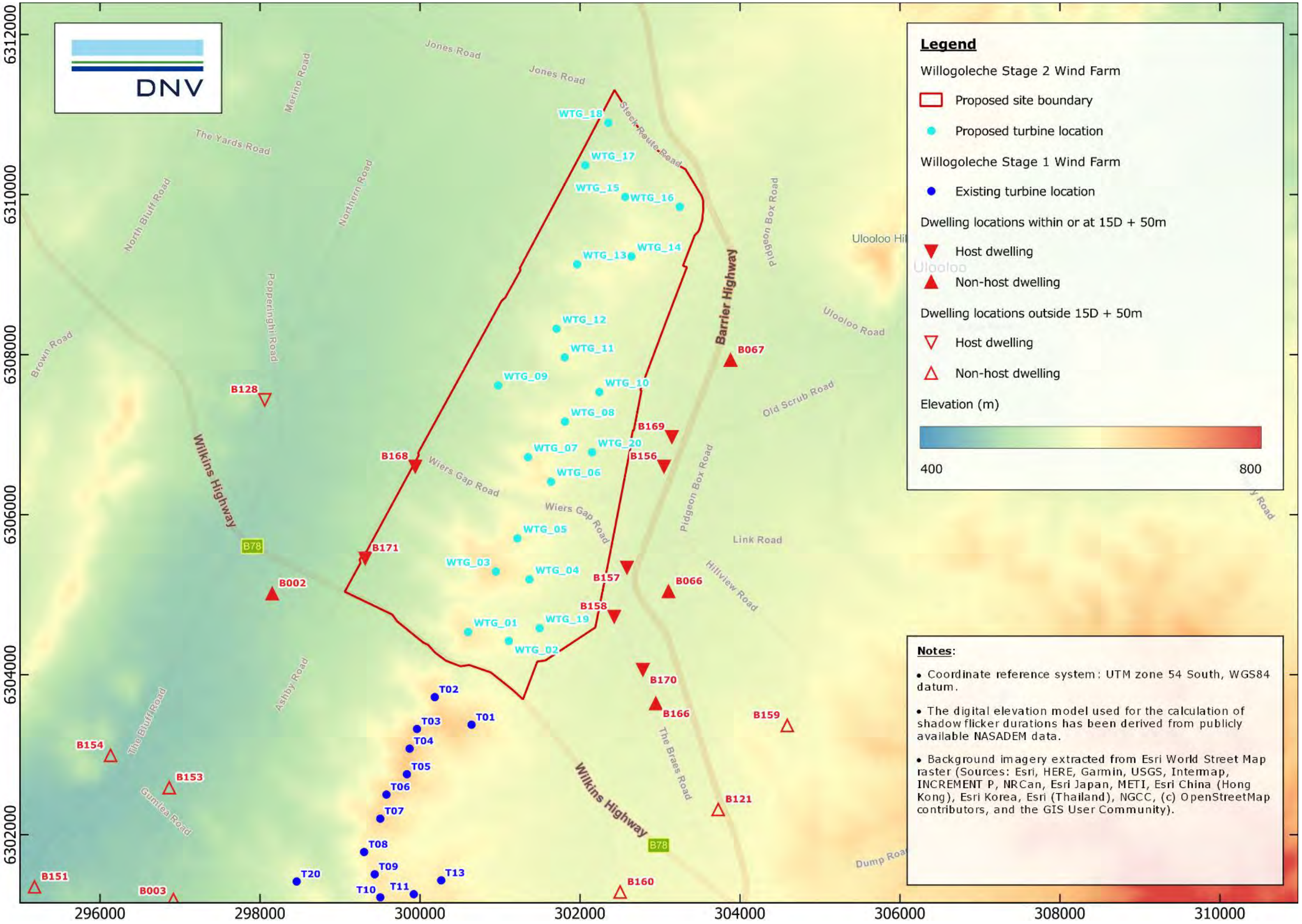


Figure 3 Map of the proposed Project, showing proposed turbine locations, nearby dwellings, and terrain elevation

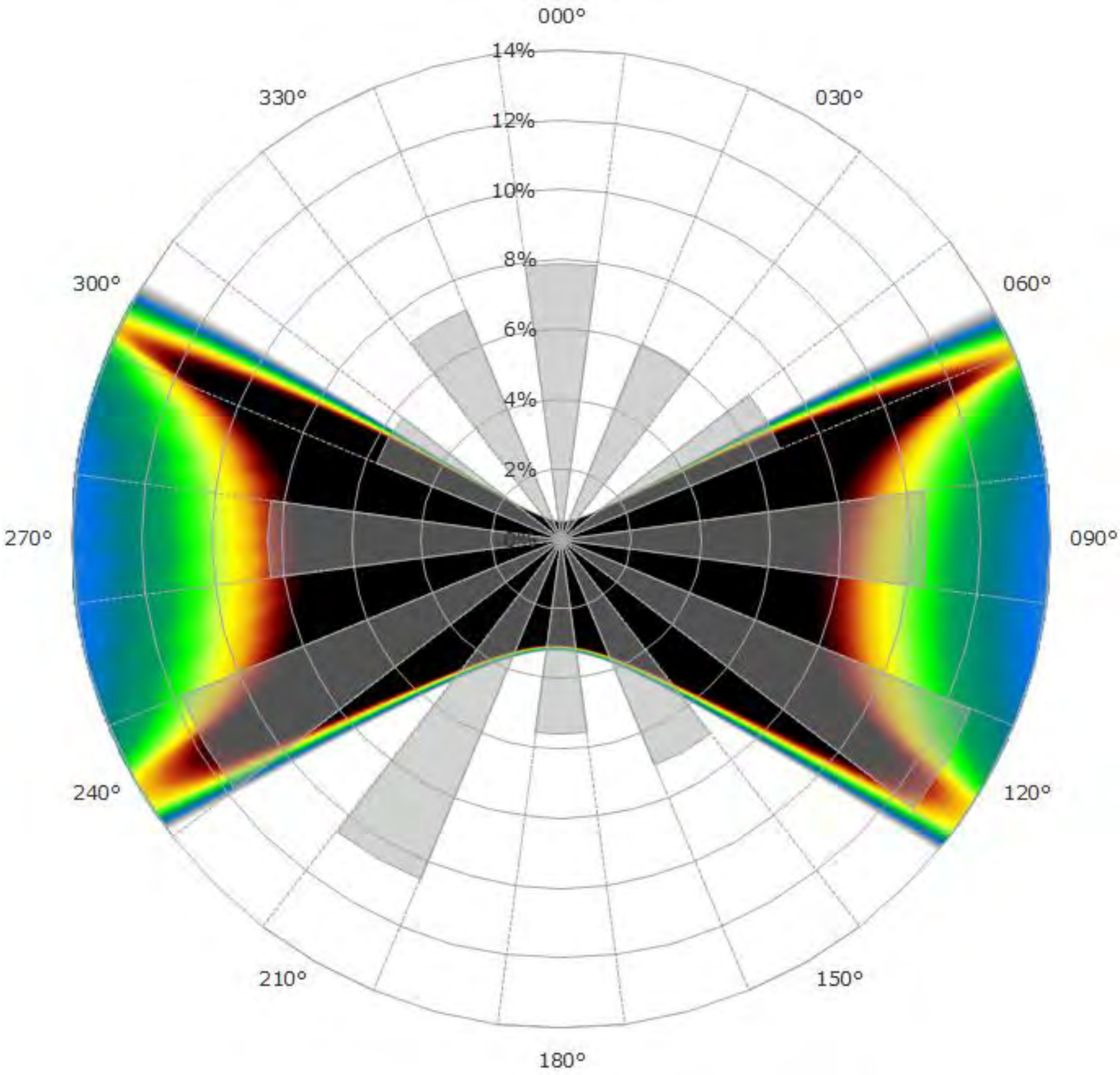


Figure 4 Indicative shadow flicker map and wind direction frequency distribution

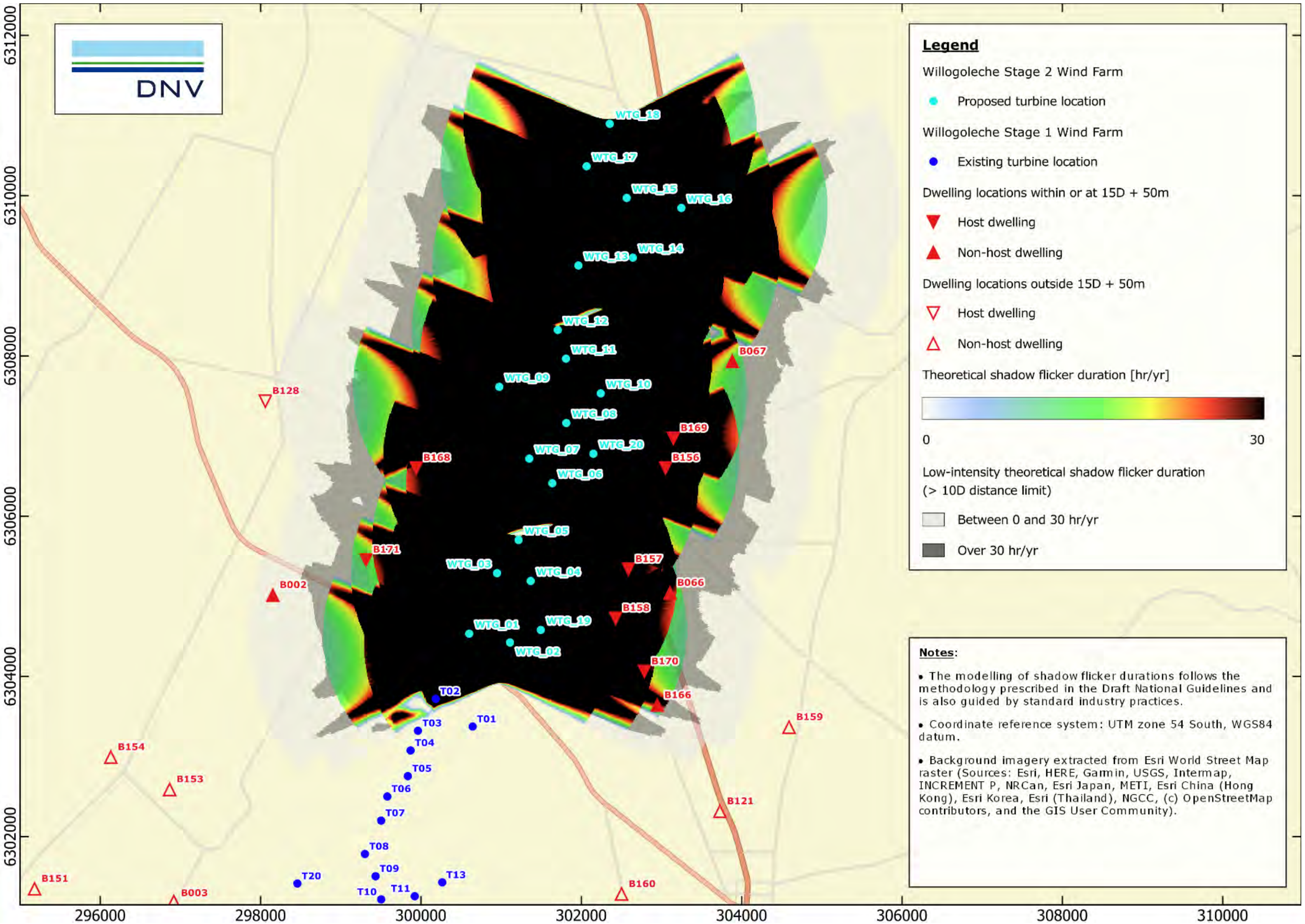


Figure 5 Theoretical annual shadow flicker duration map for the Project for a hub height of 209 m

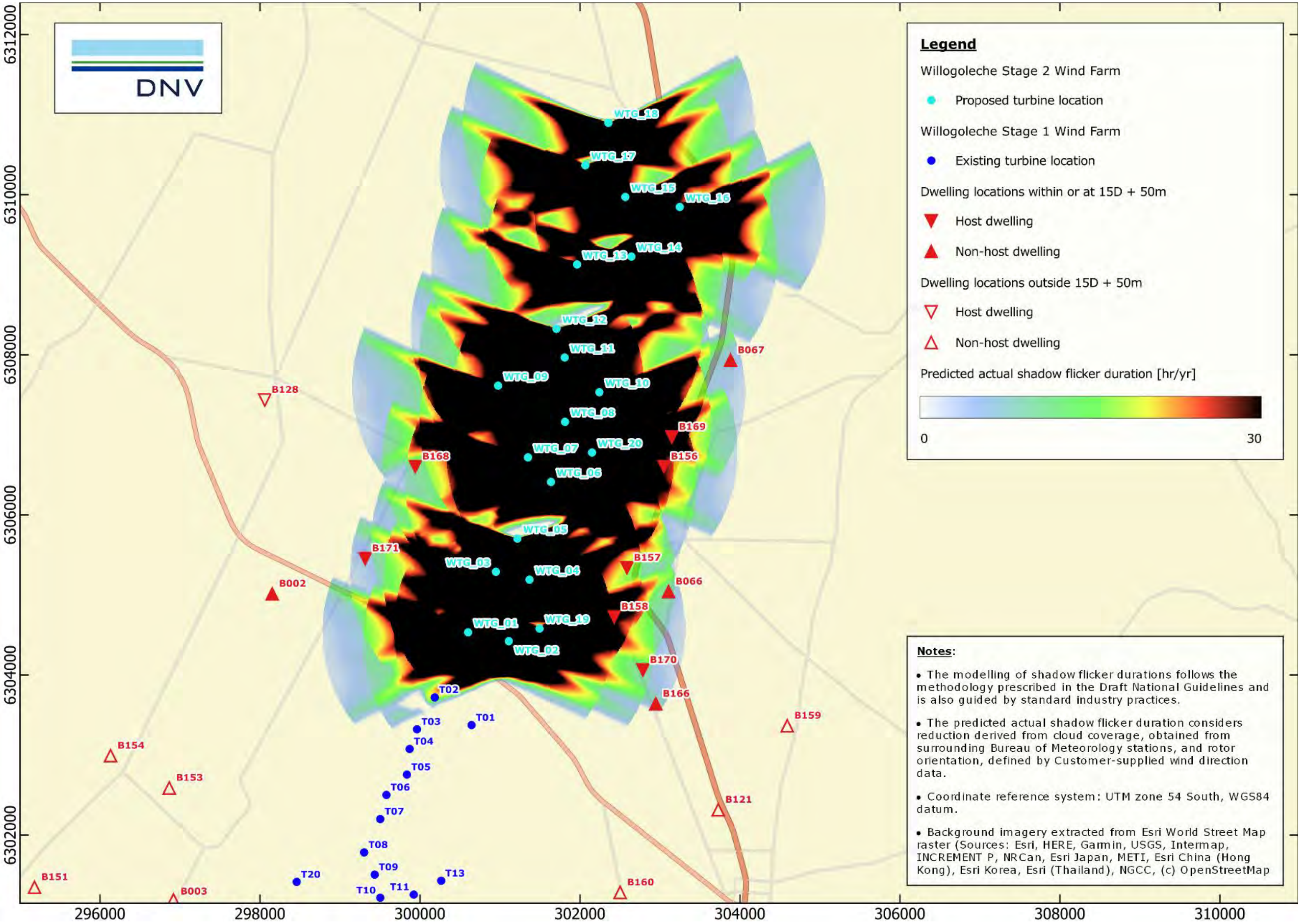


Figure 6 Predicted actual annual shadow flicker duration map for the Project for a hub height of 209 m

DNV

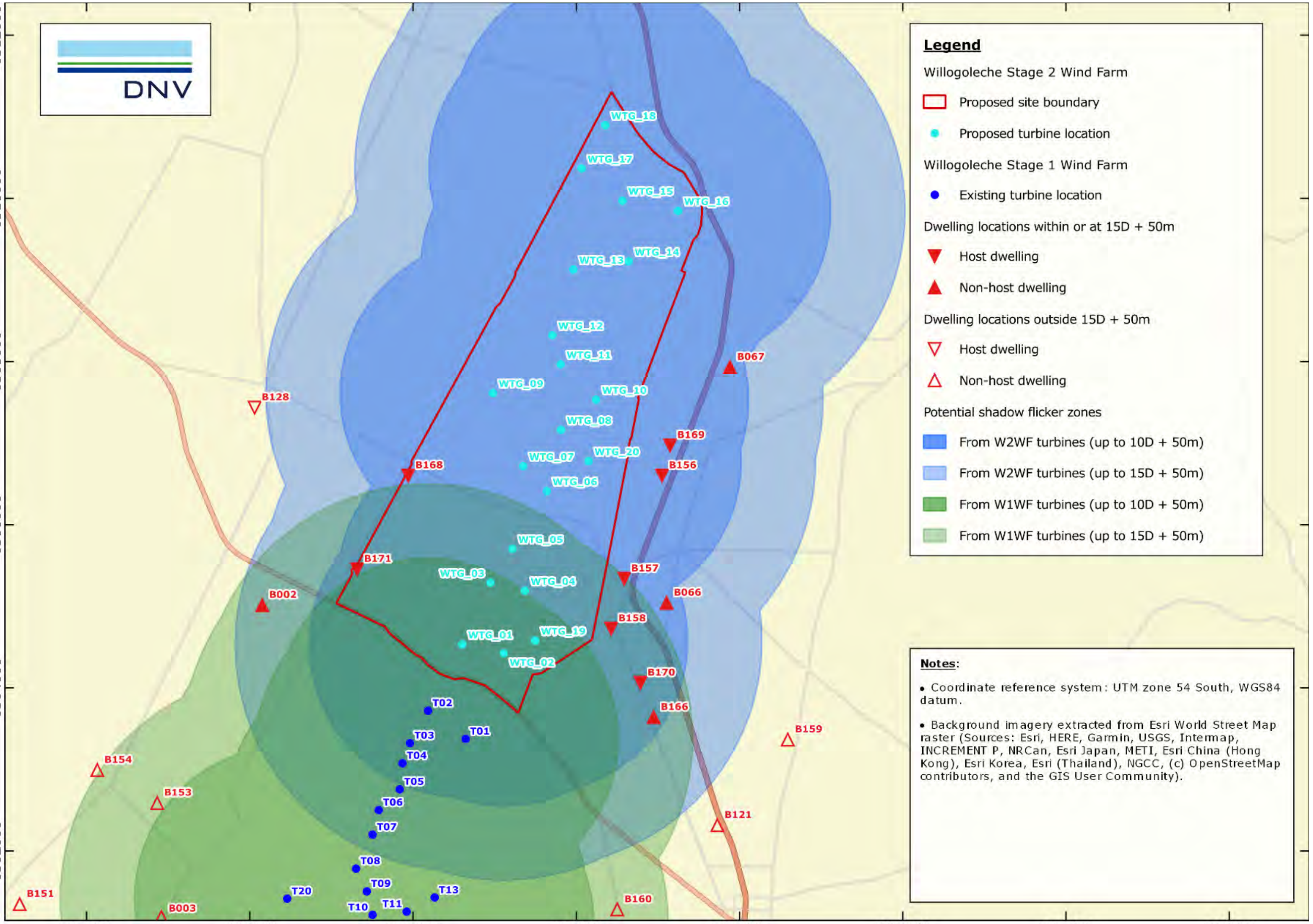


Figure 7 Potential areas for shadow flicker (cumulative impacts)

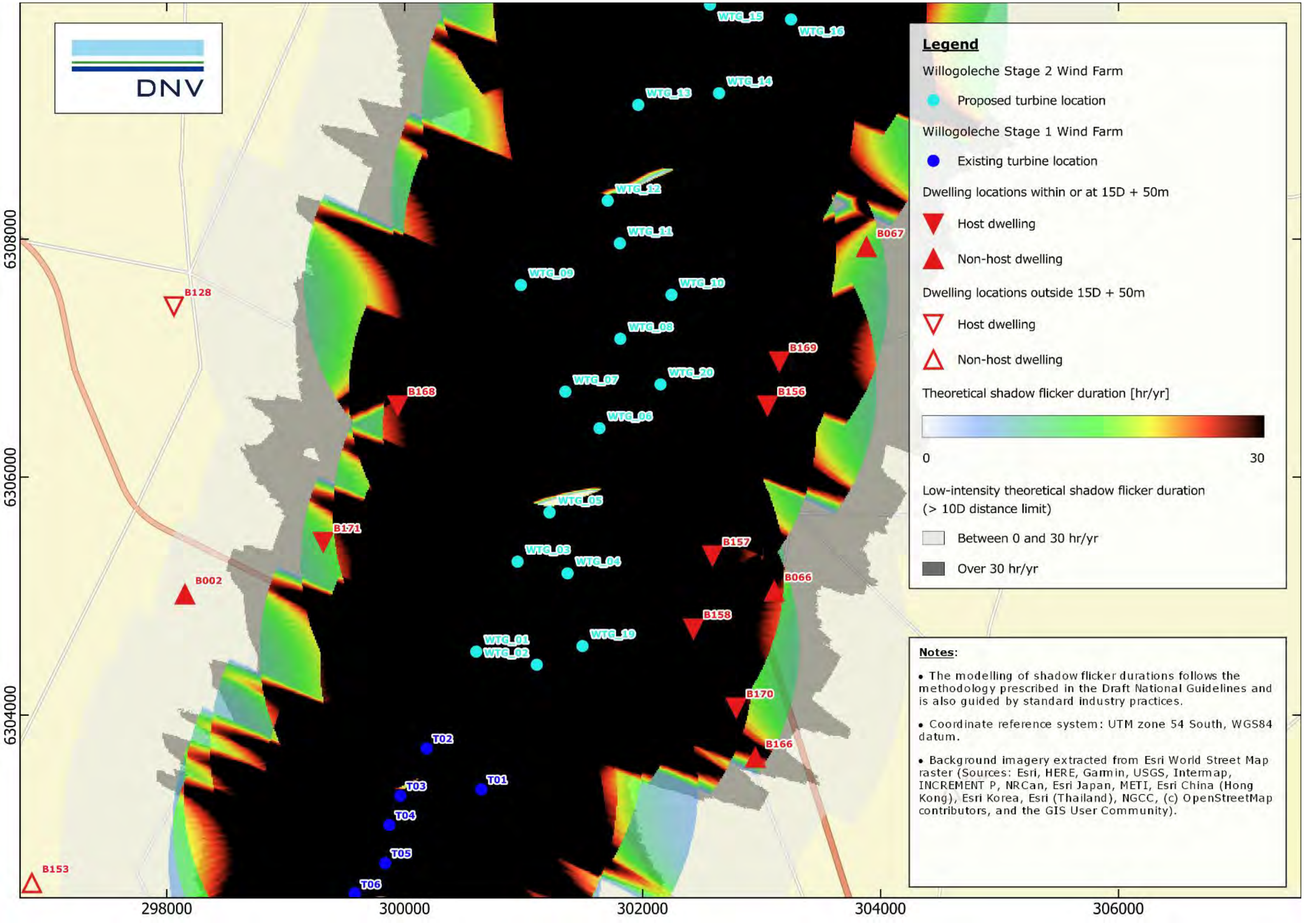


Figure 8 Theoretical annual shadow flicker duration map for the Project for a hub height of 209 m (cumulative impacts)

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimising the performance of a wind farm, analysing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

Appendix B – Photomontages

Photomontages have been prepared to illustrate the general location of the project wind turbines following construction. The photomontages have been located to illustrate views from areas close to non-host dwelling locations or to illustrate cumulative impacts where possible.

The photomontage locations were selected following a review of ZTV map, together with the site inspection to identify potential representative viewpoints. The photomontage locations were selected at a range of distances between viewpoints and wind turbines to illustrate the potential influence of distance on visibility. The photomontage locations are illustrated in **Figure 12** and photomontages presented in **Figures 13** to **24**.

Each photomontage/wireframe was generated through the following steps:

- A digital terrain model (DTM) of the project site was created from a terrain model of the surrounding area using digital contours
- The site DTM was loaded in the modelling software package
- The layout of the wind farm and 3-dimensional representation of the wind turbine was configured in the modelling software
- The wind turbine dimensions assumed are a tip height of 300m with a hub height of 209m and blade length of 91m
- The location of each viewpoint (photo location) was configured in the modelling software for sun position for each viewpoint by using the time and date of the photographs from that viewpoint
- The view from each photomontage location was then assessed in the modelling software package. This process requires accurate mapping of the terrain as modelled, with that as seen in the photographs. The photographs, taken from each photomontage location were loaded into the modelling software and the visible turbines superimposed on the photographs
- The photomontages were adjusted using Photoshop CS3 to compensate for fogging due to haze or distance, as well as screening by vegetation or obstacles and
- The final image was converted to JPG format and imported and annotated as the final figure.

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

The horizontal and vertical field of view within most of the photomontages exceeds the parameters of normal human vision. However, the eyes, head and body can all move and under normal conditions a person would sample a broad area of landscape within a panorama view. The photomontages have been prepared as extended panorama for broader visual context and detailed (around 40 degree) single photo frame photomontages to provide greater detail.

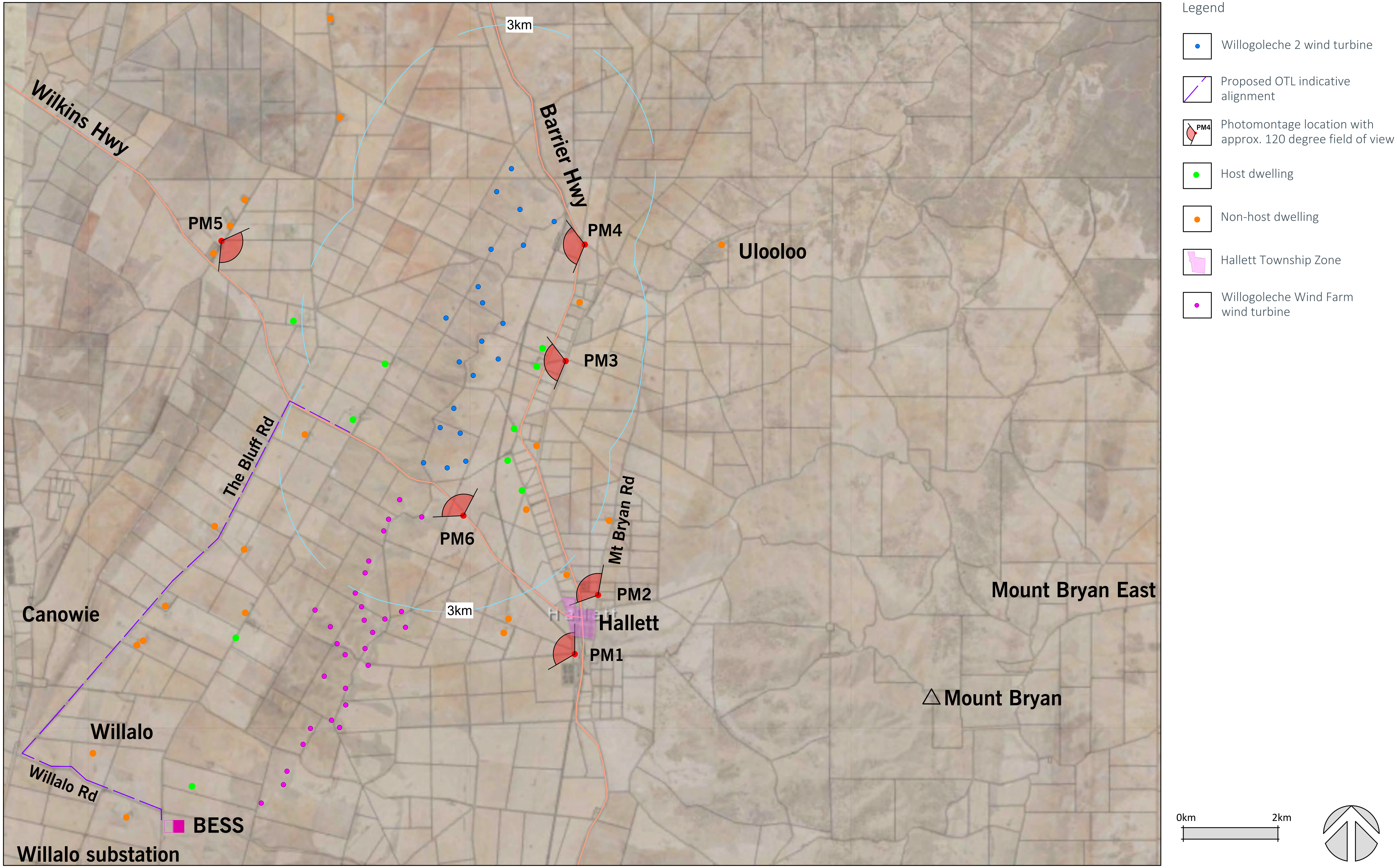


Figure 12
Photomontage locations

250° 260° 270° 280° 290° 300° 310° 320° 330° 340° 350° 360°

WSW W WNW NW NNW N

Panorama photo PM1 - Existing 120 degree field of view south west to north north west from The Government Silos Road.

Photomontage PM1 - Proposed 120 degree field of view south west to north north west from The Government Silos Road. Approximate distance to closest wind turbine 4.7km

General notes:
Coordinates:
Easting 303896, Northing 6300622

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:9.56am

Original Page Format - A4 Landscape

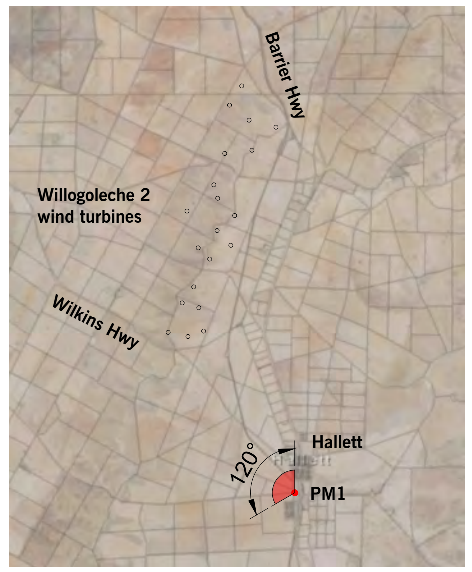
Photomontage PM1 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

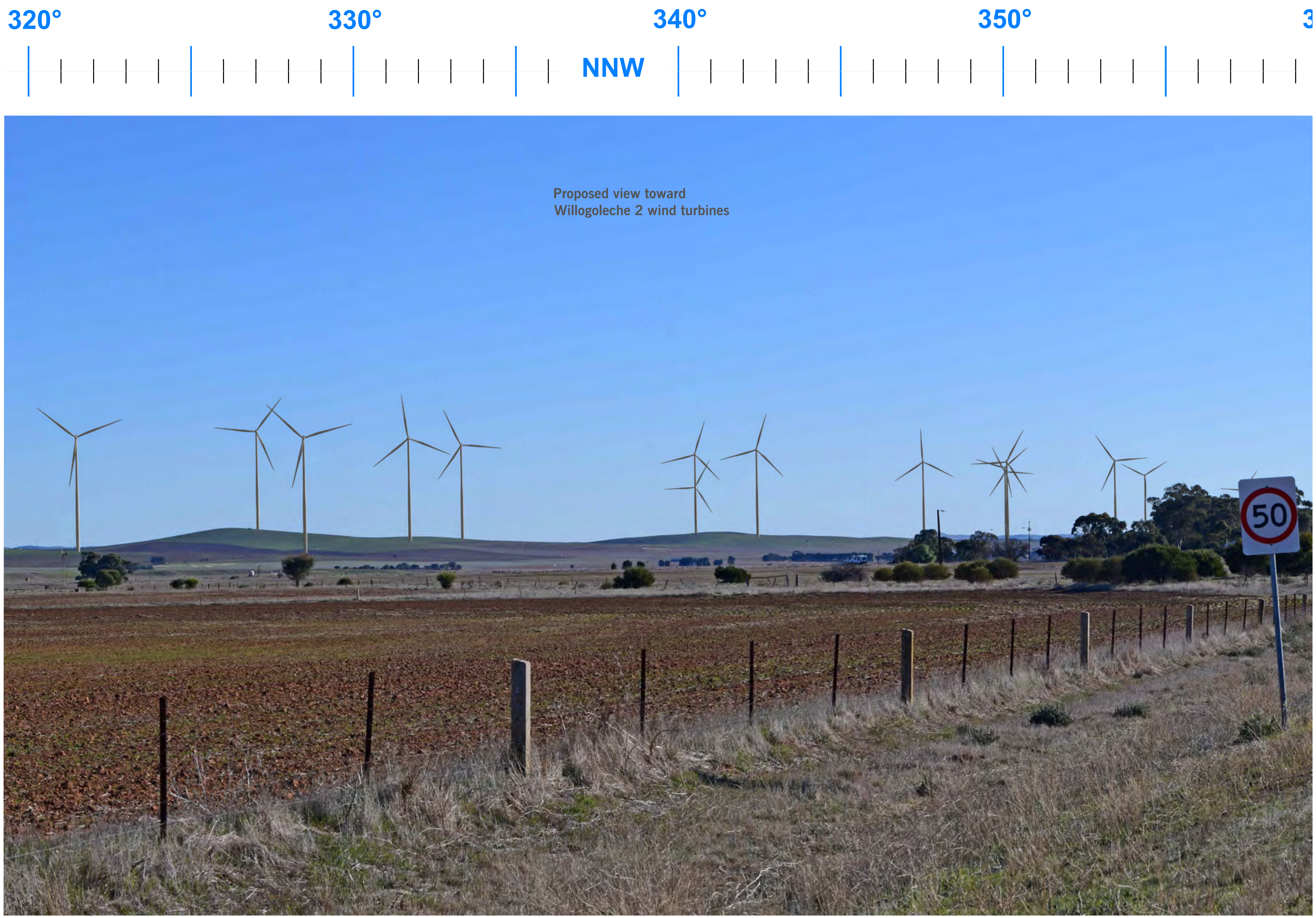
The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 13
Photomontage PM1 from The Government Silos Road



Photomontage PM1 - Proposed 40 degree field of view south west to north north west from The Government Silos Road. Approximate distance to closest wind turbine 4.7km

General notes:
Coordinates:
Easting 303896, Northing 6300622

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:9.56am

Original Page Format - A4 Landscape

Photomontage PM1 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

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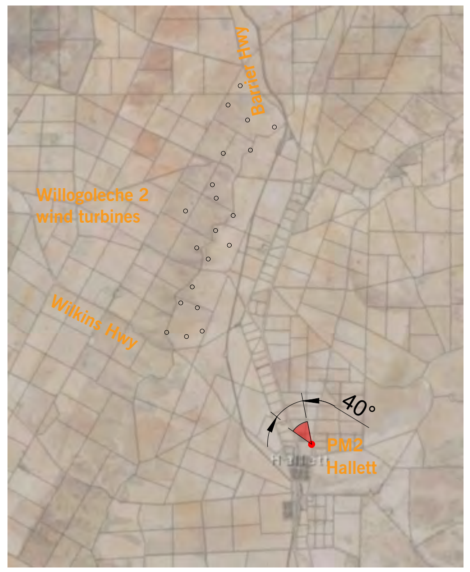
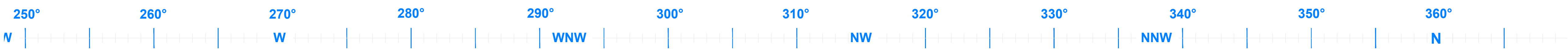


Indicative photo location and direction

Figure 14
Photomontage PM1 Government Silo Road
Willogoleche 2 Wind Farm : Landscape Character and Visual Impact Assessment

GBD
Landscape architecture



Panorama photo PM2 - Existing 120 degree field of view south west to north north west from Mount Bryan East Road.

Photomontage PM2 - Proposed 120 degree field of view south west to north north west from Mount Bryan East Road. Approximate distance to closest wind turbine 4.2km

General notes:

Coordinates:
Easting 304399, Northing 6301464

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.25am

Original Page Format - A4 Landscape

Photomontage PM2 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design

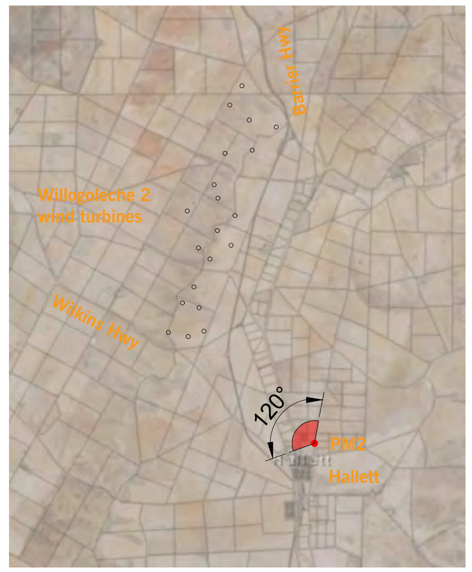
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

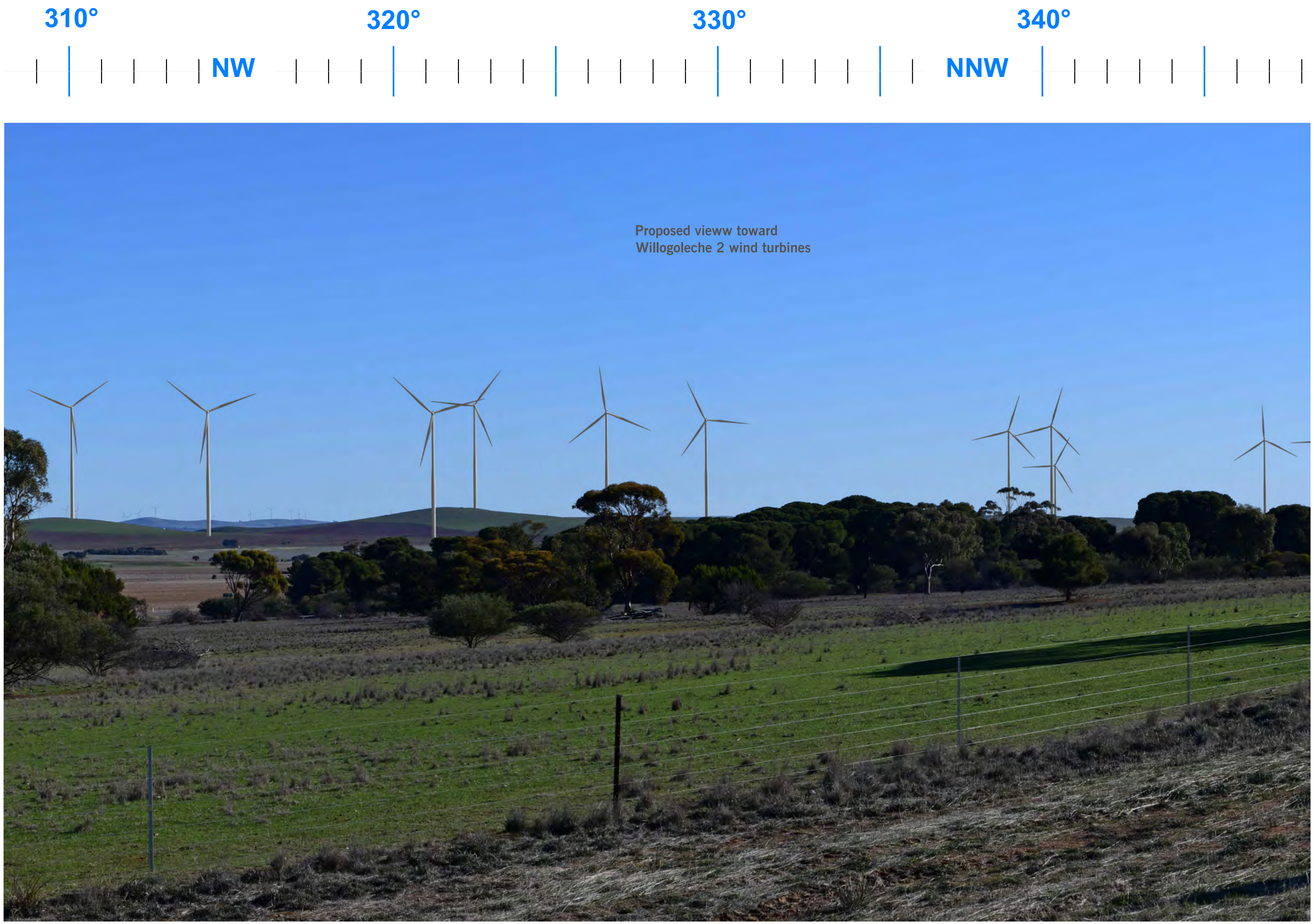
The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 15
Photomontage PM2 from Mount Bryan East Road



Photomontage PM2 - Proposed 40 degree field of view south west to north north west from Mount Bryan East Road. Approximate distance to closest wind turbine 4.2km

General notes:
Coordinates:
Easting 304399, Northing 6301464

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.25am

Original Page Format - A4 Landscape

Photomontage PM2 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.

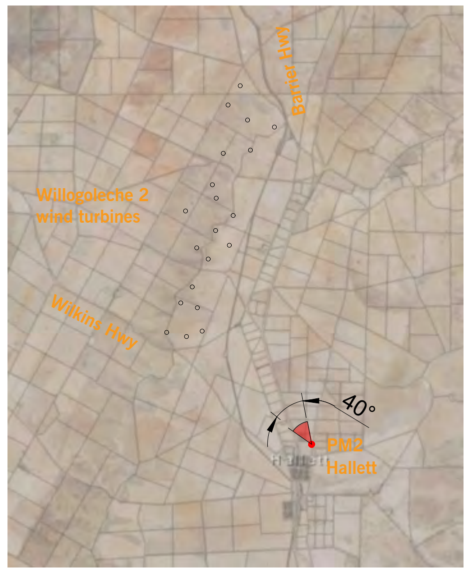


Photo location plan

GBD
Landscape architecture

Panorama photo PM3 - Existing 120 degree field of view south west to north north west from Pigeon Box Road.

Photomontage PM3 - Proposed 120 degree field of view south west to north north west from Pigeon Box Road. Approximate distance to closest wind turbine 1.4km

General notes:

Coordinates:
Easting 303550, Northing 6306734

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.41am

Original Page Format - A3 Landscape

Photomontage PM3 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design

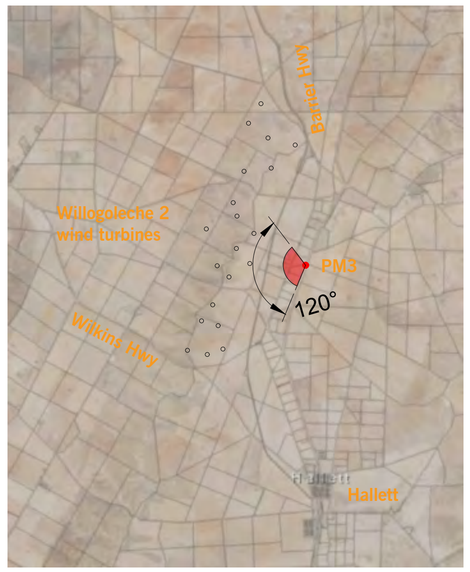
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 17
Photomontage PM3 from Pigeon Box Road

Photomontage PM3 - Proposed 40 degree field of view south west to north north west from Pigeon Box Road. Approximate distance to closest wind turbine 1.4km

General notes:
Coordinates:
Easting 303550, Northing 6306734

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.41am

Original Page Format - A3 Landscape

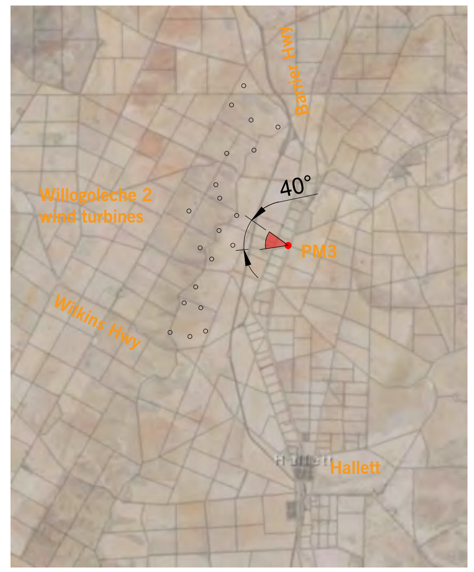
Photomontage PM3 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 18
Photomontage PM3 Pigeon Box Road
Willogoleche 2 Wind Farm : Landscape Character and Visual Impact Assessment

GBD
Landscape architecture

200° SSW 210° 220° SW 230° 240° WSW 250° 260° 270° W 280° 290° WNW 300° 310° NW 320°

Panorama photo PM4 - Existing 120 degree field of view south west to north north west from Uooloo Road (across Barrier Highway).

Panorama photo PM4 - Existing 120 degree field of view south west to north north west from Uooloo Road (across Barrier Highway). Approximate distance to closest wind turbine 885m

General notes:

Coordinates:
Easting 303928, Northing 6309278

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.58am

Original Page Format - A3 Landscape

Photomontage PM4 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design

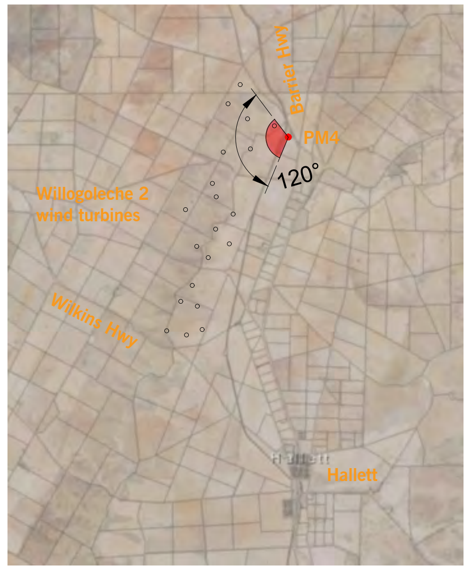
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

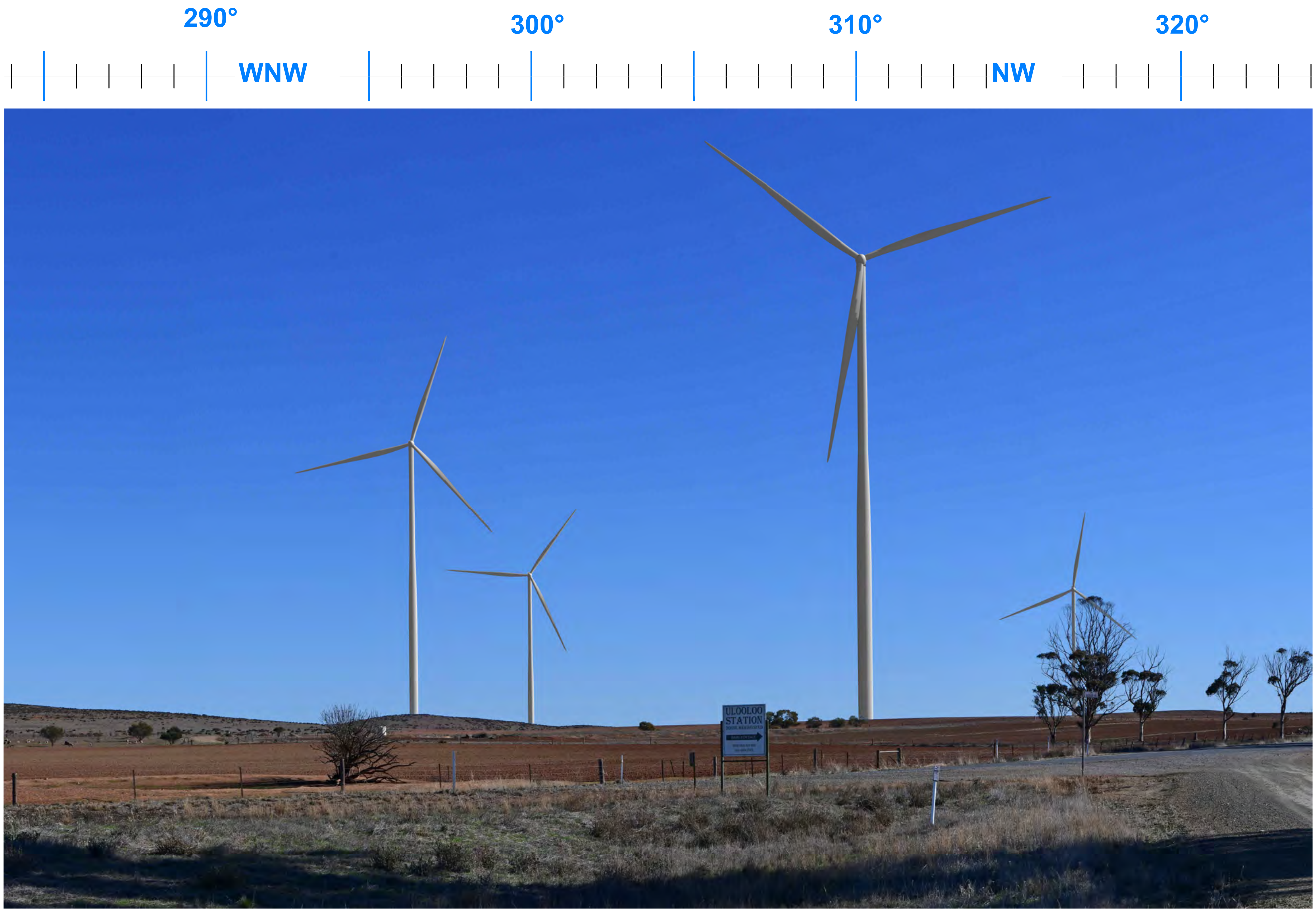
The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 19
Photomontage PM4 from Uooloo Road



Photomontage PM4 - Proposed 40 degree field of view south west to north north west from Uooloo Road (across Barrier Highway). Approximate distance to closest wind turbine 885m

General notes:

Coordinates:
Easting 303928, Northing 6309278

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:10.58am

Original Page Format - A3 Landscape

Photomontage PM4 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design

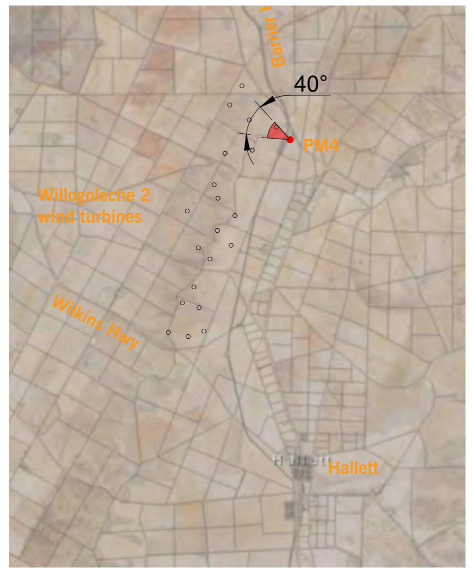
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

GBD
Landscape architecture

Photo panorama PM5 - Existing 120 degree field of view north east to south south east from North Bluff Road.

Photomontage PM5 - Proposed 120 degree field of view north east to south south east from North Bluff Road. Approximate distance to closest wind turbine 4.9km

General notes:

Coordinates:
Easting 296252, Northing 6309133

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:12.03pm

Original Page Format - A4 Landscape

Photomontage PM5 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design

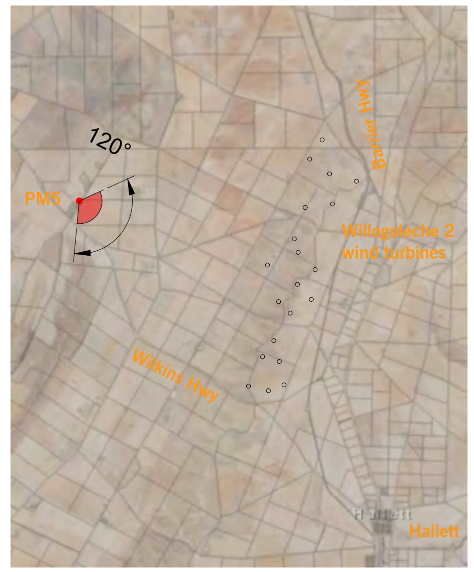
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations

A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 21
Photomontage PM5 - from North Bluff Road

Photomontage PM5 - Proposed 40 degree field of view north east to south south east from North Bluff Road. Approximate distance to closest wind turbine 4.9km

General notes:
Coordinates:
Easting 296252, Northing 6309133

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:12.03pm

Original Page Format - A4 Landscape

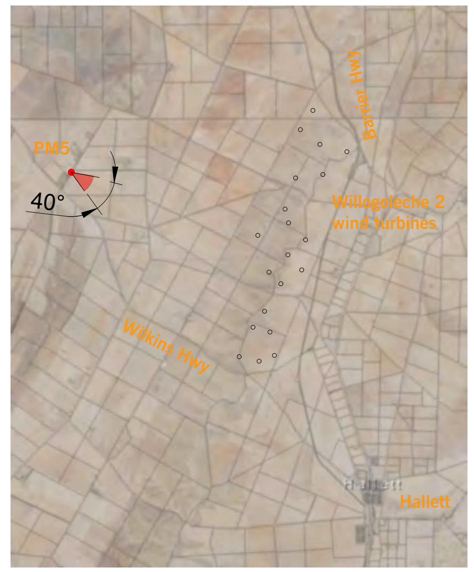
Photomontage PM5 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 22
Photomontage PM5 - from North Bluff Road

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Panorama photo PM6 - Existing 120 degree field of view north east to south south east from Wilkins Highway.

Photomontage PM6 - Proposed 120 degree field of view north east to south south east from Wilkins Highway. Approximate distance to closest wind turbine 1km

General notes:
Coordinates:
Easting 301473, Northing 6303432

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:11.48am

Original Page Format - A4 Landscape

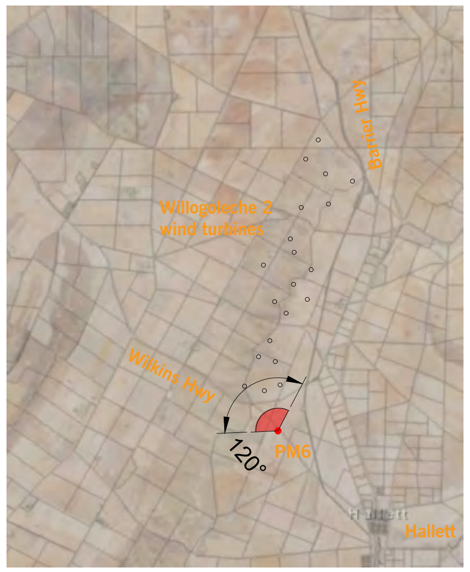
Photomontage PM6 is illustrated at a view angle of around 120 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

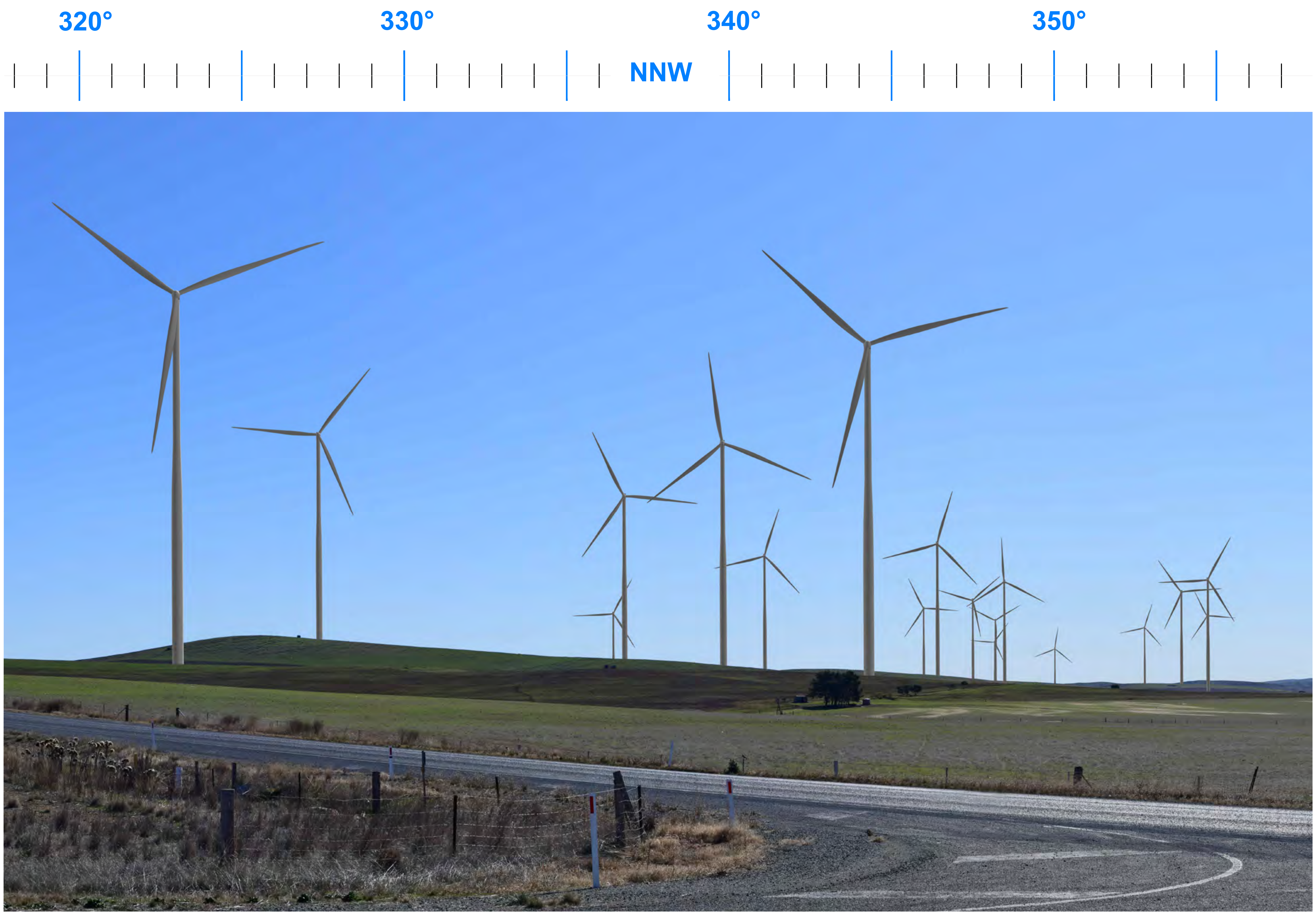
The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 23
Photomontage PM6 from Wilkins Highway (at entry road to Willogoleche 1 Wind Farm)



Photomontage PM6 - Proposed 40 degree field of view north east to south south east from Wilkins Highway. Approximate distance to closest wind turbine 1km

General notes:
Coordinates:
Easting 301473, Northing 6303432

Camera: Nikon D850 digital SLR, 50mm focal length

Date: 27 June 2024 Time:11.48am

Original Page Format - A4 Landscape

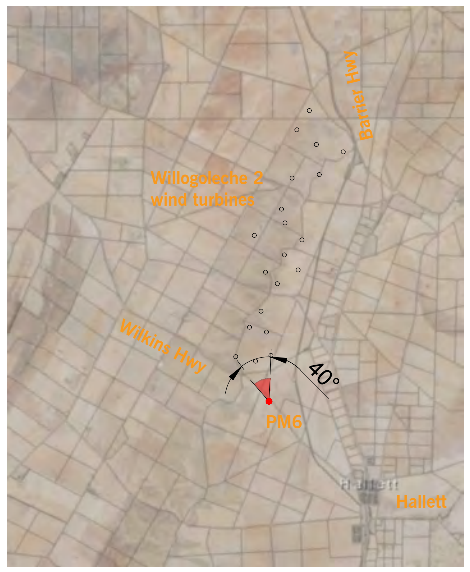
Photomontage PM6 is illustrated at a view angle of around 40 degrees which is within the central, binocular field, of human vision.

Wind turbine design
The Willogoleche 2 wind turbines illustrated in this photomontage have been modelled with a:
Hub height at 209 metres
Rotor diameter at 182 metres
Tip height at 300 metres

Photomontage limitations
A photomontage can never show exactly what the wind farm will look like in reality due to factors such as different lighting, weather and seasonal conditions which vary through time and the resolution of the image. Also a static image cannot convey turbine movement.

The images provided give a reasonable impression of the scale of the turbines and the distance to the turbines, but can never be 100% accurate.

The viewpoints illustrated are representative of views in this location, but cannot represent visibility at all locations.



Indicative photo location and direction

Figure 24
Photomontage PM6 from Wilkins Highway (at entry road to Willogoleche 1 Wind Farm)

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Appendix C - Qualifications and experience

This VIA has been prepared by Andrew Homewood, Director and Principal Landscape Architect of Green Bean Design (GBD) Pty Ltd (ABN 866 035 75702). Andrew has held this position for the past 18 years. Andrew holds post graduate, graduate and tertiary qualifications:

- Graduate Diploma Landscape Management (Sheffield University 1995)
- Bachelor Science (Dual Honours) Landscape Design and Archaeology (Sheffield University 1991-1994)
- National Diploma Amenity Horticulture (Writtle University College 1986-1989)

Andrew is a Registered Landscape Architect (membership #001245) and a member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand. Andrew has been directly employed or engaged in landscape related work/studies for the past 37 years in the United Kingdom and Australia.

Andrew has prepared numerous landscape and visual impact assessments across a range of state significant developments including renewable energy, mining, electricity transmission, waste management and transport. GBD has been commissioned to undertake VIA for over 60 wind farm projects across Australia. Our South Australian and Victorian wind farm project experience includes:

- Goyder North Wind Farm, SA
- Goyder South Renewable Energy Facility, SA
- Crystal Brook Wind Farm, SA
- Woolsthorpe Wind Farm Amendment, VIC
- Mumblin Wind Farm, VIC
- Brewster Wind Farm, VIC
- Kentbruck Green Energy Hub (referral), VIC
- Berrybank Wind Farm (micro siting review), VIC
- Hawkesdale Wind Farm amendments, VIC
- Ryan Corner Wind Farm amendments, VIC
- Jung and Wimmera Plains Wind Farm, VIC
- Alberton Wind Farm, VIC
- Moorabool Wind Farm (offsite landscape mitigation plan), VIC
- Kiata Wind Farm, VIC
- Murra Warra Wind Farm, VIC
- Ararat Wind Farm (terminal substation assessment), VIC
- Willatook Wind Farm, VIC

Professional History	Green Bean Design, Director/Principal Landscape Architect 2006 – to date
	URS Australia Pty Ltd, Practice Leader Landscape Architecture 2005 – 2006
	URS Australia Pty Ltd, Associate Landscape Architect 2003-2005
	URS Australia Pty Ltd, Senior Landscape Architect, 2002 – 2003
	URS Australia Pty Ltd, Landscape Planner, 2001-2002
	URS, Contract Landscape Architect, 2000-2001
	Blacktown City Council, Contract Landscape Planner, 2000-2001
	Knox & Partners Pty Ltd, Landscape Architect, 1996-2000
Relocated from United Kingdom to Australia 1996	Brown & Associates, Landscape Architect, 1995-1996
	University of Sheffield post graduate studies 1995-1996
	Philip Parker & Associates, Graduate Landscape Architect, 1994-1995
	University of Sheffield undergraduate studies 1991-1994
	Rendel & Branch, Landscape Assistant, 1989-1991
	Writtle University College, tertiary studies 1988-1989
	National Trust, Horticulturalist, 1987-1988
	Writtle University College, tertiary studies 1986-1987
	English Nature, Species Protection Warden, 1985-1986
	Essex Wildlife Trust, Botanist, 1984-1985
	Royal Society for the Protection of Birds, Voluntary Warden, 1983-1984

Limitations

This VIA has been prepared in accordance with the usual care and thoroughness of the consulting profession for the use of ENGIE. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the GBD Proposal April 2023.

The methodology adopted and sources of information used are outlined in this report. GBD has made no independent verification of this information beyond the agreed scope of works and GBD assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to GBD was false.

This VIA was completed between April 2023 and November 2025 and is based on the conditions encountered and information reviewed at the time of preparation. GBD disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

GBD

Landscape Architecture

gbdla.com.au

Green Bean Design Pty Ltd (GBD) is a highly experienced landscape architectural consultancy specialising in landscape and visual impact assessment. Established in 2006 as an independent consultancy, GBD provide professional advice to a range of commercial and government clients involved in large infrastructure project and policy development.

GBD Director Andrew Homewood is a Registered Landscape Architect, member of the Australian Institute of Landscape Architects and the Environmental Institute of Australia and New Zealand. Andrew has over 30 years' continuous employment in landscape consultancy and has completed numerous landscape and visual impact assessments for a range of state significant developments including wind energy, solar, mining, industrial and transport developments.

GBD has been commissioned for large scale renewable energy projects across New South Wales, Victoria, South Australia, Queensland and Tasmania.

GBD have prepared Expert Witness Statements and been engaged as a peer reviewer of renewable energy landscape and visual impact assessments in Victoria and New South Wales.

CONTACT

Green Bean Design Pty Ltd
Andrew Homewood
0430 599 995

gbdla.com.au

PO Box 3178 Austral NSW 2179